Hort Innovation

Final Report

Industry-specific impact assessment program: Mango

Impact assessment report for project *New fruit fly systems for mangoes and market access* (MG12017)

Impact analyst:

Michael Clarke

Delivery partner:

AgEconPlus and Agtrans Research

Project code:

MT20008

Date:

November 2021

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

Contents

Tables

Figures

Executive Summary

What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *MG12017: New Fruit Fly Systems for Mangoes and Market Access.* The project was funded by Hort Innovation over the period June 2013 to July 2016.

Methodology

The investment was first analysed qualitatively within a logical framework that included activities and outputs, outcomes, and impacts. Actual and/or potential impacts then were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation in monetary terms (quantitative assessment). Past and future cash flows were expressed in 2020/21 dollar terms and were discounted to the year 2020/21 using a discount rate of 5% to estimate the investment criteria and a 5% reinvestment rate to estimate the modified internal rate of return (MIRR).

Results/key findings

Investment in MG12017 has further developed the evidence base for internationally acceptable market access protocols for mangoes based on systems approaches that eliminate the requirement for specific pre- and post-harvest treatments for fruit flies. The evidence base is yet to be accepted as part of an international market access protocol.

Investment Criteria

Total funding from all sources for the project was $5.91 million (present value terms). The investment produced estimated total expected benefits of $7.68 million (present value terms). This gave a net present value of $1.78 million, an estimated benefit-cost ratio of 1.3 to 1, an internal rate of return of 5.4% and a modified internal rate of return of 5.3%. Results are broadly consistent with a pre-project cost-benefit analysis completed by the Department of Primary Industries and Fisheries, Northern Territory which generated a benefit-cost ratio of 1.9.

Conclusions

The Hort Innovation investment in Project MG12017 has shown that it is feasible to produce mangoes to the hard mature stage and deliver them to interstate and international markets without using specific pre- and post-harvest treatments for fruit fly. Adoption of this knowledge by domestic and international trade partners will increase the profitability of growing mangoes in the Northern Territory. As five economic and social impacts identified were not valued, the investment criteria estimated by the evaluation may be underestimates of the actual performance of the investment.

Keywords

Impact assessment, cost-benefit analysis, mangoes, fruit flies, market access, conditional non-host status, Queensland fruit fly, Jarvis' fruit fly.

Introduction

All research, development, and extension (RD&E) 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 relevant industry SIPs 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 berry (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, 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 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 where possible given the small sample sizes.

General Method

The impact assessment follows 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 descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts. 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. Where impact valuation was exercised, the impact assessment uses cost-benefit analysis as its principal tool. 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.

Background & Rationale

Background

The Australian mango industry has a five-year average production volume of 70,706 tonnes and a Farmgate Value of $188.9 million – Table 1.

Table 1: Mango Industry Performance 2016-2020

Year Ended 30 June	Producing Trees (000 trees)	Production (t)	Gross Value of Production ($m)	Farmgate Value ($m)
2016	1,217	61,800	210.3	199.8
2017	1,178	61,474	195.7	185.9
2018	1,262	83,314	204.3	194.1
2019	N/a	74,920	198.6	188.7
2020	N/a	72,022	185.2	175.9
Average	N/a	70,706	198.8	188.9

Source: Australian Horticulture Statistics Handbook 2017/18, 2018/19 and 2019/20.

Mangoes are a tropical fruit crop grown in the Northern Territory (NT) (51% of production), Queensland (QLD) (45%), Western Australia (WA) (3%) and New South Wales (NSW) (1%). Australian mango production is dominated by four main varieties – Kensington Pride, Calypso, R2E2, and Honey Gold. Other mangoes, such as Keitt, Tommy Atkins, Palmer, and Nam Dok Mai make a minor contribution to total production (Australian Horticulture Statistics Handbook 2019/20).

Mango research and development (R&D) activity is guided by the Mango industry's Strategic Investment Plan (SIP). The activities are funded by levies payable on mangoes produced in Australia; and the R&D levy funds are managed by Hort Innovation.

The recently completed SIP has been driven by levy payers and addressed the Australian mango industry's needs from 2017 to 2021. The SIP focussed on four outcome areas:

- Increased industry productivity through increased yields and reduced costs per hectare.
- Increased grower profitability through increased consumer demand for Australian mangoes.
- Increased R&D and extension capacity and resources supporting industry development.
- Improved industry sustainability and management of risks.

