Hort Innovation

Final Report

Industry-specific impact assessment program: Mango

2021 Aggregated Report

Impact analyst

Michael Clarke

Delivery partner:

AgEconPlus and Agtrans Research

Project code:

MT20008

Date:

November 2021

Disclaimer:

Horticulture Innovation Australia Limited (Hort Innovation) makes no representations and expressly disclaims all warranties (to the extent permitted by law) about the accuracy, completeness, or currency of information in this Final Report.

Users of this Final Report should take independent action to confirm any information in this Final Report before relying on that information in any way.

Reliance on any information provided by Hort Innovation is entirely at your own risk. Hort Innovation is not responsible for, and will not be liable for, any loss, damage, claim, expense, cost (including legal costs) or other liability arising in any way (including from Hort Innovation or any other person's negligence or otherwise) from your use or non-use of the Final Report or from reliance on information contained in the Final Report or that Hort Innovation provides to you by any other means.

Funding statement:

This project has been funded by Hort Innovation, using the research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

Published and distributed by: Hort Innovation

Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

© Copyright 2021 Horticulture Innovation Australia

Contents

Tables 4

Keywords 6
Population & Sample Selection 8
General Evaluation Method 11
Impacts 12
Results 16
Conclusions 19
Glossary of Economic Terms 20
References 21
Appendices 22
Acknowledgements 23
Abbreviations 23

Tables

Table 1: Hort Innovation RD&E Investment Value Ranges 9

Table 2: Stratified Random Sample of Three MG RD&E Projects Selected for Impact Assessment (by Project Code) 10

Table 3: Principal Economic Impacts by Project 12

Table 4: Principal Environmental Impacts by Project 12

Table 5: Principal Social Impacts by Project 12

Table 6: Impacts by Broad Economic Impact Type for each Project in the Hort Innovation 2021 MG Impact Assessment Sample 14

Table 7: Impacts by Broad Environmental Impact Type for each Project in the 2021 MG Impact Assessment Sample 14

Table 8: Impacts by Broad Social Impact Type for each Project in the 2021 MG Impact Assessment Sample 15

Table 9: Investment Criteria for Total Investment by Individual MG Project (30 years after last year of investment, 5% discount rate) 17

Table 10: Investment Criteria for the Hort Innovation Investment by Individual MG Project (30 years after last year of investment, 5% discount rate) 17

Table 11: Aggregate Investment Criteria for Total Investment in all Three Projects (5% discount rate) 17

Table 12: Aggregate Investment Criteria for Hort Innovation Investment in all Three Projects (5% discount rate) 18

Table 13: Contribution of Benefits by Source 18

Table 14: Leverage Ratio by Project 18

Table 15: Individual Impact Assessment Report Titles: Mango 2021 Sample 22

Executive Summary

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) through the Mango (MG) Industry Fund. The process has been used to identify and report the impacts from, and economic performance of, three individual project investments. These three project investments were drawn at random from a population of completed projects that was defined as projects that (1) had a final deliverable submitted during the period 1 July 2015 to 30 June 2020, (2) included Hort Innovation levy funds, (3) had at least 50% of the total investment sourced from the named industry (MG), and (4) had a total project value greater than, or equal to, $80,000 over each project's lifetime.

Methodology

Hort Innovation specified that three individual RD&E projects were to be evaluated for the MG industry impact assessments. A stratified random sampling approach was used to select the three RD&E projects for evaluation from a population of 16 MG RD&E projects. The random sample was stratified across three MG industry investment priority areas defined by the Mango Industry Strategic Investment Plan 2017-2021 and represented in the overall MG project population. The stratified random sample also was constructed to represent at least 10% (by value) of the total investment in the project population (Hort Innovation managed investment only, in nominal dollar terms). Thus, the sample for evaluation was selected to be loosely representative of the spectrum of RD&E investments under the Hort Innovation MG levy fund for investments completed in the five-year period ending June 2020.

Each of the three 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.

