Industry-specific impact assessment program: mushroom

Impact assessment report for project *Mushroom industry international collaboration* (MU09003)

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Project code:

MT18009

Date:

30 September 2019

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 *MU09003: Mushroom industry international collaboration.* The project was funded by Hort Innovation over the period July 2009 to October 2014.

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 2017/18 dollar terms and were discounted to the year 2018/19 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 has facilitated the transfer of knowledge from international research and marketing projects to the Australian mushroom industry. Consequently MU09003 is likely to contribute to a number of economic outcomes including lower mushroom production costs and increased research efficiency. Both these impacts have been quantified in the analysis. Other possible economic impacts include additional profitable sales for mushroom growers with additional awareness of health benefits generated through international research. Positive social impacts are also anticipated. These may include improved health outcomes for the Australian population associated with additional mushroom purchases and consumption and additional industry and researcher capacity. Spillover social impacts will be associated with increased income in mushroom growing areas as a result of a more profitable industry with lower production costs and additional sales.

Investment Criteria

Total funding from all sources for the project was $0.21 million (present value terms). All project funding was provided by Hort Innovation. The investment produced estimated total expected benefits of $0.61 million (present value terms). This gave a net present value of $0.40 million, an estimated benefit-cost ratio of 3 to 1, an internal rate of return of 274% and a MIRR of 20%.

Conclusions

One economic benefit (increased mushroom consumption) and a number of social impacts were not valued. When inability to value all impacts is combined with conservative assumptions for the principal economic impacts valued, it is reasonable to conclude that the valuation may be an underestimate of the actual performance of the investment.

Keywords

Impact assessment, cost-benefit analysis, MU09003, mushroom, industry, international, collaboration, International Society of Mushroom Science.

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 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 apple & pear (AP), avocado (AV), mushroom (MU) and table grape (TG) RD&E investment funds.

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

- Nine AP projects were chosen worth $15.46 million (nominal Hort Innovation investment) from an overall population of 19 projects worth an estimated $33.31 million,
- Seven AV projects worth $1.91 million (nominal Hort Innovation investment) from an overall population of 27 projects worth approximately $9.97 million,
- Five MU projects worth $1.75 million (nominal Hort Innovation investment) from a total population of 20 projects worth $7.94 million, and
- Six TG projects worth $2.84 million (nominal Hort Innovation investment) from an overall population of 11 projects worth $5.0 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2013 to 30 June 2018.

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.

Project MU09003: *Mushroom industry international collaboration* was randomly selected as one of the 22 unique MT18009 investments 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 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

In 2017/18, the Australian mushroom industry consisted of approximately 44 growers producing 70,463 tonnes of mainly white button mushroom (*Agaricus bisporus*) with a farm-gate value of $456.6 million. Mushrooms are grown close to population centres, especially Adelaide, Melbourne Metro and the Sydney Basin. Most production is destined for the fresh domestic market and a proportion of the crop is sliced (processed) and sold fresh in a value-added form. Mushrooms are produced year-round and grown under cover in controlled environments.

The Australian Mushroom Growers Association (AMGA) Limited was formed in 1961 and has been instrumental in developing the market for fresh Australian mushrooms and delivering research, development and extension (RD&E) projects. The AMGA has members who are growers, wholesalers and farm input suppliers.

The mushroom industry levy is only applied to Agaricus mushrooms. It is calculated on a dollar per kilogram of mushroom spawn. The total mushroom statutory levy (marketing and R&D) collected from growers averages approximately $4.8 million per year. The industry invests approximately 80% of the mushroom levy into marketing activities. The remaining 20% is invested into RD&E and attracts contributions from the Australian Government. R&D investment totals approximately $1.9 million per annum (Hort Innovation, 2017). Communication, extension and networking projects are a high priority for RD&E spend – the industry is relatively small and relies on shared technical information and advice, some of which is sourced overseas.

Rationale

The future technical support of the Australian mushroom industry is dependent on international collaboration as the Australian industry lacks the size and critical mass to sustain an independent professional technical support service. Attendance at international conferences, meetings and study tours of the mushroom industries in other countries are important activities for functional and beneficial networks. The development of personal links with R&D and marketing organisations and, more importantly, staff who are directly involved with mushrooms, are important investments for the future of the industry in Australia.

