Horticulture Impact Assessment Program:

Appendix 7: Benchmarking the macadamia industry 2015-2018 (MC15005 Impact Assessment)

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Project code:

MT18011

Date:

19 August 2020

Funding statement:

This project has been funded by Hort Innovation, using research and development levies 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

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What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *MC15005: Benchmarking the macadamia industry 2015-2018.* The project was funded by Hort Innovation over the period January 2016 to March 2019.

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 2019/20 dollar terms and were discounted to the year 2019/20 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

The investment in MC15005 has improved Australian macadamia producers' understanding of their farm performance and expenditure, allowed the sharing of best management practice and contributed to improved mitigation and management of adverse seasonal conditions. Consequently, MC15005 is likely to have contributed to improved productivity and profitability for some members of the Australian macadamia industry as well as to increased efficiency of resource allocation for both public and private funds invested in macadamia RD&E.

Investment Criteria

Total funding from all sources for the project was $2.11 million (present value terms). The investment produced estimated total expected benefits of $12.48 million (present value terms). This gave a net present value of $10.36 million, an estimated benefit-cost ratio of 5.9 to 1, an internal rate of return of 26.8% and a modified internal rate of return of 9.9%.

Conclusions

Several environmental and social impacts were also identified but not valued as part of the current assessment. Given the impacts not valued, combined with conservative assumptions made for the principal economic impacts valued, it is reasonable to conclude that the investment criteria reported may be an underestimate of the actual performance of the MC15005 investment.

Keywords

Impact assessment, cost-benefit analysis, MC15005, macadamia, benchmarking

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.
- Annual Reporting to Hort Innovation stakeholders.
- Reporting to the Council of Rural Research and Development Corporations (CRRDC).

Under impact assessment program MT18011, the first series of impact assessments were conducted in 2019 and included 15 randomly selected Hort Innovation RD&E investments (projects). The second series of impact assessments (current series), undertaken in 2020, also included 15 randomly selected projects worth a total of approximately $7.11 million (nominal Hort Innovation investment). The second series of projects were selected from an overall population of 85 Hort Innovation investments worth an estimated $44.64 million (nominal Hort Innovation investment) where a final deliverable had been submitted in the 2018/19 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.

Project *MC15005: Benchmarking the macadamia industry 2015-2018* was randomly selected as one of the 15 investments under MT18011 and was analysed in this report.

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 actual and/or potential 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 used 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

Macadamia is an Australian native nut that grows in tropical and sub-tropical regions. Australia is the leading producer of macadamias and contributes more than 30% of the global crop with over 70% of Australian production exported annually (Australian Macadamia Society (AMS), n.d.).

The Australian macadamia industry currently is made up of around 800 growers with approximately 5.5 million trees planted across 28,000 hectares (AMS, 2020). Macadamias are predominantly grown along the eastern seaboard of New South Wales (NSW) and Queensland (QLD) from Nambucca Heads (NSW) to Mackay (QLD) (Australian Nut Industry Council, 2019). Approximately 56% of production is grown in QLD and 44% in NSW.

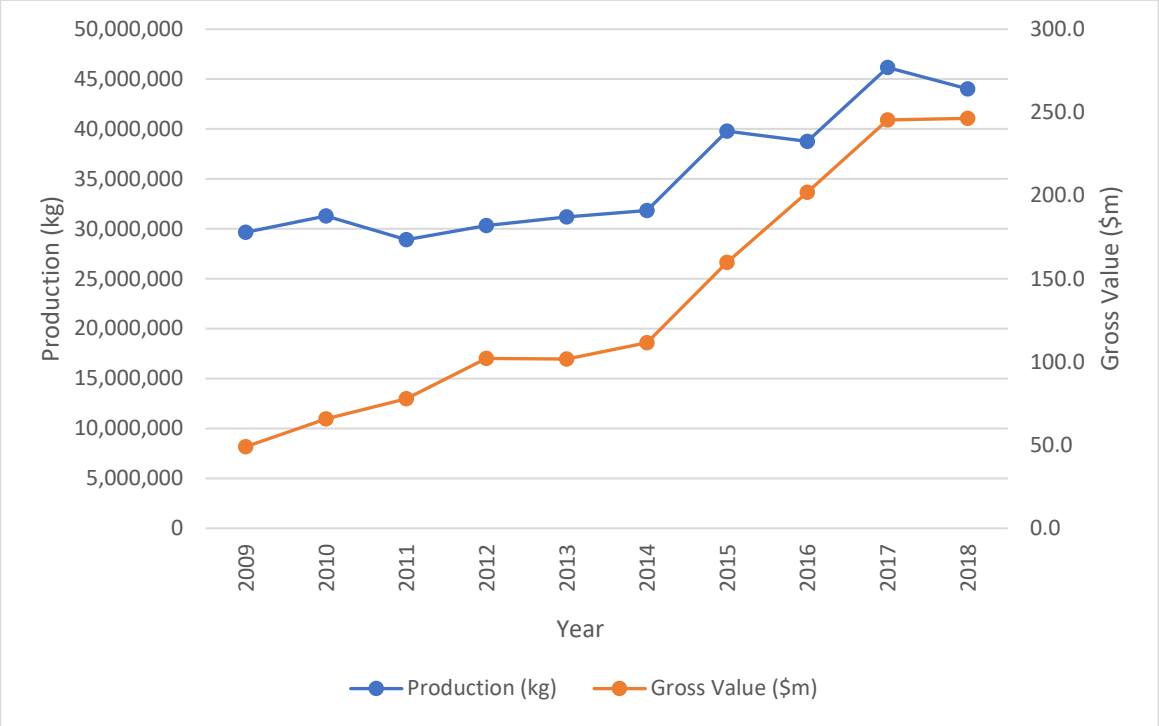
Macadamia trees typically reach commercial yields from 6 to 7 years of age. The average yield for bearing trees is approximately 7.7 kg per tree (5-year average). Table 1 provides a summary of production statistics for the Australian macadamia industry for the five-year period from 2013/14 to 2017/18. Figure 1 shows total macadamia production and industry gross value for the period 2008/09 to 2017/18 and Figure 2 shows the total number of macadamia trees planted overlayed with the number of bearing trees for the same period.