The investment criteria reported for the individual projects included the present value of costs (PVC), the present value of benefits, net present value, Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR) and Modified IRR.

The investment criteria that were estimated and reported include the investment criteria for each project investment and the aggregate investment criteria for all three projects.

Results/key findings

The three RD&E projects subjected to impact assessment were found to have produced a range of economic, environmental and social impacts. Across all three projects there were 21 individual impacts identified. Of these, approximately 38% were identified as economic (8), 14% environmental (3) and 48% social (10).

Aggregate investment criteria

Total funding from all sources for the three project investments totalled $11.19 million (present value terms) and produced estimated total expected benefits of $26.57 million (present value terms). This gave an aggregate weighted average BCR of approximately 2.4 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 2021 MG sample was considered loosely representative of the investment in Hort Innovations mango RD&E porfolio for the 2015/16 to 2019/20 period. Therefore, the individual project impacts and aggregate investment criteria estimated are broadly indicative of impacts and performance across the broader suite of MG RD&E undertaken by Hort Innovation. Thus, the results reported

should be viewed positively but interpreted with some caution by Hort Innovation, the Australian mango industry, and policy personnel responsible for allocation of public funds.

Keywords

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

Introduction

All research and development (R&D) and marketing levy investments undertaken by Horticulture Innovation Australia Limited (Hort Innovation) are guided and aligned to specific investment outcomes, defined through a Strategic Investment Plan (SIP). The SIP guides investment of the levy to achieve each industry's vision. The current industry SIPs[1] apply for the financial years 2016/17 – 2020/21.

In accordance with the Organisational Evaluation Framework, Hort innovation has the obligation to evaluate the performance of its investment undertaken on behalf of industry.

This impact assessment program addresses this requirement through conducting a series of industry-specific ex-post independent impact assessments of the berries (RB + BS), mango (MG), turf (TU), and nursery (NY) RD&E investment funds.

Fourteen RD&E investments (projects) were selected through a stratified, random sampling process. The industry samples were as follows:

- Four RB + BS projects were chosen worth $1.44 million (nominal Hort Innovation investment) from an overall population of 16 projects worth an estimated $8.59 million,
- Three MG projects worth $1.77 million (nominal Hort Innovation investment) from an overall population of 16 projects worth approximately $7.9 million,
- Four TU projects worth $0.66 million (nominal Hort Innovation investment) from a total population of 15 projects worth $4.81 million[2], and
- Three NY projects worth $0.96 million (nominal Hort Innovation investment) from an overall population of 19 projects worth $7.32 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2015 to 30 June 2020.

The projects for each industry sample were chosen such that, where possible given the small sample size required, the investments represented (1) at least 10% of the total Hort Innovation RD&E investment expenditure for each industry, and (2) the SIP outcomes (proportionally) for each industry.

This report presents a summary and the aggregate results for the impact assessment of RD&E investments made by Hort Innovation from the mango industry fund (hereafter referred to as the 2021 MG sample).

[1] The current Hort Innovation industry SIPs can be found at: https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/

[2] One project (TU13026) was subsequently excluded from the TU aggregate analysis when it was identified that it did not include Hort Innovation levy funding. As a result, the TU13026 results are not reported in the TU aggregate analysis but the individual impact assessment report for TU13026 is included as a stand-alone evaluation in the TU aggregate report appendix.

Population & Sample Selection

Defining the Population

The population of MG Hort Innovation projects from which the 2021 MG impact assessment sample was drawn was defined as all Hort Innovation projects that had the following characteristics:

(a) Were completed during the period 1 July 2015 to 30 June 2020 (5-year window). A completed project was defined as a project where the final deliverable was submitted and accepted by Hort Innovation between 1 July 2015 and 30 June 2020,
(b) Included Hort Innovation levy funds (e.g. this will exclude projects funded solely through grants and/or the Hort Innovation Frontiers fund),
(c) For multi-industry projects (MT project code), the projects must have included levy funds from the named industry (i.e. MG) representing at least 50% of the total investment in each project,
(d) Had a total Hort Innovation managed investment value of > $80,000 (excludes 'trivial' projects), and
(e) Excludes 'enabler projects' not suitable for evaluation (e.g. minor use permit, mid-term review/evaluation, consultation, and SIP development type projects).

