# Horticulture Impact Assessment Program:

## Appendix 6: Communication and education of mushroom nutrition research to health professionals - phase 2 (MU14000 Impact Assessment)

**Impact analyst:**

Michael Clarke

**Delivery partner:**

AgEconPlus and Agtrans Research

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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 *MU14000:Communication and education of mushroom nutrition research to health professionals.* The project was funded by Hort Innovation over the period October 2014 to August 2017.

### 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 is likely to contribute to additional profitable sales for mushroom growers on the domestic market. Through its Strategic Investment Plan (SIP) 2017-2021 the Australian Mushroom Industry has set itself a 'bold and ambitious' target of increasing per capita mushroom consumption from 2.8 kg in 2017 to 4 kg in 2021. It is expected that investment in communication of research on the health benefits of mushroom consumption to health professionals through MU14000 will make a positive contribution to this outcome. Positive social impacts are also anticipated. These will include improved health outcomes for the Australian population as a result of increased mushroom consumption, additional health care knowledge for dieticians, nurses and general practitioners as well as increased income in mushroom growing areas (spill-over impact).

### Investment Criteria

Total funding from all sources for the project was $1.08 million (present value terms). All project funding was provided by Hort Innovation. The investment produced estimated total expected benefits of $2.80 million (present value terms). This gave a net present value of $1.72 million, an estimated benefit-cost ratio of 2.6 to 1, an internal rate of return of 14% and a MIRR of 8%.

### Conclusions

Social impacts were not valued and when this is combined with conservative assumptions for the 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, MU14000, mushroom, health, nutrition, professionals, communication, education

# Introduction

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

- Reporting against the Hort Innovation's current Strategic Plan and the Evaluation Framework associated with Hort Innovation's Statutory Funding Agreement with the Commonwealth Government.
- Reporting against strategic priorities set out in the Strategic Investment Plan (SIP) for each Hort Innovation industry fund.
- 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 included 15 randomly selected Hort Innovation RD&E investments (projects) worth a total of approximately $9.31 million (nominal Hort Innovation investment). The investments were selected from an overall population of 85 Hort Innovation investments worth an estimated $50.38 million (nominal Hort Innovation investment) where a final deliverable had been submitted in the 2017/18 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.

Under a separate impact assessment program (MT18009), a second series of impact assessments addressed a requirement for 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.

Five projects included in the MT18009 industry specific samples were also randomly selected and evaluated as part of a separate, whole of Hort Innovation impact assessment program (MT18011). Such overlapping projects were evaluated such that the impact assessment reporting would meet Hort Innovation's requirements under both MT18011 and MT18009.

Project *MU14000*: *Communication and education of mushroom nutrition research to health professionals (phase 2)* was randomly selected as one of the 15 investments under MT18011, and also as one of the investments under MT18009, 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. Mushrooms are produced year-round and grown under cover in controlled environments. Most production is destined for the fresh domestic market. Small volumes are channelled into processing (<3%) and fresh export (<1%) (Mushroom SIP, 2017 and Hort Innovation, 2018).

In 2016, 83% of Australian households purchased mushrooms (Mushroom SIP 2017). Average per capita mushroom consumption has increased from 2.5kg per person at the turn of the century to 2.9kg per person in 2018. Canada, a similar market to Australia consumes 3.5kg of mushrooms per person (HAL, 2003 and Hort Innovation, 2018). Mushrooms are nutritious, high in dietary fibre and protein, contain many important vitamins and minerals and provide health benefits to consumers (Mushroom SIP, 2017).

### Rationale

Market analysis completed as part of the industry's research program has established the link between mushrooms and improved health as the key driver for ongoing growth in domestic mushroom consumption. Levy funded project MU04001 established that increased consumption will follow the provision of credible, easily understood up-to-date information on the health benefits of mushrooms.

