Delivery partner resource

Horticulture Impact Assessment Program

MU17004 – Optimising Nitrogen use Efficiency in Mushroom Composting – Impact Assessment

June 2025

Hort Innovation Disclaimer:

ACIL Allen Reliance and disclaimer

Funding statement:

Horticulture Impact Assessment Program 2024-25 – 2026-27 is funded by Hort Innovation. This multi-industry project is a strategic levy investment in the Hort Innovation Almond, Apple & Pear, Avocado, Banana, Blueberry, Cherry, Citrus, Dried Grape, Lychee, Macadamia, Mango, Melon, Mushroom, Nursery, Olive, Onion, Papaya, Passionfruit, Persimmon, Pineapple, Pistachio, Potato – Fresh, Potato – Processing, Raspberry and Blackberry, Strawberry, Summerfruit, Sweetpotato, Table Grape, Turf, and Vegetable Funds

Publishing details:

ISBN <Hort Innovation to add>

Published and distributed by: Horticulture Innovation Australia Limited
ABN 71 602100149

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Executive Summary

The Australian mushroom industry makes a significant contribution to the Australian horticulture market. In 2023, by production value, it was the largest vegetable crop with a total value of roughly $408 million. In the 5 years between 2019 and 2023 Australian growers produced roughly 67,060 tonnes of mushrooms annually with a gross annual production value of around $405 million.[1]

Australian mushroom crops rely on Nitrogen as means of cultivation. The primary source of Nitrogen is poultry manure, however, changes in chicken husbandry have reduced the Nitrogen content of poultry manure. As such there was a need for the identification of alternative nitrogen sources. This project sought to map these alternatives, in addition to improving understanding how the amount and form of Nitrogen addition impacts mushroom production.

This investment has a total nominal cost of $1,135,604, of this $855,604 was funded by Hort Innovation. This impact assessment identified a clear pathway to impact for the research undertaken. Two of the benefits identified were quantified to demonstrate the impacts of Hort Innovation's investment, though it should be noted that adoption of quantified research findings impacting yield and profitability are heavily reliant on further research being conducted and field testing. The benefits identified include:

— Increased productivity of existing crops – Findings relating to the amount, form, rate, and timing of nitrogen addition, as well as other composting components, may lead to higher crop yields and productivity.

— Product differentiation – The research identified higher levels of Nitrogen in later flush mushrooms, pointing to the potential for the sale of a differentiated "Super Protein" mushroom. However, it is unlikely that consumers will respond to this price differentiation, so adoption by growers is likely to be very small.

Beyond these, there were 4 additional benefits identified that could not be quantified, including:

— Increased resilience of supply chains – The uptake of alternative Nitrogen sources identified through the research would diversify the supply chain for mushroom compost, reducing supply chain risk caused by sole reliance on poultry manure for mushroom cultivation.

— Increased growth rate of crops – Bioaugmentation of compost during spawn with specific inoculums displayed an increase in the observed growth rates of crops. These findings were deemed to be unviable commercially, however.

— Identified opportunities for re-use of spent compost – Spent compost from mushroom crops was found to have high levels of Nitrogen retention (roughly 80%), suggesting the potential for re-use of spent compost through recycling.

— Improved understanding of mushroom composting systems – This research has made significant contributions to the evidence base regarding microbial biodiversity in compost, the prevalence of these microbes across composting facilities, and the role microbes play in composting.

The results show that, taking all quantified costs and benefits into account, the investment produced a positive net result. The investment has a net present value (NPV) of $0.28 million and a benefit-cost ratio (BCR) of 1.21

[1] Hort Innovation 2024, *Horticulture Statistics Handbook 2023*

at 30 years after investment completion using a 5% discount rate. This shows that the investment delivers a net positive return to levy payers and the broader community, returning $1.21 for every $1 in investment. This project has been attributed with 8% of the impacts, as the projects investment accounts for 80% of the total investment to date and the research to date accounts for around 10% of the assumed research required to realise these benefits.

