Draft Report

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Horticulture Impact Assessment Program:

2021 Aggregate Report (2019/20 Sample)

Impact analyst

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What the report is about

This report describes a process for evaluating a series of project investments in research, development and extension (RD&E) by Horticulture Innovation Australia Limited (Hort Innovation). The process has been used to identify and report the impacts from, and economic performance of, 15 individual project investments. These 15 project investments were drawn at random from a population of completed projects that was defined as projects that had a final deliverable submitted during the year ending June 2020 that included Hort Innovation levy funds and had a total project value greater than, or equal to, $80,000 over each project's lifetime.

Methodology

The sample of RD&E projects was drawn at random using a random number technique. The sample was stratified by six, pre-defined investment value ranges to represent the spectrum of Hort Innovation RD&E investments by size. Further, the stratified, random sample was constructed to make up at least 10% by value of the total project population investment (Hort Innovation investment only, in nominal terms).

Each of the 15 projects was evaluated using a logical framework approach that reported project objectives, activities and outputs, outcomes, and impacts. Impacts for each project were categorised and described in a triple bottom line framework. Some of the impacts identified were then valued in monetary terms. Project Principal Investigators, Hort Innovation personnel and industry personnel were consulted and assisted with information relevant to the project descriptions as well as to assumptions relevant to the impact valuations.

Impacts were valued for 14 of the 15 randomly selected RD&E investments. For the 14 projects where impacts were valued the investment criteria reported included the present value of costs (PVC), the present value of benefits (PVB), net present value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Modified IRR. One project was deemed not to have quantifiable impacts; for this project only the PVC was reported.

The investment criteria that were estimated and reported include the investment criteria for each project investment and the aggregate investment criteria for all 15 projects. The aggregate analysis included benefits from the 14 projects where impacts were valued and the costs for all 15 project investments, yielding a lower bound estimate of the investment criteria for the 2019/20 sample.

Results/key findings

The 15 RD&E projects subjected to impact assessment were found to have produced a range of economic, environmental and social impacts. Across all 15 projects assessed there were 76 individual impacts identified. Of these, approximately 33% were identified as economic (25), 14% environmental (11) and 53% social (40).

Across the 15 projects, leverage ratios varied from 0 to 1.52 (nominal terms). Six projects had a leverage ratio of 0 (no external funding). The highest leveraged project was the project MC14000 (*Macadamia Second Generation Breeding and Conservation*) with a leverage ratio of 1.52. The weighted average leverage ratio for all 15 projects was 0.35.

Aggregate investment criteria

Total funding from all sources for the 15 project investments totalled $39.74 million (present value terms) and produced estimated total expected benefits of $162.92 million (present value terms). This gave an aggregate weighted average BCR of approximately 4.10 to 1 after 30 years at a 5% discount rate. The results are consistent with other, similar evaluations of agricultural RD&E investments conducted by the evaluation team where average BCRs have been estimated between 2 and 6 to 1.

Conclusions

The positive results reported should be viewed with confidence by Hort Innovation, the various Australian horticulture industries represented (including their levy payers and managers), and policy personnel responsible for allocation of public funds.

The 2019/20 sample was considered largely representative of the investment in Hort Innovations overall RD&E porfolio for the same period. Therefore, the impacts and aggregate investment criteria estimated are likely to be indicative of impacts and performance across the broader suite of RD&E undertaken by Hort Innovation.

Keywords

Impact assessment, cost-benefit analysis, aggregate assessment, investment criteria, RD&E performance

Introduction

Horticulture Innovation Australia Limited (Hort Innovation) required a series of impact assessments to be carried out annually on a number of investments in the Hort Innovation research, development and extension (RD&E) portfolio. The assessments were required to meet the following Hort Innovation evaluation reporting requirements:

- Reporting against the Hort Innovation's current Strategic Plan and the Evaluation Framework associated with Hort Innovation's Statutory Funding Agreement with the Commonwealth Government.
- Reporting against strategic priorities set out in the Strategic Investment Plan for each Hort Innovation industry fund.
- Annual Reporting to Hort Innovation stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

To meet these reporting requirements, the first and second series of impact assessments was conducted in calendar year 2019 and 2020 respectively. Both the first and second series included 15 randomly selected Hort Innovation RD&E investments (projects), the 15 projects for the first series (2019) were worth a total of approximately $9.31 million (nominal Hort Innovation investment) and the second series (2020) projects were worth a total of approximately $7.11 million (nominal Hort Innovation investment).

The third series of impact assessments, carried out in calendar 2021, also included 15 randomly selected Hort Innovation RD&E investments. The investments were selected from a new population of 56 unique Hort Innovation investments worth an estimated $38.91 million (nominal Hort Innovation investment) where a final deliverable had been submitted in the 2019/20 financial year. The 15 investments were selected through a stratified, random sampling process such that investments chosen represented at least 10% of the total Hort Innovation RD&E investment in the overall population (in nominal terms) and was representative of the Hort Innovation investment across six, pre-defined project size classes.

This report presents a summary and the aggregate results for the second series of annual impact assessments of RD&E investments made by Hort Innovation (hereafter referred to as the 2019/20 sample).