This project sought funds to match industry voluntary contributions to cover the cost of the AMGA General Manager, Greg Seymour attending and chairing annual meetings of the International Society of Mushroom Science (ISMS). Subsequently, Mr Seymour chaired the ISMS between 2010 and 2014. Mr Seymour also met with project teams working on Horticulture Australia Limited (HAL, now Hort Innovation) funded international projects and attended international scientific meetings. Twelve international projects mainly focussing on the health benefits of consuming mushrooms were completed and made available to the Australian industry during Mr Seymour's tenure and a further seven projects were put in place. Meetings attended by Mr Seymour were held in the United States (US), Europe and Asia.

Funding of the project was consistent with the Mushroom Industry Plan 2006 – 2011, the Mushroom Industry Plan 2011 – 2016 and the Mushroom Industry Strategic Investment Plan (SIP) 2017-2021. The two older plans highlighted the need to establish and maintain international networks for R&D and marketing cooperation and the need to ensure the industry is equipped with the necessary skills, resources and structures to facilitate international cooperation. The current SIP focusses on sharing dedicated knowledge, efficient innovation and research capacity.

Project Details

Summary

Project Code: MU00903

Title: *Mushroom industry international collaboration*

Research Organisation: AMGA

Principal Investigator: Greg Seymour

Period of Funding: July 2009 to October 2014

Objectives

The objective of this project was to undertake international travel, conferences and meetings and develop R&D and marketing projects and linkages with other mushroom industries in other countries. The project was to deliver more efficient and effective R&D and marketing projects and better outcomes for the Australian mushroom industry.

Logical Framework

Table 1 provides a description of MU09003 in a logical framework.

Table 1: Logical Framework for Project MU09003

Activities and Outputs	Activities: • Attend and chair ISMS meetings in the US, Europe and Asia between 2009 and 2014. • Oversee the preparation and conduct of the ISMS Congress in Beijing, 2016. • Undertake international networking in US, Europe and Asia between 2012 and 2014. • Design next stage of the Mushrooms & Health Global Initiative in San Francisco, 2009. • Meet with the French mushroom growers association to develop future R&D cooperative arrangements, 2009. • Formalise a global mushroom promotions group, Dublin Ireland, 2009. • Work with other ISMS members to design a new global promotions website, 2009. • ISMS meetings, World Mushroom Cooking Competition and field visits in China, 2010. • US and Europe marketing meetings to review activities and discuss global promotion potential and review joint research projects (United Kingdom and Denmark), 2010. • Meetings with US Mushroom Council R&D Committee to review progress with the Mushrooms & Health Global Initiative, San Francisco, USA 2010. • Establish a new global collaborative group for mushroom marketing – consisting of representation from the US, Europe and Australia, 2010. • Reaffirm infrastructure for global R&D collaboration, San Francisco, USA 2010. • Attend the World Society for Mushroom Biology and Mushroom Products, Arcachon, France and the Mushroom & Health Global Initiative, Amsterdam, Netherlands, 2011. • Attend the ISMS Conference, Beijing China and visit US based R&D projects, 2012. • Attend North American Mushroom Conference (Vancouver Canada), review projects in the US and Europe, attend ISMS meetings Holland and the United Kingdom, 2013. Outputs: • Australia given access to $5 million in R&D projects and their outputs including major investments in health R&D that is vital for the Australian industry's strategic future. • Benchmarking of R&D, marketing and industry efficiencies against world practice. • Communication of meeting and networking lessons to the AMGA Board to inform policy, Mushroom Industry Advisory Committee (MIAC) to inform R&D and marketing investments, mushroom industry researchers to improve research efficiency, and mushroom supply chain participants to improve marketing efficiency.

	• Information incorporated into industry strategic and operating plans. • Funding of R&D and marketing projects that were beyond the reach of Australia. • Presentations to MIAC, grower meetings and personal discussions with researchers. • Maintenance of an international network of scientific and commercial personnel.
Outcomes	• More efficient Australian industry through the flow of new information to the industry and maintenance of a strong international network for continuing cooperation and collaboration on R&D and marketing issues and projects.
Impacts	• Lower costs of production for mushroom growers as a result of increased adoption of improved technologies and practices across the supply chain resulting from a more efficient and effective R&D program. • Improved resource allocation in research. • Additional profitable sales for mushroom growers with additional awareness of health benefits generated through international research. • Increased health outcomes for the Australian population associated with additional mushroom purchases and consumption. • Increased industry capacity and increased research capacity. • Efficiency gains in international mushroom research resource allocation. • Increased income in mushroom growing areas associated with a more profitable industry with lower production costs and additional sales (spillover impact).

