

## **Final Report**

# **Economic impact assessment for Hort Frontiers**

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HA20000

**Project:**

Economic impact assessment for Hort Frontiers (HA20000)

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## Public summary

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. Economic impact assessments were completed for eight randomly selected, Hort Frontiers RD&E project investments undertaking using guidelines prepared by the Council of Rural Research and Development Corporations (CRRDC, 2018).

An aggregate analysis and summary of the Hort Frontiers program impact assessments across all eight randomly selected projects evaluated then was conducted. The projects evaluated were:

- AS19005: Australian Protected Cropping RD&E Strategy 2030
- HG14033: SITplus: Raising Qfly Sterile Insect Technique to World Standard
- GC15002: Which plant where when and why database
- HN15000: Innovative Cold Plasma for Horticultural Industries
- AM15007: Market Development Program - Almonds
- AM17001: Developing a national systems approach for meeting bio-security requirements to access key Asian markets
- LP15001: Global Masterclass Horticulture
- PH16004: Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption

The eight Hort Frontiers projects evaluated produced a range of economic, environmental, and social impacts. Based on the conservative assumptions made and the fact that not all impacts were valued, it is likely that the aggregate estimated investment criteria reported are an underestimate of the performance of the Hort Innovation Hort Frontiers RD&E investment evaluated. The positive results demonstrate the importance and value of collaborative investment in transformative, cross-sectoral RD&E priorities for the horticulture sector and the evaluation findings should be viewed with confidence by Hort Innovation, the Australian horticulture sector, and policy personnel responsible for allocation of public funds.

## Technical summary

This report presents an aggregate analysis and summary of the Hort Frontiers program impact assessments across all eight randomly selected projects evaluated in 2022/23. Each RD&E project 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 some impacts were selected for valuation in monetary terms (quantitative assessment).

The undiscounted benefit and cost cash flows from each individual, project-level assessment for the Hort Frontiers program were extracted, integrated, and updated such that all past and future cash flows were expressed in 2021/22-dollar terms. The benefit and cost cash flows then were aggregated and discounted to the year ended 30 June 2023 (year of analysis) using a 5% discount rate. The Hort Frontiers program aggregate Present Value of Benefits (PVB) and Present Value of Costs (PVC) then were used to estimate aggregate investment criteria across all eight (8) projects evaluated. Further, investment criteria were estimated for the total aggregate investment and for the Hort Innovation Hort Frontiers investment alone for different time periods up to 30-years after the last year of aggregate investment (2021/22).

The projects evaluated were:

- AS19005: Australian Protected Cropping RD&E Strategy 2030
- HG14033: SITplus: Raising Qfly Sterile Insect Technique to World Standard
- GC15002: Which plant where when and why database
- HN15000: Innovative Cold Plasma for Horticultural Industries
- AM15007: Market Development Program - Almonds
- AM17001: Developing a national systems approach for meeting bio-security requirements to access key Asian markets
- LP15001: Global Masterclass Horticulture
- PH16004: Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption

The eight Hort Frontiers projects evaluated produced a range of economic, environmental, and social impacts. Total aggregate funding from all sources for the eight Hort Frontiers projects totalled \$87.64 million (present value terms) and produced estimated total aggregate expected benefits of \$216.07 million (present value terms). This gave an aggregate NPV of \$128.43 million and a weighted average BCR of approximately 2.47 to 1 after 30 years at a 5% discount rate. The results are consistent with other, similar evaluations of agricultural RD&E investments for small industries conducted by the evaluation team where average BCRs have been estimated between 2 and 5 to 1.

Hort Innovation directly invested \$35.62 million (undiscounted, real 2021/22-dollar terms) through the Hort Frontiers program in the eight projects evaluated and was able to leverage the organisation's investment to achieve total funding of \$70.73 million (undiscounted, real 2021/22-dollar terms). This equates to a leverage ratio, the ratio of 'other' investment to Hort Innovation Hort Frontiers investment, of approximately 1 to 1. That is, for every \$1 of Hort Frontiers program investment, RD&E funding partners contributed an additional \$1.