Two fruit fly species, Qfly and Jarvis' fruit fly, are present in the NT and are pests of economic significance for a wide range of fruit industries. These fruit fly species damage mangoes and may travel inside harvested mangoes as larvae and infest fly-free, fruit growing areas. Interstate markets and international trade partners require fruit from fruit fly areas to undergo post-harvest disinfestation prior to acceptance in their markets.

A range of post-harvest fruit fly treatments are currently used to access both interstate and international fruit fly sensitive markets. They include chemical treatments (e.g., organophosphate sprays, fumigation with methyl-bromide), physical treatments (e.g., vapour heat treatment), or irradiation. Some of these treatments are under threat from future regulatory review, while others can impact negatively on fruit quality. All post-harvest treatments involve additional costs and burdens to the industry. Removing the requirement for these post-harvest treatments would have significant advantages in terms of maintaining and improving market access for Australian mangoes into fruit fly sensitive markets, both domestically and overseas.

Rationale

The purpose of this project was to maintain and expand interstate and international market access for Australian mangoes through the pursuit of alternatives to post-harvest disinfestation for fruit flies. The key question to be addressed was whether a systems-approach based on adherence to

fruit quality standards at picking/grading, in combination with farm-wide suppression of pest fruit flies if required has the potential to replace current disinfestation treatments and gain the acceptance of international trading partners.

This project built on an initial NT Government pilot study and work undertaken via MG11005 ('*Systems approach to eliminate post-harvest disinfestation of Katherine region mangoes for fruit fly*') that has shown, even under conditions where populations can be extremely high, that the actual risk of mangoes being infested when they are picked at the correct (i.e., hard mature) stage is extremely low. Where detections do occur in untreated mangoes, the fruit is typically either over-ripe or has some other defect (such as a wound) that would signal an increased risk of fruit fly attack.

The major focus of this project was the evaluation of 'best-bet' systems approaches and tactics developed out of MG11005 as they are adopted on a commercial research scale by farms and packing sheds in the Katherine and Darwin regions. The aim of these trials was to evaluate whether a systems-approach that eliminates post-harvest disinfestation can deliver an appropriate level of phytosanitary protection to both interstate and international trading partners. This large-scale evaluation was supplemented with smaller-scale experimental studies. By expanding the research scope of MG11005 to include both the Katherine and Darwin regions any project impacts were to be directly applicable to the total NT crop which accounts for 51% of Australia's production.

The project was to also provide linkages to fruit fly research being carried out in QLD. QLD researchers have specific expertise in market access and developing and evaluating fruit fly management tools.

Project Details

Summary

Project Code: MG12017

Title: New fruit fly systems for mangoes and market access

Research Organisation: Department of Primary Industries & Fisheries, NT

Project Leader: Austin McLennan

Period of Funding: June 2013 to July 2016

Objectives

To further develop the evidence-base for internationally acceptable market access protocols for mangoes based on systems approaches that eliminate the requirement for specific pre- or post-harvest treatments for fruit fly.

Logical Framework

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

Table 2: Logical Framework for Project MG12017

Activities	• Evaluation of 'best-bet' systems approaches for mangoes developed during MG11005 to meet the requirements of international trading partners when adopted at a commercial enterprise scale, in both the Darwin and Katherine growing environments. • Support commercial enterprises in the adoption and evaluation of specific tactics within an overall systems approach to fruit fly management and market access by partnering with them in applied research. • Collection of baseline data on fruit fly risk for the Darwin mango production area and continued risk monitoring in the Katherine area. Baseline data collected included trapping data on pest fruit fly numbers and assessments of untreated fruit for levels of