Context, objective, and details of investment

As consumers and companies look for sustainable alternatives to meat, mushrooms have been identified as a suitable source of protein for the human diet. In Australia, Europe and North America, button mushrooms (*Agaricus bisporus*) have become the most popular and economically important mushroom. Globally, button mushrooms make up about 90% of the consumer market for mushrooms. The Australian mushroom industry produced over 60 tonnes of mushrooms and was valued at $393.1 million in 2020-21.[2] Victoria and New South Wales are the biggest producers of button mushrooms in Australia. In 2019-21, 97% of the Australian mushroom market was accounted by fresh domestic demand, with less than 1% being exported.[3]

This project was connected to *MU10021: Improving consistency of mushroom compost through control of biotic and abiotic parameters*. MU10021 aimed to provide details about the key microbes involved in mushroom composting and the specific successive changes that occurred. It explained that Nitrogen (N) is a key limiting nutrient in mushroom growth and advised research into understanding N transformations might improve yields.[4] N is an important component in cultivating button mushrooms and is mainly provided through poultry manure. However, it was noted that changes in chicken husbandry have reduced the availability and
N content of poultry manure, so identifying alternative sources was critical. Additional sources of nitrogen were identified as urea, ammonium sulfate, canola, cotton seed, cotton trash, soybean meal, and feather meal.

This project expanded upon the points described in MU10021. Both Carbon (C) and N are important to achieving maximum mushrooms yields and must be properly balanced. MU17004 examines how the amount of N and its form affect mushroom farming. In addition to this, it explores the rate and timing of N addition and other composting factors on yield and quality, and N loss and recovery.

Alignment with Strategic Investment Plan

MU17004 closely aligned with Outcome 2 of the Mushroom Strategic Investment Plan 2017-21[5], which seeks to ensure mushroom growers remain profitable and sustainable through increased yields, reduced costs and effective risk management. MU17004 focused on improving industry supply, productivity and sustainability. Specifically, the project aimed to enhance compost quality by better understanding and controlling nitrogen transformations during composting, thereby improving consistency in mushroom production and supporting enhanced mushroom yields. By addressing the variability in compost quality, MU17004 contributed to more consistent, efficient and higher yield mushroom production, directly supporting the SIP's goals.

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[2] Horticulture Innovation Australia.2021. Mushroom Annual Investment Plan 2022/23.

[3] Horticulture Innovation Australia. 2021. Mushroom Strategic Investment Plan 2022-2026.

[4] Horticulture Innovation Australia. 2019. Improving consistency of mushroom compost through control of biotic and abiotic parameters.

[5] Horticulture Innovation Australia. 2017. Mushroom Strategic Investment Plan 2017-2021.

Table 1 Project details of MU17004

Project code	MU17004
Title	Optimising Nitrogen use Efficiency in Mushroom Composting
Research organisation(s)	The University of Sydney
Project leader	Associate Professor Michael Kertesz
Funding period	2018-19 to 2023-24
Objective	To detail the biological processes occurring during key nitrogen-transforming activities in compost and determine the overall nitrogen balance during composting.

Source: Hort Innovation

Related investments

The project was linked with one other investment, this was:

— MU10021: Improving consistency of mushroom compost through control of biotic and abiotic parameters. This project aimed to provide detail about the key microbes involved in mushroom composting and the specific successive changes that occur.

  The project is linked to MU17004 through a shared focus on enhancing the quality and reliability of mushroom compost. MU10021 investigated the sources of variability in compost performance, identifying key microbes and nutrients that influence consistency. A critical issue MU10021 identified was the inefficient use and loss of Nitrogen throughout the composting process. MU17004 built on this research with a specific target to optimise the use of nitrogen throughout the composting process thereby improving practices for nutrient retention, environmental impact and compost consistency.

Project governance

The research project MU17004 was led by Professor Michael Kertesz from the University of Sydney and was funded by Hort Innovation through the Mushroom industry research and development (R&D) levy and contributions from the Australian Government.