Based on the conservative assumptions made and the fact that not all impacts were valued, it is likely that the aggregate estimated investment criteria reported are an underestimate of the performance of the Hort Innovation Hort Frontiers RD&E investment evaluated. The positive results demonstrate the importance and value of collaborative investment in transformative, cross-sectoral RD&E priorities for the horticulture sector and the evaluation findings should be viewed with confidence by Hort Innovation, the Australian horticulture sector, and policy personnel responsible for allocation of public funds.

## Keywords

Impact assessment, Cost-Benefit Analysis, Evaluation, Hort Frontiers, HA20000

## 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 <sup>(a)</sup> (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).

This report presents an aggregate analysis and summary of the Hort Frontiers program impact assessments across all eight randomly selected projects evaluated in 2022/23.



## Methodology

### Individual Impact Assessments

The individual, project-level 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.

### Aggregate Analysis

The undiscounted benefit and cost cash flows from each individual, project-level assessment for the Hort Frontiers program were extracted, integrated, and updated such that all past and future cash flows were expressed in 2021/22-dollar terms using the Implicit Price Deflator for Gross Domestic Product (Australian Bureau of Statistics (ABS), 2022). The benefit and cost cash flows then were aggregated and discounted to the year ended 30 June 2023 (year of analysis) using a 5% discount rate.

The Hort Frontiers program aggregate Present Value of Benefits (PVB) and Present Value of Costs (PVC) then were used to estimate aggregate investment criteria across all eight (8) projects evaluated. Further, investment criteria were estimated for the total aggregate investment and for the Hort Innovation Hort Frontiers investment alone for different time periods up to 30-years after the last year of aggregate investment (2021/22).

Investment criteria reported included the Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR), and Modified IRR (MIRR). Definitions of key economic terms can be found in the Glossary of Economic Terms at the end of this report. The PVB for the Hort Innovation Hort Frontiers investment was estimated by multiplying the total PVB for each project by the Hort Frontiers percentage of real, undiscounted investment costs for that project and then aggregating the resulting Hort Frontiers benefit cash flows. The Hort Innovation Hort Frontiers percentage of real, undiscounted investment costs ranged from 18.0% (Project PH16004) to 100% (Projects AS19005 and GC15002).

## Summary of Project Impacts

The following section summarises the key qualitative results for the eight randomly selected Hort Frontiers projects that were subjected to evaluation as part of the 2023 Hort Innovation Hort Frontiers program impact assessments program. The impacts and potential impacts from each project investments were identified, described, and then classified into economic, environmental, and social impacts, on an individual project basis. The principal impacts and potential impacts for each project are shown in Table 2 (economic impacts), Table 3 (environmental impacts), and Table 4 (social impacts).

**Table 2: Economic Impacts by Hort Frontiers Project**

Project Code	Project Title	Impacts Identified
AM15007	Market Development Program - Almonds	<ul style="list-style-type: none"> <li>• Increased demand for Australian almonds in Asian (including the Middle East) markets.</li> <li>• Improved stability of producer incomes through development of export markets that contributes to:               <ul style="list-style-type: none"> <li>○ increased export prices, or</li> <li>○ an avoidance of a price fall for Australian almonds in Asian (including the Middle East) markets, and/or</li> <li>○ avoidance of a price fall in non-Asian markets due to greater sales to Asian markets.</li> </ul> </li> </ul>
AM17001	Developing a national systems approach for meeting bio-security requirements to access key Asian markets	<ul style="list-style-type: none"> <li>• 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 phytosanitary systems approaches (PSAs) influenced by project outputs.</li> <li>• 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.</li> <li>• Reduced farm operating costs (such as disinfestation and chemical costs) through improved design, assessment, and use of PSAs.</li> <li>• Increased average product value through increased adoption of improved pest management systems leading to better fruit quality and shelf life.</li> <li>• Improved domestic biosecurity contributing to reduced risk of spread and establishment of pests of quarantine concern to interstate Pest Free Areas (PFAs) thereby avoiding future potential production losses.</li> <li>• Increased efficiency and/or effectiveness of future resource allocation for PSA RD&amp;E through the development of new and improved assessment/evaluation methods, curated industry data, and prioritisation of information gaps and industry needs.</li> <li>• 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.</li> </ul>
AS19005	Australian Protected Cropping RD&E Strategy 2030	<ul style="list-style-type: none"> <li>• More efficient protected cropping RD&amp;E expenditure.</li> <li>• In the longer term, a contribution to the profitability of protected cropping sector value chains.</li> </ul>
GC15002	Which plant where when and why database	<ul style="list-style-type: none"> <li>• A potential increase in sales and profit for green life growers (trees, shrubs, groundcover plants, turf) supplying additional demand in urban areas. The tool also helps nurseries make more informed planning and investment decisions with improved information about future plant demand.</li> </ul>