	infestation with fruit fly larvae, enabling the impacts of various risk-mitigation activities to be evaluated by the project. • A trapping grid was used to monitor fruit fly activity in and around mango orchards. • Collections of hard mature fruit from packing sheds were assembled to provide evidence that at the hard mature stage mangoes are not a host of fruit flies. • Establishment and maintenance of laboratory colonies of Qfly and Jarvis' fruit fly to provide flies for the field cage and laboratory studies. • Completion of a series of intensive field cage trials to expose hard mature mangoes to gravid females of each of the two species of fruit fly in the field. • Completion of a series of laboratory trials to observe oviposition behaviour when individual gravid females were exposed to fruit of varying stages of maturity. • Ongoing farm-scale pilot trials looking at population suppression (i.e., male annihilation technique for Jarvis fruit fly) and its potential to reduce fruit fly infestation risk in the context of a systems approach to market access. • Routine engagement with growers including farm visits and industry meetings.
Outputs	• Better interstate linkages and coordination between fruit fly research effort for the benefit of the Australian mango industry. • Increased knowledge of the biology of two key NT fruit fly species including their abundance, suppression methods for Jarvis' fruit fly and knowledge that hard mature mango is a conditional non-host of both Jarvis' fruit fly and Qfly. • Improved understanding of fruit fly risk for untreated Darwin and Katherine region mangoes and the potential to reduce these risks in both the orchard and the packhouse. • A regulatory/quarantine protocol, that if accepted by trading partners would facilitate the export of untreated mangoes into both interstate and overseas markets. • Presentations in 2013 including the Domestic Quarantine Market Access Working Group, an ABC Country Hour interview, NT Mango Industry Association (NTMIA) meetings, as well as Katherine and Darwin Mango Group meetings. • Presentations in 2014 including NTMIA R&D Committee meeting, small working group meetings, mass media events with ABC and the Katherine Times, and various field days. • Presentations in 2015 including small working group meetings, AMIA conference, and the XI International Mango Symposium. • Presentation in 2017 including AMIA conference with papers presented by both Austin McLennan and Peter Leach. • NT DPIF Plant Industries Director has communicated project findings via presentations on market access/trade development issues with overseas trading partners and market access regulators. Reports are that there was strong interest in the no disinfestation / systems approaches to market access for mangoes being researched by the project. • Preparation of a scientific report that included project trapping data, spray data, discussion of spray data and fly numbers, infestation data, cage trial results, suppression data and the proposed protocol. This report may provide an evidence base for future mango export protocols. • A final project report was prepared and accepted by Hort Innovation in 2015.
Outcomes	• Progress toward maintaining and improving access for NT mangoes into fruit fly sensitive domestic and export markets. • Progress toward delivery of lower cost market access for NT mango growers (savings from systems approach compared to current post-harvest treatments). • Reduced reliance on organophosphates for post-harvest fruit fly control in mango packing sheds.
Impacts (potential)	• Improved profitability for NT mango growers with market maintenance and additional market access (domestic and export) as well as saved pre- and post-harvest treatment costs. • Improved health outcomes with less use of organophosphates in mango packing sheds and less risk of chemical residues reaching mango consumers. • Improved environmental outcomes with fewer chemical sprays in use on farm and in packing sheds. • 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.

Project Investment

Nominal Investment

Table 3 shows the annual investment made in Project MG12017 by Hort Innovation and others. Other funds were managed by the Department of Primary Industries & Fisheries (DPIF), NT.

Table 3: Annual Investment in Project MG12017 (nominal $)

Year ended 30 June	HORT INNOVATION ($)	DPIF, NT ($)	TOTAL ($)
2013	235,877	959,080	1,194,957
2014	181,686	738,738	920,424
2015	131,206	533,486	664,692
2016	54,107	220,000	274,107
2017	158,520	644,545	803,065
Total	**761,396**	**3,095,849**	**3,857,245**

Source: MG12017 Final Contract Variation, 27 June 2016.

Program Management Costs

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

Real Investment and Extension Costs

For the purposes of the investment analysis, the investment costs of all parties were expressed in 2020/21 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2021). DPIF have communicated project findings through grower meetings, NTMIA meetings, AMIA conferences, international industry conferences, and most importantly, to trade officials responsible for setting and regulating market access. No additional extension costs were incurred.

Impacts

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

Table 4: Triple Bottom Line Categories of Principal Impacts from Project MG12017

Economic	• Improved profitability for NT mango growers with improved market access (domestic and export) and net savings in fruit fly treatment.
Environmental	• Improved environmental outcomes with fewer chemical sprays in use on farm and in packing sheds.
Social	• 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.

Public versus Private Impacts

The impacts identified from the investment are both private and public in nature. Private impacts accrue to mango growers (improved profitability for NT growers with enhanced market access and saved post-harvest treatment costs). Public impacts include the potential for fewer chemical sprays in the environment, additional researcher, and grower skills as well as potential spill-overs to regional communities from enhanced mango grower profit and sustainability.

Distribution of Private Impacts

Private impacts will be distributed between growers, packers, transporters, wholesalers, retailers, and exporters depending on both short- and long-term supply and demand elasticities in the mango market.