Health benefits established through Australian research include assistance with the prevention of breast and prostate cancer (MU04007, MU04008, MU06023 and MU06019), Alzheimer's Disease (MU10019 and MU08015), weight gain and diabetes (MU017014), liver disease (MU10004), inflammatory disease (MU10006) and cognitive function (MU10007). Mushrooms have been shown to contain high levels of vitamin D2 (when exposed to sunlight or a UV lamp) and the antioxidant ergothioneine (MU10008, MU10009, MU10010, MU10014), assist with infection resistance (MU10011) and immune function (MU10012).

The current project and the subject of this impact assessment (MU14000) is a phase two investment that builds on MU11002 (phase one). Phase one summarised and communicated information on the health and nutrition properties of mushrooms and ran from 2010/11 to 2013/14. The phase one project took advantage of the wealth of mushroom health research generated between 2006-2013. Following the completion of the phase one project, additional mushroom health research became available necessitating additional health professional education and communication activities.

The phase two project (MU14000) was designed to collect and communicate existing and new research on the health benefits of mushrooms. New information was available on breast and prostate cancer, heart disease, appetite control/weight management, brain function and health, immune function, osteoporosis, antioxidants and nutrition. This information was summarised, rewritten in plain English, packaging and communicated to health professionals and other relevant channels.

# Project Details

## Summary

Project Code: 14000

Title: *Communication and education of mushroom nutrition research to health professionals (phase 2)*

Research Organisation: Nutrition Impact Pty Ltd

Principal Investigator: Glenn Cardwell

Period of Funding: October 2014 to August 2017

## Objectives

The project's key objectives were:

1. Collate data from local and international mushroom research and condense it into easy-to-understand information.
2. Educate and communicate to health professionals by presenting at conferences, sponsored breakfasts, newsletters, and providing website information.
3. Educate and communicate mushroom nutrition research findings through lifestyle programs, newsletters, Australian Mushroom Growers Association (AMGA) staff and programs, mushroom growers, and health industry websites.
4. Educate and communicate to government agencies and health authorities via conferences, submissions, and technical papers and information.

## Logical Framework

The focus of MU14000 was to collate and disseminate findings from Australian funded (mainly Hort Innovation) and international research on the health benefits of white button mushrooms to health professionals (dietitians, GPs, nurses), government health agencies, health authorities, food service, food writers and Australian mushroom growers. Table 1 provides a description of the project in a logical framework.

Table 1: Logical Framework for Project MU14000

| | |
|---|---|
| Activities and Outputs | • Worldwide literature search on how mushrooms influence health including up-to-date literature from overseas and Australia e.g. research funded by Hort Innovation.<br>• Preparation of packages of issue-based information (positive impact of mushroom consumption on cancer, heart disease, weight management, diabetes prevention, Vitamin D, antioxidants, osteoporosis, etc.) and rewrite this information in a format that is relevant to non-scientific audiences.<br>• Production of information in a range of media e.g. websites (powerofmushrooms and mushroomsandhealth), conference presentations, posters, brochures, submissions to inquiries, media releases, PR materials, and newsletters.<br>• Communicate packaged information to health professionals by presenting at conferences, sponsored breakfasts, newsletters, farm tours, cooking demonstrations.<br>• Communicate packaged information through lifestyle programs, newsletters, AMGA staff, Mushroom Lovers Club, mushroom growers/supply chain and industry websites.<br>• Work with industry to ensure they are informed advocates for mushrooms.<br>• Communicate with and educate government agencies through attendance at conferences, provision of submissions and technical papers.<br>• Plan and deliver a program of visits by international experts with knowledge of the health benefits of mushrooms.<br>• Work with industry to develop Vitamin D enhanced mushrooms (mushrooms exposed to sunlight or placed under a UV light). Food Standards Australia New Zealand now formally recognise mushrooms as high in Vitamin D. |