Based on this population definition, Hort Innovation personnel provided the evaluation team (AgEconPlus and Agtrans Research) with an MG population dataset that contained 16 individual project investments with a total Hort Innovation investment value of approximately $7.9 million (whole population) representing three of the four potential MG SIP outcome areas.

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

Hort Innovation specified that three individual RD&E projects were to be evaluated for the MG industry impact assessments. A stratified random sampling approach was used to select the three RD&E projects for evaluation from a population of 16 MG RD&E projects. The random sample was stratified across three MG industry investment priority areas defined by the Mango Industry Strategic Investment Plan 2017-2021 and represented in the overall MG project population. The stratified random sample also was constructed to represent at least 10% (by value) of the total investment in the project population (Hort Innovation managed investment only, in nominal dollar terms). Thus, the sample for evaluation was selected to be loosely representative of the spectrum of RD&E investments under the Hort Innovation MG levy fund for investments completed in the five-year period ending June 2020 (see Table 1 below).

Table 1: Hort Innovation RD&E Investment Value Ranges

MG SIP Outcome Area Identifier	MG SIP Outcome Area	Total Project Value[(a)] in each SIP Outcome area ($)	SIP Outcome Area as a Proportion of MG Population (%)
1	Increased industry productivity through increased yields and reduced costs per hectare.	3,023,677	38.3
2	Increased grower profitability through increased consumer demand for Australian mangoes.	3,119,149	39.5
3	Increased R&D and extension capacity and resources supporting industry development.	1,754,771	22.2
4	Improved industry sustainability and management of risks.	0	0.0
Total		7,897,597	100.0

(a) Hort Innovation managed investment.

Sample Selection Process

The sample selection was initiated using a spreadsheet that utilised only the project code, SIP code, and total Hort Innovation managed investment for each of the projects in the population. A random number technique then was applied to the 16 unique Hort Innovation RD&E projects in the MG population to generate the first random sample of three projects for 2020/21 evaluations.

The first set of 3 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 three Hort Innovation MG RD&E projects had a total Hort Innovation managed investment value of approximately $1.77 million (nominal dollars) representing approximately 22.4% of the overall Hort Innovation managed investment in the population ($7.9 million). Further, for the SIP Outcome area criterion, one was selected for SIP Outcome area 1, one for Outcome area 2, and one for Outcome area 3. Within the MG population no projects were completed in Outcome area 4.

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

No.	Project Code	Project Title	Total Hort Innovation Investment ($)	Start Date	End Date	SIP Outcome Area (Identifier)
1	MG12012	Manipulating mango flowering to extend harvest window	664,198	13/03/2013	31/05/2017	O1
2	MG12017	New fruit fly systems for mangoes and market access	620,047	30/06/2013	1/07/2016	O2
3	MG15006	Mango industry communication program 2016-2017	485,808	2/02/2016	31/05/2018	O3
Total Hort Innovation Investment			**1,770,053**			

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 2021 MG 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 three randomly selected MG projects that were subjected to impact assessment as part of the 2021 Hort Innovation industry-specific 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 principal impacts and potential impacts for each project are shown in Table 3 (economic impacts), Table 4 (environmental impacts), and Table 5 (social impacts).

Table 3: Principal Economic Impacts by Project

Economic	MG12012	• Improved profitability for Northern Territory (NT) growers able to apply project findings, consistently deliver early season fruit, achieve production cost savings (harvesting labour and packhouse operation efficiencies) and realise additional early season price premiums.
	MG12017	• Improved profitability for NT mango growers with improved market access (domestic and export) and net savings in fruit fly treatment.
	MG15006	• Lower costs of production for mango growers as a result of increased awareness and adoption of research, marketing, market access and biosecurity information. • Additional profitable mango sales with increased awareness and realisation of new market opportunities.