Project Code	Project Title	Impacts Identified
HG14033	SITplus: Raising Qfly Sterile Insect Technique to World Standard	<ul style="list-style-type: none"> <li>• Increased efficiency and/or effectiveness of resource allocation for future Queensland Fruit Flu (Qfly) sterile insect technique (SIT) RD&amp;E through the realisation of essential foundational scientific knowledge and increased coordination and collaboration for Qfly SIT RD&amp;E in Australia (for example, research outputs used to inform FF17001 and related Qfly SIT RD&amp;E).</li> <li>• Contribution to potentially reduced SIT production and implementation costs through the adoption of recommendations that improve mass-rearing processes and SIT program logistics.</li> <li>• Contribution to improved effectiveness and efficiency of future SIT programs to control or eradicate Qfly in Australia. This in turn is expected to lead to increased long-term productivity and/or profitability for Australian horticultural producers in Qfly affected regions through:               <ul style="list-style-type: none"> <li>○ Reduced Qfly damage and control costs.</li> <li>○ Increased value because of increased average product quality.</li> <li>○ Maintained or increased market access (both domestic and international).</li> <li>○ Reduced future Qfly eradication costs from Qfly incursions/spread to new regions (e.g., WA and other domestic Qfly PFAs).</li> </ul> </li> </ul>
HN15000	Innovative Cold Plasma for Horticultural Industries	<ul style="list-style-type: none"> <li>• Potential reduction in the risk of a food safety incident with improved foodborne pathogen control. Foodborne illness costs include additional demand on the public health system.</li> <li>• Increased grower and packer profit with a reduction in produce safety related recalls, reduced postharvest spoilage and increased demand for horticultural produce. Food safety failures damage consumer confidence, market, and trade opportunities. Growers and packers will lose less of the crop to supply chain spoilage and enjoy additional demand from increased consumer confidence in fresh produce and improved access to export markets.</li> </ul>
LP15001	Global Masterclass Horticulture	<ul style="list-style-type: none"> <li>• Increased wellbeing for individuals (graduates), particularly through increased earning capacity because of enhanced personal and professional capacity and capability.</li> <li>• Increased economic sustainability (long-term productivity and/or profitability) for some horticultural businesses through improved business management and leadership.</li> </ul>
PH16004	Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption	<ul style="list-style-type: none"> <li>• Progress toward increased enterprise returns with improved pollination, average crop yield and quality for some crops in some locations.</li> <li>• Potential for reduced crop yield loss with Varroa mite (or a similar honeybee pest e.g., tropilaelaps) establishing in Australia.</li> <li>• Spill-over benefits including shade/shelter for livestock, and erosion control following the planting of native vegetation to encourage pollinators.</li> </ul>