Population & Sample Selection

Defining the Population

The population of Hort Innovation projects from which the third annual impact assessment sample was drawn was defined as all Hort Innovation projects that:

(a) Were completed in the 2019/20 financial year (a completed project was defined as an RD&E investment where a final deliverable had been submitted and subsequently accepted by Hort Innovation by 30 June 2020),
(b) Included Hort Innovation RD&E levy funds, and
(c) Had a total Hort Innovation managed investment value of $\geq$ $80,000.

Based on this evaluation population definition, Hort Innovation personnel provided the evaluation team (AgEconPlus and Agtrans Research) with an initial population dataset that contained 445 potential Hort Innovation investment data entries. From this initial dataset:

- 344 investments were removed on the basis that the total Hort Innovation investment was less than $80,000 (population criterion c above),
- 25 investments were removed from the population because they were designated 'MK' projects and were funded through Hort Innovation's marketing levies (population criterion b above),
- 18 investment were removed as they were funded through the Hort Innovation Frontiers Fund (population criterion b above), and
- 2 investments were removed as they did not have a completed final report available (population criterion a above).

This resulted in a final evaluation population of 56 unique, individual project investments with a total Hort Innovation investment value of approximately $38.91 million (whole population).

For each project in the population a suite of project data was captured to support selection of the stratified random sample. Data included the project code, project title, project fund code, start date, and completion date. The data for each project also included financial data (total investment over each project's life) for Hort Innovation and its funding partners.

The data were integrated and rationalised by the evaluation team so that all relevant information (e.g. project code, completion date, and total Hort Innovation managed investment) could be observed and used in the sampling process.

Sample Selection Criteria

The sample of projects to be subjected to impact assessment (evaluation) was selected against the following criteria:

1. A total of 15 projects in the sample.
2. The total sample to represent at least 10% of the total Hort Innovation managed investment in the overall population ($38.91 million in nominal terms).
3. Sample projects must be randomly selected from the population (defined above).
4. The sample to be stratified across a set of pre-determined, Hort Innovation investment value ranges according to the proportion of projects (by Hort Innovation investment value) in each value range in the population (see Table 1 below).

Table 1: Hort Innovation RD&E Investment Value Ranges

Range Identifier	Life of Project (LOP) Value Range	Total Project Value[(a)] in each Value Range ($)	No. of Projects in Population	Value Range as a Proportion of Population (% by value)
1	$50,000 and under[(b)]	0	0	0.0
2	$50,000 - $100,000	557,848	6	1.4
3	$100,000 - $200,000	1,646,739	12	4.2
4	$200,000 - $500,000	4,822,812	14	12.4
5	$500,000 - $1M	11,143,855	15	28.6
6	$1M and above	20,737,706	9	53.3
Total		38,908,959	56	100.0

(a) Hort Innovation managed investment.
(b) Excluded based on population definition.

Hort Innovation also requested that, where possible, within each value range strata, each project should represent a unique Hort Innovation program area (also known as investment themes[1]).

Sample Selection Process

The sample selection was initiated using a spreadsheet that utilised only the project code, value range identifier, total Hort Innovation managed investment, and program data for each of the projects in the population. A random number technique then was applied to the 56 unique Hort Innovation RD&E projects in the population to generate the first random sample of 15 projects for the 2019/20 evaluations.

The first set of 15 randomly selected projects was checked against the sample selection criteria (described previously). Where a criterion was not met (for example, the total Hort Innovation investment in the sample did not meet the 10% minimum value hurdle), individual projects were progressively removed based on the sample criteria required and then replaced with alternative, randomly drawn projects until all stratification criteria were met. The final sample is shown in Table 2.

The final stratified, random sample of 15 Hort Innovation RD&E projects had a total Hort Innovation managed investment value of approximately $23.36 million (nominal dollars) representing approximately 51.3% of the overall Hort Innovation managed investment in the population ($38.91 million). Table 3 describes how the sample compared to the the value range criterion. The 2019/20 evaluation population was somewhat skewed toward higher LOP value range projects, thus the final random sample also was skewed toward higher value projects.

It was not possible to randomly select a sample where, within each LOP value range, no more than one project for each Hort Innovation Portfolio area was included in the sample. Twelve of the projects within the population did not include Portfolio data (i.e. Portfolio Name and Portfolio Manager) and the sample criteria required that eight projects be selected for LOP 6 and there were only nine LOP 6 projects in the whole evaluation population (56 projects).

[1] Hort Innovation's Program Framework identifies 11 cross-sectoral investment themes: (1) pest and disease management, (2) crop production, (3) sustainability, (4) novel technologies, (5) data insights, (6) industry development, (7) domestic market development, (8) international market development, market access and trade, (9) product integrity, (10) corporate services, and (11) strategic drive. For more information see Hort Innovation's 2017/18 annual report, available at: https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/company-annual-report/

Table 2: Stratified Random Sample of 15 RD&E Projects Selected for Impact Assessment (by Project Code)