| | |
|---|---|
| | • Publish the Mushroom and Health Global Bulletin explaining recently published research and linking this resource to the 2014 CSIRO Mushroom and Health Report.<br>• Continually update communication collateral and address any public misconceptions regarding mushroom consumption (e.g. mushrooms cause gout, have gluten).<br>• Respond to enquiries for mushroom information (e.g. media, school groups).<br>• Identify gaps in existing scientific knowledge to inform future research.<br>• Final report identifies that 'thousands of health professionals around the country are now aware of mushrooms are high in a wide range of nutrients'. |
| Outcomes | • Improved understanding of the health benefits of mushrooms by health professionals who are trusted by consumers ('thousands of health professionals now aware').<br>• Improved understanding of the health benefits of mushrooms by other stakeholders (e.g. media, industry, government agencies).<br>• Improved community understanding of the health/nutrition benefits of mushrooms.<br>• A sound platform for industry's investment in mushroom promotion.<br>• Increased domestic consumption of Australian mushrooms. |
| Impacts | • Increase in profitable sales for mushroom growers.<br>• Health professionals, communication stakeholders, industry and government have additional health care knowledge and capacity.<br>• Improved health outcomes for the Australian population.<br>• Increased income in mushroom growing areas associated with a more profitable and sustainable industry (spill-over impact). |

# Project Investment

### Nominal Investment

Table 2 shows the annual investment (cash and in-kind) in project MU14000 by Hort Innovation. There were no 'other' investors in this project.

Table 2: Annual Investment in the Project MU14000 (nominal $)

| Year ended 30 June | Hort Innovation ($) | Other ($) | Total ($) |
|---|---|---|---|
| 2015 | 208,534 | 0 | 208,534 |
| 2016 | 254,267 | 0 | 254,267 |
| 2017 | 252,665 | 0 | 252,665 |
| 2018 | 50,534 | 0 | 50,534 |
| **Totals** | 766,000 | 0 | 766,000 |

### 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, Extension and Coordination 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. Project extension was included in budget totals. Industry coordination costs were included in budget totals. However, the project was varied at the first milestone report in September 2015 to remove payments to AMGA from Nutrition Impact Pty Ltd (the principal investigator) for the coordination role they were scheduled to undertake in Years 2 & 3 of the project. Subsequently, a separate contract was negotiated between Hort Innovation and AMGA for coordination of this project and a payment of $16,000 was made in 2017/18. This cost plus the relevant management cost multiplier has been included in the analysis.

# 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 MU14000

| | |
|---|---|
| Economic | • Increase in profitable sales for mushroom growers. |
| Environmental | • Nil. |
| Social | • Improved health outcomes for the Australian population – 83% of the population already consume some mushrooms and there is scope to increase mushroom consumption to levels achieved in similar markets such as Canada. Australia presently consumes 2.9kg per person per year; Canada consumes 3.5kg per person per year.<br>• Health professionals, communication stakeholders, industry and government have additional health care knowledge and capacity.<br>• Increased income in mushroom growing areas associated with a more profitable and sustainable industry (spill-over impact). |

### Public versus Private Impacts

Impacts identified in this evaluation are both private and public in nature. Private benefits will be realised by mushroom growers who will secure additional profitable sales. Public benefits will be realised by the Australian community with improved health outcomes for those who start to consume mushrooms. Public benefits also include increased capacity (health professionals, communication stakeholders, industry and government) as well as increased income in mushroom growing areas associated with a more profitable and sustainable industry.

### Distribution of Private Impacts

The impacts on the mushroom industry from investment in this project will be shared along the supply chain with growers, transporters, wholesalers and retailers all sharing impacts produced by the project. The share of benefits captured by each link in the supply chain will depend on the interplay of both short- and long-term supply and demand elasticities for mushrooms.

### Impacts on Other Australian Industries

Impacts on industries other than the mushroom industry and its associated sectors may include potential gains in other industries via any future spill-overs from the increases in research and extension capacity.

### Impacts Overseas

Up-to-date, plain English and public summaries of the literature available through media such as conference presentations and websites will also be of value to mushroom industries in other countries. Other countries, especially those based on large-scale commercial production also grow white button mushrooms.