Table 3: Environmental Impacts by Hort Frontiers Project

Project Code	Project Title	Impacts Identified
AM15007	Market Development Program - Almonds	<ul style="list-style-type: none"> <li>• Nil</li> </ul>
AM17001	Developing a national systems approach for meeting bio-security requirements to access key Asian markets	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
AS19005	Australian Protected Cropping RD&E Strategy 2030	<ul style="list-style-type: none"> <li>• Contribution to more efficient PC production with less risk of waste/pollution of the farm environment through RD&amp;E strategies that provide information on ways to reduce the environmental footprint of PC systems.</li> </ul>
GC15002	Which plant where when and why database	<ul style="list-style-type: none"> <li>• Environmental gain in urban areas e.g., mitigation of extreme heat caused by heat islands and a warmer climate, air pollution mitigation, reduction in stormwater damage with vegetation slowing/ absorbing runoff, carbon sequestration, and improved urban biodiversity.</li> </ul>
HG14033	SITplus: Raising Qfly Sterile Insect Technique to World Standard	<ul style="list-style-type: none"> <li>• Some contribution to improved environmental outcomes through reduced agricultural chemical use for Qfly and therefore potential for reduced chemical export off-farm.</li> </ul>
HN15000	Innovative Cold Plasma for Horticultural Industries	<ul style="list-style-type: none"> <li>• Less reliance on postharvest chemicals and less risk of chemical contamination affecting the farm and post-farm environment. Reduced use of chemical sanitisers (e.g., chlorine) entering the environment and cutting water pollution with degradation products of chemical disinfectants. Cold plasma will reduce the volume of water used in the fresh produce cleaning process but potentially add to electricity consumption. A potential tool to achieve sustainability agenda with ultra-low chemical usage in the postharvest handling of horticultural products.</li> </ul>
LP15001	Global Masterclass Horticulture	<ul style="list-style-type: none"> <li>• Nil.</li> </ul>
PH16004	Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption	<ul style="list-style-type: none"> <li>• Additional biodiversity within the farm environment e.g., additional native pollinators and the presence of native birds and small mammals which feed on pollinators and additional populations of other insects.</li> <li>• Increased carbon sequestration with an increase in revegetated land and native vegetation managed for pollination.</li> </ul>

Table 4: Social Impacts by Hort Frontiers Project

Project Code	Project Title	Impacts Identified
AM15007	Market Development Program - Almonds	<ul style="list-style-type: none"> <li>• Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of project contribution to maintenance of current levels of Australian almond production and profitability.</li> <li>• An increase in the strategic capacity of Australian almond marketers to develop improved strategies in the future.</li> </ul>

Project Code	Project Title	Impacts Identified
AM17001	Developing a national systems approach for meeting bio-security requirements to access key Asian markets	<ul style="list-style-type: none"> <li>Increased scientific knowledge and research capacity associated with data, modelling, analysis, and stakeholder engagement for PSAs.</li> <li>Increased regional community wellbeing through spillover benefits from more profitable and economically sustainable Australian horticultural industries.</li> </ul>
AS19005	Australian Protected Cropping RD&E Strategy 2030	<ul style="list-style-type: none"> <li>Additional strategic planning and protected cropping research capacity.</li> <li>Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of more productive and profitable protected cropping industries.</li> </ul>
GC15002	Which plant where when and why database	<ul style="list-style-type: none"> <li>An increase in quality of life and health benefits for people in urban areas including improved mental and physical wellbeing with an improved environment, less heat exhaustion, increased willingness to participate in physical exercise, psychological relaxation, and alleviation of stress.</li> <li>Increased public and industry awareness of the value of urban green spaces and trees as well as the likely impacts of climate change.</li> <li>Capacity – additional researcher skills in managing complex projects, understanding flora, the impacts of climate change on flora, and developing online databases of benefit to experts and the public.</li> <li>Capacity – those who work with green life will have additional skills in creating and sustaining urban green spaces. Nursery owners will have additional skills in long-term planning.</li> <li>Regional spill-over benefits including income, employment, and longevity associated with a more vibrant horticultural industry (nursery, turf, etc.).</li> </ul>
HG14033	SITplus: Raising Qfly Sterile Insect Technique to World Standard	<ul style="list-style-type: none"> <li>Maintained returns to investment in RD&amp;E because of increased scientific knowledge and research capacity achieved through the support and training of over 20 post-graduate students and research fellows.</li> </ul>
HN15000	Innovative Cold Plasma for Horticultural Industries	<ul style="list-style-type: none"> <li>Additional Australian research capacity in the application of plasma technology to practical industry applications (e.g., food and medical industries).</li> <li>Social – a healthier Australian population with less sickness and productivity loss.</li> <li>Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of more productive and profitable horticultural industries.</li> </ul>
LP15001	Global Masterclass Horticulture	<ul style="list-style-type: none"> <li>Increased businesses management and leadership capability and capacity for horticultural producers, business owners, and other industry stakeholders completing the Masterclass in Horticultural business.</li> <li>Maintained or enhanced long-term capability and capacity in horticulture and horticulture-related industries.</li> <li>Some increased wellbeing for rural/ regional communities associated with horticultural supply chains because of more spillover benefits from more economically sustainable and resilient horticultural businesses.</li> </ul>
PH16004	Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption	<ul style="list-style-type: none"> <li>Additional skills in understanding and managing pollinators. Skills developed by researchers (including postgraduate, PhD, and post-doctoral training) and growers (planting and vegetation management for pollination).</li> <li>A repository of DNA data in SA on crop pollinating bees, and pollen types. Data available as an aid to future research.</li> <li>Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of more productive and profitable agricultural industries.</li> </ul>