No.	Project Code	Project Title	Total Hort. Innovation Investment ($)	Start Date	End Date	Portfolio Name	Value Range (Identifier)
1	AL14007	Almond Productivity: Tree architecture and development of new growing systems	1,530,380	1/08/2014	1/11/2019	Crop Production	6
2	AL16001	Australian Almond Industry Innovation and Adoption Program	1,194,482	1/02/2017	1/04/2020	Technology Transfer and Adoption	6
3	BA14014	Fusarium wilt Tropical Race 4 Research Program	4,500,018	29/06/2015	1/06/2020	Plant Health: Pathology / Virology / Nematodes	6
4	BS15004	Facilitating the development of the Australian strawberry industry – temperate regional delivery	480,050	1/04/2016	31/08/2019	Technology Transfer and Adoption	4
5	CT17003	Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility	659,871	1/01/2018	30/12/2019	Crop Production	5
6	MC14000	Macadamia Second Generation Breeding and Conservation	1,989,071	30/01/2015	23/12/2019	Breeding	6
7	MC15008	Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps	188,276	15/09/2015	30/10/2019	Breeding	3
8	MT17005	Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)	474,094	1/04/2018	15/06/2020	Biosecurity Trade	4
9	MU17005	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	793,453	1/09/2018	19/09/2019	Natural Resources	5
10	VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	1,151,000	7/12/2015	9/08/2019	Plant Health: Pathology / Virology / Nematodes	6
11	VG15027	Vegetable Industry Communication Program 2016-2019	4,859,322	20/02/2016	31/08/2019	*No Data*	6
12	VG15067	Development of a Vegetable Education Resource - Stage 2	667,500	28/06/2016	30/10/2019	Human Nutrition	5
13	VG16009	Adoption of precision systems technology	2,709,875	23/12/2016	31/01/2020	Emerging Technologies	6
14	VG16042	Pathogen Persistence from Paddock to Plate	831,229	15/09/2017	1/12/2019	Product Integrity	5
15	VG18003	National Industry Development for the Vegetable Industry	1,329,720	1/07/2019	31/03/2020	Extension - North East Region	6
Total Hort Innovation Managed Investment			**23,358,342**				

Table 3: Hort Innovation 2019/20 Impact Assessment Sample – Value Range Criterion

Range Identifier	Total Project Value[(a)] in each LOP Value Range ($)	Proportion of Population[(a)] (Sample Target) (%)	Total Project Value (for Sample) in each LOP Value Range[(b)] ($)	Value by Range as a Proportion of Total Investment in the Sample (%)	No. of Projects Selected (Sample)
1	0	0.0	0	0.0	0
2	557,848	1.4	0	0.0	0
3	1,646,739	4.2	188,276	0.8	1
4	4,822,812	12.4	954,144	4.1	2
5	11,143,855	28.6	2,952,053	12.6	4
6	20,737,706	53.3	19,263,868	82.5	8
Total	38,908,959	100.0	23,358,342	100.0	15

(a) See Table 1.
(b) Hort Innovation managed investment.

General Evaluation Method

The individual impact assessments followed general evaluation guidelines that are 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 included both qualitative and quantitative assessments that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018). The quantitative assessments used cost-benefit analysis as its principal tool.

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts for each RD&E investment selected for the 2019/20 sample. The principal economic, environmental and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were then valued in monetary terms. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the project. However, as not all impacts were valued, the investment criteria reported for individual investments potentially represent an underestimate of the performance of that investment.

Impacts

Summary of Project Impacts

The following section summarises the key qualitative results for the 15 randomly selected projects that were subjected to impact assessment as part of the Hort Innovation annual impact assessment program. The impacts and potential impacts from each project investment were identified, described, and then classified into economic, environmental, and social impacts, on an individual project basis. The actual and potential impact types identified for each project are shown in Table 4 (economic impacts), Table 5 (environmental impacts), and Table 6 (social impacts).

Table 4: Principal Economic Impacts by Project

Economic	AL14007	• Progress toward higher yielding and more profitable almond orchards.
	AL16001	• Lower costs of production for almond growers as a result of industry innovation and research adoption. • More profitable sales for almond growers with improved market conditions.
	BA14014	• Avoided future banana production losses from Fusarium wilt Tropical Race 4 for some Australian growers. • Improved efficiency and/or effectiveness of resource allocation associated with investment in banana breeding through improved prioritisation. • Improved efficiency and/or effectiveness of resource allocation for Fusarium wilt Tropical Race 4 RD&E investment.
	BS15004	• Increased productivity and profitability of some strawberry growers in temperate regions derived from increased adoption of best practices and more cohesive and efficient strawberry supply chains.
	CT17003	• Reduced risk and associated costs of an outbreak of Huanglongbing in the Australian citrus industry.
	MC14000	• Increased average productivity and/or profitability for some Australian macadamia growers. • Increased efficiency and/or effectiveness of resource allocation for macadamia breeding RD&E. • Reduced nursery management costs through implementation of new breeding strategies such as higher density planting and planting seedlings within six months of germination rather than the conventional 24 months. This, in turn, results in up to an 80% reduction in progeny maintenance and evaluation costs.
	MC15008	• A contribution to the recent macadamia breeding program investment (Project MC14000) via the production of the linkage map data. • Potentially, the future Australian macadamia industry will benefit from the use of improved genomic information in breeding of new varieties that will lead to productivity and profitability gains by growers.