Table 1: Australian Macadamia Industry Statistics (2013/14 to 2017/18)

Year (ended 30 June)	2014	2015	2016	2017	2018
Total Trees (no.)	6,080,485	5,572,946	5,408,290	5,516,270	5,570,536
Bearing Trees (no.)	5,701,076	5,273,349	5,047,334	5,013,538	5,018,922
Production (kg)	31,840,639	39,783,457	38,758,806	46,165,174	44,013,988
Yield (kg/tree)	6.0	7.5	7.7	9.2	8.8
Gross Value ($m)	111.5	159.8	202.0	245.5	246.4

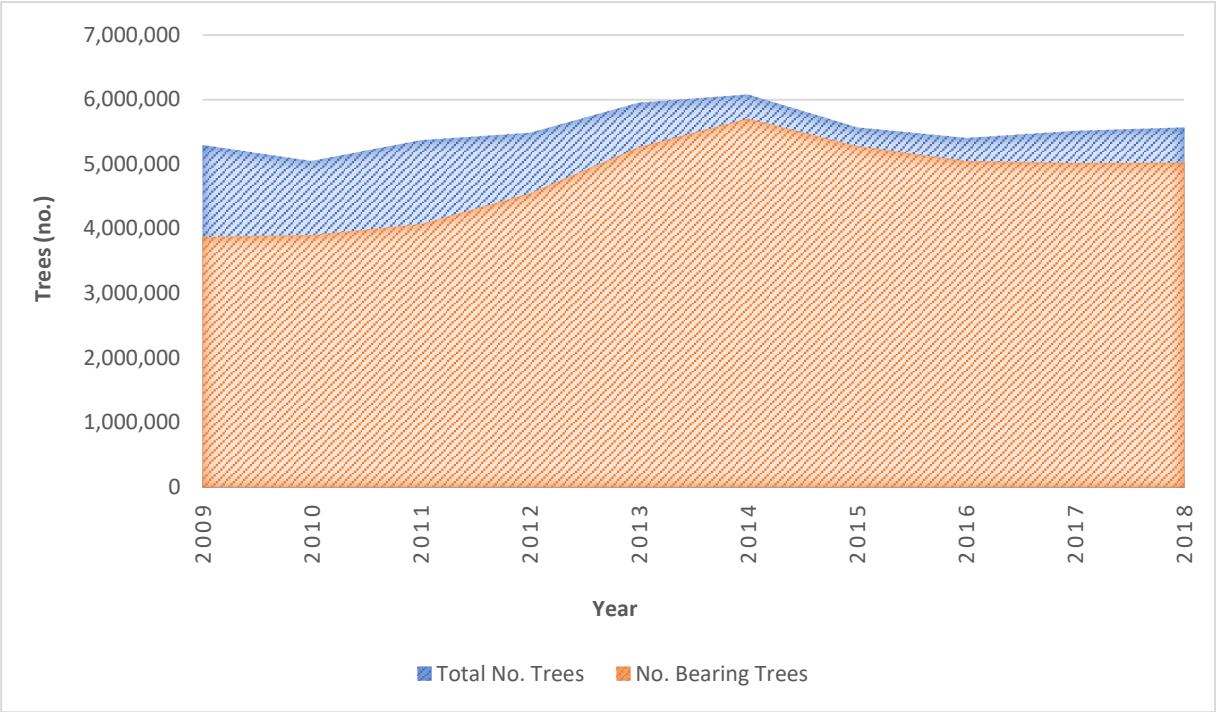
Source: Australian Bureau of Statistics (ABS) Agricultural Commodities Statistics (Series 7121.0) and Value of Agricultural Commodities Produced (Series 7503.0)