## Results

All costs and benefits were discounted to 2022/22 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the 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 aggregate investment (2021/22) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

### Investment Criteria by Hort Frontiers Project

The individual project investment criteria for the total investment and for the Hort Innovation Hort Frontiers investment for each of the eight Hort Frontiers projects evaluated are reported in Table 5 and Table 6.

**Table 5: Investment Criteria for Total Investment by Hort Frontiers Project  
(30 years, 5% discount rate)**

Project Code	PVB (\$m)	PVC (\$m)	NPV (\$m)	BCR	IRR (%)	MIRR (%)
AM15007	15.08	1.41	13.67	10.68	81.8	18.8
AM17001	11.38	8.37	3.01	1.36	7.9	6.0
AS19005	0.39	0.18	0.20	2.10	28.4	7.7
GC15002	46.43	14.97	31.46	3.10	13.2	8.9
HG14033	63.57	30.41	33.16	2.09	9.6	11.6
HN15000	36.10	7.99	28.10	4.52	20.7	10.3
LP15001	20.68	4.47	16.21	4.63	28.7	12.0
PH16004	22.44	19.83	2.61	1.13	5.4	5.3

**Table 6: Investment Criteria for Hort Innovation Hort Frontiers Investment by Hort Frontiers Project  
(30 years, 5% discount rate)**

Project Code	PVB (\$m)	PVC (\$m)	NPV (\$m)	BCR	IRR (%)	MIRR (%)
AM15007	6.31	0.59	5.72	10.68	81.8	18.2
AM17001	3.04	2.24	0.80	1.36	2.7	6.0
AS19005	0.39	0.18	0.20	2.10	28.4	7.7
GC15002	46.43	14.97	31.46	3.10	13.2	8.9
HG14033	25.47	12.19	13.29	2.09	9.6	11.6
HN15000	34.40	7.65	26.75	4.50	20.7	10.3
LP15001	9.51	2.05	7.46	4.63	28.7	12.0
PH16004	4.03	3.54	0.49	1.14	5.5	5.3

## Aggregate Investment Criteria

Table 7 and Table 8 show the aggregate investment criteria estimated for different periods of benefits for the total aggregate investment and the Hort Innovation Hort Frontiers only aggregate investment.

