Hort Innovation

Final Report

Economic impact assessment for Hort Frontiers: An evaluation of *Developing a national systems approach for meeting biosecurity requirements to access key Asian markets* (AM17001)

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Delivery partner:

AgEconPlus

Project code:

HA20000

Project:

Economic impact assessment for Hort Frontiers (HA20000)

Disclaimer:

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Hort Frontiers invests funds from a wide range of co-investors including businesses, research agencies, government departments, education institutions, the Australian Government and horticulture levies. Economic impact assessment of these investments is required to meet Hort Innovation obligations under its Organisational Evaluation Framework, its Statutory Funding Agreement, and to demonstrate a return to a diverse set of co-investors and other stakeholders.

This economic impact assessment of the Hort Frontiers program addresses these requirements through the completion of a series of project-specific, ex-post, independent impact assessments of the program. The economic impact assessment was completed using guidelines prepared by the Council of Rural Research and Development Corporations (CRRDC, 2018).

The project assessed in this impact assessment *was AM17001 Developing a National Systems Approach for Meeting Biosecurity Requirements to Access Key Asian Markets*. Investment in project AM17001 produced a range of relevant and useful data, models, tools, and other outputs that has improved design and risk assessment of systems approach protocols, improved acceptance and use of systems approaches by Australian biosecurity regulators, and contributed to Australian horticulture industries with a stronger understanding and acceptance of systems approaches to achieve improvement to existing markets or access to new markets.

Based on the conservative assumptions used in the analysis, and the fact that several economic and social impacts identified were not valued, the investment criteria reported are likely to be underestimates of the true performance of the investment in AM17001. However, project costs were relatively large and upfront while benefits, such as improved market access, are likely to be concentrated in the future, rather than the near-term. Consequently, return on investment was modest even with analysis over thirty years from the last year of project investment.

Technical summary

This report presents the results of an impact assessment of a Hort Frontiers International Markets Fund project *AM17001: Developing a National Systems Approach for Meeting Biosecurity Requirements to Access Key Asian Markets*. The project was funded by Hort Innovation over the period November 2017 to May 2022.

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 2021/22-dollar terms and were discounted to the year 2021/22 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).

Investment in project AM17001 produced a range of relevant and useful data, models, tools, and other outputs that has improved design and risk assessment of systems approach protocols, improved acceptance and use of systems approaches by Australian biosecurity regulators, and contributed to Australian horticulture industries with a stronger understanding and acceptance of systems approaches to achieve improvement to existing markets or access to new markets.

Total funding from all sources for the project was $8.37 million (present value terms). The investment produced estimated total expected net benefits of $11.38 million (present value terms). This gave a net present value of $3.01 million, an estimated benefit-cost ratio of 1.36 to 1, an internal rate of return of 2.7% and a modified internal rate of return of 6.0%.

Based on the conservative assumptions used in the analysis, the fact that several economic and social impacts identified were not valued, and that Australian exports data includes the period where exports were affected by Covid-19 trade disruptions, the investment criteria reported are likely to be underestimates of the true performance of the investment in AM17001.

Keywords

Impact assessment, Cost-Benefit Analysis, International Markets Fund, Hort Frontiers, Asian Markets, Market Access, Phytosanitary Systems Approach, Systems Approach, Pest Management System, Cherry, Citrus, Rubus, Apple

Introduction

The Hort Frontiers program facilitates collaborative cross-industry investments that are focused on high-risk, transformative research, development, and extension (RD&E) with the potential for significant impact. Investments are longer-term, complex, and focus on traditionally underinvested themes.

Hort Frontiers invests funds from a wide range of co-investors including businesses, research agencies, government departments, education institutions, the Australian Government and horticulture levies. Economic impact assessment of these investments is required to meet Hort Innovation obligations under its Organisational Evaluation Framework, its Statutory Funding Agreement, and to demonstrate a return to a diverse set of co-investors and other stakeholders.

This economic impact assessment of the Hort Frontiers program addresses these requirements through the completion of a series of project-specific, ex-post, independent impact assessments of the program. A total of eight (8) RD&E investments (projects) were selected through a stratified, random sampling process. The projects, and the total life-of-project (LOP) value of their Hort Innovation managed investment in nominal terms are described in Table 1.

Table 1: Hort Frontiers Project Sample for Impact Assessment

Hort Frontiers Fund	Project Code	Project Title	Total LOP Investment[(a)] (nominal $)
Advanced Production Systems	AS19005	Australian Protected Cropping RD&E Strategy 2030	140,322
Fruit Fly	HG14033	SITplus: Raising Qfly Sterile Insect Technique to World Standard	20,502,806
Green Cities	GC15002	Which plant where when and why database	10,573,638
Health, Nutrition & Food Safety	HN15000	Innovative Cold Plasma for Horticultural Industries	5,080,321
International Markets	AM15007	Market Development Program - Almonds	925,499
International Markets	AM17001	Developing a national systems approach for meeting bio-security requirements to access key Asian markets	4,830,614
Leadership	LP15001	Global Masterclass Horticulture	3,235,805
Pollination	PH16004	Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption	2,182,967

(a) Hort Innovation managed investment

The project population for each fund from which the random sample was selected included completed projects where a final deliverable had been submitted and accepted in the three-year period from 1 July 2019 to 30 June 2022.

The projects in the random sample were selected such that:

(1) The total LOP sample value (in nominal dollar terms) represented at least 10% of the total Hort Innovation managed investment in the overall Hort Frontiers project population, and
(2) The total Hort Innovation managed investment in each project was greater than, or equal to, $100,000 (to exclude 'trivial' projects).

Further, the random sample was stratified first by Hort Frontiers Fund, to ensure all relevant Funds were represented, and then by LOP value range.

The final stratified random sample shown in Table 1 included the required eight (8) projects. At least one project from each Hort Frontiers Fund was selected and at least one project from each LOP range (as defined by Hort Innovation). The final random sample had a total nominal LOP value of $47.47 million (Hort Managed investment) equivalent to approximately 51.6% of the overall total nominal LOP value in the population. Also, the final random sample included one project completed in 2019/20, two completed in 2020/21, and five completed in 2021/22 (all relevant years represented).

Project AM17001: *Developing a National Systems Approach for Meeting Biosecurity Requirements to Access Key Asian Markets* was one of the investments randomly selected and is analysed in this report.

Methodology

The impact assessments followed 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 assessment components that are in accord with the impact assessment guidelines of the Council of Rural Research and Development Corporations (CRRDC) (CRRDC, 2018).

The evaluation process followed an input to impact continuum and involved identifying and briefly describing project objectives, activities, outputs, actual and expected outcomes, and any actual and/or potential impacts associated with project outcomes. The principal economic, environmental, and social impacts then were summarised in a triple bottom line framework.

Once impacts were identified and described, a decision then was made whether to value any of the impacts in monetary terms. Where it was decided to value one or more of the impacts, some, but not necessarily all, of the impacts identified were then valued in monetary terms. The decision to value an impact identified was based on:

- Data availability and information necessary to form credible valuation assumptions,
- The complexity of the relevant valuation methods applicable given project resources,
- The likely magnitude of the impact and/or the expected relative value of the impact compared to other impacts identified, and
- The strength of the linkages between the RD&E investment and the impact identified.

Where impact valuation was exercised, the impact assessment used cost-benefit analysis (CBA) as a principal tool. 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 the individual investment evaluated are likely to represent an underestimate of the true performance of the investment.

Background and Rationale

Background

Most horticultural trade of products considered hosts of important pests, such as fruit fly, rely on exporters demonstrating that their commodity comes from an area that is certified to be free of specific pests or diseases (pest free production areas; PFAs) or must apply an agreed, stringent end-point treatment, such as methyl bromide fumigation or irradiation. Such end-point treatments often are costly and can have negative impacts on product quality. Such end-point treatments may be avoidable where other risk mitigation factors are accepted by importing countries.

Systems approaches integrate pre- and post-harvest practices used in production, harvest, packing, and distribution of a commodity that cumulatively meet requirements for quarantine security (Jang & Moffitt, 1994). Use of an agreed systems approach sets safeguards and mitigation measures that individually and cumulatively reduce plant pest risk for both importers and exporters of horticultural commodities (Liquido, Griffin, & Vick, 1997).

Systems approaches already play a key role in ensuring the quality and phytosanitary status of Australian horticultural exports. Systems approaches have previously been promoted as a more flexible option for meeting biosecurity requirements and generic considerations for development of such approaches are included in the International Standard for Phytosanitary Measures (ISPM) Numbers 14 and 35. A number of domestic and international trade protocols already recognize systems approaches and provide an opportunity for production areas where pests and diseases of quarantine importance are being effectively managed but are not 100% pest free.

Rationale

Despite the potential of systems approaches to improve market access for Australian horticultural trade, there had been minimal adoption of systems approaches for the management of fruit flies and other key quarantine pests. Affected industries and models relied heavily on either chemical control pre-harvest, or an end-point post-harvest treatment as the primary pest control activity. Domestic and international agreement for systems approaches as an alternative to end-point treatment had remained uncommon because they were seen as difficult to quantify practically.

Project AM17001 was funded to develop a practical, quantitative model for combining various pest control and quality measures along a production pathway to provide reliable estimates (with confidence limits) of pest infestation levels in consignments. The development of the model in conjunction with engagement with relevant scientific, industry, and regulatory stakeholders, would provide confidence to biosecurity regulators about the efficacy of a phytosanitary systems approach (PSA) and improve domestic, and ultimately international, adoption.

Project Details

Summary

Project Code: AM17001

Title: *Developing a National Systems Approach for Meeting Biosecurity Requirements to Access Key Asian Markets*

Lead Research Organisation: Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Partner Research Organisations Department of Primary Industries and Regions (DPIRD) Western Australia (WA), New South Wales Department of Primary Industries (NSW DPI), and Agriculture Victoria

Project Leader: Rieks Van Klinken, Senior Research Scientist, CSIRO Health and Biosecurity

Period of Funding: November 2017 to May 2022 (final report date)

Objectives

The overall objective of AM17001 was to develop a quantitative systems approach that will be acceptable to regulators to help Australian horticultural enterprises realise market opportunities in Australia and Asia.

The required outputs of AM17001 included:

- An international review of systems approaches, identifying robust systems approach pathways that Australia could follow, published through peer review.
- An agreement from participating state governments to receive and review as a priority at least three data packages developed during the project (supported by at least three peer reviewed publications) as a scientifically valid basis for domestic trade.
- A peer reviewed, robust, versatile, validated, quantitative systems approach methodology that is acceptable to regulators and industry. It will consist of a series of independent and dependent measures that may be used by industries depending on pests of concern and production region.
- Verification and efficacy data collected for systems components of case-study commodities. Specific work will be guided by sensitivity analysis using the systems approach models.
- Economic and institutional assessment of systems approaches, including consideration of potential constraints, for the acceptance of systems approaches domestically and in key Asian markets, to help design systems approaches and for industry to assess the merits of pursuing systems approaches.
- A Systems Implementation Plan for industry, drawing on findings from across the project, developed to allow industry ownership and adoption following conclusion of the project.
- Communication:
    - At least three peer reviewed journal publications
    - Industry and regulator adoption activities:
        - Presentations at three relevant international conferences
        - Presentations (at least 10) at key industry forums and regulator committees and meetings
        - Articles (at least five) in relevant industry and trade newsletters and magazines.

Logical Framework

Table 2 provides a detailed description of project AM17001 in a logical framework.