Figure 1: Australian Macadamia Production and Gross Value (2008/09 to 2017/18)



Source: Derived from ABS data from Agricultural Commodities Statistics (Series 7121.0) and Value of Agricultural Commodities Produced (Series 7503.0)

Figure 2: No. of Macadamia Trees (Total and Bearing) (2008/09 to 2017/18)



Source: Derived from ABS data from Agricultural Commodities Statistics (Series 7121.0) and Value of Agricultural Commodities Produced (Series 7503.0)

Rationale

Industry benchmarking is used to understand the performance of a particular industry and to examine the range and variability of performance within an industry, compare business practices and methods, and identify performance gaps and areas for improvement. It also can be used by individual growers to compare performance to other growers in the industry, and also to appraise their likely performance if they changed their production practices in a specific way. Project MC15005 (*Benchmarking the macadamia industry 2015-2018*) was funded to continue and expand the work of a previous Hort Innovation macadamia industry benchmarking project (MC09001) to facilitate improved farm productivity and profitability within the Australian macadamia industry.

Project Details

Summary

Project Code: MC15005

Title: *Benchmarking the macadamia industry 2015-2018*

Research Organisation: Department of Agriculture and Fisheries Queensland (DAF)

Principal Investigator: Shane Mulo

Period of Funding: January 2016 to March 2019

Objectives

The objectives of the investment were to:

1. Increase awareness of individual farm performance and industry productivity trends.
2. Increase knowledge and understanding of the economics of macadamia production.
3. Identify and facilitate adoption of management practices that lead to high orchard productivity.

Logical Framework

Table 2 provides a description of MC15005 in a logical framework.

Table 2: Logical Framework for Project MC15005

Activities	• Utilising existing participants from macadamia industry productivity groups (formerly known as best practice groups) from the project MC09001 (known as 'benchmarking groups' under the current project MC15005), an annual, national industry census of macadamia yield, quality, planting and cost information was conducted. • Two types of forms were developed to collect information from growers: 1) the basic form covered consignment yield and quality details, planting information and limitations to production, such as weather, pests, and diseases 2) the comprehensive form included the same basic information plus included production costs across defined expenditure categories, including unpaid labour. • An average of 276 farms participated in the benchmarking study each year and approximately 80% of participants provided consent for their yield and quality data to be sourced from their processor(s). • Each year of the project, confidential farm level reports were produced for each participating farm business. • These reports compared and ranked individual farm performance based on yield, quality, and production costs. • Each farm was ranked against averages of other farms of similar size, location, weighted average tree age, planting density, management structure or irrigation usage. • Industry level reports also were produced each season following the release of the farm level reports to summarise key findings for the whole benchmark sample. • Six groups of benchmarking participants were established across major growing areas (Central QLD, Gympie, Glasshouse Mountains, Northern Rivers of NSW, and the Mid Coast of NSW). • A total of 18 benchmark group meetings were held to provide a forum for industry discussion of benchmark findings and exchange of information and experience.

	• Participation in benchmark group meetings was offered to all benchmarking participants and key consultants, processor representatives, and RD&E service providers also were invited to participate. • Six case studies were developed and produced in video format to communicate specific, compelling examples of innovation, highly productive farms, or significant research outcomes. • Seasonal benchmarking data underpinned the development of templates for economic modelling for farm business scenarios using purpose-built software (Financial Planner for Macadamia). • Benchmarking data was subjected to statistical analysis and a series of annual, industry level benchmarking reports were developed. • Project findings were presented at industry events including MacGroup meetings, industry conferences, consultants' meetings, and processor field days and a series of articles was published in the Australian Macadamia Society News Bulletin. • The project team provided ad hoc analyses and reports to investors, industry stakeholders, RD&E service providers, and other authorities over the course of the project. The team also were present at industry strategic planning meetings to ensure that industry-level benchmarking results were an input to decision making.
Outputs	• A series of farm level reports ranking farm performance against industry averages for similar farms produced for each participating business each season. • A series of annual industry level benchmarking reports circulated to industry participants and published on the QLD government publications portal. • A final industry report for the macadamia industry for the 2009 to 2018 seasons that included the following information: o Scope and coverage of data o Rules and assumptions o Summary of plantings o Metrics from the most recent season, including factors limiting production o Seasonal yield, quality and cost trends o Top performing farms (based on sustained performance over multiple seasons) o Seasonal trends by region o Productivity and quality percentiles o Productivity and quality by tree age o Productivity and quality by farm size o Productivity and quality by planting density The 2009-2018 macadamia industry benchmarking report can be found at: https://www.publications.qld.gov.au/dataset/18517168-df7c-41d9-bf92-50ff4ccfb6ac/resource/76587ac2-fb21-4483-bc61-1a5088d02712/fs_download/macadamia-industry-benchmark-report-2009-18.pdf • Six video case studies published on the QLD Agriculture YouTube channel: 1) Maximising orchard productivity through orchard floor management 2) Investing in orchard productivity 3) A holistic approach to orchard productivity 4) Tree height reduction to maintain productivity 5) Improving yield through supplementary irrigation 6) Macadamia seed weevil: monitoring and control • A number of presentations and articles to support communication of project findings.