### 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 primarily to Rural RD&E Priority 4, and to Science and Research Priorities 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<br>2. Biosecurity<br>3. Soil, water and managing natural resources<br>4. Adoption of R&D | 1. Food<br>2. Soil and Water<br>3. Transport<br>4. Cybersecurity<br>5. Energy and Resources<br>6. Manufacturing<br>7. Environmental Change<br>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 MU14000 addressed Mushroom Strategic Investment Plan (SIP) Outcome 1, Strategy 1.5.

## 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.

A single impact of the project was valued – increase in profitable sales for mushroom growers.

### Impacts Not Valued

Not all of the impacts identified in Table 3 could be valued in the assessment. The social impacts were hard to value due to lack of evidence/data, difficulty in quantifying the causal relationship and pathway between MU14000 and the impact and the complexity of assigning monetary values to the impact. This was particularly true for improved health outcomes – data would be needed on the health profile of new and additional mushroom consumers, the change in health outcomes with mushroom consumption and the value of additional health created (medical costs avoided, life expectancy increase, etc.) These data were not available to the analyst.

The social impacts identified but not valued were:

- Health professionals, communication stakeholders, industry and government with additional health care knowledge and capacity.
- Improved health outcomes for the Australian population.
- Increased income in mushroom growing areas associated with a more profitable and sustainable industry (spill-over impact).

### Valuation of Impact 1: Increase in Profitable Sales for Mushroom Growers

The MU14000 investment resulted in improved understanding of the health benefits of mushrooms by media, industry, government agencies and health professionals. As a result of this additional understanding, positive messages about consuming mushrooms have been communicated to the Australian community.

Improved community understanding of the health benefits of consuming mushrooms is part of a package of R&D, marketing and promotion measures industry is investing in to increase mushroom consumption. Through its SIP

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

the industry has set itself a 'bold and ambitious' target of increasing profitable mushroom sales from 2.8 kg per capita in 2017 to 4.0 kg per capita by 2021.

**Attribution**

If the increase in profitable mushroom sales occurs it will be due to a number of investments identified in SIP Outcome 1. These include an annual marketing program, monitoring changes in per capita consumption, a food service sector program, new market development, investment in health professionals (including MU14000) and market intelligence. The forecast spend for SIP Outcome 1 is $8,062,789. MU14000 constitutes 9.6% of this total.

**Counterfactual**

If project MU14000 had not been completed it is likely that some of the more recent findings from medical research highlighting the benefits of mushroom consumption would have found their way into the Australian community's consciousness and influenced consumption patterns e.g. project press releases. Consequently it is appropriate that a share of project benefits be attributed to the counterfactual.

### 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: Increase in Profitable Sales for Mushroom Growers** | | |
| Additional mushroom sales targeted through the SIP. | 28,600 t/year | Mushroom SIP 2017-21 page 11 notes the increase target of 4kg/capita is equivalent to total demand of 550,000kg/week (by 52 weeks). |
| Mushroom grower profit on additional sales. | $460/tonne | Farm gate value of mushroom industry production of $456.6 M divide production of 70,463 tonnes to give a gross value of $6,480/tonne (Hort Innovation, 2018). Grower profit is 7.1% of gross value (IBIS World, 2018). |
| Attribution of additional mushroom sales to MU14000. | 9.6% | See above. |
| Year of first impact. | 2017/18 | Year of project completion and recognising communication efforts that have been underway as part of MU14000 since 2014/15. |
| Year in which impact reaches a peak. | 2020/21 | Consistent with Mushroom SIP 2017-21. |
| Probability of achieving 'bold and ambitious' SIP target. | 30% | Mushroom SIP 2017-21 notes that target was deliberately set as a challenge for industry. |
| Counterfactual | 60% | Analyst assumption after considering alternative communication channels. |
| Probability that activities completed as part of MU14000 will have an impact on mushroom sales. | 80% | Analyst assumption after considering successful linkages required i.e. health benefits result in increased consumption. |