Table 2: Logical Framework for Project AM17001

Activities	**Project Management and Governance** • A Project Leadership Team was created that included at least one member from each project partner (participating state governments and CSIRO). The Project Leadership Team was responsible for ensuring project delivery and communicated regularly by teleconference/videoconference throughout the life of the project. • A Project Advisory Committee (PAC) was put together that consisted of relevant senior representatives from key external stakeholders including leaders from the Australia Department of Agriculture, Fisheries and Forestry (DAFF; formerly the Department of Agriculture, Water and Environment), Plant Health Australia (PHA), and relevant industry bodies. The PAC met annually and provided strategic guidance throughout the project. • The project was split into Working Groups each designed to deliver on specific aspects of the project. Further, project activities were focussed through relevant case study commodities for particular regions/states. • A Program Logic Model, Governance and Engagement Plan, and Monitory and Evaluation (M&E) Plan were developed to ensure a strong link between project activities, outputs, and outcomes. • An independent mid-term review of the project was conducted by Vincent Hudson and Will Zacharin in early calendar 2020. **Development of a PSA Model** • The CSIRO research team led the qualitative and quantitative aspects of the PSA modelling as well as conducting engagement activities necessary to ensure acceptance by regulators and industry. • A literature review first was completed including reviews of any systems protocols in development domestically and internationally, and any existing datasets. • A qualitative model then was developed. This model was essentially a Hazard Analysis and Critical Control Points (HACCP) System used to capture and communicate the range of factors that need to be considered. • The qualitative model was initially populated through expert elicitation and available data sets supplemented by some additional empirical work carried out as needed. • A quantitative model to estimate the risk of a commodity having pests above accepted thresholds also was needed. To develop the quantitative model a range of possible approaches were assessed with the intent that the final model could be applied across a range of potential applications and that the approach used would be acceptable for regulators and industry. • Sensitivity analyses were conducted for a number of case study commodities to focus effort and determine any key data gaps. • The qualitative and quantitative models developed were used to determine the efficacy of each dependent and independent measures used within each case study and define the scientific data required to achieve proof of efficacy. • Three-year datasets from the project were analysed and used to underpin peer-reviewed scientific papers that would assist government trade negotiators to satisfy Australian trading partners that Australia is implementing effective, robust PSAs. **Case Studies** • Case studies were run by partner state agencies and were selected based on participating industries that had identified that the development of PSAs was important for market access, where data (and ideally protocols) already were available, and where at least one of the participating states had expertise to lead the work.

- The case studies selected were as follows:
  - Western Australia (DPIRD) – apple industry
    - Mediterranean fruit fly (Medfly) is an established pest in a number of horticultural production areas of WA. The loss of key pesticides had made Medfly control more difficult and though growers had relied on cover sprays as a main control method, they were in the process of adopting an orchard freedom and areas of low pest prevalence approach.
    - The WA apple industry case study included a number of linked components within a PSA that would allow growers in the Manjimip and Pemberton region to better manage and control Medfly, moths, and other pests.
    - As well as providing general RD&E needed to develop the case study, DPIRD WA also tested whether data sets generating through improved trapping methods could improve the ability of a PSA to demonstrate pests in the target commodity are below acceptable levels.
    - Also, data generated by a related DPIRD WA Sterile Insect Technique (SIT) was used in the systems modelling to determine the potential benefits of SIT within a PSA.
  - NSW (NSW DPI) – cherries and high-value citrus industries

    Cherries
    - The pre-existing ICA for cherries produced in Queensland fruit fly (Qfly) endemic regions required cherries to be treated with Trichlorfon, Maldison, or Clothianindin every 7 to10 days from 28 days prior to harvest to end of harvest regardless of pest pressure. Growers disliked the ICA for a number of regions, including that cover sprays disrupt integrated pest management for a range of other pests.
    - An industry desire to market fresh cherries into south-east Asia had created significant interest in running a domestic trial for a Seasonal Pest Absence systems approach to Qfly control.
    - Victoria and NSW had undertaken a pilot program for a cherries systems approach based on ISMP 35 requirements.
    - The current case study involved adapting and amending the types of data being collected and the systems approach model being used, working with CSIRO modellers to improve the understanding of the system and conduct validation and efficacy testing, source, provide and interpret required data, and liaise with industry and other jurisdictions and contribute to publications needed to support acceptance of the case study PSA.
    - NSW DPI also undertook research on brown sugar floatation testing as a new technology for detecting fruit fly infestation in cherries.

    Citrus
    - A pre-existing ICA (ICA28) required bait spraying with Maldison, Chlorpyrifos, Trichlorfon or Spinosad from 12 weeks prior to commencing harvest, to the completion of harvest of fruit for certification, regardless of the monitored pest pressure.
    - Southern and Central NSW citrus growers had been working with NSW DPI to develop alternative measures to pest free areas and ICA28, including a fruit fly systems approach for market access of citrus grown in the Riverina region.
    - A market access trial testing the validity of a winter window concept was undertaken.
    - For the case study, the types of data collected, and the systems approach model used were adapted and amended.
    - The NSW team worked with CSIRO to improve understanding and modelling of the system and conducted validation and efficacy testing.
    - New and improved data to develop and test the new systems approach was sources and interpreted.
    - NSW participants liaised with industry and other jurisdictions and contributed to publications needed to support acceptance of the case study PSA.

	• Victoria (Agriculture Victoria) – cherries, with the possibility of including raspberries/blackberries and summerfruit at later stages in the project. *Summerfruit* • A feasibility study was conducted with the summerfruit industry to determine whether a systems approach trial was appropriate. *Berries – Rubus (raspberry and blackberry) and Strawberry* • Based on initial success of a previous trial with cherries (see above NSW cherry case study description), a feasibility study was conducted with the rubus industry to determine whether a systems approach trial was appropriate. • A berry case study was subsequently undertaken led by Agriculture Victoria. • The berry case study included field trials in Rubus (raspberry and blackberry) and strawberry crops. • The same core set of measures as for cherries were applied, with refinements made to tailor the protocols to the crops' production methods as the trials progressed. • For each case study, a best practice market access model for control of pests of quarantine concern using a systems approach was developed. • The models detailed the cumulative effective of multiple control points along a production pathway. • Each state tailored the approach to ensure that the industry targeted could achieve new or improved market access opportunities within Australia, through Interstate Certificate Assurance (ICA), or international market access in line with international standards. • Existing ICAs also were explored as measures in themselves, including pre-harvest and post-harvest inspection protocols. • ICAs developed were presented to the Australian Domestic Quarantine Committee for consideration. **Economics and Stakeholder Engagement** • Development of the systems approaches within the project were accompanied by a broad quantitative economic assessment of their costs and benefits. • The cost/benefit information was used to inform the engagement process. The engagement process in turn provided feedback that enabled the development of various economic scenarios to capture and report on important issues affecting PSAs beyond the farm gate. • Early advice from DAFF was that any new approach intended to improve market access would need to be adopted domestically before any consideration would be given to international trade negotiations. • National stakeholder engagement was undertaken, guided by the project's Program Logical and Governance and Engagement Plan. • Engagement activities included building relationships and communication with relevant teams and individuals within DAFF both through formal representation, structured engagement activities (such as workshops), and informal interactions. • Engagement with industry also was undertaken through the Australian Trade Assessment Panel and Australian Horticultural Exporters and Importers Association. • Internationally, relationships were developed with relevant scientists in Asia, including through the Chinese Academy of Sciences, peer-reviewed publications were produced to demonstrate the scientific validity and robustness of the PSAs, and presentations at key international conferences and forums were made to socialise the methods being developed. • Results of the international engagement were used to inform development of a Systems Implementation Plan for Industry.
Outputs	• A PSA online resource centre (website) was created. The website, https://research.csiro.au/psa/, provides a portal to phytosanitary risk management science tools for horticultural industries and for national biosecurity stakeholders.

	• A phytosanitary risk reduction framework was published and made available online (https://research.csiro.au/psa/tools-and-resources/systems-approaches/). The framework sets out how trade-related phytosanitary risks can be mitigated through one of four risk reduction objectives applied in three stages. The framework underpins all other phytosanitary risk modelling and analytical tools and resources developed through the project. • A 'menu' of phytosanitary measures technical manual/guidelines was finalised and made available online at https://research.csiro.au/psa. The manual/guidelines identify 39 distinct ways (measures) to that risk can be reduced, grouped under 10 measure categories. • A Pest Risk Reduction Scenario Tool, known as PRReSTo, was created. The tool can be run through commercial software packages such as 'Netica' and CSIRO developed a prototype web interface that will be made available through the online PSA resource centre. • The PRReSTo tool allows users to estimate pest infestation rates in consignments and to quantitatively compare the risk-reducing effect of one or more selected measures. The model underpinned the analysis for the cherry data package developed in the project. • A web-based inspection sampling tool was developed and made available through the PSA resources website. The tool allows users to quantify and compare the benefits of different fruit sampling strategies including inspected packed fruit, fruit from reject bins, and crop inspection. • A surveillance design model was created that evaluates detection probabilities of different trap arrangements and therefore guide optimal trap placement for block-based surveillance. • A suite of coding functions in R for the synthesis and analysis of surveillance data. The code combined observations (trapping data) with phenology (development models) and climate data to return concise information of regional and orchard-level pest pressure. • A method for evaluating protocol efficacy from compliance data was finalised. The statistical methodology was developed to quantitatively estimate confidence in trade protocols through analysis of surveillance and fruit inspection data. • A prototype comparative cost tool was developed to compare costs (per tonne or per hectare) of implementing protocols. The tool was Excel® based and currently is available on request from the project team. • A draft cherry systems approach protocol and data package was completed. Altogether this formed a new ICA for cherries, operational procedures for NSW (CA19) and Victoria (PS41) and supporting data package. • A series of horticultural industry implementation road maps were completed. These road maps were essentially brief summary documents for case study industries outlining opportunities to apply data and tools from the project to improve market access, including through PSA pathways. • A citrus protocol and data package was completed. The CA15 domestic trade procedure for winter citrus was completed collaboratively with NSW citrus growers. • A draft plan to recognise the equivalence of cherry and citrus crop monitors for export and domestic trade to manage the quarantine risk, simply audits, and reduce costs for industry. • Current parallel processes between authorised crop monitors for exports (a DAFF responsibility) and government authorised officers for domestic trade (a state and territory responsibility) results in costly duplication. The project team reported that allowing already authorised export crop monitors to conduct trap and crop monitoring for domestic trade could save a business $3,000/yr. • Recognising that a business has an equivalent training, accreditation, audit, and results reporting authorised crop monitor was reported to save a business up to $100,000 a year in duplicated administration, as a dedicated position is required. • A data package to support a systems approach for Medfly in Western Australian apples also was completed. This included a set of evaluated phytosanitary measures such as area freedom from Qfly and Codling moth, area of low pest prevalence for medfly and *Epiphyas* sp., trapping, pest avoidance (harvesting in a period when fruit fly and moths are absent) and quality grading.

	• A case study quantifying the relative risk of *Epiphyas* moths in apple orchards in Western Australia was also produced to determine what this means for South Australia. • As a part of the apple case study an overview of the market access opportunities for apples and details of national and international apple production were documented in a snapshot of the national and international pome fruit industry. • An operational procedure (PS-47) outlining the requirements for a systems approach for Qfly management in berries for trade from Victoria to Western Australia and South Australia and associated case study report was produced. • Data collected through the project including trapping, brown sugar flotation, fruit inspection and fruit rear-out were provided to Hort Innovation as a complete curated set for the period 2017-2022.

Outcomes	• The web-based inspection sampling tool helped support the inclusion of crop inspection as a measure in the cherry PSA and helped regulators design more effective protocols.
	• The surveillance design method was applied to give confidence in the efficacy of the cherry PSA and was utilised to demonstrate the benefits of pre-harvest surveillance and of multiple fruit inspections.
	• The prototype comparative cost tool played an important role in demonstrating of establishing an authorised officer model for trap surveillance and crop inspections.
	• The draft cherry systems approach protocols for NSW and Victoria (CA19 and PS41) were both submitted to the Subcommittee on Domestic Quarantine and Market Access (SDQMA) for review in March 2022.
	• Opportunities to pursue PSA pathways and, more broadly, to apply the data and tools generated through the project to support improved market access have been discussed with peak industry bodies for apples, berries, cherries, and citrus.
	• The road maps outlining priority opportunities are being shared directly with peak industry groups and could also be considered by Hort Innovation and its Strategic Investment Advisory Panels (SIAPs).
	• The draft plan demonstrating equivalence of cherry and citrus crop monitors was prepared to support the DAFF “Busting Congestion” Project as a workplan priority for SDQMA on seeking greater equivalence in export/domestic protocol implementation.
	• Protocol CA15 winter citrus now is available for use in NSW if sufficient demand arises, and if permits from Qfly sensitive jurisdictions can be secured. It has been shared and discussed with jurisdictions who are experiencing outbreaks in Qfly PFAs.
	• A complete, curated, data set has been provided to Hort Innovation which may be a valuable resource going forward for industry.
	