Outcomes	• Data, analyses and specialised reports were provided to a number of external stakeholders to support decision making, farm valuation, research, and other areas. • Data and analyses from the project also were used to support a number of other macadamia industry RD&E projects, including: MC11001 (*Regional Variety Trials*), MC14000 (*Macadamia breeding*), MC15009 (*Crop forecasting*), MC16005 (*Integrated pest management*), MC15011 (*Abnormal vertical growth*), MC15004 (*Industry innovation and adoption program*) and MC15003 (*National macadamia communication program*). • Participating macadamia producers now have an improved understanding of their farm's productivity and quality in relation to other farms. • Each year of the project, an average of 276 farms gained insight into their ranking within the Australian macadamia industry for productivity and quality. • Also, an average of 70 farms each year gained insight into how their expenditure compared with other farms submitting cost data. • In addition to bringing growers together via Benchmark Groups to share their experience (good and bad) the project has focused on managing or mitigating the impact of challenging seasonal conditions. Identifying top performing farms in the sample and analysing their approaches and practices is an important part of building the case for increased adoption of what is currently industry best practice. • A final survey of benchmark group meeting participants indicated that up to 77% of participating growers (representing 91 farms) had changed, or planned to change, practices as a result of the project. • Benchmarking participants, processors, consultants, researchers, investors, and other stakeholders have used the annual industry reports to inform a range of decision-making aimed at improving productivity and profitability for Australian macadamia producers.

Impacts	• Increased productivity and/or profitability for some Australian macadamia producers driven by:
	  ○ Improved understanding of farm productivity and quality performance within the industry,
	  ○ Improved mitigation and management of challenging seasonal conditions,
	  ○ Increased adoption of industry best practice,
	  ○ Improved understanding of farm expenditure, and
	  ○ Improved decision making guided by robust farm and industry data, tools and models.
	• Improved efficiency of macadamia RD&E resource allocation through better prioritisation of key constraints and limitations to producer performance.
	• Increased industry capacity, particularly for business and financial management skills, through training and extension activities aimed at improving farm productivity and quality.
	• Potentially, some contribution to improved environmental outcomes through increased adoption of best management practices (e.g. integrated pest and disease management, improved chemical use, etc.).
	• Potentially, improved regional community well-being from spill-over benefits from more productive and profitable Australian macadamia producers.

Project Investment

Nominal Investment

Table 3 shows the annual investment (cash and in-kind) in project MC15005 by others. Other investors included the Department of Agriculture and Fisheries QLD, NSW Department of Primary Industries, and the University of Southern QLD.

Table 3: Annual Investment in the Project MC15005 (nominal $)

Year ended 30 June	Hort Innovation ($)	Others ($)	Total ($)
2016	100,430	264,433	364,863
2017	153,762	404,762	558,488
2018	113,913	299,934	413,847
2019	93,021	244,926	337,947
Totals	462,090	1,214,054	1,675,144

Source: MC15005 Project Agreement and Variation documents supplied by Hort Innovation 2020

Program Management Costs

For the Hort Innovation investment the cost of managing and administrating 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, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 3.

For the investment by others (including DAF, NSW Department of Primary Industries and the University of Southern QLD), it was assumed that the management and administration costs were already included in the nominal values reported in Table 3.

Real Investment and Extension Costs

For the purposes of the investment analysis, investment costs of all parties were expressed in 2019/20 dollar terms using the Gross Domestic Product deflator index (ABS, 2020). No additional costs associated with project extension were incorporated as the project included a high level of industry participation and a number of extension activities. Results were communicated to macadamia growers and other industry stakeholders (e.g. consultants, researchers and investors) as part of the project.

Impacts

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

Table 4: Triple Bottom Line Categories of Principal Impacts from Project MC15005

Economic	• Increased productivity and/or profitability for some Australian macadamia producers driven by:
	  ○ Improved understanding of farm productivity and quality performance within the industry,
	  ○ Improved mitigation and management of challenging seasonal conditions,
	  ○ Increased adoption of industry best practice,
	  ○ Improved understanding of farm expenditure, and
	  ○ Improved decision making guided by robust farm and industry data, tools and models.
	• Improved efficiency of macadamia RD&E resource allocation through better prioritisation of key constraints and limitations to producer performance.

Environmental	• Potentially, some contribution to improved environmental outcomes through increased adoption of best management practices (e.g. integrated pest and disease management, improved chemical use, etc.).
Social	• Increased industry capacity, particularly for business and financial management skills, through training and extension activities aimed at improving farm productivity and quality. • Potentially, improved regional community well-being from spill-over benefits from more productive and profitable Australian macadamia producers.