Impacts on Other Australian Industries

Australia grows and sells interstate and overseas a large number of fruit types vulnerable to Qfly and Jarvis' fruit fly. Principles developed through this research project for mangoes (systems-approach and adherence to fruit quality standards) may be applicable to other fruit crops. For example, avocadoes which are also harvested in a mature green state.

Impacts Overseas

Fruit flies are problematic in many countries and while Qfly and Jarvis's fruit fly are endemic to Australia, protocols developed based on a systems-approach and adherence to fruit quality standards may be applicable to export of mangoes and other fruit crops in other countries. Overseas consumers will also benefit from a sustainable and lower cost supply of Australian mangoes.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project outcomes and related impacts will contribute to Rural RD&E Priority 2, and to Science and Research Priorities 1 and potentially 8.

Table 5: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities (est. 2015)	**Science and Research Priorities (est. 2015)**
1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	1. Food 2. Soil and Water 3. Transport 4. Cybersecurity 5. Energy and Resources 6. Manufacturing 7. Environmental Change 8. Health

Sources: (DAWR, 2015) and (OCS, 2015)

Alignment with the Mango Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the mango industry are outlined in the Mango Industry's

Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2017). Project MG12017 addressed outcome two ('increased grower profitability through increased consumer demand for Australian mangoes').

Valuation of Impacts

Impacts Valued

Analyses were undertaken for total benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly when some uncertainty was involved. Sensitivity analyses were undertaken for those variables where there was greatest uncertainty or for those that were identified as key drivers of the investment criteria.

The impact that was valued was improved profitability for NT mango growers with improved market access (domestic and export) and net savings in fruit fly treatment.

Impacts Not Valued

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

- Improved environmental outcomes with fewer chemical sprays in use on farm and in packing sheds.
- 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.

These impacts were not valued due to lack of data to support credible assumptions.

Summary of Assumptions

A summary of the key assumptions made for valuation of progress toward higher yielding and more profitable mango orchards is provided in Table 6.

Table 6: Summary of Assumptions for Impact Valuation

Variable	Assumption	Source/Comment
Mango production in the NT.	5,151,429 trays	Based on 5-year average Australian production of 70,706 tonnes (see Table 1), NT accounting for 51% of production and an average of 7kg/tray.
Share of NT production that is either destined for fruit fly sensitive domestic and export markets or pre/post-harvest treated to minimise fruit fly damage.	100%	The NT mango crop is all treated pre/post-harvest for fruit fly and all but a small proportion, which is consumed in the NT, is exported/sent interstate to fruit fly sensitive markets.
Increase in profit when MG12017 implemented.	$1.00/tray	Estimate prepared after considering current profit of $2.50/tray (AgEconPlus 2019) and allowing for decreased pre-harvest sprays, decreased post-harvest

[1] For further information, see: https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/

		treatment (domestic and export), and increased grading costs, product inspection at destination, fruit fly monitoring and fruit fly suppression costs.
Year of first impact.	2024/25	Assumes 8 years required after MG11005 finished in 2016/17 to finalise and have new protocol accepted in domestic and markets.
Attribution of impacts to this project.	50%	AgEconPlus assumption that allows for previous work (including MG11005) and future work required to achieve acceptance of proposed protocol.
Probability of the project generating useful outputs.	100%	Outputs have been delivered through research and communicated to industry and trade officials responsible for setting and regulating market access.
Probability of valuable outcomes.	80%	Changes to protocols, especially for export markets, are subject to both science and policy priorities.
Probability of impact (assuming successful outcome)	80%	Increased profits are subject to market conditions.
Counterfactual.	50%	In the absence of MG12017 research, it is 50% likely that results would have been generated by another project.

Results

All costs and benefits were discounted to 2020/21 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the Modified Internal Rate of Return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the project investment period plus 30 years from the last year of investment (2016/17) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Table 7 and 8 show the investment criteria estimated for different periods of benefits for the total investment and Hort Innovation investment, respectively. The present value of benefits (PVB) attributable to Hort Innovation investment only, shown in Table 8, has been estimated by multiplying the total PVB by the Hort Innovation proportion of real investment (21%).