Project Investment

Nominal Investment

Table 2 shows the annual investment (cash and in-kind) in project MU09003 by Hort Innovation. Hort Innovation investment included levy, Commonwealth matching payments and voluntary contributions made by AMGA. There were no 'other' investors in this project.

Table 2: Annual Investment in the Project MU09003 (nominal $)

Year ended 30 June	Hort Innovation ($)	Other ($)	Total ($)
2010	15,000	0	15,000
2011	15,000	0	15,000
2012	30,000	0	30,000
2013	30,000	0	30,000
2014	15,000	0	15,000
2015	15,000	0	15,000
Totals	120,000	0	120,000

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 2.

Real Investment and Extension Costs

For the purposes of the investment analysis, investment costs of all parties were expressed in 2017/18 dollar terms using the GDP deflator index. There were no additional costs associated with project extension. Every element of the project was focussed on technology transfer.

Impacts

Table 3 provides a summary of the principal types of impacts delivered by the project. Impacts have been categorised into economic, environmental and social impacts.

Table 3: Triple Bottom Line Categories of Principal Impacts from Project MU09003

Economic	• Lower costs of production for mushroom growers as a result of research adoption of improved technologies and practices across the supply chain resulting from a more efficient and effective R&D program. • Improved resource allocation in research. • Additional profitable sales for mushroom growers with additional awareness of health benefits generated through international research.
Environmental	• Nil.
Social	• Increased health outcomes for the Australian population associated with additional mushroom purchases and consumption. • Increased industry capacity and increased researcher capacity. • Efficiency gains in international mushroom research resource allocation. • Increased income in mushroom growing areas associated with lower production costs and additional sales (spillover impact).

Public versus Private Impacts

Impacts identified in this evaluation are both public and private in nature. Private benefits will be realised by mushroom growers with lower costs of production, additional profitable sales, improved resource allocation in research and efficiency gains in industry development planning. Public benefits will include increased health outcomes (additional mushroom consumption), capacity (industry and researcher) as well as increased income in mushroom growing areas associated with a more profitable industry.

Distribution of Private Impacts

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

Impacts on Other Australian Industries

Impacts on industries other than the mushroom industry may include potential gains in other industries via any future spillovers from the increase in researcher capacity.

Impacts Overseas

The project has focussed on international collaboration. There will therefore be impacts to international mushroom industries from increased capacity (both for industry and researchers), as well as efficiencies in research due to the international cooperation and collaboration.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 4. The project findings and related impacts will contribute to Rural RD&E priorities 1 and 4 and to Science and Research Priority 1 and 8.

Table 4: 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 Mushroom Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the mushroom industry are outlined in the Mushroom Strategic Investment Plan 2017-2021[1] (Hort Innovation, 2016). Project MU08010 addressed SIP Outcome 2, Strategies 2.1, 2.2 and 2.3.

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 of the project were valued. The first impact was lower costs of production for mushroom growers. The second impact was efficiency gains in Australian mushroom research resource allocation.

Impacts Not Valued

Not all of the impacts identified in Table 3 could be valued in the assessment. A number of economic and social impacts were hard to value due to lack of evidence/data, difficulty in quantifying the causal relationship and pathway between MU09003 and the impact and the complexity of assigning monetary values to the impact.

The economic impact identified but not valued was:

- Additional profitable sales for mushroom growers with additional awareness of health benefits generated through international research.

The social impacts identified but not valued were:

- Increased health outcomes for the Australian population associated with additional mushroom consumption.
- Increased industry capacity and increased research capacity.
- Efficiency gains in international mushroom research resource allocation.
- Increased income in mushroom growing areas associated with a more profitable industry with lower production costs and additional sales (spillover impact).

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

Valuation of Impact 1: Lower Costs of Production for Mushroom Growers

MU09003, international mushroom industry collaboration, provided access to R&D findings from research programs in the US, Europe and Asia. Research originating from international collaboration is expected to contribute to improved mushroom grower productivity. While some production costs may increase to achieve this improved productivity, the increase in productivity is assumed to more than compensate for this, and therefore there will be an overall cost reduction for production costs per unit of mushrooms produced.