The project was governed by Hort Innovation, while the research itself was conducted by staff from the University of Sydney in collaboration with staff from Australian composting facilities and mushroom farms across Australia. Between these two groups a Project Reference Group (PRG) was established, the PRG provided strategic oversight, advice and feedback, while they also ensured the project aligned with the needs of industry and growers.

Due to limited information on the governance structure for this project an assessment of governance efficacy and impact were not able to be determined.

Impact pathway

A clear pathway from input to impacts can be identified. Overall, the investment produced 6 impactful benefits for both levy payers and the broader communities. Table 2 shows the logical pathway to impact of the investment.

Table 2 Impact pathway of MU17004

<table>
<tr><th>Pathway</th><th>Description</th></tr>
<tr><td>Inputs and activities</td><td>Literature review and consultations
A literature review, supplemented by stakeholder consultations, identified alternative Nitrogen inputs for mushroom composting.
Training of industry personnel
The research team trained industry personnel to undertake compost sampling on site and ship samples to the University of Sydney for analysis.
Compost sampling
Compost samples were collected from 9 facilities across New South Wales, Victoria, Queensland, South Australia and Tasmania.
Compost physicochemical measurements
Roughly twelve different measurements were taken at various stages throughout the composting process to determine the physicochemical composition of compost samples.
Nitrogen inputs and outputs survey
Process data was collected from composting facilities around Australia to determine the nitrogen balance throughout the mushroom composting process. The data captured a range of inputs and outputs at each phase of the composting process. Samples were normalised to allow comparison between sites.</td></tr>
<tr><td>Outputs</td><td>Literature review
A literature review, supplemented by stakeholder consultations, identified alternative Nitrogen inputs for mushroom composting.
Publication of research and findings
The research has been published both domestically and internationally, with 4 reviewed articles in international journals and 2 further articles in the Australian Mushroom Journal.
Conference participation and presentations
In addition to published reporting, the research, and related findings, has been presented to a range of domestic and international audiences. This included one webinar to an international audience, presentations at 5 international conferences, regular presentations to the Australian Mushroom Growers Association (AMGA) conferences, and an oral presentation to the Australian Society of Microbiology congress.
Information transfer to stakeholders
Beneficiaries of the research have been kept abreast of findings as they emerge through regular information transfers at AMGA congresses, AMGA journals and webinars.
PhD thesis
As a result of the research, a research team member submitted their PhD thesis to the University of Sydney, positively contributing to the fields evidence base and researcher pool.</td></tr>
<tr><td>Outcomes</td><td>Cataloguing of alternative Nitrogen sources for composting
The research has identified and catalogued a range of alternative nitrogen sources for composting, however, there is limited appetite among compost users to try these substrates as substitutes for poultry manure.
Increased knowledge base for nitrogen use efficiency
The research adds to the existing knowledge base concerning compost microbiology.
Enhanced knowledge of compost microbiology
This research has made significant contributions to the evidence base surrounding the microbes present in Australian compost, the varying composition of these microbes between states and the role they play in composting.
Enhanced understanding of microbial interactions and nitrogen supplementation</td></tr>
</table>