Table 7: Investment Criteria for Total Investment in Project MG12017

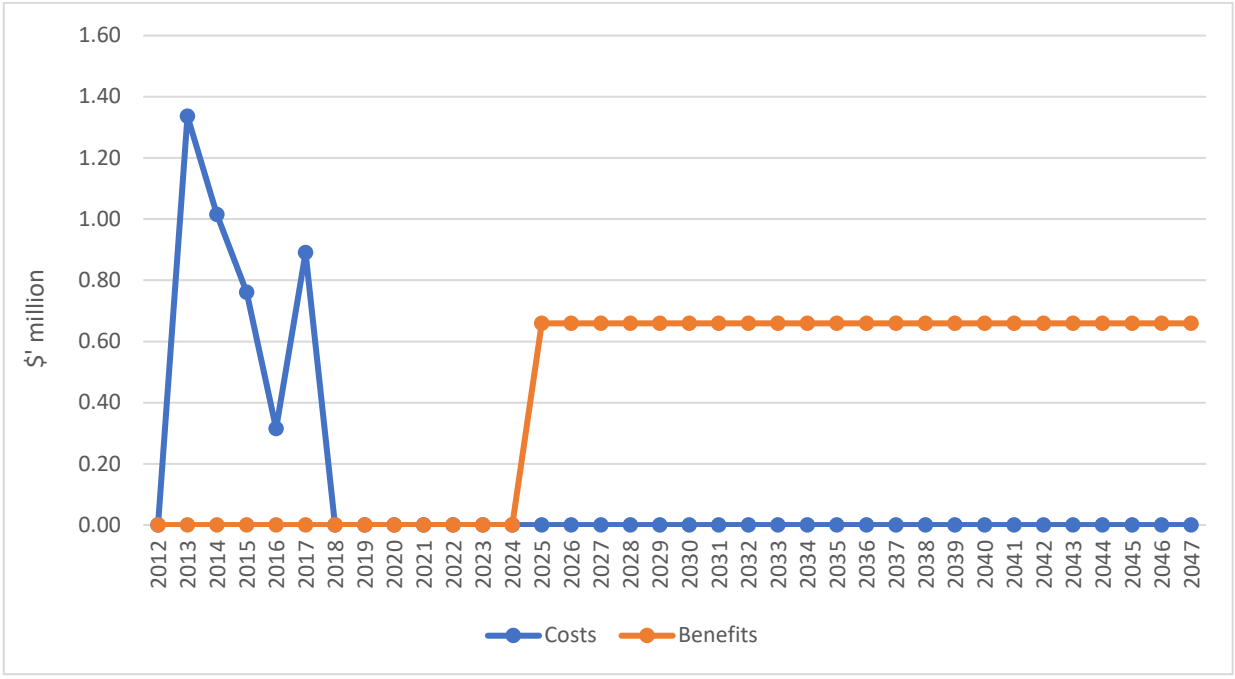
Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Benefits ($m)	0.00	0.00	1.55	3.68	5.35	6.66	7.68
Present Value of Costs ($m)	5.91	5.91	5.91	5.91	5.91	5.91	5.91
Net Present Value ($m)	-5.91	-5.91	-4.36	-2.23	-0.56	0.75	1.78
Benefit-Cost Ratio	0.00	0.00	0.26	0.62	0.91	1.13	1.30
Internal Rate of Return (%)	negative	negative	negative	-0.5	2.9	4.6	5.4
MIRR (%)	negative	negative	negative	0.8	3.6	4.7	5.3

Table 8: Investment Criteria for Hort Innovation Investment in Project MG12017

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.00	0.00	0.32	0.77	1.12	1.39	1.60
Present Value of Costs ($m)	1.23	1.23	1.23	1.23	1.23	1.23	1.23
Net Present Value ($m)	-1.23	-1.23	-0.90	-0.46	-0.11	0.16	0.38
Benefit-Cost Ratio	0.00	0.00	0.26	0.63	0.91	1.13	1.31
Internal Rate of Return (%)	negative	negative	negative	-0.5	3.0	4.6	5.5
MIRR (%)	negative	negative	negative	0.8	3.6	4.8	5.3

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the MG12017 investment plus 30 years from the last year of investment are shown in Figure 1.

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



Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 9 presents the results. The results are sensitive to the discount rate, and this is due to the lag between project investment and realisation of protocol change benefits.

Table 9: Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present Value of Benefits ($m)	15.17	7.68	4.40
Present Value of Costs ($m)	4.32	5.91	8.00
Net Present Value ($m)	10.85	1.78	-3.60
Benefit-cost ratio	3.51	1.30	0.55

A sensitivity analysis was then undertaken for the increase in NT mango profit achieved when the findings from MG12017 are implemented. Results are provided in Table 10. When assumed increase in profit is $0.50/tray, and all other factors remain unchanged, project costs exceed project benefits.