	More broadly the investment in project AM17001 has contributed to the following outcomes:
	• Improved acceptance and use of systems approaches by Australian biosecurity regulators, through the application of science-based principles and tools.
	  • SDQMA working groups and state-based regulators have sought assistance through the project to apply the tools to help review/improve poorly performing systems approach protocols, refine inter-state trade regulations, and develop systems approach-based movement controls for horticulture produce from outbreak zones in PFAs.
	  • State/territory governments have committed to participate in a follow-on project to facilitate application of the tools to improve the domestic regulation of trade-related biosecurity risks, including the use of systems approaches where appropriate.
	  • The proposed project was endorsed by the Plant Health Committee (PHC) in March 2022 as being in the national-interest and highly aligned with the strategic priorities of the Plant Health Committee
	  • DAFF also has committed to invest in a partnership project with CSIRO to facilitate application of the tools within the department, including a strategy to support the use of systems approaches for international market access.

	• Improved design and risk assessment of systems approach protocols leading to improved acceptance for use for domestic trade of horticulture produce.
	  • Feedback from DAFF and state regulators was gathered through briefings/discussions of the cherry protocol and data package throughout 2021/22.
	  • States provided their individual feedback on the cherry protocol and data package through SDQMA. At the time of reporting, it was understood that the states had indicated general support for the protocol.
	  • The cherry data package is considered to set a precedent and improved benchmark for supporting evidence for systems approach protocols it has been referred by SDQMA to the PHC Australian Fruit Fly Technical Advisory Subcommittee for further review.
	• Australian horticulture industries have a stronger understanding and acceptance of systems approaches, with road maps developed that outline opportunities where systems approach pathways could achieve improvement to existing markets or access to new markets.
	  • Industry feedback was gathered through targeted workshops and meetings, and through participation in industry conferences and forums. The apple and cherry industry indicated their interest to participate in a follow-on project, with the intent of applying systems approaches to protect and enhance international market access.
	  • Data gathering and analysis through the cherry, citrus, berry, and apple case studies demonstrated to the participating industries that robust and defensible systems approaches can be developed to improve market access. Strategic engagement with peak industry bodies identified opportunities to develop systems approach pathways or apply the risk science tools to support wider technical market access efforts.

Potential Impacts	The investment in project AM17001 has potentially contributed to the following impacts: • Maintained or improved domestic market access for the cherry, citrus, berry, and apple industries, as well as other horticultural industries adopting the models and tools produced by the project or accepting and adopting PSAs influenced by project outputs. • Maintained or improved international market access for the cherry, citrus, berry, and apple industries, as well as other horticultural industries adopting the models and tools produced by the project or accepting and adopting PSAs influenced by project outputs. • Reduced farm operating costs (such as disinfestation and chemical costs) through improved design, assessment, and use of PSAs. • Increased average product value through increased adoption of improved pest management systems leading to better fruit quality and shelf life. • Improved domestic biosecurity contributing to reduced risk of spread and establishment of pests of quarantine concern to interstate PFAs thereby avoiding future potential production losses. • Increased efficiency and/or effectiveness of future resource allocation for PSA RD&E through the development of new and improved assessment/evaluation methods, curated industry data, and prioritisation of information gaps and industry needs. • Improved reputation of Australian horticultural exports because of improved pest management systems, fruit quality and shelf life leading to maintained premium prices for Australian export produce. • Increased scientific knowledge and research capacity associated with data, modelling, analysis, and stakeholder engagement for PSAs. • Increased regional community wellbeing through spillover benefits from more profitable and economically sustainable Australian horticultural industries.

Source: AM17001 project documentation and consultation with project personnel and other expert stakeholders

Project Investment

Nominal Investment

Table 3 shows the annual investment made in Project AM17001. In addition to the Hort Frontiers International Markets Fund investment, funds were sourced from the Hort Innovation industry levies, and other partners including CSIRO (project delivery partner), NSW DPI, and AgVic.

Table 3: Annual Investment in Project AM17001 (nominal $, cash and in-kind)

Year (ended 30 June)	HORT FRONTIERS ($)	HORT INDUSTRY LEVIES ($)	OTHERS[(a)] ($)	TOTAL ($)
2018	309,764	141,500	791,493	1,242,757
2019	309,764	153,000	795,149	1,257,913
2020	309,764	198,500	809,615	1,317,879
2021	309,766	176,000	802,462	1,288,228
2022	309,765	151,000	794,514	1,255,279
Total	**1,548,823**	**820,000**	**3,993,233**	**6,362,056**

Source: Hort Innovation Project AM17001 Variation Agreement Number CON-001279-6
(a) Other funding includes $1,534,783 in-kind contributions by CSIRO ($1,393,492), NSW DPI ($32,000), and AgVic ($109,291). In-kind contributions by other funding partners were allocated to each financial year of the project based on the relative annual cash investment.

Program Management Costs

For the Hort Frontiers investment the cost of managing the Hort Innovation funding was added to the Hort Innovation contribution for the project via a management cost multiplier (1.162). This multiplier was estimated based on the share of 'payments to suppliers and employees' in total Hort Innovation expenditure (3-year average) reported in the Hort Innovation's Statement of Cash Flows (Hort Innovation Annual Report, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 2.

Real Investment and Extension Costs

For the purposes of the investment analysis, the investment costs of all parties were expressed in 2021/22-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2022). Project AM17001 included a substantial allocation of resources for industry, government, and other stakeholder engagement, communication of project outputs, development of published resources, and other extension activities. No additional extension costs were assumed to be required for the delivery of attributable impacts and therefore no additional extension costs were incorporated in the quantitative analyses.

Impacts

Table 4 provides a summary of the principal types of impacts delivered by the project, based on the logical framework (Table 2). Impacts have been categorised into economic, environmental, and social impacts.

Table 4: Triple Bottom Line Categories of Principal Impacts from Project AM17001

Economic	• Maintained or improved domestic market access for the cherry, citrus, berry, and apple industries, as well as other horticultural industries adopting the models and tools produced by the project or accepting and adopting PSAs influenced by project outputs. • Maintained or improved international market access for the cherry, citrus, berry, and apple industries, as well as other horticultural industries adopting the models and tools produced by the project or accepting and adopting PSAs influenced by project outputs. • Reduced farm operating costs (such as disinfestation and chemical costs) through improved design, assessment, and use of PSAs. • Increased average product value through increased adoption of improved pest management systems leading to better fruit quality and shelf life. • Improved domestic biosecurity contributing to reduced risk of spread and establishment of pests of quarantine concern to interstate PFAs thereby avoiding future potential production losses. • Increased efficiency and/or effectiveness of future resource allocation for PSA RD&E through the development of new and improved assessment/evaluation methods, curated industry data, and prioritisation of information gaps and industry needs. • Improved reputation of Australian horticultural exports because of improved pest management systems, fruit quality and shelf life leading to maintained premium prices for Australian export produce.
Environmental	• Nil. Though no direct environmental impacts were identified, it is possible that the project may contribute to a reduction in net reduction in agricultural chemical use, thereby contributing to reduced chemical export off-farm and long-term improved environmental sustainability.
Social	• Increased scientific knowledge and research capacity associated with data, modelling, analysis, and stakeholder engagement for PSAs. • Increased regional community wellbeing through spillover benefits from more profitable and economically sustainable Australian horticultural industries.

Public versus Private Impacts

The impacts identified from the investment are both private and public in nature. Private impacts will primarily accrue to growers, particularly those within the Australian cherry, citrus, berry, and apple industries. For example, improved international market access, reduced farm operating costs, and maintained export price premiums. Public impacts may include increased efficiency/effectiveness of public resource allocation for PSA RD&E, increased scientific knowledge and research capacity, and spillovers to regional communities from enhanced horticultural producer profitability.

Distribution of Private Impacts

Private impacts will initially be captured by horticultural producers and exporters, particularly within the Australian cherry, citrus, berry, and apple industries. Private impacts likely will be shared along horticultural produce supply chains, including input supplied, trade partners, and domestic and international consumers according to relevant short- and long-term supply and demand elasticities.

Impacts on Other Australian Industries

While the project focused on the cherry, citrus, berry, and apple industries as case studies, the models, methods, tools, and relationships established (e.g., the PSA online resource centre, phytosanitary risk reduction framework, PRResTo tool, etc.) were designed to be applicable to other horticultural industries in other states/regions.

Impacts Overseas

The overall objective of AM17001 was to develop a quantitative systems approach that would be acceptable to regulators and help Australian horticultural enterprises realise market opportunities in Australia and Asia. The outputs of project AM17001 have successfully been used to draft domestic ICAs, inform DAFF and the SDQMA, and assist state-based regulators to help review/improve poorly performing systems approach protocols, refine inter-state trade regulations, and develop systems approach-based movement controls for horticulture produce from outbreak zones in PFAs. Implementation of project outputs domestically is likely to contribute to positive impacts for international consumers through improved fruit quality and shelf life. Further, improved domestic pest management systems and biosecurity measures are likely to contribute to reduced risk of the spread of Australian pests and diseases to other countries.

Match with National Priorities

The Australian Government's National Science and Research Priorities and National Agricultural Innovation Priorities are reproduced in Table 5. The project outcomes and related impacts will contribute to National Science and Research Priority 1 and National Agricultural Innovation Priority 1 with some contribution to Priority 3.

Table 5: Australian Government Research Priorities

Australian Government Strategies and Priorities	
National Science and Research Priorities[1]	**National Agricultural Innovation Priorities[2]**
1. Food – optimising food and fibre production and processing; agricultural productivity and supply chains within Australia and global markets. **2. Soil and Water** – improving the use of soils and water resources, both terrestrial and marine. **3. Transport** – boosting Australian transportation: securing capability and capacity to move essential commodities; alternative fuels; lowering emissions. **4. Cybersecurity** – improving cybersecurity for individuals, businesses, government, and national infrastructure. **5. Energy and Resources** – supporting the development of reliable, low cost, sustainable energy supplies and enhancing the long-term viability of Australia's resources industries. **6. Manufacturing** – supporting the development of high value and innovative manufacturing industries in Australia. **7. Environmental Change** – mitigating, managing, or adapting to changes in the environment. **8. Health** – improving the health outcomes for all Australians.	On 11 October 2021, the National Agricultural Innovation Policy Statement was released. It highlights four long-term priorities for Australia's agricultural innovation system to address by 2030. These priorities replace the Australian Government's Rural Research, Development and Extension Priorities which were published in the 2015 Agricultural Competitiveness White Paper. **1.** Australia is a trusted exporter of premium food and agricultural products by 2030. **2.** Australia will champion climate resilience to increase the productivity, profitability, and sustainability of the agricultural sector by 2030. **3.** Australia is a world leader in preventing and rapidly responding to significant incursions of pests and diseases through futureproofing our biosecurity system by 2030. **4.** Australia is a mature adopter, developer, and exporter of digital agriculture by 2030.

[1] See: 2015 Australian Government Science and Research Priorities. https://www.industry.gov.au/data-and-publications/science-and-research-priorities
[2] See: 2021 National Agriculture Innovation Policy Statement. https://www.awe.gov.au/agriculture-land/farm-food-drought/innovation/research_and_development_corporations_and_companies#government-priorities-for-investment

Alignment with the Hort Frontiers International Markets Fund Strategic Priorities

The Hort Frontiers International Markets Fund had four key investment themes defined by the Hort Innovation's Co-Investment Strategic Intent: International Markets Fund document (Hort Innovation, 2018):

1) Market development
2) Export capability
3) Market access
4) Collaborative partnerships

Project AM17001 directly delivered against theme 3 (market access) with indirect contributions to theme 2 and 4.