<table>
<tr><th>Pathway</th><th>Description</th></tr>
<tr><td></td><td>The research adds to the existing knowledge base concerning compost microbiology and has deepened the understanding of microbial dynamics and interactions within mushroom compost cultures.
Development of a new fertigation system
As part of the experiment a new fertigation system was developed enabling phased supplementation of compost and crops, and time crop enrichment with alternative compounds.
Increased understanding of the value of industry funded research and development
Stakeholders within the mushroom industry provided ‘strong feedback’ confirming the ongoing value placed on industry funded research and development.
Identification of higher protein concentration in later flush crops
The study observed that later flush mushrooms had significantly higher levels of nitrogen content (protein).</td></tr>
<tr><td>Impacts</td><td>Increased supply chain resilience
The uptake of alternative Nitrogen sources identified through the research would diversify the supply chain for mushroom compost, reducing supply chain risk caused by sole reliance on poultry manure for mushroom cultivation.
Improved crop yields
The implementation of project findings regarding the amount and form of Nitrogen added, the rate and timing of Nitrogen addition, and other compost components used would lead to increased crop yields and crop productivity. Further, the adoption of the phased biofertigation system developed by the researchers would enable crop supplementation at specific times during cropping to supplement compounds and elements limiting crop production.
Reduced crop variability
The application of microbe mixtures, designed by the researchers, to low-productivity compost would reduce the variability of crop yields.
Product differentiation
By marketing lower yield, protein rich, later flushes of mushrooms as a “Super Protein” source, there is potentially a profitable opportunity for product differentiation.
Increased growth rate of crops
Bioaugmentation of compost during spawn with specific inoculums displayed an increase in the observed growth rates of crops.
Identified opportunities for re-use of spent compost
Spent compost from mushroom crops was found to have high levels of Nitrogen retention (roughly 80%) and suggests there is potential for re-use of spent compost through recycling.
Improved understanding of mushroom composting systems
This research has significantly enhanced the evidence base around microbial bio-diversity in compost, how the prevalence of these microbes varies across the country, and the role they play in composting.</td></tr>
</table>

Source: ACIL Allen

Cost and benefits

Costs

Cost of the investment

The investment was a collaboration between Hort Innovation and the University of Sydney. Hort Innovation contributed $745,400 in cash and $110,204 in overheads, while the University of Sydney contributed $280,000 in kind (ex. GST amounts). Table 3 below shows the total nominal cash and in-kind contributions from each research partner.

Table 3 Nominal costs of the investment by contributing partners of MU17004

Organisation	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Total
Hort Innovation – Cash	$165,800	$165,600	$165,600	$82,800	$41,400	$124,200	**$745,400**
Hort Innovation – Overheads	$24,726	$25,441	$22,839	$11,105	$5,916	$20,177	**$110,204**
University of Sydney – In kind	$46,667	$46,667	$46,667	$46,667	$46,667	$46,667	**$280,000**
Total	**$237,193**	**$237,708**	**$235,106**	**$140,571**	**$93,983**	**$191,043**	**$1,135,604**

Source: Hort Innovation

The total nominal investment of $1.14 million is adjusted for inflation to represent the real value of investment. Adjustment for inflation is meant to present historical costs in today's dollars, by making periods comparable by converting nominal values to real values (adjusted for changes in purchasing power due to inflation).

Costs of the investment, in nominal term and real term, are provided in Table 4 below.

Table 4 Real costs of the investment MU17004

Organisation	Hort Innovation	Partners	Total
Nominal costs	$855,604	$280,000	**$1,135,604**
Real costs ($2025 financial year)	$981,220	$313,934	**$1,295,155**

Source: ACIL Allen, modelled using ABS's data

After converting to real terms, the cost of the investment is around $1.30 million, and Hort Innovation's portion of all investments is $981,220.

Benefits

Table 5 below summarises the potential benefits of the investment and categorised them into 3 categories: economic, environmental and social impact. It provides a description of the benefits and how the investment could achieve them. The table also shows the assessment method that was used for each benefit.

Table 5 Summary of potential impacts of MU17004

Type of impact	Assessment	Description
Economic impact	Quantified	**Increased productivity of existing crops.** Research findings relating to the amount, form, rate, and timing of nitrogen addition, as well as other composting components, may lead to higher crop yields and productivity. Further, the adoption of the phased biofertigation system developed by the researchers would enable crop supplementation at specific times during cropping to supplement compounds and elements limiting crop production.
	Quantified	**Product differentiation.** By marketing lower yield, protein rich, later flush mushrooms as a "super protein" source, there is an opportunity to create a differentiated product and sell these mushrooms at a premium. This