**Table 7: Aggregate Investment Criteria for Total Aggregate Investment (all eight Hort Frontiers projects)**

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	9.52	36.42	86.86	132.63	167.46	195.39	216.07
Present Value of Costs (\$m)	87.64	87.64	87.64	87.64	87.64	87.64	87.64
Net Present Value (\$m)	-78.12	-51.22	-0.78	44.99	79.82	107.75	128.43
Benefit-Cost Ratio	0.11	0.42	0.99	1.51	1.91	2.23	2.47
Internal Rate of Return (%)	negative	negative	4.9	8.9	10.4	11.1	11.4
MIRR (%)	negative	negative	4.9	8.5	9.0	8.9	8.6

n.s.: no unique solution

**Table 8: Aggregate Investment Criteria for Hort Innovation Hort Frontiers Aggregate Investment (all eight Hort Frontiers projects)**

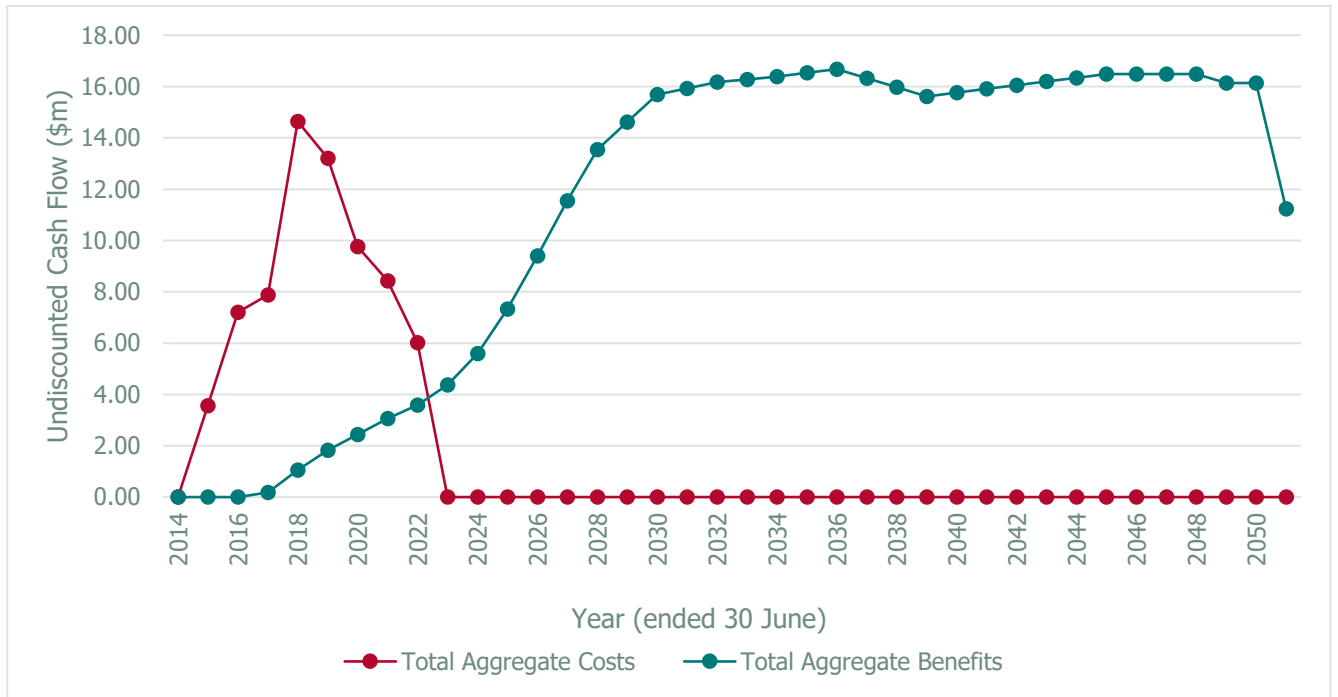
Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	4.10	18.59	49.83	78.03	99.71	116.76	129.58
Present Value of Costs (\$m)	43.41	43.41	43.41	43.41	43.41	43.41	43.41
Net Present Value (\$m)	-39.31	-24.82	6.42	34.62	56.30	73.36	86.18
Benefit-Cost Ratio	0.09	0.43	1.15	1.80	2.30	2.69	2.99
Internal Rate of Return (%)	negative	negative	6.6	10.6	12.0	12.6	12.9
MIRR (%)	negative	negative	6.8	9.9	10.0	9.7	9.3

n.s.: no unique solution

All eight of the randomly selected Hort Frontiers projects evaluated for the Hort Frontiers program impact assessments included impacts that were valued in monetary terms. The total investment across all eight Hort Frontiers RD&E investments ranged from \$0.18 million (Project AS19005) to \$30.41 million (Project HG14033) in present value terms. Estimated benefits ranged from \$0.39 million (Project AS19005) to \$63.57 million (Project HG14033) in present value terms. The highest NPV was \$33.16 million for Project HG14033. The highest BCR was estimated at 10.68 to 1 for Project AM15007.