Case Study

The following section provides real world feedback on how the outputs of the investment have benefited growers.

R&D CASE STUDY: CHERRY PICKING FOR THE EXPORT MARKET

THE CHALLENGE

For east coast tree crop producers, Queensland fruit fly (Qfly) can pose a significant barrier to interstate and international trade. Recent incursions and outbreaks have sharpened a focus on ensuring trade protocols and risk management measures are effective and backed by solid scientific evidence.

MEET ANDREW

When it comes to Australian stone fruit, Andrew Fairley is of noble lineage. His grandfather and great uncle established Shepparton Preserving Company (which you may know as SPC) in 1918, transforming the initially humble operation into what would become the largest fruit-canning company in the Southern Hemisphere. A corporate lawyer, philanthropist and now fruit grower, Andrew Fairley AM has built a successful cherry business nestled among the rolling Warramate Hills of the Yarra Valley. Yarra Valley Cherries are a boutique producer of premium cherries and cherry products, including jams and cold pressed cherry juice. All their fruit is grown, picked, graded, and packed on-farm at the orchard in the upper Yarra Valley.

Andrew Fairley AM (photo credit Agriculture Victoria, 2019)

High on Andrew's priority list for Yarra Valley Cherries is the development of the business' international exports. However, the challenge for him and his team lies in finding a way to meet international pest and disease-free assurance measures without the use fumigation methods, which he believes diminishes the quality of his fruit.

"Our markets are overwhelmingly domestic at the moment, we've got a reasonably good export market into Singapore, Malaysia and Hong Kong, but we would very much like to expand that," says Andrew.

THE APPROACH

Yarra Valley Cherries, along with six other Victorian cherry growers, participated in a systems approach trial throughout the 2018-19 season. During the 2018-19 season, the measures trialled included setting traps to detect Qfly and implement corrective actions when pest thresholds are exceeded.

The Victorian Government partnered with the CSIRO and other state governments to increase the range of pest management options available to exporting producers. Programs like the systems approach can be more affordable and less damaging to fruit quality and enhance biosecurity standards in compliance with internationally accepted processes.

Andrew says weekly visits from government representatives allow his business to develop a credible audit trial based on the inspection of traps and randomly selected fruit.

Cherry cut half (photo credit shutterstock, 2022)

"When we are sending pallets to export markets, we've accepted the need to inspect and actually cut up about two per cent of every pallet or from different boxes, randomly selected. It's all very well for us to say we have no fruit fly, but we have an independent audit trail run by government that says 'we come out every week and we inspect your traps and we inspect the traps of all of the places that participate in the systems approach… we can show them that we actually do undertake this random selection of fruit, we cut it up and are able to check." Andrew says.

THE IMPACT

Charlotte Brunt is an industry development officer at Cherry Growers Australia and has been involved in the implementation of the systems approach trials - which she says are shaping up to be a real game-changer.

"Growers were keen on a non-treatment pathway for domestic and international market access. The benefit of a non-treatment pathway means that there are no treatment costs, extra steps in the pathway," she says.

Crates of recently harvested cherries (photo credit Yarra Valley Cherries, 2022)

"Growers will be able to ship direct from the farm, bypassing the need for treatment, this will mean produce will get to the destination quicker and transport and treatment costs will be minimised. It's also better for the product – no heating, long term storage or irradiation, and better for the environment as methyl bromide is an ozone depleting gas and not always recaptured in fumigation facilities."

Charlotte says the industry is in the midst of a growth phase, and development of export markets is critical for success.

"We need to make sure that our fruit is of the highest quality and build on Australia's trusted brand of fresh, clean, green and safe food," she says (Agriculture Victoria, 2019).

Valuation of Impacts

Impacts Not Valued

Not all the impacts identified in Table 4 could be valued in the assessment. Those not valued included:

- Maintained or improved domestic market access for the cherry, citrus, berry, and apple industries, as well as other horticultural industries adopting the models and tools produced by the project or accepting and adopting PSAs influenced by project outputs. This impact was not valued because the CBA method for the evaluation takes a national approach which means that interstate trade transactions are treated as transfer payments (e.g., increased interstate exports would be a cost to the importing region and a benefit to the exporting region cancelling each other out in terms of net benefits for Australia).
- Increased scientific knowledge and research capacity associated with data, modelling, analysis, and stakeholder engagement for PSAs. This impact was not valued due to a lack of available data and information necessary to form credible valuation assumptions.
- Increased regional community wellbeing through spillover benefits from more profitable and economically sustainable Australian horticultural industries. This impact was not valued as it was a secondary, indirect impact and a lack of available data and information necessary to form credible valuation assumptions.
- Improved domestic biosecurity contributing to reduced risk of spread and establishment of pests of quarantine concern to interstate PFAs thereby avoiding future potential production losses. This impact was not valued because of the complexity of the relevant valuation methods applicable given project resources and a lack of available data and information necessary to form credible valuation assumptions.

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.

Five impacts were valued within the quantitative assessment:

1. Maintained or improved international market access for the cherry, citrus, berry, and apple industries.
2. Reduced farm operating costs (such as disinfestation and chemical costs).
3. Increased average product value.
4. Increased efficiency and/or effectiveness of future resource allocation for PSA RD&E.
5. Improved reputation of Australian horticultural exports leading to maintained premium prices for Australian export produce.

Impact 1 and 5 (combined): Maintained or improved international market access for the Australian cherry, citrus, berry, and apple industries (incorporating maintained premium pricing for Australia export produce)

The investment in project AM17001 has resulted in improved acceptance and use of systems approaches by Australian biosecurity regulators, improved design and risk assessment of systems approach protocols, and stronger understanding and acceptance of systems approaches by horticultural industries, with road maps developed that outline opportunities where systems approach pathways could achieve improvement to existing markets or access to new markets. Further, the knowledge, models, tools, scientific evidence and data, and government and industry capacity developed through the project are likely to contribute to improved domestic biosecurity practices and increased future adoption of systems approaches that will both enhance the quality and reputation of Australian export produce and contribute to maintained and improved future market access for Australian horticultural exports translating to maintained export prices and increased export volumes for Australian horticulture.

Industry Production and Export Data

The following tables show the annual production volume, value of production (farm gate value), volume of fresh exports, and value of fresh exports for the Australian cherry, citrus, rubus (berry), and apple industries where case studies for PSAs were developed in project AM17001.

Table 6: Export Statistics for Australian Cherries (2016/17 to 2020/21)

Year (ended 30 June)	2016	2017	2018	2019	2020	2021
Fresh Export Volume (t)	5,593	2,462	4,114	5,035	4,460	4,715
Fresh Export Value ($m)	76.1	43.3	62.2	79.5	81.7	82.4
Total Production (t)	18,854	11,012	15,650	20,147	14,720	20,074
Total Value of Production ($m)	164.2	120.7	148.7	189.3	184.0	231.3
Fresh Supply Volume (t)	13,444	10,321	12,702	15,379	11,124	14,537
Fresh Supply Wholesale Value ($m)	130.8	126.3	135.1	167.6	161.7	206.0

Source: Australian Horticultural Statistics Handbook (Hort Innovation, various years)

Table 7: Export Statistics for Australian Citrus[(a)] (2016/17 to 2020/21)

Year (ended 30 June)	2016	2017	2018	2019	2020	2021
Fresh Export Volume (t)	214,164	218,211	258,196	252,124	284,496	238,432
Fresh Export Value ($m)	297.3	331.7	427.8	456.8	507.9	441.1
Total Production (t)	714,154	718,282	746,297	762,520	767,766	708,827
Total Value of Production ($m)	678.5	742.0	797.8	875.2	942.4	936.3
Fresh Supply Volume (t)	305,415	313,304	294,228	311,048	301,866	300,916
Fresh Supply Wholesale Value ($m)	525.7	580.1	533.0	592.6	619.0	685.6

(a) Includes grapefruit, lemon and lime, mandarin, and orange.

Source: Australian Horticultural Statistics Handbook (Hort Innovation, various years)

Table 8: Export Statistics for Australian Rubus (2016/17 to 2020/21)

Year (ended 30 June)	2016	2017	2018	2019	2020	2021
Fresh Export Volume (t)	2.0	7.0	3.0	8.0	13.0	13.0
Fresh Export Value ($m)	<0.1	0.2	<0.1	0.10	0.20	0.20
Total Production (t)	4,974	5,946	6,922	9,478	9,932	11,123
Total Value of Production ($m)	127.6	166.5	175.1	207.5	216.0	232.9
Fresh Supply Volume (t)	4,504	5,468	5,702	8,825	9,100	10,179
Fresh Supply Wholesale Value ($m)	149.1	194.6	184.1	243.2	252.9	273.0

Source: Australian Horticultural Statistics Handbook (Hort Innovation, various years)

Table 9: Export Statistics for Australian Apples (2016/17 to 2020/21)

Year (ended 30 June)	2016	2017	2018	2019	2020	2021
Fresh Export Volume (t)	4,665	4,950	5,060	4,416	2,953	2,147
Fresh Export Value ($m)	12.4	12.7	11.3	10.6	7.6	5.9
Total Production (t)	316,758	319,686	315,185	310,876	301,667	280,273
Total Value of Production ($m)	441.5	497.2	465.3	512.8	8578.5	619.9
Fresh Supply Volume (t)	219,811	223,234	219,115	213,712	213,309	199,775
Fresh Supply Wholesale Value ($m)	490.2	554.5	519.5	572.6	652.2	720.1

Source: Australian Horticultural Statistics Handbook (Hort Innovation, various years)

Valuation of Impacts 1 and 5 (combined)

Impact 1 (maintained or improved international market access) and Impact 5 (maintained premium prices for Australian exports) were valued under a single valuation framework because it was not possible within the scope of the current assessment to identify the individual, independent contribution of each impact to the overall benefit cash flow.

It was assumed that the investment in project AM17001 has contributed improved market access and potential access to new markets in the future which, in turn, will result in long-term increases in fresh export volumes relative to total production for each industry. Further, it was assumed that the price premiums received by exporters of Australian horticultural products will be maintained through improved product quality and shelf life, as well as improved reputation of Australian horticultural products.

Specific assumptions used in the valuation of Impacts 1 and 5 (combined) are described in Table 10.

Impact 2 and 3 (combined): Increased profitability for Australian horticultural producers through increased average value and reduced farm operating costs

The investment in project AM17001 produced a range of relevant and useful models, tools, and methods to design, assess, and implement PSAs for horticultural industries across Australia. In particular, the project contributed to the submission of a number of state ICAs (CA19 and PS41 for cherries in NSW and Victoria respectively, and CA15for winter citrus in NSW). Industry feedback gathered showed strong interest in the PSA research and the apple and cherry industries indicated their interest to participate further in a follow-on project, with the intent of applying systems approaches to protect and enhance market access.

Project AM17001 outputs and outcomes are likely to have contributed to reduced farm operating costs for some producers, such as disinfestation and chemical costs, through improved design, assessment, and use of PSAs. Also, the investment is likely to contribute to longer-term increases in average product value through increased adoption of improved pest management systems leading to better fruit quality and shelf life.

Valuation of Impacts 2 and 3 (combined)

Impact 2 (reduced farm operating costs) and Impact 3 (increased average product value) were valued under a single valuation framework because specific data on the change in operating costs or average product value attributable to practices changes implemented because of project AM17001 were not readily available.

It was assumed that the investment in project AM17001 has contributed a net increase in profits (gross margin) for domestic production for some producers in the cherry, citrus, rubus, and apple industries where growers have adopted or will adopt pest management best practice systems that optimise pest control and fruit quality (in line with PSAs).

Specific assumptions used in the valuation of Impacts 2 and 3 (combined) are described in Table 10.

Impact 4: Increased efficiency and/or effectiveness of resource allocation for PSA RD&E

Outputs produced by project AM17001 included models, tools, and methods as well as industry data that may be used to inform, prioritise, and streamline future PSA RD&E. For example, project outputs included a complete, curated, data set that was provided to Hort Innovation to be used as a resource going forward, the cherry data package produced by the project has set a precedent and improved benchmark for supporting evidence for systems approach protocols, and road maps were developed that outline opportunities where systems approach pathways could achieve improvement to existing markets or access to new markets.