		• Any Australian prospective future productivity gains based on genomic information will be likely to maintain or increase the Australian competitive advantage over macadamia production in other countries.
	MT17005	• Reduced potential losses of susceptible fruit in Australia and New Zealand due to an increased probability of containment and reduced area of impact. • Increased efficiency of use of resources in reducing risk of entry and resources in addressing curtailment of spread should an incursion occur.
	MU17005	• Progress toward a more profitable Australian mushroom industry.
	VG15009	• Avoidance or mitigation of soilborne disease costs for brassica and carrot growers adopting DNA-based pre-plant soil tests.
	VG15027	• Lower costs of production for vegetable growers as a result of increased research adoption.
	VG15067	• Increased vegetable consumption by primary school aged children (8- to 12-year-olds) resulting in additional profitable vegetable sales by Australian growers.
	VG16009	• Increase in future use of precision agriculture technologies by levy paying Australian vegetable growers resulting in increased productivity and profitability of vegetable production.
	VG16042	• Potential cost savings for growers with ongoing use of cost-effective manures / composts and cost savings associated with the sterilisation of irrigation water.
	VG18003	• Lower costs of production for vegetable growers as a result of increased R&D adoption.

Table 5: Principal Environmental Impacts by Project

Environmental	AL14007	• Nil.
	AL16001	• Nil.
	BA14014	• Nil.
	BS15004	• Potential for some environmental benefits to be captured from more informed use of agrichemicals by temperate strawberry growers.
	CT17003	• Nil.
	MC14000	• Some contribution to reduced on-farm chemical use in the future through the development of varieties with increased pest and disease resistance. This may lead to improved environmental outcomes such as increased beneficial biodiversity and reduced chemical export off-farm.

	MC15008	• Nil.
	MT17005	• Potentially, some contribution to improved environmental outcomes through increased adoption of best management practices (e.g. integrated pest and disease management, protection of beneficials).
	MU17005	• Progress toward a reduction in the environmental cost of mushroom waste disposal.
	VG15009	• The potential for less chemicals in the farm environment with fewer pre-plant soil treatments.
	VG15027	• An improved farm environment with adoption of research findings that facilitate sustainable vegetable production.
	VG15067	• Reduced vegetable waste, in both households and the supply chain, associated with increased consumption.
	VG16009	• More targeted use of inputs (e.g. fertilisers) potentially resulting in reduced export of nutrient to external environments. • More targeted use of and pest control chemicals resulting in slower development of resistance and in reduced chemical export to external environments.
	VG16042	• Avoided environmental impacts associated with the accumulation of animal waste no longer required by the vegetable industry.
	VG18003	• An improved farm environment with adoption of research findings that facilitate sustainable vegetable production.

Table 6: Principal Social Impacts by Project

Social	AL14007	• Additional researcher skills in the assessment of tree architecture and almond growing systems. • More informed almond breeders with knowledge on architectural traits required for future intensive growing systems. • Contribution to improved regional community wellbeing from spillover benefits as a result of increased crop yields and grower income.
	AL16001	• ABA staff, almond growers, and the supply chain with additional skills in liaison, extension, innovation, and production. • Direct employment of 7.5 FTE[2] persons in regional Australia. • Contribution to improved regional community wellbeing from spillover benefits as a result of a sustainable, profitable almond industry.

[2] FTE: Full-Time Equivalent

	BA14014	• Increased scientific knowledge and research capacity through the creation of new knowledge (e.g. knowledge of the banana microbiome), biosecurity education and training, and facilitation of international collaborative networks. • Potentially, maintained regional community wellbeing through spillover benefits of a more secure banana industry.
	BS15004	• Some regional social impacts may have been derived from increased spillovers to families and businesses in temperate strawberry areas from increased grower and supply chain profitability increases. • Increased capability and capacity of temperate strawberry growers to change and to further adopt improved practices in future.
	CT17003	• Some regional social impacts may have been derived from increased spillovers to families and businesses in citrus growing regions from reduced negative impacts on citrus grower incomes. • Increased capability and capacity of citrus growers and nurseries to understand the risks and impacts of Huanglongbing and associated vectors being introduced to Australia.
	MC14000	• Increased scientific knowledge and research capacity associated with macadamia breeding. • Some contribution to enhanced future regional community wellbeing through spillover benefits associated with a more productive and/or profitable Australian macadamia industry.
	MC15008	• Potentially, improved regional community wellbeing will be delivered from spillover benefits from any future increases in macadamia grower and supply chain profitability. • The project has made a contribution to increased skills and knowledge of scientists and macadamia breeders working with the macadamia genome.
	MT17005	• Increased capacity and skills by industry and others in recognising and managing an incursion of Spotted Wing Drosophila. • Potentially, improved regional community well-being from spillover benefits from the reduced negative impacts on the production of susceptible horticultural industries.
	MU17005	• Progress toward augmentation of the mushroom industry's social licence to operate. • Capacity built by researchers understanding waste reduction and value adding opportunities. • Potential spillover impacts with a more sustainable and profitable industry adding to economic activity in mushroom growing areas.

	VG15009	• Increased researcher, grower, and advisor capacity in the testing and interpretation of DNA-based soil tests. • Future contribution to regional community wellbeing with more profitable and sustainable vegetable growers.
	VG15027	• Enhanced vegetable industry social licence to operate with improved environmental performance. • Additional communication capacity in AUSVEG. • Additional grower capacity and understanding of the importance of the vegetable research and development levy. • Future contribution to improved regional community wellbeing with more profitable and sustainable vegetable growers.
	VG15067	• Children eating additional healthy vegetables, forming positive life-long habits, and reducing the costs of endemic diseases such as obesity, cardiovascular disease, type 2 diabetes, and certain cancers. • Researchers with a better understanding of what motivates children and the design of effective education programs. • Contribution to improved regional community wellbeing with more profitable vegetable growers and healthy school-aged children.
	VG16009	• Increased capacity and skills by vegetable growers and supply contractors throughout Australia in the use of PA technologies. • Potentially, future improved regional community wellbeing from spillover benefits from the increased productivity and profitability of vegetable growers.
	VG16042	• Reduced risk of a food safety scare (e.g., *Listeria* detection) on vegetables reducing consumer confidence, consumption and prices received by growers. • Improved food safety systems with the possibility of improved health outcomes for Australian vegetable consumers. • Additional grower food safety capacity and researcher food safety capacity. • Increased income in vegetable growing areas associated with a more profitable and sustainable industry (spillover impact).
	VG18003	• Additional grower capacity and understanding of innovation and the role of R&D outputs in their businesses. • Additional extension capacity – project researchers, managers and industry development officers. • Future contribution to improved regional community wellbeing with more profitable and sustainable vegetable growers.