# 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

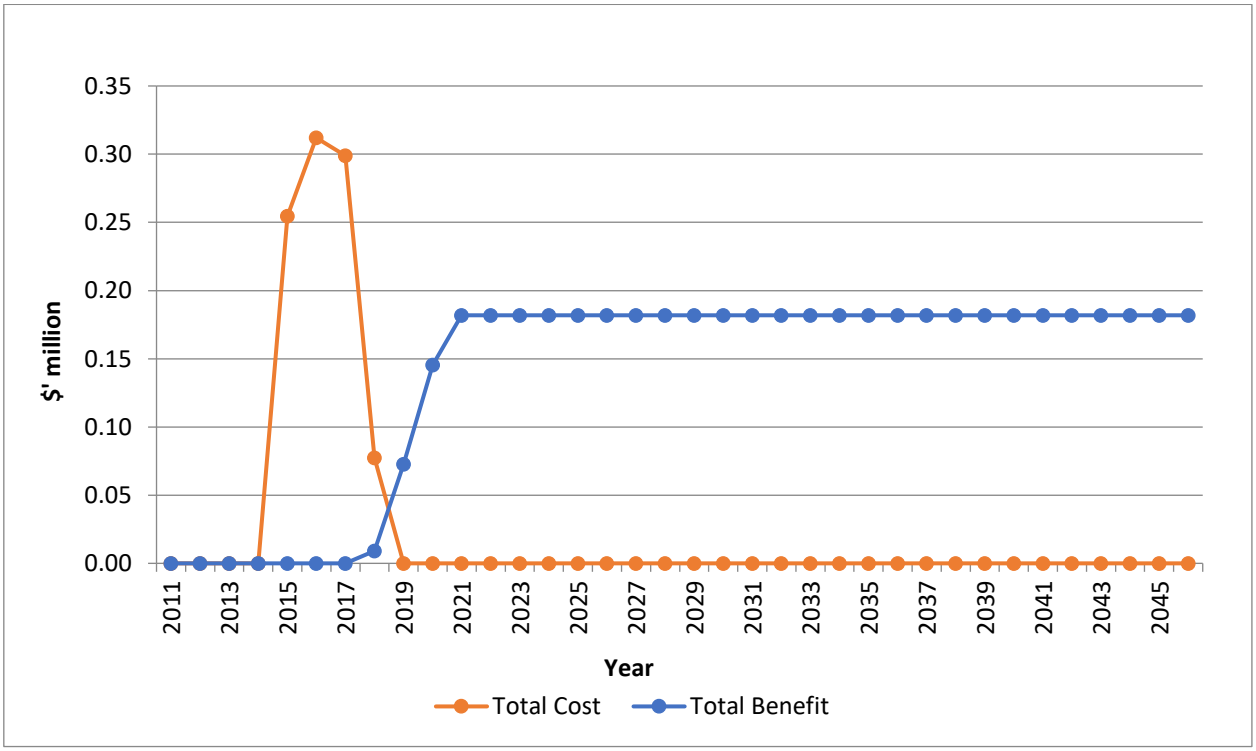
Tables 6 shows the investment criteria estimated for different periods of benefit for the total investment. Hort Innovation was the only contributor to this project so there is no second set of analyses showing results for Hort Innovation.

Table 6: Investment Criteria for Total Investment in Project MU14000

| Investment Criteria | Years after Last Year of Investment | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| Present Value of Benefits ($m) | 0.01 | 0.69 | 1.34 | 1.85 | 2.25 | 2.56 | 2.80 |
| Present Value of Costs ($m) | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 | 1.08 |
| Net Present Value ($m) | -1.07 | -0.39 | 0.26 | 0.77 | 1.16 | 1.48 | 1.72 |
| Benefit-Cost Ratio | 0.01 | 0.64 | 1.24 | 1.71 | 2.08 | 2.36 | 2.59 |
| Internal Rate of Return (%) | negative | negative | 7.6 | 11.5 | 12.9 | 13.5 | 13.7 |
| MIRR (%) | negative | negative | 6.5 | 8.2 | 8.4 | 8.3 | 8.1 |

The annual undiscounted benefit and cost cash flows for the total investment for the duration of MU14000 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 7 present the results. The results show a moderate sensitivity to the discount rate.