The annual undiscounted total aggregate benefit and cost cash flows for the total aggregate investment for the duration of the Hort Frontiers aggregate investment plus 30 years from the last year of investment are shown in Figure 1.

Figure 1: Annual Cash Flow of Undiscounted Total Aggregate Benefits and Total Aggregate Investment Costs



### Sources of Benefits

Table 9 shows the contribution of each Hort Frontiers project evaluated to the total aggregate PVB (Total Investment)

Table 9: Contribution of Benefits by Hort Frontiers Project

Project Code	PVB (\$m)	Contribution to Total PVB (%)
AM15007	15.08	7.0
AM17001	11.38	5.3
AS19005	0.39	0.2
GC15002	46.43	21.5
HG14033	63.57	29.4
HN15000	36.10	16.7
LP15001	20.68	9.6
PH16004	22.44	10.4
<b>Totals</b>	<b>216.07</b>	<b>100.0</b>

Project HG14033 contributed the largest share of benefits with a PVB of \$63.57 million representing 29.4% of the total aggregate PVB of \$216.07 million across all eight Hort Frontiers projects evaluated.



## Leverage

Co-investment to facilitate large scale, collaborative RD&E is an essential component of the Hort Frontiers program. Hort Innovation directly invested \$35.62 million (undiscounted, real 2021/22-dollar terms) through the Hort Frontiers program in the eight projects evaluated and was able to leverage the organisation's investment to achieve total funding of \$70.73 million (undiscounted, real 2021/22-dollar terms). This equates to a leverage ratio, the ratio of 'other' investment to Hort Innovation Hort Frontiers investment, of approximately 1 to 1. That is, for every \$1 of Hort Frontiers program investment, RD&E funding partners contributed an additional \$1. At a project level, leverage ranged from zero (100% Hort Frontiers funded, Projects AS19005 and GC15002) to 4.6 to 1 (Project PH16004).

## Conclusions

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 typically longer-term, complex, and focus on traditionally underinvested themes.

Impact assessments were carried out on eight (8) randomly selected Hort Innovation Hort Frontiers program RD&E projects. The final sample of projects evaluated included at least one project from each Hort Frontiers Fund 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, nominal dollars). Also, the final random sample included one project completed in 2019/20, two completed in 2020/21, and five completed in 2021/22.

The projects evaluated were:

- AS19005: Australian Protected Cropping RD&E Strategy 2030
- HG14033: SITplus: Raising Qfly Sterile Insect Technique to World Standard
- GC15002: Which plant where when and why database
- HN15000: Innovative Cold Plasma for Horticultural Industries
- AM15007: Market Development Program - Almonds
- AM17001: Developing a national systems approach for meeting bio-security requirements to access key Asian markets
- LP15001: Global Masterclass Horticulture
- PH16004: Securing pollination for productive agriculture: guidelines for effective pollinator management and stakeholder adoption

Some, but not all, of the impacts identified for each project investment were valued as part of the evaluation process. Impacts from all eight projects from the Hort Frontiers program sample were valued as part of the Hort Innovation impact assessment process. The decision not to value certain impacts was, in general, due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the RD&E project investments.

The eight Hort Frontiers projects evaluated produced a range of economic, environmental, and social impacts. Total aggregate funding from all sources for the eight Hort Frontiers projects totalled \$87.64 million (present value terms) and produced estimated total aggregate expected benefits of \$216.07 million (present value terms). This gave an aggregate NPV of \$128.43 million and a weighted average BCR of approximately 2.47 to 1 after 30 years at a 5% discount rate. The results are consistent with other, similar evaluations of agricultural RD&E investments for small industries conducted by the evaluation team where average BCRs have been estimated between 2 and 5 to 1.