Table 4: Principal Environmental Impacts by Project

Environmental	MG12012	• Additional understanding of Australian mango variety performance in a changing climate. • Improved environmental outcomes with a potential shift from paclobutrazol to biodegradable prohexidione calcium.
	MG12017	• Improved environmental outcomes with fewer chemical sprays in use on farm and in packing sheds.
	MG15006	• Nil.

Table 5: Principal Social Impacts by Project

Social	MG12012	• Additional researcher skills in mango phenology with PhD students trained as part of the project. • Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of a more profitable and sustainable mango industry.
	MG12017	• Improved health outcomes with less use of organophosphates in mango packing sheds and less risk of chemical residues reaching mango consumers. • Additional researcher skills in fruit fly biology and management. • Additional NT mango grower skills in fruit fly suppression.

		• Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of a more profitable and sustainable mango industry.
	MG15006	• A more sustainable and cohesive industry. • Additional Australian Mango Industry Association and other provider skills in industry communication. • Additional grower skills across mango production, marketing, and biosecurity. • Contribution to improved regional community wellbeing from spill-over income and employment benefits as a result of a more profitable and sustainable mango industry.

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 3 (broad economic impact types), 2 (broad environmental impact types) and 4 (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 3 projects assessed there were 21 individual impacts identified. Of these, approximately 38% were identified as economic (8), 14% environmental (3) and 48% social (10).

Table 6: Impacts by Broad Economic Impact Type for each Project in the Hort Innovation 2021 MG Impact Assessment Sample

Project Code	**Economic Impact Type**		
	Improved profitability for Australian mango growers as a result of more consistent supply.	Improved profitability for Australian mango growers as a result of improved market access/new market opportunities.	Cost savings for Australian mango growers (including savings in fruit fly treatment).
MG12012	✓		✓
MG12017		✓	✓
MG15006	✓	✓✓	✓
Impact Count	**2**	**3**	**3**

Table 7: Impacts by Broad Environmental Impact Type for each Project in the 2021 MG Impact Assessment Sample

Project Code	**Environmental Impact Type**	
	Reduced risk of potentially harmful chemical export to the off-farm environment	Climate change adaptation
MG12012	✓	✓
MG12017	✓	
MG15006		
Impact Count	**2**	**1**

Table 8: Impacts by Broad Social Impact Type for each Project in the 2021 MG Impact Assessment Sample

Project Code	**Social Impact Type**			
	Improved health outcomes for farm workers and consumers (e.g., less use of organophosphates).	Increased scientific knowledge and capacity.	Increased mango grower and industry association knowledge and capacity.	Productivity/ profitability benefits having a flow-on effect to support improved regional community wellbeing.
MG12012		✓		✓
MG12017	✓	✓	✓	✓
MG15006			✓✓✓	✓
Impact Count	**1**	**2**	**4**	**3**

Results

Overview

The following sections present the estimated investment criteria for each of the three Hort Innovation MG RD&E project investments evaluated and for all three 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 2020/21 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2021). All benefits after 2020/21 also were expressed in 2020/21 dollar terms. All costs and benefits were discounted to 2020/21 (year of evaluation) using a discount rate of 5% and using a reinvestment rate of 5% for calculating the Modified Internal Rate of Return (MIRR) as per the CRRDC Impact Assessment guidelines. 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 MIRR. Definitions for these terms may be found in the Glossary of Economic Terms at the end of this report. Impacts from all 3 projects were valued in monetary terms.

Investment Criteria by Project

The individual project investment criteria for the total investment and the Hort Innovation investment for the 2021 MG sample are reported in Table 9 and

Table 10 respectively. Hort Innovation contributed 100% of the funding for one of the three projects (MG15006). For MG15006 the investment criteria in Table 9 and Table 10 are the same.