Valuation of Impact 4

Project AM17001 has helped researchers, government, and industry develop a deeper understanding of PSAs for horticultural industries and has helped to identify, prioritise, and focus new investments in PSA RD&E. Though the total annual investment in PSA related RD&E across Australia was uncertain, it was assumed that the average annual investment in project AM17001 was indicative of the level of investment sought for new PSA RD&E and associated with Hort Innovation research. The investment in AM17001 then was assumed to have created an efficiency dividend for PSA research conducted over the next 10 years. That is, without the project AM17001 investment, future PSA RD&E would have cost relatively more to produce the same outputs.

Specific assumptions used in the valuation of Impact 4 are described in Table 10.

Counterfactual

Defining the counterfactual, or without investment scenario, is critical to the outcome of the analysis, and usually entails more than simply projecting current industry trends indefinitely into the future. In ex-post analyses, the counterfactual is a hypothetical scenario and determining the characteristics of this counterfactual requires judgements about the course of events that would have transpired in the absence of the research outputs produced by the investment under consideration. This counterfactual scenario obviously did not, and will not occur, and can only be inferred from knowledge of the industry and its markets and through consultation/expert opinion (CRRDC, 2018).

For the analysis of the investment in project AM17001 a counterfactual was defined for each of the impact valuations as follows:

- **Impact 1 and 5 (combined):** Project AM17001 built on and leveraged prior investments in PSA RD&E conducted at a state level through NSW DPI, AgVic, DPIRD WA and others. Therefore, it was assumed that without the investment in AM17001 new and improved PSA research would have continued to be progressed but would likely have been less effective or efficient because of the lack of a coordinated, collaborative approach.
- **Impact 2 and 3 (combined):** Similar to the counterfactual for Impact 1 and 5 (combined), ad hoc state-based RD&E in PSAs would likely have continued without the investment in AM17001 and but would have been less effective or efficient at delivering relevant outputs, outcomes, and impacts for target industries.
- **Impact 4:** It was assumed that without the investment in AM17001 the future efficiencies in PSA RD&E would not have occurred.

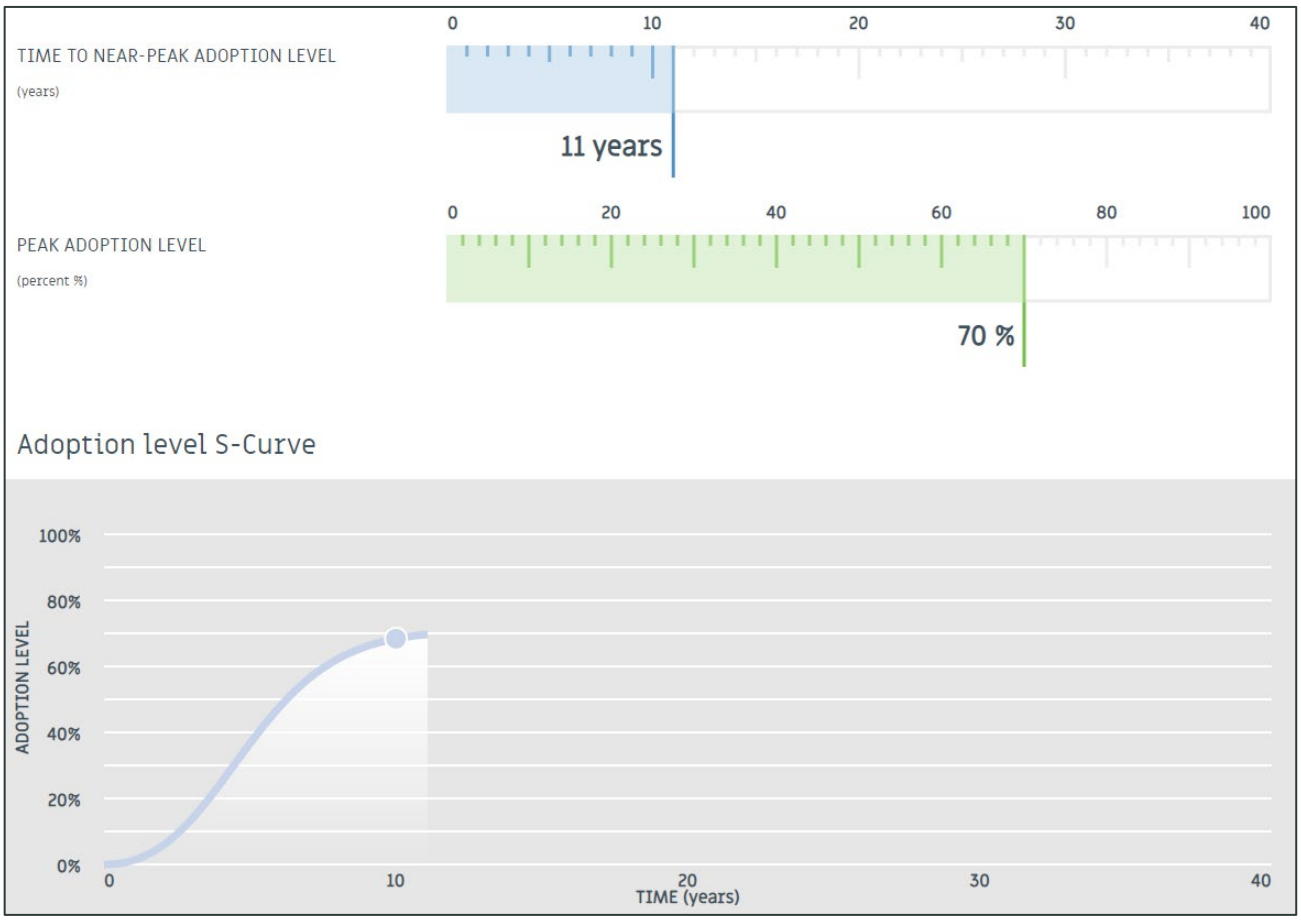
CSIRO Adopt Model Insights

Project parameters were entered into the CSIRO Adopt Model to estimate an adoption/impact profile for the investment in AM17001. Adoption was defined in two parts, first was industry adoption of practice changes aligned with pest management best practice and PSAs to achieve reduced pest impacts and improved fruit quality and shelf life. Second was the broader adoption of PSAs at an industry level used to negotiate improved or new domestic and international market access. The following results were provided by the CSIRO Adopt Tool:

- Time to peak adoption: 11 years.
- Peak adoption level: 70% of target population.
- In 5 years from start: 37% of the population will have adopted.
- In 10 years from start: 68% of the population will have adopted.
- Time to reach 50% of peak adoption: 4.9 years.

The adoption profile and levels modelled using the CSIRO Adopt Tool are shown in Figure 1 below. These insights were considered when preparing valuation assumptions. Project parameters were entered into the CSIRO Adopt Model. Assumptions, inputs, and outputs used are detailed in Appendix 1.

Figure 1: CSIRO Adopt Model, Adoption Level S-Curve for AM17001



Summary of Assumptions

Table 10 contains a summary of other assumptions required for estimation of quantified impacts (Impacts 1 to 5).

Table 10: Summary of Additional Assumptions for Impact Valuation

Variable	Assumption/Value	Source/Comment
Impact 1 and 5 (combined): Improved international market access (including maintained export price premiums)		
Without project AM17001		
Total average annual production by industry		
Cherries	16,743 tonnes	Six-year average based on total annual production from 2016/17 to 2020/21. See Tables 6 to 9. Derived from production statistics published in the Australian Horticultural Statistics Handbook (Hort Innovation, various years)
Citrus	736,308 tonnes	
Rubus	8,063 tonnes	
Apples	307,408 tonnes	
Average export volume as a proportion of total average annual production (by industry)		
Cherries	26.3%	Based on six-year average export volume as a proportion of average annual production from 2016/17 to 2020/21. See Tables 6 to 9.
Citrus	33.2%	
Rubus	0.1%	

Apples	1.3%	Derived from production statistics published in the Australian Horticultural Statistics Handbook (Hort Innovation, various years) Note: the export volumes average export volumes assumed likely are an underestimate over the long-term as the underlying data for 2019/20 and 2020/21 include Covid-19 trade disruptions.
Derived export price (free on board) by industry ($/kg)		
Cherries	$16.12	Based on derived six-year average export prices and volumes (export value/volume, reported free on board) for 2016/17 to 2020/21. See Tables 6 to 9. Derived from production statistics published in the Australian Horticultural Statistics Handbook (Hort Innovation, various years)
Citrus	$1.68	
Rubus	$19.57	
Apples	$2.50	
Farm share of export price	60%	Based on average farm share of export price of approximately 56.7% for raw sugar and 66% for beef (ABARES, 2023).
Estimated average export premium for producers as % of farm share	20%	Average farm profitability of between 10% and 20% based on average total operating profit (before tax) as a % of total sales and services income for Australian agriculture (10-year average, 2013-2022) (ABS, 2023).
Net reduction in export price premiums that would have occurred without AM17001	50%	Analyst assumption – based on risk of loss of PFA status causing exports to go to lower value international markets or the domestic market therefore depressing prices. See counterfactual description reported previously.
With project AM17001		
Average export volume as a proportion of total average annual production (by industry)		
Cherries	35.0% by 2030	Analyst assumption - conservative estimate based on Tasmanian cherry exports of approximately 50% of total state production through PSA supported market access (Prowse, 2021).
Citrus	40.0% by 2030	Analyst assumption - based on Citrus Australia target to grow exports by 30,000 tonnes of class-1 fruit by 2030 (Citrus Australia, 2022).
Rubus	1.0% by 2030	Analyst assumption - based on ongoing strategic focus on growing Australian berry exports (Russell, 2022)
Apples	10.0% by 2030	Analyst assumption - based on industry target to grow apple and pear exports to 10% of marketable production by 2027 (Apple and Pear Australia Ltd, n.d.)
Export price premium over farm gate price by industry ($/kg)	Maintained at same premiums as before AM17001	Analyst assumption - based on increased demand for Australian export produce from international consumers because of improved quality and shelf-life reputational factors
First year of impact	2022/23	Based on successful completion of project AM17001 in May 2022
Year of maximum impact	2032/33	11 years from first year of impact based on CSIRO Adopt Tool adoption profile.

Maximum proportion of producers undertaking practice change in line with PSAs to improve market access	50%	Conservative estimate across all target industries based on CSIRO Adopt Tool adoption model
Period of stable maximum impact	5 years (2032/33 to 2036/37)	Analyst assumption - assumes disadoption by some growers and/or reduced relevance of project outputs overtime as global market conditions and other factors change. Assumes no further investment in PSAs for the four target industries.
Last year of impact	2038/39	
Other factors		
Attribution of benefits to investment in AM17001	10%	A wide range of previous pest management and systems approach RD&E was built on and leveraged to enable the success of project AM17001. Also, increased exports and export price premiums are influenced by a range of research, industry, political and global factors. The attribution of benefits assumed allows for these factors.
Counterfactual – proportion of benefits that would have occurred without the AM17001 investment	50%	Analyst assumption – see counterfactual scenarios described previously.
Probability of output	100%	Represents the probability of technical success of the project investment. Based on successful completion of AM17001 and delivery of numerous relevant and useful outputs.
Probability of outcome	90%	Represents the probability that the adoption/ usage of project outputs occurs as assumed given output success.
Probability of impact	80%	Represents the probability that the impact occurs as assumed given adoption (outcome). Allows for exogenous factors that may affect the realization of impacts such as global market factors, climate change, etc.
Impact 2 and 3 (combined): Increased net profits for some producers		
Without project AM17001		
Estimated gross margin by industry ($/ha)		
Cherries	$73,950 per ha	Conservative estimate based on 95% of a gross margin for cherries of $77,850/ha published by the Department of Primary Industries, Parks, Water and Environment (DPIPWE) Tasmania (DPIPWE, 2018a)
Citrus	$790 per ha	Conservative estimate based on 95% of a gross margin for Riverina navel oranges (non-export) of $831/ha published in the NSW DPI Citrus Farm Budget Handbook (Falivene & Creek, 2018)
Rubus	$140,000 per ha	Conservative estimated based on 95% of a gross margin for raspberries of $147,081/ha published by the DPIPWE Tasmania (DPIPWE, 2018b)
Apples	$42,250 per ha	Conservative estimate based on 95% of a gross margin estimate of $44,453/ha for a 40ha apple enterprise published by the Western Australian Agriculture Authority (Dee & Ghose, 2016).