The average cost of production (including packing, marketing and transport) of Australian mushrooms was estimated from IBIS World data (IBIS World, 2018) at $5.06/kg and this is broadly consistent with the Chudleigh (2011) estimate of $4.34/kg when adjusted for CPI to $5.00/kg. It is assumed that application of findings from international research will, on average, decrease this cost of production by 1% or $0.05/kg. A 1% cost of production decrease is conservative given long term productivity growth across Australian agriculture is 1% per annum (ABARES, 2019).

This cost reduction is assumed to apply to 16.6% of total industry production. This is the equivalent of one large grower adopting research outcomes. Three large Australian mushroom growers produce approximately 50% of total output while the remaining 41 growers produce the balance of Australia's mushrooms (Mushroom Industry SIP 2017-2021).

Annual industry production is 70,463 tonnes (Hort Innovation, 2018). Innovation linked to MU09003 occurs during the project but takes up to 5 years to be realised as a cost reduction on farm – investment is made and there is a lag before the cost reduction occurs due to the process of integrating the new technology into the existing production system.

Attribution

A 40% attribution factor has been assumed for MU09003's contribution to lower costs of production – the investment works in tandem with other R&D investments targeting lower production costs/increasing industry productivity. Project impacts also build on lessons learned from previous international collaboration. Previous international collaboration projects include MU03009, MU03011, MU05009, MU06011, MU07004, MU07019 and MU08017.

Counterfactual

It is assumed that in the absence of Hort Innovation investment in MU09003 (levy, matching and voluntary contribution), international collaboration would have occurred using only AMGA funds and 50% of the impacts would have been realised.

Valuation of Impact 2: Efficiency Gains in Australian Mushroom Research Resource Allocation

Annually, $1.28 million is spent on mushroom research by the industry – three year average of Hort Innovation mushroom program expenditure sourced from the company's annual reports. It is assumed that this is equivalent to the total investment in mushroom R&D in Australia. MU09003 will contribute additional overseas generated information and increased cooperation and collaboration between researchers. It will also contribute to improved understanding of industry issues, current and past research, and therefore improvements in the setting of goals and priorities for research funding. Therefore, it can be assumed that the research investment is made in a more efficient manner than it would have been without the project being funded.

It is assumed that there is an efficiency of 2% of R&D spending. That is, the same outcomes and impact will be achieved with a 2% reduction in R&D spending. It is assumed that this gain commences in 2014/15 – knowledge becomes available early in the project but time is required to implement change and shift from current investments. Benefits flow through to 2018/19 (five years after benefit commencement). This short term of benefits is assumed as the project will only influence research investment for a limited period of time.

Attribution

All impacts are attributed to MU09003; the impact of previous investments on research resource allocation is short lived and the impact of previous projects is assumed to have been exhausted.

Counterfactual

It is assumed that in the absence of Hort Innovation investment in MU09003 (levy, matching and voluntary contribution), international collaboration would have occurred using only AMGA funds and 50% of the impacts would have been realised.

Summary of Assumptions

A summary of the key assumptions made for valuation of the impacts is shown in Table 5.

Table 5: Summary of Assumptions

Variable	Assumption	Source/Comment
Impact 1: Lower Costs of Production for Mushroom Growers		
Average cost of production without MU08010.	$5.06/kg	Estimated from IBIS World 2018 and cross checked with Chudleigh 2011.
Saving in cost of production due to MU09003.	1%	A 1% cost of production decrease is conservative given long term productivity growth across Australian agriculture is 1% per annum (ABARES, 2019)
Total annual production of mushrooms.	70,463 tonnes	Hort Innovation, 2018
Proportion of production achieving cost reduction.	16.6%	Equivalent of one large grower adopting research outcomes. Three large Australian mushroom growers produce approximately 50% of total output and there are approximately 44 mushroom growers (Mushroom Industry SIP 2017-2021).
Year of first impact.	2014/15	Innovation linked to MU09003 occurs during the project but takes up to 5 years to be realised as a cost reduction on farm.
Number of years to maximum impact is reached.	10 years	Analyst assumption based on a classic adoption profile – slow gain is industry use, followed by a plateau and gradual replacement as new technologies are adopted.
Number of years of maximum impact.	5 years	
Number of years over which impact declines to zero.	10 years	
Attribution of impacts to MU08010.	40%	See above text.
Counterfactual.	50%	See above text.
Impact 2: Efficiency Gains in Australian Mushroom Research Resource Allocation		
Total annual expenditure on mushroom research.	$1.28 million	Three year average of data (2015/16, 2016/17 and 2017/18) sourced from Hort Innovation annual reports.
Efficiency of spending due to MU09003.	2%	Analyst assumption and reviewed using sensitivity testing.
Year of first impact.	2014/15	Knowledge becomes available early in the project but time is required to implement change and shift from current investments..
Year in last impact.	2018/19	Five years after first year of impact.