Table 9: Investment Criteria for Total Investment by Individual MG Project (30 years after last year of investment, 5% discount rate)

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
MG12012	Manipulating mango flowering to extend harvest window	17.43	4.42	13.00	3.94	19.1	9.3
MG12017	New fruit fly systems for mangoes and market access	7.68	6.02	1.67	1.28	5.4	5.3
MG15006	Mango industry communication program 2016-2017	1.46	0.75	0.72	1.96	13.4	7.3

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

Project Code	Project Title	PVB ($m)	PVC ($m)	NPV ($m)	BCR	IRR (%)	MIRR (%)
MG12012	Manipulating mango flowering to extend harvest window	4.50	1.14	3.36	3.94	19.5	9.4
MG12017	New fruit fly systems for mangoes and market access	1.71	1.34	0.37	1.28	5.3	5.2
MG15006	Mango industry communication program 2016-2017	1.46	0.75	0.72	1.96	13.4	7.3

The total investment per project (PVC) across all three MG RD&E investments (Table 9) ranged from $0.75 million to $6.02 million (present value terms). Estimated benefits (PVB) ranged from $1.46 million to $17.43 million (present value terms). The highest NPV ($13.0 million) was reported for project MG12012 (*Manipulating mango flowering to extend harvest window*). Project MG12012 also recorded the highest BCR.

Aggregate Investment Criteria (3 Projects)

Table 11 and

Table 12 provide the aggregate investment criteria for all three projects for both total investment and the Hort Innovation investment only.

Table 11: Aggregate Investment Criteria for Total Investment in all Three Projects (5% discount rate)

Investment Criteria	Years after last year of investment						
	0	5	10	15	20	25	30
PVB ($m)	1.02	6.06	12.36	17.69	21.60	24.63	26.57
PVC ($m)	11.19	11.19	11.19	11.19	11.19	11.19	11.19
NPV ($m)	-10.17	-5.12	1.17	6.50	10.42	13.44	15.39
BCR	0.09	0.54	1.10	1.58	1.93	2.20	2.38
IRR (%)	negative	negative	4.0	8.4	10.0	10.7	11.0
MIRR (%)	negative	negative	4.4	6.9	7.4	7.5	7.4

Table 12: Aggregate Investment Criteria for Hort Innovation Investment in all Three Projects (5% discount rate)

Investment Criteria	Years after last year of investment						
	0	5	10	15	20	25	30
PVB ($m)	0.30	1.78	3.63	5.19	6.34	7.23	7.80
PVC ($m)	3.22	3.22	3.22	3.22	3.22	3.22	3.22
NPV ($m)	-2.93	-1.44	0.40	1.97	3.12	4.01	4.58
BCR	0.09	0.55	1.13	1.61	1.97	2.24	2.42
IRR (%)	negative	negative	4.8	9.1	10.7	11.4	11.6
MIRR (%)	negative	negative	4.8	7.3	7.8	7.8	7.6

The results in Table 11 show that the weighted average BCR for all three projects was approximately 2.4 to 1 for the total investment after 30 years. The simple average BCR was also approximately 2.4 to 1 (derived from Table 9). The aggregate investment criteria were positive after ten years (BCR of 1.1).

The PVB for the Hort Innovation investment (

Table 12) 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 three projects. The proportion of Hort Innovation investment at the project level varied from approximately 22.2% (Project MG12017) to 100% (MG15006).

Source of Benefits

Table 13 shows the contribution of each project to the total PVB (Total Investment)

Table 13: Contribution of Benefits by Source

Project Code	Project Title	PVB ($m)	Proportion of Total PVB (%)
MG12012	Manipulating mango flowering to extend harvest window	17.43	65.6
MG12017	New fruit fly systems for mangoes and market access	7.68	28.9
MG15006	Mango industry communication program 2016-2017	1.46	5.5
Total		26.57	100.0

Leverage

Leverage is expressed here as the ratio of non-Hort Innovation investment to Hort Innovation investment. Across the three projects, leverage ratios varied from 0 to 3.5 (nominal terms). A single project (MG15006) had a leverage ratio of 0 (no external funding). The highest leveraged project was the project MG12017 (*New fruit fly systems for mangoes and market access*).