Estimated total average annual production area by industry (ha)		
Cherries	2,845 ha	Based on industry data published by Cherry Growers Australia (Cherry Growers Australia Inc., 2020)
Citrus	28,000 ha	Based on industry data published by Citrus Australia (Citrus Australia, n.d.)
Rubus	700 ha	Based on industry data published by Plant Health Australia (Plant Health Australoia, 2020a)
Apples	9,375 ha	Based on industry data published by Plant Health Australia (Plant Health Australia, 2020b)
With project AM17001		
Increase in gross margin for producers implementing practice change in line with PSAs in applicable case study industries/ regions	10% net increase	Analyst assumption – informed by project documented evidence that adoption of improved pest management systems/PSAs may contribute to reduced farm operating costs for some producers, such as disinfestation and chemical costs, and longer-term increases in average product value through better fruit quality and shelf life.
Maximum proportion of growers adopting practice change to achieve gross margin benefits (by industry)		
Maximum proportion of producers undertaking practice change in line with PSAs to improve market access	50%	Conservative estimate across all target industries based on CSIRO Adopt Tool adoption model
First year of impact	2022/23	Based on successful completion of project AM17001 in May 2022
Year of maximum impact	2032/33	11 years from first year of impact based on CSIRO Adopt Tool adoption profile
Period of stable maximum impact	5 years (2032/33 to 2036/37)	Analyst assumption - assumes disadoption by some growers and/or reduced relevance of project outputs overtime as global market conditions and other factors change. Assumes no further investment in PSAs for the four target industries.
Last year of impact	2038/39	
Other factors		
Attribution of benefits to investment in AM17001	10%	A wide range of previous pest management and systems approach RD&E was built on and leveraged to enable the success of project AM17001. Also, a range of other factors, such as domestic market conditions, pest pressure, and climate conditions may influence whether and how growers adopt various pest management systems.
Counterfactual – proportion of benefits that would have occurred without the AM17001 investment	50%	Analyst assumption – see counterfactual scenarios described previously.
Probability of output	100%	Represents the probability of technical success of the project investment. Based on successful completion of AM17001 and delivery of numerous relevant and useful outputs.
Probability of outcome	90%	Represents the probability that the adoption/ usage of project outputs occurs as assumed given output success.

Probability of impact	80%	Represents the probability that the impact occurs as assumed given adoption (outcome). Allows for exogenous factors that may affect the realization of impacts such as global market factors, climate change, etc.
Impact 4: Increased efficiency of resource allocation for PSA RD&E		
Without project AM17001		
Total average annual expenditure on PSA RD&E	$1.44 million	Based on the total average annual investment (cash and in-kind) in project AM17001 in real dollar terms and accounting for project administration and management costs.
With project AM17001		
Efficiency dividend for resource allocation for PSA RD&E	10.0%	Analyst assumption
Total annual expenditure saving	$144,000 per annum	5.0% x $1.44 million
First year of impact	2022/23	Based on successful completion of project AM17001 in May 2022
Period of stable maximum impact	10 years (2022/23 to 2031/32	Based on a conservative estimate of at least two subsequent PSA RD&E investments of similar length to AM17001 (5 years)
Last year of impact	2033/34	Analyst assumption - assumes disadoption of project outputs and new/improved PSA information produced over time.
Other factors		
Attribution of benefits to investment in AM17001	100%	The specific investment in AM17001 was the direct cause of the efficiency dividend assumed.
Counterfactual – proportion of benefits that would have occurred without the AM17001 investment	0%	Analyst assumption – benefits would not have occurred without the investment. See counterfactual scenarios described previously.
Probability of output	100%	Represents the probability of technical success of the project investment. Based on successful completion of AM17001 and delivery of numerous relevant and useful outputs.
Probability of outcome	90%	Represents the probability that the adoption/ usage of project outputs occurs as assumed given output success.
Probability of impact	80%	Represents the probability that the impact occurs as assumed given adoption (outcome). Allows for exogenous factors that may affect the realization of impacts such as global market factors, climate change, etc.

Results

All costs and benefits were discounted to 2021/22 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 (2021/22) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Table 11 and Table 12 show the investment criteria estimated for different periods of benefits for the total investment and the Hort Frontiers only investment. Hort Frontiers present value of benefits (Table 12) was estimated by multiplying the total present value of benefits by the Hort Frontiers proportion of total undiscounted costs expressed in 2021/22-dollar terms (26.7%).

Table 11: Investment Criteria for Total Investment in Project AM17001

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	2.26	6.45	10.67	11.38	11.38	11.38
Present Value of Costs ($m)	8.37	8.37	8.37	8.37	8.37	8.37	8.37
Net Present Value ($m)	-8.37	-6.11	-1.92	2.30	3.01	3.01	3.01
Benefit-Cost Ratio	0.00	0.27	0.77	1.27	1.36	1.36	1.36
Internal Rate of Return (%)	n.s.	negative	negative	2.2	2.7	2.7	2.7
MIRR (%)	negative	negative	3.1	6.4	6.4	6.1	6.0

n.s.: no unique solution

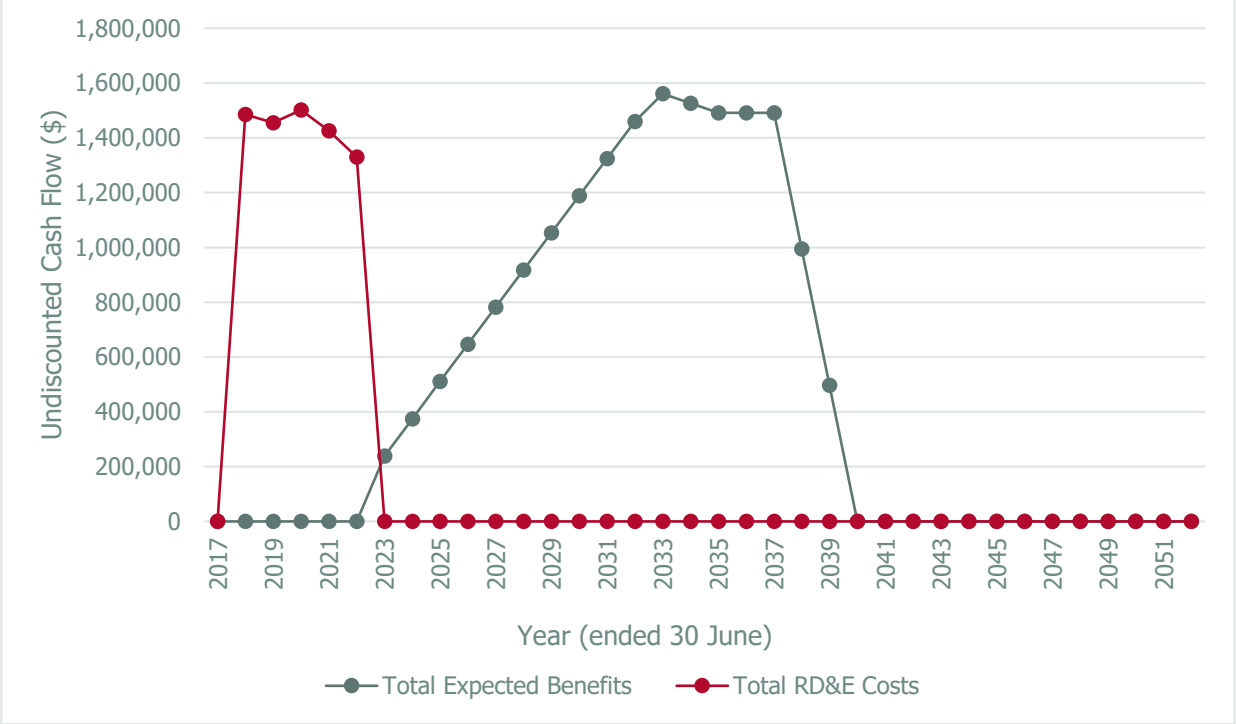
Table 12: Investment Criteria for Hort Frontiers Only Investment in Project AM17001

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	0.60	1.72	2.85	3.04	3.04	3.04
Present Value of Costs ($m)	2.24	2.24	2.24	2.24	2.24	2.24	2.24
Net Present Value ($m)	-2.24	-1.63	-0.51	0.61	0.80	0.80	0.80
Benefit-Cost Ratio	0.00	0.27	0.77	1.27	1.36	1.36	1.36
Internal Rate of Return (%)	n.s.	negative	negative	2.2	2.7	2.7	2.7
MIRR (%)	negative	negative	3.14	6.3	6.3	6.1	6.0

n.s.: no unique solution

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the AM17001 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



Source of benefits

Table 13 shows the contribution to total benefits from each of the two benefits valued. The benefits from improved market access (increased proportion of total production going to export markets) at maintained premium export prices was the highest impact valued in terms of the contribution to total benefits.

Table 13: Source of Total Benefits
(Total investment, 30 years)

Impact	Contribution to PVB ($m)	Share of Total Benefits (%)
Impact 1 & 5: Improved market access with maintained export price premiums	1.29	11.4
Impact 2 & 3: Increased profitability from improved quality and shelf life	9.18	80.7
Impact 4: Increased efficiency of resource allocation for PSA RD&E	0.90	7.9
Total	**11.38**	**100.0**

Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 14 presents the results. The results are sensitive to the discount rate. At a discount rate of 10% estimated project benefits do not cover project costs. The break-even[3] discount rate was approximately 7.86%.

[3] Break-even point is the point at which the present value of benefits equals the present value of costs giving a net present value of zero and a benefit-cost ratio of 1:1.

Table 14: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount Rate		
	0%	5% (base)	10%
Present Value of Benefits ($m)	17.55	11.38	7.82
Present Value of Costs ($m)	7.20	8.37	9.71
Net Present Value ($m)	10.35	3.01	-1.90
Benefit-cost ratio	2.44	1.36	0.80

A sensitivity analysis was then undertaken on the maximum adoption level assumed for impacts 1 & 5 and impacts 2 & 3 as this was considered a key driver of the investment criteria. Results are provided in Table 15. When the maximum adoption level across all target industries was set to 35.6% and all other factors remain unchanged, the project is approximately at "break-even".

Table 15: Sensitivity to Maximum Level of Adoption
(Total investment, 30 years)

Investment Criteria	Maximum Adoption Level Assumed (Impacts 1 & 5 and Impacts 2 & 3)		
	30%	50% (base)	70%
Present Value of Benefits ($m)	7.19	11.38	15.57
Present Value of Costs ($m)	8.37	8.37	8.37
Net Present Value ($m)	-1.18	3.01	7.20
Benefit-cost ratio	0.86	1.36	1.86

A final sensitivity analysis tested the assumed attribution of benefits from impacts 1 & 5 and impacts 2 & 3 to the specific investment in AM17001. The results (Table 16) showed a moderate to high sensitivity to the assumed attribution. The project would 'break-even' at an attribution of just 7.1% with all other factors unchanged.

Table 16: Sensitivity to Assumed Attribution of Benefits to AM17001
(Total investment, 30 years)

Investment Criteria	Attribution of Benefits to AM17001 (Impacts 1 & 5 and Impacts 2 & 3)		
	5%	10% (base)	20%
Present Value of Benefits ($m)	6.14	11.38	21.86
Present Value of Costs ($m)	8.37	8.37	8.37
Net Present Value ($m)	-2.23	3.01	13.48
Benefit-cost ratio	0.73	1.36	2.61

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 17). 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 17: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium-High	Medium

Coverage of benefits valued was assessed as Medium-High, five of nine impacts identified were valued and the five impacts included in the valuation were deemed to represent the most important and most direct impacts from the investment in AM17001. Confidence in assumptions was rated as Medium, most of the data and assumptions used were underpinned by credible, published data and/or expert consultation. However, where no data/evidence was available within the scope of the assessment, a number of key assumptions were estimated by the analyst.