Table 7: Sensitivity to Discount Rate
(Total investment, 30 years)

| **Investment Criteria** | **Discount rate** | | |
|---|---|---|---|
| | **0%** | **5%** | **10%** |
| Present Value of Benefits ($m) | 5.32 | 2.80 | 1.75 |
| Present Value of Costs ($m) | 0.94 | 1.08 | 1.23 |
| Net Present Value ($m) | 4.38 | 1.72 | 0.52 |
| Benefit-cost ratio | 5.64 | 2.59 | 1.42 |

A sensitivity analysis was then undertaken for the assumed probability of achieving the 'bold and ambitious' SIP target. Even with a more modest assumption on achieving the SIP target (15% probability) the project produces a positive return on investment – Table 8.

Table 8: Sensitivity to Achieving SIP Target
(Total investment, 30 years)

| **Investment Criteria** | **Probability of Achieving SIP Target** | | |
|---|---|---|---|
| | **15%** | **30% (base)** | **60%** |
| Present Value of Benefits ($m) | 1.40 | 2.80 | 5.60 |
| Present Value of Costs ($m) | 1.08 | 1.08 | 1.08 |
| Net Present Value ($m) | 0.32 | 1.72 | 4.52 |
| Benefit-cost ratio | 1.30 | 2.59 | 5.18 |

A final sensitivity test examined the assumed probability that increased health knowledge will translate into additional mushroom sales. At half the assumed probability, the investment criteria continue to show a favourable result – Table 9.

Table 9: Sensitivity to the Link between Health Knowledge to Additional Mushroom Sales
(Total investment, 30 years)

| **Investment Criteria** | **Probability that Extra Health Knowledge will Increase Mushroom Sales** | | |
|---|---|---|---|
| | **40%** | **80% (base)** | **100%** |
| Present Value of Benefits ($m) | 1.40 | 2.80 | 3.50 |
| Present Value of Costs ($m) | 1.08 | 1.08 | 1.08 |
| Net Present Value ($m) | 0.32 | 1.72 | 2.42 |
| Benefit-cost ratio | 1.30 | 2.59 | 3.24 |

## 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 10). 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 10: Confidence in Analysis of Project

| Coverage of Benefits | Confidence in Assumptions |
|---|---|
| High | Medium-low |

Coverage of benefits was assessed as high. The main benefit of the research project was increased mushroom sales and this was quantified.

Confidence in assumptions was rated as medium-low. Data was mostly drawn from industry sources. However, probability factors were required and these data were estimates.

# Conclusion

The investment in MU14000 is likely to contribute to additional profitable sales for mushroom growers on the domestic market. Through its SIP the Australian Mushroom Industry has set itself a 'bold and ambitious' target of increasing per capita mushroom consumption from 2.8 kg in 2017 to 4 kg in 2021. It is expected that communication of research on health benefits of mushroom consumption through MU14000 will make a positive contribution to this outcomes. Positive social impacts are also anticipated. These will include improved health outcomes for the Australian population as a result of increased mushroom consumption, additional health care knowledge for dieticians, nurses and general practitioners as well as increased income in mushroom growing areas (spill-over impact).

Total funding from all sources for the project was $1.08 million (present value terms). All project funding was provided by Hort Innovation. The investment produced estimated total expected benefits of $2.80 million (present value terms). This gave a net present value of $1.72 million, an estimated benefit-cost ratio of 2.6 to 1, an internal rate of return of 14% and a modified internal rate of return of 8%.

Social impacts identified were not valued and when this is combined with conservative assumptions for the 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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## Abbreviations

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|---|---|
| AMGA | Australian Mushroom Growers Association |
| CRRDC | Council of Research and Development Corporations |
| DAWR | Department of Agriculture and Water Resources (Australian Government) |
| GDP | Gross Domestic Product |
| GPs | General Practitioners |
| HAL | Horticulture Australia Limited (now Hort Innovation) |
| IRR | Internal Rate of Return |
| 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 |