Type of impact	Assessment	Description
		increases the profitability of mushroom harvests with no cost impacts for growers.
	Unquantified	**Increased resilience of supply chains.** The uptake of alternative Nitrogen sources identified through the research would diversify the supply chain for mushroom compost, reducing supply chain risk caused by sole reliance on poultry manure for mushroom cultivation. While this may have long term benefits, there has been no appetite from growers to adopt new Nitrogen source. The impact is not quantified due to limited cost data on alternative Nitrogen sources and there being no evidence of potential adoption.
	Unquantified	**Increased growth rate of crops**. While further research is required, initial findings using bioaugmentation of compost during spawn with specific inoculums displayed an increase in the observed growth rates of crops. However, initial trials suggest this impact is unlikely to be commercially viable and further research is required. This impact has not been quantified due to a lack of data on potential increases in crop growth rates, and because the projected improvement is considered commercially unviable.
Environmental impact	Unquantified	**Identified opportunities for re-use of spent compost.** The research indicated that spent compost from mushroom crops had high levels of Nitrogen retention (roughly 80%). The research suggests there is potential for re-use of spent compost through recycling. This may potentially impact the profitability of existing farms by reducing expenses related to replacing compost. This impact has not been quantified due to limited data availability.
Social impact	Unquantified	**Improved understanding of mushroom composting systems.** This research has significantly enhanced the evidence base around microbial bio-diversity in compost, how the prevalence of these microbes varies across the country, and the role they play in composting. The research has enabled the uptake of new research pathways that were previously inaccessible. Due to the impacts of the additional research supported by these findings being unknown and / or not yet realised, the benefits have not been quantified.

Source: ACIL Allen

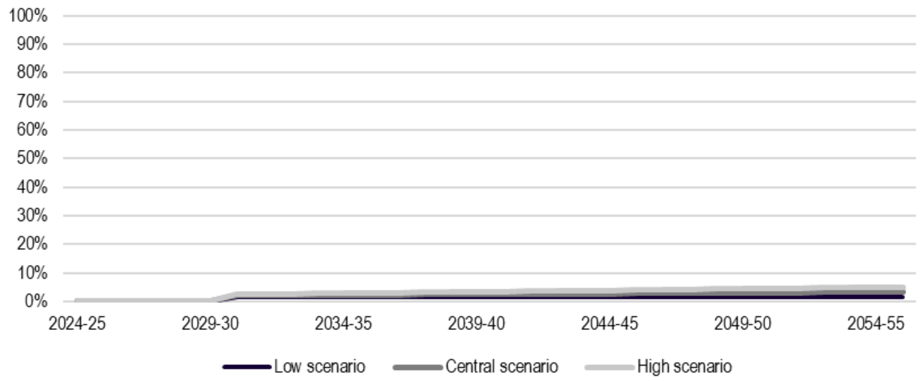
Data and assumptions

The required data, assumptions and calculations used to estimate the impacts of the investment are presented in Table 6 below. The data were sourced from project data, external sources through literature review, industry data provided by Hort Innovation and other publicly available databases.

Assumptions were informed by stakeholder consultations and are designed to be conservative considering the uncertainties underlying the magnitude of the impacts. These uncertainties include the rate and extent of industry uptake and variability in the application of recommendations by growers. Additionally, the scale of the investment's potential impact on crop yields spanned a range with some uncertainty. As many projects have a long-term focus and benefits may take years to fully emerge, using conservative assumptions helps avoid overstating expected returns. This cautious approach reflects best practice in economic evaluation where future adoption patterns and external influences cannot be predicted with high confidence.