Conclusions

Investment in project AM17001 produced a range of relevant and useful data, models, tools, and other outputs that has improved design and risk assessment of systems approach protocols, improved acceptance and use of systems approaches by Australian biosecurity regulators, and contributed to Australian horticulture industries with a stronger understanding and acceptance of systems approaches to achieve improvement to existing markets or access to new markets.

Total funding from all sources for the project was $8.37 million (present value terms). The investment produced estimated total expected net benefits of $11.38 million (present value terms). This gave a net present value of $3.01 million, an estimated benefit-cost ratio of 1.36 to 1, an internal rate of return of 2.7% and a modified internal rate of return of 6.0%.

Based on the conservative assumptions used in the analysis, the fact that several economic and social impacts identified were not valued, and that Australian exports data includes the period where exports were affected by Covid-19 trade disruptions, the investment criteria reported are likely to be underestimates of the true performance of the investment in AM17001.

Recommendations

Impact assessment is now a mature process within Hort Innovation. No recommendations are made for further refinement.

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- Andrew Fairley, Owner, Yarra Valley Cherries

Abbreviations and Acronyms

RD&E	Research, Development and Extension
CBA	cost-benefit analysis
CRRDC	Council of Rural Research and Development Corporations
DAFF	Department of Agriculture, Fisheries and Forestry (Commonwealth)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tasmania)
HACCP	Hazard Analysis and Critical Control Points
Hort Innovation	Horticulture Innovation Australia Limited
ICA	Interstate Certificate Assurance
ISPM	International Standard for Phytosanitary Measures
LOP	the total life-of-project
M&E	Monitoring and Evaluation
Medfly	Mediterranean Fruit Fly
MIRR	modified internal rate of return
PAC	Project Advisory Committee
PFA	Pest Free Production Area
PHA	Plant Health Australia
PHC	Plant Health Committee
PRReSTo	Pest Risk Reduction Scenario Tool
PSA	Phytosanitary Systems Approach
Qfly	Queensland Fruit Fly
SDQMA	Subcommittee on Domestic Quarantine and Market Access
SIAPs	Strategic Investment Advisory Panels

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.,0020present 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.

Appendix 1: CSIRO Adopt Model Detailed Assumptions, Inputs, and Outputs

Assumptions, inputs, and outputs used to develop an adoption profile for Project AM17001: *Developing a National Systems Approach for Meeting Biosecurity Requirements to Access Key Asian Markets* are reproduced in this appendix.

Model to Run

Standard ADOPT model

Which model should be used for evaluation? The Smallholder ADOPT model works best for innovations in a developing country smallholder context. For all other innovations, select the Standard ADOPT model.

Project Title (required)

AM17001

What innovation or practice change is being considered?

Project Author/s

Rieks van Klinken

Who has contributed to the answers given in this project?

Description of the Innovation

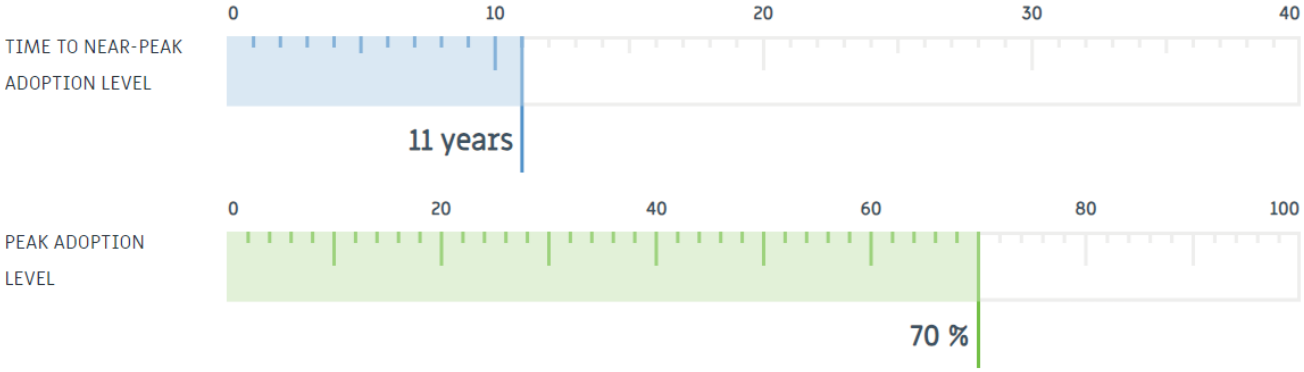
PSA models, tools, methods to design, assess and implement PSAs for horticultural industries to create new and improved domestic and international market access.

Why is this innovation or practice change being considered?

Description of the Target Population

Australian cherry industry, citrus industry, rubus industry, and apple industry (growers/producers and exporters).

Who is the innovation or practice change relevant to?



AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

1. Profit orientation
- Environmental orientation
- Risk orientation
- Enterprise scale
- Management horizon
- Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

1 Profit orientation

What proportion of the target population has maximising profit as a strong motivation?

- ○ Almost none have maximising profit as a strong motivation
- ○ A minority have maximising profit as a strong motivation
- ○ About half have maximising profit as a strong motivation
- ○ A majority have maximising profit as a strong motivation
- ◉ Almost all have maximising profit as a strong motivation

What is your reasoning for this answer? (Optional)

Project has potential to impact export market access. Exporting typically is undertaken because of the availability of premium prices or to ensure production does not flood the domestic market causing price reductions.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

- Profit orientation
2. Environmental orientation
- Risk orientation
- Enterprise scale
- Management horizon
- Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

2 Environmental orientation

What proportion of the target population has protecting the natural environment as a strong motivation?

- ○ Almost none have protection of the environment as a strong motivation
- ○ A minority have protection of the environment as a strong motivation
- ○ About half have protection of the environment as a strong motivation
- ◉ A majority have protection of the environment as a strong motivation
- ○ Almost all have protection of the environment as a strong motivation

What is your reasoning for this answer? (Optional)

Protection of the environment through biosecurity and reduced/minimised agricultural chemical use are increasingly important concerns for primary producers.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

- Profit orientation
- Environmental orientation
- 3 Risk orientation
- Enterprise scale
- Management horizon
- Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

3 Risk orientation

What proportion of the target population has risk minimisation as a strong motivation?

- ○ Almost none have risk minimisation as a strong motivation (risk takers)
- ○ A minority have risk minimisation as a strong motivation
- ○ About half have risk minimisation as a strong motivation
- ○ A majority have risk minimisation as a strong motivation
- ● Almost all have risk minimisation as a strong motivation (risk averse)

What is your reasoning for this answer? (Optional)

Farmers face numerous operational risks from climate to international trade. Minimising risk wherever possible is a typical priority.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

- Profit orientation
- Environmental orientation
- Risk orientation
- 4 Enterprise scale
- Management horizon
- Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

4 Enterprise scale

On what proportion of the target farms is there a major enterprise that could benefit from the innovation?

- ○ Almost none of the target farms have a major enterprise that could benefit
- ○ A minority of the target farms have a major enterprise that could benefit
- ● About half of the target farms have a major enterprise that could benefit
- ○ A majority of the target farms have a major enterprise that could benefit
- ○ Almost all of the target farms have a major enterprise that could benefit

What is your reasoning for this answer? (Optional)

Large corporates are present in relevant Australian horticultural industries.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

- Profit orientation
- Environmental orientation
- Risk orientation
- Enterprise scale
- 5 Management horizon
- Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

5 Management horizon

What proportion of the target population has a long-term (greater than 10 years) management horizon for their farm?

- ○ Almost none have a long-term management horizon
- ◉ A minority have a long-term management horizon
- ○ About half have a long-term management horizon
- ○ A majority have a long-term management horizon
- ○ Almost all have a long-term management horizon

What is your reasoning for this answer? (Optional)

Pest management and international trade considerations typically is a medium-term management concern.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

- Profit orientation
- Environmental orientation
- Risk orientation
- Enterprise scale
- Management horizon
- 6 Short term constraints
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

6 Short term constraints

What proportion of the target population is under conditions of severe short-term financial constraints?

- ○ Almost all currently have a severe short-term financial constraint
- ◉ A majority currently have a severe short-term financial constraint
- ○ About half currently have a severe short-term financial constraint
- ○ A minority currently have a severe short-term financial constraint
- ○ Almost none currently have a severe short-term financial constraint

What is your reasoning for this answer? (Optional)

International competition for horticultural exports is strong.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

LEARNABILITY CHARACTERISTICS OF THE INNOVATION

7 Trialable

Innovation complexity

Observability

LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

7 Trialable

How easily can the innovation (or significant components of it) be trialled on a limited basis before a decision is made to adopt it on a larger scale?

- Not trialable at all
- Difficult to trial
- (•) Moderately trialable
- Easily trialable
- Very easily trialable

What is your reasoning for this answer? (Optional)

Trials require area wide coordination and centralised management. However, successful trials have already been demonstrated.

AM17001

Edit Project Settings >

RELATIVE ADVANTAGE FOR THE POPULATION

LEARNABILITY CHARACTERISTICS OF THE INNOVATION

Trialable

8 Innovation complexity

Observability

LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

8 Innovation complexity

Does the complexity of the innovation allow the effects of its use to be easily evaluated when it is used?

- Very difficult to evaluate effects of use due to complexity
- Difficult to evaluate effects of use due to complexity
- (•) Moderately difficult to evaluate effects of use due to complexity
- Slightly difficult to evaluate effects of use due to complexity
- Not at all difficult to evaluate effects of use due to complexity

What is your reasoning for this answer? (Optional)

As for trialability (Q7).

AM17001

Edit Project Settings >

- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
  - Trialable
  - Innovation complexity
  - 9 Observability
- LEARNABILITY OF POPULATION
- RELATIVE ADVANTAGE OF THE INNOVATION

9 Observability

To what extent would the innovation be observable to farmers who are yet to adopt it when it is used in their district?

- ○ Not observable at all
- ○ Difficult to observe
- ○ Moderately observable
- ● Easily observable
- ○ Very easily observabley

What is your reasoning for this answer? (Optional)

AM17001

Edit Project Settings >

- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION
  - 10 Advisory support
  - Group involvement
  - Relevant existing skills & knowledge
  - Innovation awareness
- RELATIVE ADVANTAGE OF THE INNOVATION

10 Advisory support

What proportion of the target population uses paid advisors capable of providing advice relevant to the project?

- ○ Almost none use a relevant advisor
- ● A minority use a relevant advisor
- ○ About half use a relevant advisor
- ○ A majority use a relevant advisor
- ○ Almost all use a relevant advisor

What is your reasoning for this answer? (Optional)

Systems approach requires monitoring and reporting for accreditation and likely will only be undertaken by highly engaged producers.

AM17001

Edit Project Settings >

- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION

LEARNABILITY OF POPULATION

- Advisory support
- 11 Group involvement
- Relevant existing skills & knowledge
- Innovation awareness
- RELATIVE ADVANTAGE OF THE INNOVATION

11 Group involvement

What proportion of the target population participates in farmer-based groups that discuss farming?

- Almost none are involved with a group that discusses farming
- A minority are involved with a group that discusses farming
- About half are involved with a group that discusses farming
- (•) A majority are involved with a group that discusses farming
- Almost all are involved with a group that discusses farming

What is your reasoning for this answer? (Optional)

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- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION

LEARNABILITY OF POPULATION

- Advisory support
- Group involvement
- 12 Relevant existing skills & knowledge
- Innovation awareness
- RELATIVE ADVANTAGE OF THE INNOVATION

12 Relevant existing skills & knowledge

What proportion of the target population will need to develop substantial new skills and knowledge to use the innovation?