Public versus Private Impacts

Impacts identified in this evaluation are both private and public in nature. Private benefits are likely to be realised by Australian macadamia producers through a net increase in farm profitability driven by improved understanding of orchard performance leading to improved decision making, increased adoption of best practice, and improved understanding of on-farm expenditure. Further private benefits may also be delivered through increased industry capacity. Public benefits may include improved increased efficiency of resource allocation of public funds directed toward macadamia RD&E, and, potentially, improved environmental outcomes as well as increased income in macadamia production communities/regions associated with a more profitable industry.

Distribution of Private Impacts

The impacts on the Australian macadamia industry from investment in project MC15005 will be shared along the macadamia supply chain with input suppliers, growers, processors, transporters, wholesalers, retailers, and consumers all sharing impacts produced by the project. The share of impact realised by each link in the supply chain will depend on both short- and long-term supply and demand elasticities in the macadamia market.

Impacts on Other Australian Industries

Outputs from the project are specific to the Australian macadamia industry. However, lessons learned about industry benchmarking may benefit other Australian tree crop industries via potential future spill-overs from the increase in knowledge and industry capacity.

Impacts Overseas

No significant or direct overseas impacts were identified. However, the knowledge created by the project and shared through international scientific and industry networks may results in some positive impacts for macadamia industries overseas where similar benchmarking activities may be useful.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project findings and related impacts will contribute to Rural RD&E Priority 3, with some potential contribution to Priority 4, and to Science and Research Priorities 1 and 2.

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 6. Resources 7. Advanced Manufacturing 8. Environmental Change 9. Health

Sources: (Commonwealth of Australia, 2015) and (Australian Government, 2015)

Alignment with the Macadamia Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the macadamia industry are outlined in the Macadamia Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2017). Project MC15005 primarily addressed Outcome 1 with some contribution to Outcome 3 (through Strategy 3.2 and 3.4).

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

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.

Two impacts were valued. The first was the net increase in profitability for Australian macadamia growers driven by increased understanding of farm performance and expenditure leading to improved decision making, improved mitigation and management of challenging seasonal conditions, and increased adoption of industry best practice. The second impact valued was improved resource allocation efficiency for future macadamia RD&E funded by Hort Innovation.

Impacts Not Valued

Not all of the impacts identified in Table 3 could be valued in the assessment. Specifically, within the scope of the current Hort Innovation impact assessment program, environmental and social impacts were hard to value due to lack of evidence/data on which to base credible assumptions, difficulty in quantifying the causal relationship and pathway between MC15005 and the impact and the complexity of assigning magnitudes and monetary values to the impact.

The environmental impacts identified but not valued were:

- Potentially, some contribution to improved environmental outcomes through increased adoption of best management practices (e.g. integrated pest and disease management, improved chemical use, etc.).

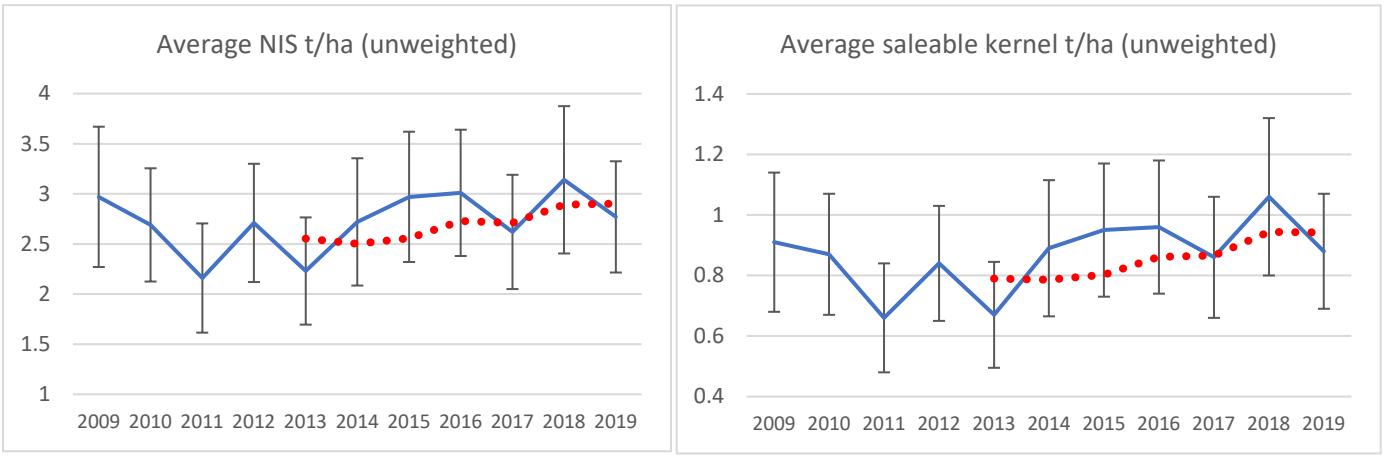
The social impacts identified but not valued were:

- Increased industry capacity, particularly for business and financial management skills, through training and extension activities aimed at improving farm productivity and quality (this impact may be partially captured through the valuation of increased profitability described below).
- Potentially, improved regional community well-being from spill-over benefits from more productive and profitable Australian macadamia producers.