Table 6 Data and assumptions used for MU17004

Data/Assumption	Source and rationale
Data	
Domestic mushroom production	61,633 tonnes (2023) Australian Horticulture Statistics Handbook 2023-24
Price per kilo	$6.61/kg (2023) Australian Horticulture Statistics Handbook 2023-24
Percentage of domestic mushroom production that are button mushrooms	98% Australian Mushroom Growers Association and the RDC (https://www.pc.gov.au/inquiries/completed/rural-research/submissions/sub155.pdf)
Percentage of total crop yield attributed to the first 2 flushes	~67% A.K.Nasir, et al. (2021). *Effect of maize residues and sawdust substrates on the growth and yield of oyster mushroom Pleurotus sapidus.*
Change in willingness to pay from a superior health rating	3.7% S.L.Cooper, et al. (2020). *Australian Consumers Are Willing to Pay for the Health Star Rating Front-of-Pack Nutrition Label.*
Increased crop yield	Observed range beyond control: Min: 0% Max: 7% MU17004 – Optimise nitrogen transformations in Mushroom Production
Assumption	
Attribution	Attribution for this research project is estimated to be 8% in the central scenario. This is based on funding for MU17004 accounting for roughly 80% of total funding among linked projects. This is then multiplied by 10%, which is the estimated total attribution of this research project towards identified quantifiable impacts. Attribution is notably low for this project as many findings were preliminary and set a foundation for future research, as opposed to identifying immediate implementable actions for growers.
Counterfactual	Due to industry size and research costs, the outcomes of this project are unlikely to be achieved by organisations other than Hort Innovation and the University of Sydney. The counterfactual scenario can be assessed as there is a very low likelihood the project would be undertaken without funding from Hort Innovation.
Adoption	Adoption of research findings impacting yield and profitability are heavily reliant on further research being conducted and field testing. As they currently stand it is unlikely many growers would adopt the practices found by researchers. Yield impacting findings are delayed and small. Thus, adoption is assumed to rise from 2% of growers to 3% over the observed life of impacts. **Figure 1 Adoption curve**

Data/Assumption	Source and rationale
	 *Source: ACIL Allen* Adoption of marketing later flush mushrooms as a protein source could commence immediately. However, it is unlikely that consumers will respond to price differentiation, so adoption by growers is likely to be very small and is estimated to remain around 3% over the impact period.
Confidence level	At the time of assessment, there are many uncertainties regarding the impacts of the project as future research is required for the practice changes to be adopted by the industry. This analysis has quantified the potential impacts with a medium level of confidence of 50%.
Calculation	
Increased productivity of existing crops	*Increase in crop yields x Average production value of domestic button mushrooms*
Product differentiation	*Average production value of domestic button mushrooms x Change in willingness to pay x Proportion of market that will pay price premium*

Source: ACIL Allen

Net impact

A summary of the net impact of the investment is presented in Table 7. The results show that, taking all quantified costs and benefits into account, the investment produced a positive net result. The investment has an NPV of $276,561 and a BCR of 1.21 at 30 years after investment completion.

When taking only costs and benefits attributable to Hort Innovation into account, the investment generated an NPV of $182,565 and a BCR of 1.21 at 30 years after investment completion. The benefits attributed to Hort Innovation were in proportion to the nominal costs.

Table 7 Net impact results of MU17004

	Years after investment completion						
	0	5	10	15	20	25	30
Whole investment							
PV of Costs ($m)	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
Benefits ($m)	$0.00	$0.00	$0.00	$1.14	$1.91	$2.76	$3.69
PV of Benefits ($m)	$0.00	$0.00	$0.00	$0.69	$1.03	$1.32	$1.57

NPV ($m)	-$1.30	-$1.30	-$1.30	-$0.60	-$0.26	$0.03	$0.28
BCR	0.00	0.00	0.00	0.54	0.80	1.02	1.21
IRR	Negative	Negative	Negative	Negative	3.1%	5.2%	6.3%
MIRR	Negative	Negative	Negative	0.4%	3.8%	5.1%	5.7%
Attributable to Hort Innovation							
PV of Costs ($m)	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85	$0.85
Benefits ($m)	$0.00	$0.00	$0.00	$0.75	$1.26	$1.82	$2.44
PV of Benefits ($m)	$0.00	$0.00	$0.00	$0.46	$0.68	$0.87	$1.04
NPV ($m)	-$0.85	-$0.85	-$0.85	-$0.40	-$0.17	$0.02	$0.18
BCR	0.00	0.00	0.00	0.54	0.80	1.02	1.21
IRR	Negative	Negative	Negative	Negative	3.1%	5.1%	6.2%
MIRR	Negative	Negative	Negative	0.4%	3.7%	5.1%	5.7%