Hort Innovation directly invested \$35.62 million (undiscounted, real 2021/22-dollar terms) through the Hort Frontiers program in the eight projects evaluated and was able to leverage the organisation's investment to achieve total funding of \$70.73 million (undiscounted, real 2021/22-dollar terms). This equates to a leverage ratio, the ratio of 'other' investment to Hort Innovation Hort Frontiers investment, of approximately 1 to 1. That is, for every \$1 of Hort Frontiers program investment, RD&E funding partners contributed an additional \$1.

Based on the conservative assumptions made and the fact that not all impacts were valued, it is likely that the aggregate estimated investment criteria reported are an underestimate of the performance of the Hort Innovation Hort Frontiers RD&E investment evaluated. The positive results demonstrate the importance and value of collaborative investment in transformative, cross-sectoral RD&E priorities for the horticulture sector and the evaluation findings should be viewed with confidence by Hort Innovation, the Australian horticulture sector, and policy personnel responsible for allocation of public funds.

## Recommendations

### 1) Stakeholder engagement and extension/adoption planning

The Hort Frontiers impact assessments showed that end-user awareness, understanding, and adoption of key RD&E outputs is critical to the realisation of impacts and industry benefits. Where projects included a high level of stakeholder/end-user/industry engagement, ownership of project outputs appeared higher and contributed to greater confidence in project outcomes and impacts estimated.

Future collaborative RD&E initiatives should allocate resources to end-of-project extension, stakeholder engagement, and RD&E output adoption activities from project inception. Project success and future impact is highly dependent on stakeholder awareness, understanding, acceptance, and adoption of RD&E outputs. Therefore, particularly for large, complex investments such as GC15002 and HG14033, it is recommended that future RD&E initiatives:

- Set aside resources and put in place a formal Plan for end-of-project extension and adoption activities during project planning, contracting and inception (in addition to, or integrated with, project Monitoring and Evaluation (M&E) and Communications Plans),
- Enhance engagement with external stakeholders during project activities to improve project success and increase the likelihood of adoption and impact, and/or
- Engage with key end-user stakeholder groups and obtain commitments for resources to (a) fund post-project engagement, extension, and adoption activities (either through the project team or other delivery partners), and/or (b) undertake their own, independent extension and adoption activities.

### 2) Expert input to future monitoring and evaluation processes

When Hort Innovation next updates, amends and/or revises the organisation's Evaluation Framework and/ or other M&E processes, it is recommended that Hort Innovation seek input from a suitably qualified/experienced analyst familiar with evaluation and/or impact assessment of agricultural RD&E to ensure that the organisation's performance measures (i.e., key performance indicators) and data collection procedures appropriately contribute to future assessment of impacts and/or evaluation of the performance of Hort Innovation Hort Frontiers RD&E investments.

This may involve development of an impact specific M&E framework within the overall Hort Innovation Evaluation Framework that specifically addresses assessment and estimation of project/program outcomes and impacts and explicitly describes end-of-project evaluation data/information requirements and responsibilities.

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## Abbreviations and Acronyms

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
DNA	Deoxyribonucleic Acid
Hort Innovation	Horticulture Innovation Australia Ltd
IRR	Internal Rate of Return
LOP	Life Of Project
MIRR	Modified Internal Rate of Return
NPV	Net Present Value
NSW	New South Wales
NT	Northern Territory
PFA	Pest Free Area
PhD	Doctor of Philosophy
PSA	Phytosanitary Systems Approach
PVB	Present Value of Benefits
PVC	Present Value of Costs
Qfly	Queensland Fruit Fly
QLD	Queensland
RD&E	Research, Development, and Extension
SA	South Australia
SIT	Sterile Insect Technique
TAS	Tasmania
VIC	Victoria
WA	Western Australia

## 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., $\text{present value of benefits} - \text{present value of costs}$ .
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.