Valuation of Impact 1: Increased Net Profitability for Australian Macadamia Growers

Figure 3 below shows key metrics of annual macadamia productivity, including five-year moving averages, for participating farms in the MC15005 benchmarking study for the 2009 to 2019 period. The upward trends in the data are evidence of positive change across the whole benchmarking sample.

Figure 3: Annual Productivity for Participating Farms in the MC15005 Benchmarking Study (including 5-year moving average)



Source: Shane Mulo, pers. comm., 2020

However, increased productivity for participating farms should be interpreted with caution. The MC15005 benchmarking project is just one of several in the Hort Innovation RD&E portfolio aimed at increasing productivity. The role of MC15005 was to provide objective information to support improved decision-making (Shane Mulo, pers. comm., 2020). Additionally, there is typically high variability in productivity between farms but also between seasons for any given farm. A five-year moving average helps to smooth this out, but it can still be influenced by significant seasonal fluctuations, such as weather or major farm changes (Shane Mulo, pers. comm., 2020).

The valuation of increased net profitability is based on an increase in the average gross margin for a proportion of mature macadamia farms participating in the benchmarking study. Average productivity for mature farms providing cost data to the benchmarking study in 2017 and 2018 was 3.24 t/ha. At an average nut-in-shell (NIS) price of $5.20/kg this equates to a gross margin of approximately $6,900/ha (Queensland Government, 2019).

Specific assumptions are described in Table 6.

Attribution

As noted above, project MC15005 was just one of several investments that are contributing to increased productivity and profitability for the Australian macadamia industry. The valuation focused on macadamia producers that participated in the benchmarking study that may have benefited from improved understanding of their farm's perofrmance and expenditure, orchard best management pracitce, and mitigation and management of challenging climate conditions. An attribution factor of 50% was applied to the benefits estimated to accommodate other factors that may have influenced producer decision making.

Counterfactual

It was assumed that, in the absence of Hort Innovation investment in MC15005, the benefits estimated would not have occurred.

Valuation of Impact 2: Efficiency Gains in Australian Macadamia RD&E Resource Allocation

Each year, approximately $2.42 million is spent on macadamia RD&E through Hort Innovation and its funding partners (based on a three-year average) (Hort Innovation, 2017 to 2019). Through the identification of key factors limiting productivity by region, MC15005 has contributed to the identification and prioritisation of future macadamia RD&E investments. Therefore, it was assumed that macadamia RD&E investment, guided in part by the information developed as a result of MC15005, will be made in a more efficient manner than it would have been without the project being funded. It was assumed that there will be an efficiency dividend equivalent to 5% of RD&E spending over a 10-year period. That is, the same outcomes and impact will be achieved with a 5% reduction in the RD&E spending that would have occurred without project MC15005.

Specific assumptions are described in Table 6.

Attribution

As for Impacts 1, it was considered likely that, any efficiency gain in RD&E resource allocation will likely be due to MC15005 as well as a number of other macadamia RD&E investments. Thus, for the purposes of this assessment, a 50% attribution factor was applied to the estimated benefits for MC15005.

Counterfactual

It was assumed that, in the absence of Hort Innovation investment in MC15005, the benefits estimated would not have occurred.

Summary of Assumptions

A summary of the key assumptions made for valuation of the impacts is shown in Table 6.

Table 6: Summary of Assumptions

Variable	Assumption	Source/Comment
Baseline Data		
Average gross margin for Australian macadamia producers	$6,900/ha	Average for 2017 and 2018 for farms reporting cost data. Macadamia industry benchmarking report – 2009 to 2018 seasons (Queensland Government, 2019)
Area of farms participating in the benchmarking study	10,487 ha	Total across 272 farms participating in the benchmarking study for the 2018 season. Macadamia industry benchmarking report – 2009 to 2018 seasons (Queensland Government, 2019)
Impact 1: Increased average gross margin for Australia macadamia growers (mature farms)		
Valuation Assumptions		
Proportion of macadamia growing area (participating farms) implementing changes to increase profitability	50%	Conservative estimate based on MC15005 anonymous client surveys for 2016 and 2018 where 64% and 67% of clients respectively indicated that they "had made, or intended to make, changes to your business as a result of participating in the benchmarking study" (data supplied by Shane Mulo).
Attribution of practice change to MC15005 benchmarking study	50%	Analyst assumption
Net increase in gross margin for macadamia producers implementing changes	5%	Conservative estimate based on evidence of up to 20% increase (~0.5 t/ha) in NIS yields (5-year moving average) for participating farms – see Figure 3.
First year of impact	2016/17	Based on evidence from the 2016 MC15005 anonymous client survey that producers had or intended to make changes on-farm.
Year of maximum impact	2025/26	10-years after first year of impact – allows for implementation of longer-term orchard changes.
Risk Factors and Other Variables		
Probability of Impact	90%	Analyst assumption – accommodates the risk that exogenous factors may prevent the predicted impact from being achieved
Impact 2: Efficiency Gains in Australian Macadamia RD&E Resource Allocation		
Valuation Assumptions: with MC15005		
Total average annual expenditure on macadamia RD&E by Hort Innovation and other funding partners	$2.42 million p.a. (3-year average)	Hort Innovation annual report (2017-2019)