Overview of Impact Types

The specific, project level impacts then were generalised into broad impact categories/types to describe the overall economic, environmental and social impacts of the total Hort Innovation RD&E portfolio, as represented by the stratified, random sample of projects assessed. Each individual project impact is represented by one tick mark (✓) in Table 7 (broad economic impact types), Table 8 (broad environmental impact types) and Table 9 (broad social impact types). Some projects have multiple ticks in the one category; this is because these impacts were different to one another but fell into the same category.

Across all 15 projects assessed there were 76 individual impacts identified. Of these, approximately 33% were identified as economic (25), 14% environmental (11) and 53% social (40).

Table 7: Impacts by Broad Economic Impact Type for each Project in the Hort Innovation 2019/20 Impact Assessment Sample

Project Code	**Economic Impact Type**			
	Increased productivity and/or profitability for Australian horticulture crops[(a)]	Improved rates of genetic gain for key horticultural crops	Reduced impact and control costs from endemic horticultural pests and/or diseases	Increased efficiency of resource allocation, particularly for horticulture RD&E expenditure
AL14007	✓			
AL16001	✓✓			
BA14014	✓		✓	✓✓
BS15004	✓			
CT17003	✓		✓	
MC14000	✓	✓	✓	✓
MC15008		✓		
MT17005	✓		✓	✓
MU17005	✓			
VG15009			✓	
VG15027	✓			
VG15067	✓			
VG16009	✓			
VG16042	✓			
VG18003	✓			
Impact Count	**14**	**2**	**5**	**4**

(a) Includes drivers such as increased average yields, reduced production costs, improved market conditions, avoided production losses, increased area grown, increased average product value, and increased average product quality.

Table 8: Impacts by Broad Environmental Impact Type for each Project in the Hort Innovation 2019/20 Impact Assessment Sample

Project Code	**Environmental Impact Type**			
	Reduced risk of chemical export to the off-farm environment	Avoided and/ or reduced waste	Increased adoption of environmentally friendly, best management practices	Other/ miscellaneous
AL14007				
AL16001				
BA14014				
BS15004	✓			
CT17003				
MC14000	✓			
MC15008				
MT17005			✓	
MU17005		✓		
VG15009	✓			
VG15027				✓
VG15067		✓		
VG16009	✓			✓
VG16042		✓		
VG18003				✓
Impact Count	**4**	**3**	**1**	**3**

Table 9: Impacts by Broad Social Impact Type for each Project in the Hort Innovation 2019/20 Impact Assessment Sample

Project Code	**Social Impact Type**				
	Increased knowledge and scientific/ research capacity	Productivity/ profitability benefits having a flow-on effect to support improved regional community wellbeing	Maintained or enhanced social licence to operate for some Australian horticultural producers	Increased industry or other stakeholder capacity (e.g. export capacity)	Other/ miscellaneous (e.g. improved human health and wellbeing)
AL14007	✓	✓		✓	
AL16001		✓		✓	✓
BA14014	✓	✓			
BS15004		✓		✓	
CT17003		✓		✓	
MC14000	✓	✓			
MC15008	✓	✓			
MT17005		✓		✓	
MU17005	✓	✓	✓		
VG15009	✓	✓		✓	
VG15027		✓	✓	✓✓	
VG15067	✓	✓			✓
VG16009		✓		✓	
VG16042		✓		✓	✓✓
VG18003		✓		✓✓	
Impact Count	**7**	**15**	**2**	**12**	**4**

Results

Overview

The following sections present the estimated investment criteria for each of the 15 Hort Innovation RD&E project investments evaluated and for all 15 projects in aggregate. The total investment for each project was usually a combination of resources from Hort Innovation and other funding partners, for example from State departments or other research/industry organisations. The investment criteria for each project investment are reported for both the total investment (including that of Hort Innovation) and for the Hort Innovation investment alone.

The investment costs for all resources (cash and in-kind) were expressed in 2019/20 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2020). All benefits after 2019/20 also were expressed in 2019/20 dollar terms. All costs and benefits were discounted to 2019/20 using a discount rate of 5% and using a reinvestment rate of 5% for calculating the Modified Internal Rate of Return (MIRR). The base analyses used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All individual analyses ran for the length of the individual project investment period plus 30 years from the last year of investment.

Results presented include the Present Value of Costs (PVC), estimated Present Value of Benefits (PVB), Net Present Value (NPV), Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Modified IRR (MIRR). Definitions for these terms may be found in the Glossary of Economic Terms at the end of this report.