Results

All costs and benefits were discounted to 2018/19 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 (2017/18) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

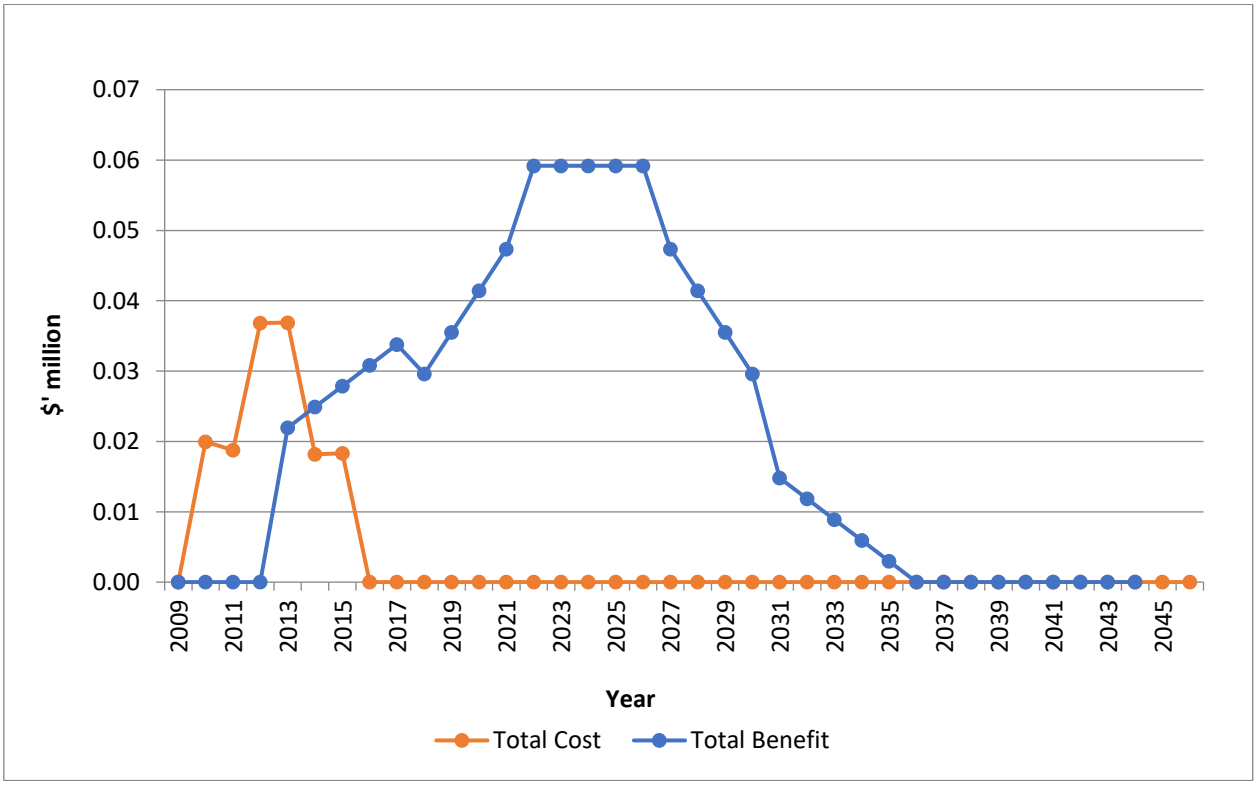
Tables 6 shows the investment criteria estimated for different periods of benefit for the total investment. Hort Innovation was the only contributor to this project so there is no second set of analyses showing results for Hort Innovation.