The leverage ratios by project are provided in Table 14.

Table 14: Leverage Ratio by Project

Project Code	Project Title	Leverage Ratio[(a)]
MG12012	Manipulating mango flowering to extend harvest window	2.87
MG12017	New fruit fly systems for mangoes and market access	3.50
MG15006	Mango industry communication program 2016-2017	0.00

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

Conclusions

Impact assessments were carried out on three randomly selected Hort Innovation MG industry 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 three projects assessed, 21 individual impacts were identified. Of these, 38% were identified as economic (8), 14% environmental (3) and 48% social (10).

Total funding from all sources for the three project investments totalled $11.19 million (present value terms) and produced estimated total expected benefits of $26.57 million (present value terms). This gave an aggregate weighted average BCR of approximately 2.4 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 (RDCs) funded by the CRRDC generated a weighted average BCR of approximately 4.5 to 1 (Agtrans Research, AgEconPlus & EconSearch, 2016).

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 2020,
- was loosely representative across the specific industry SIP outcomes given the small sample size, 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 2021 MG sample was considered loosely representative of the investment in Hort Innovations overall MG industry RD&E porfolio for the 2015/16 to 2019/20 period. Therefore, the impacts and aggregate investment criteria estimated are broadly indicative of impacts and performance across the broader suite of MG RD&E undertaken by Hort Innovation.

Thus, the results reported should be viewed positively but interpreted with some caution by Hort Innovation, the Australian mango industry, and policy personnel responsible for allocation of public funds.

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.

References

Agtrans Research, AgEconPlus & EconSearch. (2016). *Cross-RDC Impact Assessment and Performance Reporting Update.* Canberra ACT: Council of Rural Research and Development Corporations. Retrieved August 2020, from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/161021-CRRDC-Cross-RDC-Impact-Assessment-2010-2015-FINAL-REPORT.pdf

Australian Bureau of Statistics. (2021, June 02). *Australian National Accounts: National Income, Expenditure and Product. Quarterly estimates of key economic flows in Australia, including gross domestic product (GDP), consumption, investment, income and saving*. Table 5. Expenditure on Gross Domestic Product (GDP), Implicit price deflators. Retrieved from Australian Bureau of Statistics: https://www.abs.gov.au/statistics/economy/national-accounts/australian-national-accounts-national-income-expenditure-and-product/latest-release#data-download

Council of Rural Research and Development Corporations. (2018). *Cross-RDC Impcat Assessment Program: Guidelines.* Canberra: Council of Rural Research and Development Corporations. Retrieved from http://www.ruralrdc.com.au/wp-content/uploads/2018/08/201804_RDC-IA-Guidelines-V.2.pdf

Appendices

The following table lists the titles of the individual impact assessment reports that form the appendices to the mango industry specific impact assessment.

Table 15: Individual Impact Assessment Report Titles: Mango 2021 Sample

Project Code	Project Title
MG12012	Manipulating mango flowering to extend harvest window
MG12017	New fruit fly systems for mangoes and market access
MG15006	Mango industry communication program 2016-2017

Acknowledgements

AgEconPlus and Agtrans Research would like to thank all the project and program personnel associated with Horticulture Innovation Australia Limited that were involved in the evaluation process. Their cooperation and feedback throughout the evaluation process contributed significantly to this report.

Abbreviations

RD&E	Research, Development and Extension
ABS	Australian Bureau of Statistics
BCR	Benefit-Cost Ratio
CRRDC	Council of Rural Research and Development Corporations
FNQ	Far North Queensland
Hort Innovation	Horticulture Innovation Australia Ltd
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
NPV	Net Present Value
PVB	Present Value of Benefits
PVC	Present Value of Costs
R&D	Research and Development
RDC	Research and Development Corporation