Table 10: Sensitivity to Increase in NT Mango Grower Profit Increase After MG12017 Implemented (Total investment, 30 years)

Investment Criteria	Increase in Profit Due MG12017		
	$0.50/tray	$1.00/tray (base)	$1.50/tray
Present Value of Benefits ($m)	3.84	7.68	11.52
Present Value of Costs ($m)	5.91	5.91	5.91
Net Present Value ($m)	-2.07	1.78	5.62
Benefit-cost ratio	0.65	1.30	1.95

A final sensitivity analysis tested the share of NT mango production adopting MG12017 recommendations. The results (Table 11) show that if share of production adopting MG12017 is only 60% then project benefits approximately equal project costs.

Table 11: Sensitivity to Share of NT Mango Production Adopting MG12017 Findings (Total investment, 30 years)

Investment Criteria	Share of NT Mango Production Adopting Findings		
	60%	80% (base)	100%
Present Value of Benefits ($m)	5.76	7.68	9.60
Present Value of Costs ($m)	5.91	5.91	5.91
Net Present Value ($m)	-0.14	1.78	3.70
Benefit-cost ratio	0.98	1.30	1.63

Confidence Rating

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 12). The rating categories used are High, Medium, and Low, where:

High: denotes a good coverage of benefits or reasonable confidence in the assumptions made

Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made

Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 12: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium	Medium-Low

Coverage of benefits valued was assessed as Medium, while the key impact (additional grower profit) was valued other environmental and social benefits were not. Confidence in assumptions was rated as Medium-Low, key data was estimated by the analyst.

Conclusion

Investment in MG12017 has further developed the evidence base for internationally acceptable market access protocols for mangoes based on systems approaches that eliminate the requirement for specific pre- and post-harvest treatments for fruit flies. The evidence base is yet to be accepted as part of an international market access protocol.

Total funding from all sources for the project was $5.91 million (present value terms). The investment produced estimated total expected benefits of $7.68 million (present value terms). This gave a net present value of $1.78 million, an estimated benefit-cost ratio of 1.3 to 1, an internal rate of return of 5.4% and a modified internal rate of return of 5.3%. Results are broadly consistent with a pre-project cost-benefit analysis completed by DPI&F which generated a benefit-cost ratio of 1.9.

As five economic and social impacts identified were not valued, the investment criteria estimated by the evaluation may be underestimates of the actual performance of the investment.

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.

Reference List

AgEconPlus (2019) Profitability Analysis of Northern Australian Kensington Pride Production. Prepared for PHA Tropical Plant Industries Biosecurity Strategy.

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 Impact 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

Department of Agriculture and Water Resources (DAWR). (2015). Agricultural Competitiveness White Paper. Canberra: Commonwealth of Australia. Retrieved from http://agwhitepaper.agriculture.gov.au/SiteCollectionDocuments/ag-competitiveness-white-paper.pdf

Hort Innovation (2017) Mango Strategic Investment Plan - 2017-2021. Retrieved from https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/

Hort Innovation (2019) Horticulture Statistics Handbook 2019/20. Retrieved from https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/australian-horticulture-statistics-handbook/

Office of the Chief Scientist (OCS). (2015). Strategic Science and Research Priorities. Canberra: Commonwealth of Australia. Retrieved from http://www.chiefscientist.gov.au/wp-content/uploads/STRATEGIC-SCIENCE-AND-RESEARCH-PRIORITIES_181214web.pdf

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.

Specific acknowledgements:
Trevor Dunmall, Industry Development Manager, AMIA when MG12017 was completed
Austin McLennan, Senior Entomologist, Biosecurity QLD (Principal Investigator MG12017)
Brendan O'Keeffe, Analyst, Hort Innovation

Abbreviations

AMIA	Australian Mango Industry Association
CRRDC	Council of Research and Development Corporations
DAWR	Department of Agriculture and Water Resources (Australian Government)
GDP	Gross Domestic Product
GVP	Gross Value of Production
IDM	Industry Development Manager
IRR	Internal Rate of Return
KP	Kensington Pride
MIRR	Modified Internal Rate of Return
NT	Northern Territory
NTMIA	Northern Territory Mango Industry Association
OCS	Office of Chief Scientist Queensland
PVB	Present Value of Benefits
R&D	Research and Development
RD&E	Research, Development and Extension
SIP	Strategic Investment Plan