For the third series of Hort Innovation's annual impact assessments, 14 of the 15 projects had impacts that were valued in monetary terms. Impacts were not valued for project MC15008 and detailed reasoning behind the decision not to value the impacts identified can be found in the individual project evaluation report available from Hort Innovation. For the project where no impacts are valued, only the PVC is reported, with all other investment criteria appearing as NR (not reported) where applicable. However, the cost cash flows for projects with no impacts valued are still included in the calculation of the aggregate investment criteria for all 15 projects.

Investment Criteria by Project

The individual project investment criteria for the total investment and the Hort Innovation investment for the 2019/20 random sample are reported in Table 10 and Table 11 respectively.

Table 10: Investment Criteria for Total Investment by Individual Project (30 years after last year of investment, 5% discount rate)

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
AL14007	Almond Productivity: Tree architecture and development of new growing systems	4.80	1.53	3.27	3.13	10.6	8.5
AL16001	Australian Almond Industry Innovation and Adoption Program	5.29	1.50	3.78	3.51	21.7	9.0
BA14014	Fusarium wilt Tropical Race 4 Research Program	94.98	9.43	85.55	10.08	24.9	13.8
BS15004	Facilitating the development of the Australian strawberry industry – temperate regional delivery	2.09	0.64	1.45	3.28	17.4	9.5
CT17003	Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility	3.03	0.97	2.06	3.12	19.8	9.0
MC14000	Macadamia Second Generation Breeding and Conservation	10.30	6.70	3.60	1.54	8.6	3.6
MC15008	Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps	NR	0.26	NR	NR	NR	NR
MT17005	Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)	1.59	0.70	0.89	2.26	16.7	7.8
MU17005	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	3.97	0.96	3.00	4.12	14.8	9.5
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	8.55	1.69	6.86	5.05	23.7	10.7
VG15027	Vegetable Industry Communication Program 2016-2019	11.39	5.70	5.69	2.00	13.1	7.2
VG15067	Development of a Vegetable Education Resource - Stage 2	1.54	1.13	0.41	1.36	7.0	6.0
VG16009	Adoption of precision systems technology	10.26	6.00	4.26	1.71	10.9	6.9
VG16042	Pathogen Persistence from Paddock to Plate	1.84	0.99	0.85	1.86	10.8	6.9
VG18003	National Industry Development for the Vegetable Industry	3.29	1.53	1.77	2.16	33.7	7.5

NR: Not Reported

Table 11: Investment Criteria for the Hort Innovation Investment by Individual Project (30 years after last year of investment, 5% discount rate)

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
AL14007[(a)]	Almond Productivity: Tree architecture and development of new growing systems	4.80	1.53	3.27	3.13	10.6	8.5
AL16001[(a)]	Australian Almond Industry Innovation and Adoption Program	5.29	1.50	3.78	3.51	21.7	9.0
BA14014	Fusarium wilt Tropical Race 4 Research Program	63.39	6.29	57.10	10.08	24.9	13.8
BS15004[(a)]	Facilitating the development of the Australian strawberry industry – temperate regional delivery	2.09	0.64	1.45	3.28	17.4	9.5
CT17003[(a)]	Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility	3.03	0.97	2.06	3.12	19.8	9.0
MC14000	Macadamia Second Generation Breeding and Conservation	4.08	2.65	1.43	1.54	8.6	3.6
MC15008	Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps	NR	0.24	NR	NR	NR	NR
MT17005	Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)	1.29	0.57	0.72	2.26	16.7	7.9
MU17005[(a)]	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	3.97	0.96	3.00	4.12	14.8	9.5
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	7.76	1.54	6.22	5.04	23.6	10.7
VG15027	Vegetable Industry Communication Program 2016-2019	1.19	0.88	0.31	1.35	7.0	5.9
VG15067	Development of a Vegetable Education Resource - Stage 2	1.19	0.88	0.31	1.35	7.0	5.9
VG16009	Adoption of precision systems technology	6.32	3.69	2.63	1.71	10.9	6.6
VG16042[(a)]	Pathogen Persistence from Paddock to Plate	1.84	0.99	0.85	1.86	10.8	6.9
VG18003	National Industry Development for the Vegetable Industry	2.91	1.35	1.56	2.16	33.7	7.5

NR: Not Reported

(a) 100% Hort Innovation managed investment. Thus, investment criteria for the total investment (Table 10) and the Hort Innovation investment are the same.

Of the 15 projects randomly selected for the 2019/20 sample for the Hort Innovation annual impact assessment program, 14 included impacts that were valued in monetary terms. The total investment per project (PVC) across all 15 RD&E investments (Table 10) ranged from $0.26 million to $9.43 million (present value terms). Estimated benefits (PVB) for individual projects where impacts were valued ranged from $1.54 million to $94.98 million (present value terms).

Table 12 and Table 13 identify the three projects with the highest NPVs and BCRs. The projects are listed in descending order of each key investment criterion.

Table 12: Top Three Projects by Net Present Value
(Total Investment, 30 years, 5% discount rate)

Project Code	Project Title	NPV ($ million)
BA14014	Fusarium wilt Tropical Race 4 Research Program	85.55
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	6.86
VG15027	Vegetable Industry Communication Program 2016-2019	5.69

Table 13: Top Three Projects by Benefit-Cost Ratio
(Total Investment, 30 years, 5% discount rate)

Project Code	Project Title	BCR ($ million)
BA14014	Fusarium wilt Tropical Race 4 Research Program	10.08
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	5.05
MU17005	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	4.12

Aggregate Investment Criteria (15 Projects)

Table 14 and Table 15 provide the aggregate investment criteria for all 15 projects for both total investment and the Hort Innovation investment only.