Efficiency dividend	5%	Analyst assumption.
RD&E saving	$121,000 p.a.	5% x $2.42 million
Year of first impact.	2019/20	Consistent with publication of final MC15005 outputs in 2018/19
Last year of impact	2028/29	10-years after first year of impact – assumes diminishing relevance of RD&E priorities identified from the outputs of MC15005 over time
Risk Factors and Other Variables		
Attribution of efficiency dividend to MC15005	50%	Analyst assumption.
Probability of impact	90%	Analyst assumption – accommodates the risk that exogenous factors may prevent the predicted impact from being achieved

Results

All costs and benefits were discounted to 2019/20 (year of evaluation) 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 (2018/19) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Table 7 shows the investment criteria estimated for different periods of benefit for the total investment. Table 8 shows the investment criteria estimated for different periods for the Hort Innovation only. The present value of benefits (PVB) for Hort Innovation was estimated by multiplying the total PVB by the proportion of Hort Innovation investment in project MC15005 (30.6%).

Table 7: Investment Criteria for Total Investment in Project MC15005

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.53	2.91	5.94	8.21	9.99	11.38	12.48
Present Value of Costs ($m)	2.11	2.11	2.11	2.11	2.11	2.11	2.11
Net Present Value ($m)	-1.58	0.79	3.82	6.10	7.88	9.27	10.36
Benefit-Cost Ratio	0.25	1.38	2.81	3.88	4.73	5.39	5.90
Internal Rate of Return (%)	negative	13.54	24.23	26.10	26.59	26.73	26.77
MIRR (%)	negative	15.24	18.45	15.24	12.87	11.17	9.88

Table 8: Investment Criteria for Hort Innovation Investment in Project MC15005

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.16	0.89	1.82	2.51	3.06	3.48	3.82
Present Value of Costs ($m)	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Net Present Value ($m)	-0.48	0.24	1.17	1.87	2.41	2.84	3.17
Benefit-Cost Ratio	0.25	1.38	2.81	3.88	4.73	5.39	5.90
Internal Rate of Return (%)	negative	13.54	24.23	26.10	26.58	26.73	26.77
MIRR (%)	negative	15.24	18.45	15.24	12.87	11.17	9.88

The annual undiscounted benefit and cost cash flows for the total investment for the duration of MC15005 investment plus 30 years from the last year of investment are shown in Figure 4.