Source: ACIL Allen

Sensitivity analysis

Sensitivity analysis was conducted to test the robustness of susceptibility of the analysis to key assumptions and parameters. Given the uncertainty of a number of assumptions used in this CBA, sensitivity testing is important to determine the appropriateness of underlying assumptions.

The results of the sensitivity analysis are presented in Table 8 below.

Table 8 Sensitivity analysis results of MU17004

	NPV	BCR	IRR	MIRR
Under standard assumptions (Central case scenario and 5% discount rate)	$0.28	1.21	6.3%	5.7%
3% Discount rate	$0.88	1.68	6.3%	5.7%
7% Discount rate	-$0.13	0.90	6.3%	5.7%
Low adoption (starts at 1.1% and reaches 1.5% in 7 years)	-$0.27	0.79	3.6%	4.1%
High adoption (starts at 2.8% and reaches 3% in 6 years)	$0.80	1.62	8.3%	6.8%
Lower increase in crop productivity (Central scenario -25%)	-$0.08	0.94	4.6%	4.8%
Higher increase in crop productivity (Central scenario +25%)	$0.63	1.49	7.7%	6.4%
Lower willingness to pay for differentiated product (Central scenario -50%)	$0.20	1.16	5.9%	5.5%
Higher willingness to pay for differentiated product (Central scenario +50%)	$0.35	1.27	6.6%	5.9%
Lower proportion of population willing to pay price premium (Central scenario -50%)	$0.20	1.16	5.9%	5.5%

	NPV	BCR	IRR	MIRR
Higher proportion of population willing to pay price premium (Central scenario +50%)	$0.35	1.27	6.6%	5.9%
Low confidence (Central scenario -10%)	-$0.59	0.55	1.4%	2.8%
High confidence (Central scenario +10%)	$1.30	2.00	9.9%	7.5%

Source: ACIL Allen

Key findings

The following key findings have been identified for this assessment:

— The research has identified and progressed a number of research pathways which, once fully realised, will enable improvements in productivity, waste reduction, and foster more resilient supply chains for mushroom composting. Quantifiable benefits include:

  — The potential for increased crop productivity through the adoption of research findings relating to the amount, form, rate, and timing of nitrogen addition, as well as other composting components.

  — The research identified higher levels of nitrogen in later flush mushrooms, pointing to the potential for the sale of a differentiated “Super Protein” mushroom. However, it is unlikely that consumers will respond to this price differentiation, so adoption by growers is likely to be very small.

— Beyond these quantified benefits there are a number of unquantified benefits, which further emphasises the value of this research and the information it has produced. Unquantified benefits include:

  — The research identified and catalogued a range of potential alternative nitrogen sources. While these could lead to a diversified supply chain in the future, there is currently low appetite among industry for their adoption, with producers preferring to continue their use of poultry manure.

  — Research findings suggest the bioaugmentation of compost during spawn, with specific inoculums, led to faster growth rates of crops, however, currently these findings are deemed as being unviable commercially, suggesting any potential benefits are again reliant on further research.

  — This research has made significant contributions to the evidence base regarding microbial biodiversity in compost, the prevalence of these microbes across composting facilities, and the role microbes play in composting.

— The adoption of the research findings, and therefore the realisation of identified benefits, will be highly dependent on further research and field testing being conducted.

— At the time of assessment, there are many uncertainties regarding the impacts of the project as future research is required for the practice changes to be adopted by the industry.

Consultations

The following stakeholders were consulted on this assessment:

— Tom McCue, Hort Innovation

— Michael Kertesz, University of Sydney.

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