Table 14: Aggregate Investment Criteria for Total Investment in all 15 Projects
(5% discount rate)

Investment Criteria	Years after last year of investment						
	0	5	10	15	20	25	30
PVB ($m)	1.07	20.90	59.65	99.18	125.01	144.17	162.92
PVC ($m)	33.56	39.74	39.74	39.74	39.74	39.74	39.74
NPV ($m)	-32.49	-18.84	19.90	59.43	85.26	104.43	123.18
BCR	0.03	0.53	1.50	2.50	3.15	3.63	4.10
IRR (%)	negative	negative	11.0	15.7	16.9	17.4	17.6
MIRR (%)	negative	negative	9.7	10.6	9.5	8.5	7.8

Table 15: Aggregate Investment Criteria for Hort Innovation Investment in all 15 Projects (5% discount rate)

Investment Criteria	Years after last year of investment						
	0	5	10	15	20	25	30
PVB ($m)	0.79	16.52	45.61	73.37	91.70	105.53	118.98
PVC ($m)	24.90	29.41	29.41	29.41	29.41	29.41	29.41
NPV ($m)	-24.11	-12.89	16.20	43.96	62.29	76.11	89.57
BCR	0.03	0.56	1.55	2.49	3.12	3.59	4.05
IRR (%)	negative	negative	11.6	16.0	17.1	17.5	17.7
MIRR (%)	negative	negative	9.9	10.5	9.4	8.4	7.7

The results in Table 14 show that the weighted average BCR for all 15 projects was approximately 4.1 to 1 for the total investment after 30 years. The simple average BCR was approximately 3.2 to 1 (derived from Table 10). The aggregate investment criteria were positive after ten years (BCR of 1.5).

The PVB for the Hort Innovation investment (Table 15) was estimated by multiplying the total PVB for each individual project by the Hort Innovation proportion of real investment in each project and then aggregating the Hort Innovation benefit cash flows for all 15 projects. The proportion of Hort Innovation investment at the project level varied from approximately 15.4% (Project VG15027) to 100% (six projects).

Source of Benefits

Table 16 shows the contribution of each project to the total PVB (Total Investment)

Table 16: Contribution of Benefits by Source

Project Code	Project Title	PVB ($m)	Proportion of Total PVB (%)
AL14007	Almond Productivity: Tree architecture and development of new growing systems	4.80	2.9
AL16001	Australian Almond Industry Innovation and Adoption Program	5.29	3.2
BA14014	Fusarium wilt Tropical Race 4 Research Program	94.98	58.3
BS15004	Facilitating the development of the Australian strawberry industry – temperate regional delivery	2.09	1.3
CT17003	Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility	3.03	1.9
MC14000	Macadamia Second Generation Breeding and Conservation	10.30	6.3
MC15008	Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps	NR	0.0
MT17005	Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)	1.59	1.0
MU17005	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	3.97	2.4
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	8.55	5.2
VG15027	Vegetable Industry Communication Program 2016-2019	11.39	7.0

VG15067	Development of a Vegetable Education Resource - Stage 2	1.54	0.9
VG16009	Adoption of precision systems technology	10.26	6.3
VG16042	Pathogen Persistence from Paddock to Plate	1.84	1.1
VG18003	National Industry Development for the Vegetable Industry	3.29	2.0
Total		162.92	100.0

NR: Not Reported

Leverage

Leverage is expressed here as the ratio of non-Hort Innovation investment to Hort Innovation investment. Across the 15 projects, leverage ratios varied from 0 to 1.52 (nominal terms). Six projects had a leverage ratio of 0 (no external funding). The highest leveraged project was the project MC14000 (*Macadamia Second Generation Breeding and Conservation*) with a leverage ratio of 1.52.

The leverage ratios by project are provided in Table 17. The weighted average leverage ratio for all 15 projects was 0.35.

Table 17: Leverage Ratio by Project

Project Code	Project Title	Leverage Ratio[(a)]
AL14007	Almond Productivity: Tree architecture and development of new growing systems	0.00
AL16001	Australian Almond Industry Innovation and Adoption Program	0.00
BA14014	Fusarium wilt Tropical Race 4 Research Program	0.50
BS15004	Facilitating the development of the Australian strawberry industry – temperate regional delivery	0.00
CT17003	Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility	0.14
MC14000	Macadamia Second Generation Breeding and Conservation	1.52
MC15008	Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps	0.07
MT17005	Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)	0.24
MU17005	Identify and evaluate the potential in adding value and monitoring the mushroom waste streams	0.00
VG15009	Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry	0.10
VG15027	Vegetable Industry Communication Program 2016-2019	0.00
VG15067	Development of a Vegetable Education Resource - Stage 2	0.29
VG16009	Adoption of precision systems technology	0.62
VG16042	Pathogen Persistence from Paddock to Plate	0.00
VG18003	National Industry Development for the Vegetable Industry	0.13
Weighted Average Leverage Ratio (all 15 projects)		0.35

(a) Ratio of non-Hort Innovation managed investment to Hort Innovation investment

Conclusions

Impact assessments were carried out on 15 randomly selected Hort Innovation RD&E investments that were completed with a final deliverable submitted in the year ended June 2020. These investments produced a range of economic, environmental and social impacts. Across all 15 projects assessed there were 76 individual impacts identified. Of these, approximately 33% were identified as economic (25), 14% environmental (11) and 53% social (40).