Figure 4: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs

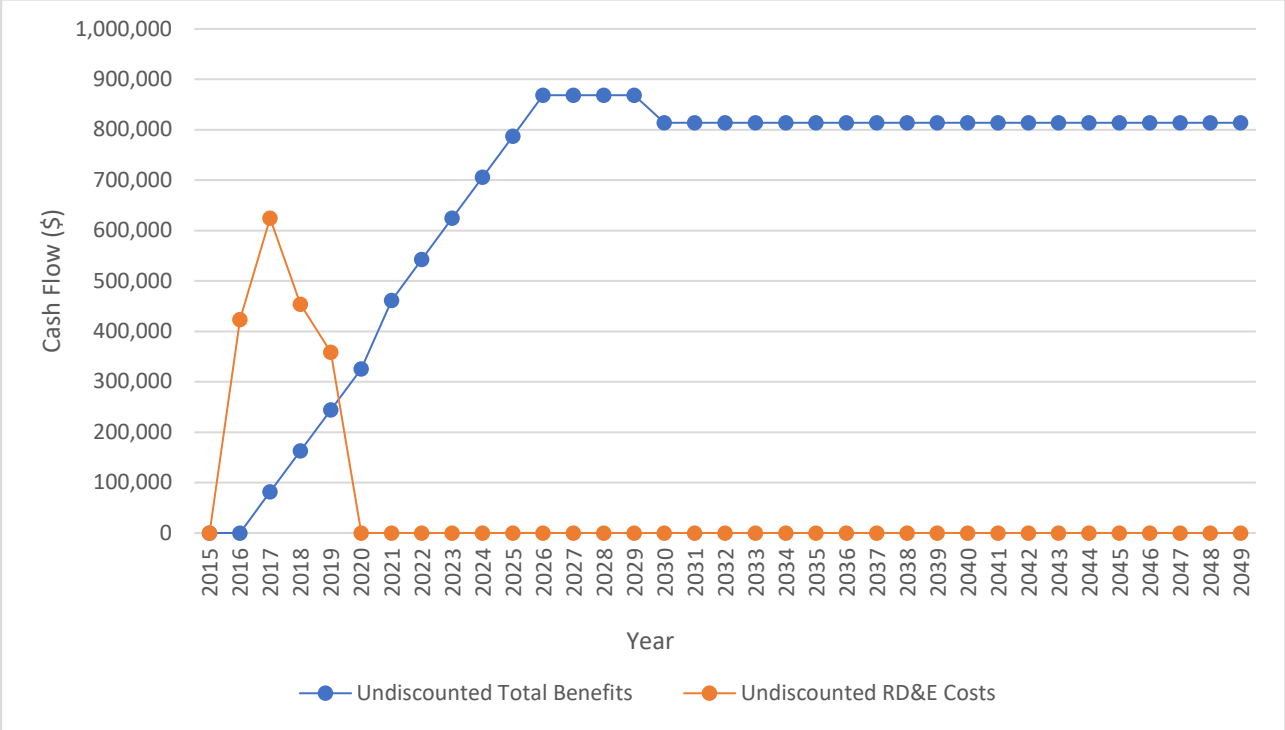


Table 9 shows the contribution of each impact to the total PVB.

Table 9: Contribution of Benefits

Impact	PVB ($m)	% of Total PVB
Impact 1: Increased profitability for Australian macadamia producers	12.09	96.9%
Impact 2: Increased efficiency of RD&E resource allocation	0.39	3.1%
Total	12.48	100.0%

Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 10 present the results. The results showed a moderate to low sensitivity to the discount rate. This is largely due to the benefit cash flows for the increased gross margin occurring in the future and therefore being subjected to more significant discounting.

Table 10: Sensitivity to Discount Rate (Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5%	10%
Present Value of Benefits ($m)	23.69	12.48	7.86
Present Value of Costs ($m)	1.86	2.11	2.39
Net Present Value ($m)	21.83	10.36	5.46
Benefit-cost ratio	12.74	5.90	3.28

A sensitivity analysis was then undertaken for the assumed increase in the average macadamia gross margin as this was a key driver of the investment criteria. The results are presented in Table 11 and show a moderate to high sensitivity to the assumed gross margin increase. A break-even analysis indicated that the investment criteria were positive at an assumed gross margin increase of 0.71% (all other assumptions held at their base valued).

Table 11: Sensitivity to Increase in Gross Margin (Total investment, 30 years)

Investment Criteria	Increase in macadamia gross margin		
	5% (base)	10%	20%
Present Value of Benefits ($m)	12.48	24.57	48.75
Present Value of Costs ($m)	2.11	2.11	2.11
Net Present Value ($m)	10.36	22.45	46.63
Benefit-cost ratio	5.90	11.62	23.06

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
High	Medium

Coverage of benefits was assessed as High – the two major economic benefits identified were quantified.

Confidence in assumptions was rated as Medium. Data used in the analysis were mostly drawn from published and/or credible sources such as project personnel (Shane Mulo), Hort Innovation, the Australian Macadamia Society, and the ABS. However, the attribution and counterfactual estimates assumed were analyst derived and were major drivers of the investment criteria reported.

Conclusion

The investment in MC15005 has improved Australian macadamia producers' understanding of their farm performance and expenditure, allowed the sharing of best management practice and contributed to improved mitigation and management of adverse seasonal conditions. Consequently, MC15005 is likely to have contributed to improved productivity and profitability for some members of the Australian macadamia industry as well as to increased efficiency of resource allocation for both public and private funds invested in macadamia RD&E.

Total funding from all sources for the project was $2.11 million (present value terms). The investment produced estimated total expected benefits of $12.48 million (present value terms). This gave a net present value of $10.36 million, an estimated benefit-cost ratio of 5.9 to 1, an internal rate of return of 26.8% and a modified internal rate of return of 9.9%. The estimated benefits were driven by two impacts: increased net profitability for Australian macadamia growers and improved efficiency of resource allocation associated with Australian macadamia RD&E.

Several environmental and social impacts were also identified but not valued as part of the current assessment. Given the impacts not valued, combined with conservative assumptions made for the principal economic impacts valued, it is reasonable to conclude that the investment criteria reported may be an underestimate of the actual performance of the MC15005 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.

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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 acknowledgments:

Shane Mulo, Team Leader, Subtropical Fruit Production Systems, DAF QLD

Brendan O'Keeffe, Analyst, Hort Innovation

Abbreviations

ABS	Australian Bureau of Statistics
AMS	Australian Macadamia Society
CRRDC	Council of Rural Research and Development Corporations
DAF	Department of Agriculture and Fisheries (Queensland)
Hort Innovation	Horticulture Innovation Australia Ltd
MIRR	Modified Internal Rate of Return
NIS	Nut-in-Shell
NSW	New South Wales
PVB	Present Value of Benefits
QLD	Queensland
RD&E	Research, Development and Extensions