Table 6: Investment Criteria for Total Investment in Project MU09003

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits ($m)	0.03	0.21	0.38	0.55	0.60	0.61	0.61
Present Value of Costs ($m)	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Net Present Value ($m)	-0.18	0.00	0.17	0.35	0.39	0.40	0.40
Benefit-Cost Ratio	0.13	1.04	1.84	2.69	2.94	2.96	2.96
Internal Rate of Return (%)	negative	272.3	274.2	274.3	274.3	274.3	274.3
MIRR (%)	negative	86.7	55.4	38.6	29.0	23.4	19.9

The annual undiscounted benefit and cost cash flows for the total investment for the duration of MU09003 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



NB: Unusual benefit profile is due to the impact of the second benefit (efficiency gains in research allocation) that is short lived and 'spikes' during and soon after project investment.

Table 7 shows the contribution of each impact to the total PVB.

Table 7: Contribution of Benefits

Impact	PVB ($M)	% of Total PVB
Impact 1: lower costs of production for mushroom growers	0.50	82.7%
Impact 2: efficiency gains in research resource allocation	0.11	17.3%
Total	0.61	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 8 present the results. The results are moderately sensitive to the discount rate.

Table 8: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5%	10%
Present Value of Benefits ($m)	0.79	0.61	0.50
Present Value of Costs ($m)	0.15	0.21	0.28
Net Present Value ($m)	0.64	0.40	0.22
Benefit-cost ratio	5.29	2.96	1.79

A sensitivity analysis was then undertaken for the assumed proportion of mushroom production achieving a cost reduction. Even with a halving of the assumed proportion of production achieving a cost reduction, the project produces a positive return on investment – Table 9.

Table 9: Sensitivity to Share of Mushroom Production Achieving Cost Reduction
(Total investment, 30 years)

Investment Criteria	Proportion of Mushroom Production Achieving Cost Reduction		
	8.3%	16.6% (base)	33.2%
Present Value of Benefits ($m)	0.36	0.61	1.11
Present Value of Costs ($m)	0.21	0.21	0.21
Net Present Value ($m)	0.15	0.40	0.91
Benefit-cost ratio	1.74	2.96	5.41

A final sensitivity test examined the assumed efficiency gain in research resource allocation attributable to MU09003. Halving the assumed gain in research resource allocation efficiency attributable to MU09003 makes only a relatively minor change to overall impact assessment results – Table 10.

Table 10: Sensitivity to Efficiency in Research Spend Attributable to MU09003
(Total investment, 30 years)

Investment Criteria	Increase in Efficiency of Research Spend Attributable to MU08010		
	1%	2% (base)	5%
Present Value of Benefits ($m)	0.56	0.61	0.77
Present Value of Costs ($m)	0.21	0.21	0.21
Net Present Value ($m)	0.35	0.40	0.56
Benefit-cost ratio	2.71	2.96	3.73

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 11). 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 11: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium-high	Medium-low

Coverage of benefits was assessed as medium-high. Two major benefits were quantified but impact of overseas research on increased mushroom consumption could not be quantified – data linking cause and effect was not available.

Confidence in assumptions was rated as medium-low. Data were mostly drawn from Hort Innovation and AMGA sources. However, percentage based estimates were required and these data were estimates.

Conclusion

The investment has facilitated the transfer of knowledge from international research and marketing projects to the Australian mushroom industry. Consequently MU09003 is likely to contribute to a number of economic outcomes including lower mushroom production costs and increased research efficiency. Both these impacts have been quantified in the analysis. Other possible economic impacts include additional profitable sales for mushroom growers with additional awareness of health benefits generated through international research. Positive social impacts are also anticipated. These may include improved health outcomes for the Australian population associated with additional mushroom purchases and consumption and additional industry and researcher capacity. Spillover social impacts will be associated with increased income in mushroom growing areas as a result of a more profitable industry with lower production costs and additional sales.

One economic benefit (increased mushroom consumption) and a number of social impacts were not valued. When inability to value all impacts is combined with conservative assumptions for the principal economic impacts valued, it is reasonable to conclude that the valuation may be an underestimate 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.

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Acknowledgements

Geoff Martin, Acting General Manager, AMGA
John Vatikiotis, Mushroom Program Manager, Hort Innovation

Abbreviations

AMGA	Australian Mushroom Growers Association Limited
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
HAL	Horticulture Australia Limited
ISMS	International Society of Mushroom Science
IRR	Internal Rate of Return
MIAC	Mushroom Industry Advisory Committee
MIRR	Modified Internal Rate of Return
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
US	United States of America