- Almost all need new skills and knowledge
- A majority will need new skills and knowledge
- About half will need new skills and knowledge
- (•) A minority will need new skills and knowledge
- Almost none will need new skills or knowledge

What is your reasoning for this answer? (Optional)

AM17001

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- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION

LEARNABILITY OF POPULATION

- Advisory support
- Group involvement
- Relevant existing skills & knowledge
- 13 Innovation awareness
- RELATIVE ADVANTAGE OF THE INNOVATION

13 Innovation awareness

What proportion of the target population would be aware of the use or trialing of the innovation in their district?

- ○ It has never been used or trialed in their district(s)
- ○ A minority are aware that it has been used or trialed in their district
- ○ About half are aware that it has been used or trialed in their district
- ◉ A majority are aware that it has been used or trialed in their district
- ○ Almost all are aware that it has been used or trialed in their district

What is your reasoning for this answer? (Optional)

Qfly is a major horticultural pest and of significant concern to exporters.

AM17001

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- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

- 14 Relative upfront cost of the project
- Reversibility of the innovation
- Profit benefit in years that it is used
- Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- Risk exposure

14 Relative upfront cost of the innovation

What is the size of the up-front cost of the investment relative to the potential annual benefit from using the innovation?

- ○ Very large initial investment
- ○ Large initial investment
- ○ Moderate initial investment
- ◉ Minor initial investment
- ○ No initial investment required

What is your reasoning for this answer? (Optional)

AM17001

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- RELATIVE ADVANTAGE FOR THE POPULATION
- LEARNABILITY CHARACTERISTICS OF THE INNOVATION
- LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- 15 Reversibility of the innovation
- Profit benefit in years that it is used
- Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit

15 Reversibility of the innovation

To what extent is the adoption of the innovation able to be reversed?

- ○ Not reversible at all
- ○ Difficult to reverse
- ○ Moderately difficult to reverse
- ○ Easily reversed
- ● Very easily reversed

What is your reasoning for this answer? (Optional)

AM17001

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- LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- Reversibility of the innovation
- 16 Profit benefit in years that it is used
- Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- Risk exposure

16 Profit benefit in years that it is used

To what extent is the use of the innovation likely to affect the profitability of the farm business in the years that it is used?

- ○ Large profit disadvantage in years that it is used
- ○ Moderate profit disadvantage in years that it is used
- ○ Small profit disadvantage in years that it is used
- ○ No profit advantage or disadvantage in years that it is used
- ● Small profit advantage in years that it is used
- ○ Moderate profit advantage in years that it is used
- ○ Large profit advantage in years that it is used
- ○ Very large profit advantage in years that it is used

What is your reasoning for this answer? (Optional)

Contribution to profit advantage through maintained market access.

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- LEARNABILITY OF POPULATION

RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- Reversibility of the innovation
- Profit benefit in years that it is used
- 17 Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- Risk exposure

17 Future profit benefit

To what extent is the use of the innovation likely to have additional effects on the future profitability of the farm business?

- ○ Large profit disadvantage in the future
- ○ Moderate profit disadvantage in the future
- ○ Small profit disadvantage in the future
- ○ No profit advantage or disadvantage in the future
- ○ Small profit advantage in the future
- ● Moderate profit advantage in the future
- ○ Large profit advantage in the future
- ○ Very large profit advantage in the future

What is your reasoning for this answer? (Optional)

Long-term market access and producer income stability implications.

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RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- Reversibility of the innovation
- Profit benefit in years that it is used
- Future profit benefit
- 18 Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- Risk exposure
- Ease and convenience

18 Time until any future profit benefits are likely to be realised

How long after the innovation is first adopted would it take for effects on future profitability to be realised?

- ○ More than 10 years
- ○ 6 - 10 years
- ● 3 - 5 years
- ○ 1 - 2 years
- ○ Immediately
- ○ Not Applicable

What is your reasoning for this answer? (Optional)

Once systems approach is implemented - benefits are typically immediate where accepted/agreed in international trade relationships.

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RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- Reversibility of the innovation
- Profit benefit in years that it is used
- Future profit benefit
- Time until any future profit benefits are likely to be realised
- 19 Environmental costs & benefits
- Time to environmental benefit
- Risk exposure

19 Environmental costs & benefits

To what extent would the use of the innovation have net environmental benefits or costs?

- Large environmental disadvantage
- Moderate environmental disadvantage
- Small environmental disadvantage
- No net environmental effects
- (•) Small environmental advantage
- Moderate environmental advantage
- Large environmental advantage
- Very Large environmental advantage

What is your reasoning for this answer? (Optional)

Improved pest management likely to have some agri-chemical and/or biodiversity impacts.

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RELATIVE ADVANTAGE OF THE INNOVATION

- Relative upfront cost of the project
- Reversibility of the innovation
- Profit benefit in years that it is used
- Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- 20 Time to environmental benefit
- Risk exposure

20 Time to environmental benefit

How long after the innovation is first adopted would it take for the expected environmental benefits or costs to be realised?

- More than 10 years
- 6 - 10 years
- 3 - 5 years
- 1 - 2 years
- (•) Immediately
- Not Applicable

What is your reasoning for this answer? (Optional)

Implementation of systems approach leads to immediate improvement in pest management practices and associated environmental impacts.

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RELATIVE ADVANTAGE OF THE INNOVATION

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- Future profit benefit
- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- 21 Risk exposure
- Ease and convenience

21 Risk exposure

To what extent would the use of the innovation affect the net exposure of the farm business to risk?

- ○ Large increase in risk
- ○ Moderate increase in risk
- ○ Small increase in risk
- ○ No increase in risk
- ○ Small reduction in risk
- ● Moderate reduction in risk
- ○ Large reduction in risk
- ○ Very Large reduction in risk

What is your reasoning for this answer? (Optional)

Systems approach and best management only a part of international market access and trade relationships.

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- Time until any future profit benefits are likely to be realised
- Environmental costs & benefits
- Time to environmental benefit
- Risk exposure
- 22 Ease and convenience

22 Ease and convenience

To what extent would the use of the innovation affect the ease and convenience of the management of the farm in the years that it is used?

- ○ Large decrease in ease and convenience
- ○ Moderate decrease in ease and convenience
- ● Small decrease in ease and convenience
- ○ No change in ease and convenience
- ○ Small increase in ease and convenience
- ○ Moderate increase in ease and convenience
- ○ Large increase in ease and convenience
- ○ Very large increase in ease and convenience

What is your reasoning for this answer? (Optional)

Most growers already using practices aligned with systems approaches. Minor to moderate adaptations and additional record keeping may be required.

Project Details

PROJECT TITLE

AM17001

MODEL

Standard

YOUR INNOVATION

PSA models, tools, methods to design, assess and implement PSAs for horticultural industries to create new and improved domestic and international market access.

YOUR POPULATION

Australian cherry industry, citrus industry, rubus industry, and apple industry (growers/producers and exporters).

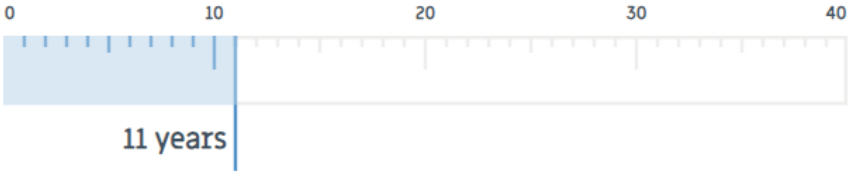
Results

Based on the data entered, the ADOPT model predicts the following:

Adoption Level

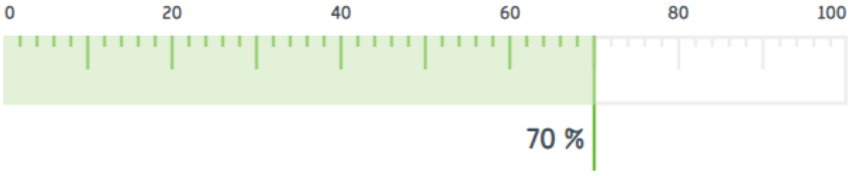
TIME TO NEAR-PEAK ADOPTION LEVEL

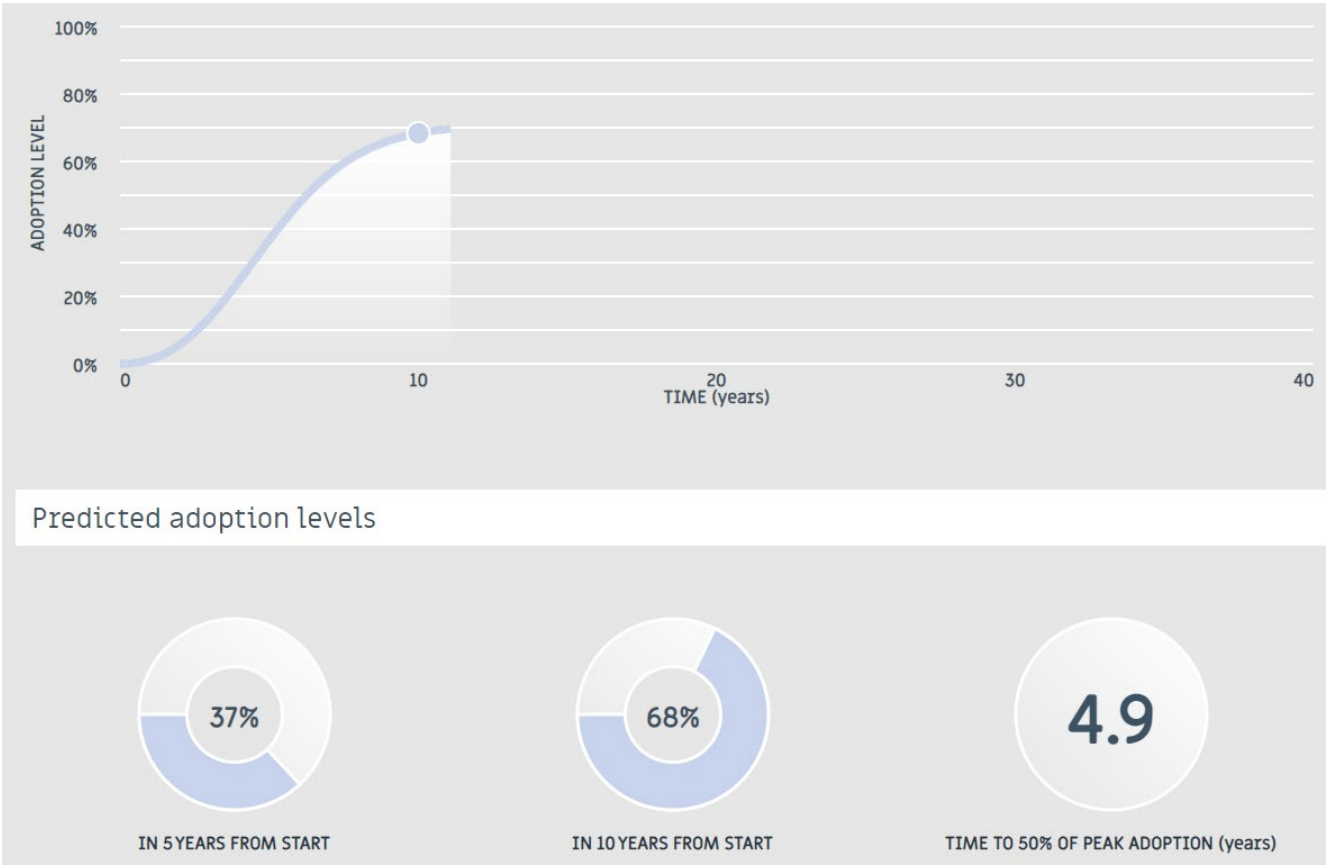
(years)



PEAK ADOPTION LEVEL

(percent %)




100%
80%
60%
40%
20%
0%
ADOPTION LEVEL
0
10
20
30
40
TIME (years)
Predicted adoption levels
37%
IN 5 YEARS FROM START
68%
IN 10 YEARS FROM START
4.9
TIME TO 50% OF PEAK ADOPTION (years)