Total funding from all sources for the 15 project investments totalled $39.74 million (present value terms) and produced estimated total expected benefits of $162.92 million (present value terms). This gave an aggregate weighted average BCR of approximately 4.10 to 1 after 30 years at a 5% discount rate. The results are consistent with other, similar evaluations of agricultural RD&E investments conducted by the evaluation team where average BCRs have been estimated between 2 and 6 to 1. For example, an aggregate assessment of some 288 evaluations of RD&E investments across all 15 Australian Research and Development Corporations funded by the CRRDC generated a weighted average BCR of approximately 4.5 to 1 (Agtrans Research, AgEconPlus & EconSearch, 2016).

Impacts from 14 of the 15 projects from the 2019/20 sample were valued in monetary terms as part of the Hort Innovation annual impact assessment process.

The sample of projects evaluated:

- represented more than 10% of the total Hort Innovation lifetime funding of projects with a final deliverable submitted in the year ended 30 June 2019,
- was representative of funding across the pre-defined Hort Innovation project value ranges, and
- was drawn at random.

Some, but not all, of the impacts identified for each project investment were valued as part of the evaluation 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. As not all impacts were valued, it is likely that the estimated investment criteria reported are an underestimate of the performance of the Hort Innovation RD&E investment evaluated.

The positive results reported should be viewed with confidence by Hort Innovation, the various Australian horticulture industries represented (including their levy payers and managers), and policy personnel responsible for allocation of public funds.

The 2019/20 sample was considered largely representative of the investment in Hort Innovation's overall RD&E porfolio for the same period. Therefore, the impacts and aggregate investment criteria estimated are indicative of impacts and performance across the broader suite of RD&E undertaken by Hort Innovation. Further, as part of Hort Innovation's ongoing, annual impact assessment program, the representative results from the 2017/18 (first series), 2018/19 (second series) and 2019/20 (third series) evaluations will contribute to Hort Innovation's performance story over time.

Recommendations

The evaluation process reported was the third year of an annual process completed over a three-year period of evaluations of Hort Innovation RD&E under Project MT18011. It was intended that Hort Innovation and the evaluation team assess the overall evaluation process each year and make any reasonable improvements for any subsequent evaluation of Hort Innovation RD&E investments. The following suggestions are made in this context with the intention of them being considered by Hort Innovation personnel before any future evaluations.

Consultation with Key Project Personnel

As with the previous series of impact assessments conducted in calendar 2019 and 2020, an important step in the impact assessment process is consultation with key project personnel including, potentially, the project's Principal Investigator and/or the project's Hort Innovation Portfolio Manager.

One of the major challenges faced by the evaluation team was gaining the cooperation of key project personnel to provide data, feedback, and/or details of additional contacts (e.g. industry stakeholders) regarding each project's impact assessment (e.g. misinterpretations and/or omissions within the logical framework and feedback on key assumptions/data used in the impact valuations).

Prior to any future impact assessments being undertaken, it is recommended that the relevant Principal Investigators and/or Portfolio Managers for the projects sampled are advised in advance by Hort Innovation regarding the requirement to provide assistance for the impact assessment process.

Glossary of Economic Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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Appendices

The following table lists the titles of the individual impact assessment reports that form the appendices to the 2021 Aggregate Report (2019/20 Sample).

Table 18: Individual Impact Assessment Report Titles: Hort Innovation Impact Assessment Program 2019/20 Sample

Project Code	Report Title
AL14007	Appendix 1: Almond Productivity: Tree architecture and development of new growing systems
AL16001	Appendix 2: Australian Almond Industry Innovation and Adoption Program
BA14014	Appendix 3: Fusarium wilt Tropical Race 4 Research Program
BS15004	Appendix 4: Facilitating the development of the Australian strawberry industry – temperate regional delivery
CT17003	Appendix 5: Maximising the Biosecurity of the Australian Citrus Industry Budwood Facility
MC14000	Appendix 6: Macadamia Second Generation Breeding and Conservation
MC15008	Appendix 7: Establishing an open-source platform for unravelling the genetics of Macadamia: integration of linkage and genome maps
MT17005	Appendix 8: Improving the biosecurity preparedness of Australian horticulture for the exotic Spotted Wing Drosophila (Drosophila suzukii)
MU17005	Appendix 9: Identify and evaluate the potential in adding value and monitoring the mushroom waste streams
VG15009	Appendix 10: Improved soilborne disease diagnostic capacity for the Australian Vegetable Industry
VG15027	Appendix 11: Vegetable Industry Communication Program 2016-2019
VG15067	Appendix 12: Development of a Vegetable Education Resource - Stage 2
VG16009	Appendix 13: Adoption of precision systems technology
VG16042	Appendix 14: Pathogen Persistence from Paddock to Plate
VG18003	Appendix 15: National Industry Development for the Vegetable Industry

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Abbreviations

RD&E	Research, Development and Extension
BCR	Benefit-Cost Ratio
CRRDC	Council of Rural Research and Development Corporations
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
NR	Not Reported
PVB	Present Value of Benefits
PVC	Present Value of Investment Costs