

Final report

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Development of a Biosecurity Plan for Australian Mushrooms

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Public summary

Australia's biosecurity system works in a dynamic environment with major challenges growing and evolving rapidly. Through this project, Plant Health Australia (PHA), with Horticulture Innovation levy investment, has developed a Biosecurity Risk Mitigation Plan for the Australian Mushroom Industry. This Plan recognises that the operating environments affecting the biosecurity of the Australian mushroom industry is constantly changing, and that its response capabilities need to keep pace if they are to remain relevant and effective into the future.

This Plan lays the foundation for a stronger biosecurity system and more resilient mushroom production by identifying and prioritising the growing number of exotic pests and pathogens that could, if introduced, impact on mushroom production and trade. The Plan also provides a program of current and future activities that will strengthen industry's biosecurity responses preparedness.

The Plan was developed with valuable input from stakeholders including Australian Mushroom Growers Association (AMGA) along with biosecurity experts from state, territory and commonwealth governments.

There are three major components to this Biosecurity Risk Mitigation Plan. The first is a review of all known exotic pest and disease species that are known to infect the common (white) mushroom, *Agrotus bisporus*. This review highlighted 87 different exotic pest and disease species that, if introduced, could impact on its production. These species' reviews informed the development of risk ratings for each of the identified exotic pests and diseases. The risk ratings focus on the potential of each species to enter, establish and spread within Australia and an estimate of their potential economic impact. Of those species reviewed, two species were deemed to be High Priority Pests (HPP) for the mushroom industry: *A. bisporus* virus 16 (AbV16) and Brown Cap Mushroom Virus (BCMV) both of which are the causal agent for Brown Cap Mushroom Disease.

The second component is the Established Pests of Biosecurity Significance table which lists pests and diseases already present in Australia that are economically important to the mushroom industry. However, the risk of entry of these species onto a farm can be minimised by the adoption of good biosecurity practices. By identifying these species, mechanisms can be put in place to better align industry and government resources and provide a stronger base for biosecurity risk management for the industry. Identification of these pests also assists in the delivery of effective grower awareness and information material and the development of pest-specific mitigation activities.

The third and final component of the Risk Mitigation Plan is the development of a Recommendation Table, aligned to the National Biosecurity Strategy, describes the critical activities that, if implemented, will improve the industries' biosecurity preparedness and response capabilities. The Recommendations Table, was developed and reviewed initially through a Biosecurity Reference Panel (BRP), comprising of industry and government representatives and later by a Consultative Committee comprised of AMGA directors, executive and technical experts. The Recommendations Table outlines strategies, communication and engagement activities specific to the mushroom industries and identifies potential international and domestic collaboration opportunities.

This Plan is principally designed for decision makers. It provides the Australian mushroom industry and government with a mechanism to identify exotic pests as well as to address the strengths and weaknesses of the industry's current biosecurity position.

Keywords

Biosecurity, High Priority Pests, exotic, pests, diseases

Introduction

It is estimated that there are over 2,000 fungal species accepted as fit for human consumption, but only a small number are commercially grown. The most cultivated mushroom species globally is the common or white mushroom, *Agaricus bisporus*.¹ Though believed to be commonly cultivated by French farmers from the early 1600's, the first scientific description of *A. bisporus* cultivation is attributed to the botanist Joseph Pitton de Tournefort in 1707.² However, this species was originally pale brown with the now commonly cultivated white form isolated and cultured in Pennsylvania in 1925.³

Now grown commercially in over 70 countries,⁴ *A. bisporus* has become a staple food stuff in many modern households. Indeed, 71% of Australian households purchase mushrooms weekly with an average annual consumption of 2.23 kg per person per year. These mushrooms are produced in Australia by an estimated 77 commercial growers⁵ with 56,941 t of mushrooms produced in 2023/24 valued at \$382.8M.⁶

Despite *B. agaricus* being cultivated under controlled environmental conditions where inputs such as water and substrate contamination by established pests and diseases can be effectively managed to maximise quality and yield, incursions of deleterious organisms such as viruses, nematodes and mites persist which impact enterprise profitability. These impacts can be further exacerbated by exotic species incursions observed through increased people movement and international trade of both fresh and dried fungi.

Biosecurity planning provides industries with knowledge of the exotic pests and diseases that pose the greatest threat to their enterprises' viability and describes strategies and actions that improve their biosecurity preparedness and response capability. It also provides a mechanism for industry, governments and other stakeholders to assess current biosecurity practices and future biosecurity needs. The identification, prioritisation and management of key biosecurity risks, through the development and implementation of a Biosecurity Plan is a critical industry preparedness activity.

In collaboration with Australian Mushroom Growers' Association (AMGA) and Commonwealth and State Governments, Plant Health Australia (PHA) has developed Biosecurity Risk Mitigation Plan for the mushroom industry. This Plan provides a framework for improved biosecurity preparedness and practice through increasing industry awareness and risk mitigation relating to exotic pest incursions.

There are three major components to this Plan. The first is the review of exotic pest species that are known hosts of the chosen industry. This species' review informs the development of risk ratings for each of the exotic pests identified. These risk ratings focus on the potential of each pest to enter, establish and spread within Australia and an estimate of their potential economic impact. The species that receive high risk ratings are given 'High Priority Pest' (HPP) status.

The second component is the Established Pests of Biosecurity Significance table which lists pests and diseases already present in Australia that are economically important to the mushroom industry. However, the risk of entry of these species onto a farm can be minimised by the adoption of good biosecurity practices. These pests were considered to enable prioritised investment but did not undergo a formal pest risk assessment. By identifying these pests which growers already manage, mechanisms can be put in place to better align industry and government resources and provide a stronger base for biosecurity risk management for the industry. Identification of these pests also assists in the delivery of effective grower awareness and information material and the development of pest-specific mitigation activities.

The third and final component is the development of a Recommendation Table. The Recommendation Table, developed through consultation with industry, outlines the strategies and activities intended to improve the industry biosecurity preparedness and response capabilities including to the exotic pests of greatest concern to industry. The activities outlined in Table includes any required communication and engagement activities, activities and resources currently utilised by other industries that share some of the same exotic pest threats, potential international and domestic collaboration opportunities and RD&E needs that may be addressed in the future.

Methodology

The development of the Biosecurity Risk Mitigation Plan for the Mushroom Industry (version 1.0) commenced with an extensive literature review and tabulation of exotic pests and diseases of the mushroom species produced by the sector. The review utilised a range of resources, including available peer-reviewed scientific literature and other noted sources such as the Centre for Agriculture and Biosciences International (CABI). With the assistance of AMGA, a Technical Expert Group (TEG) was then formed to review the literature gathered and to characterise each species based on its risk profile. The risk ratings were based on an assessment for their potential to enter, establish and spread in Australia and their potential economic impact on the mushroom industry. The TEG was coordinated by PHA and included representatives from AMGA and state and territory agriculture agencies (Table 1). The TEG initially met on the 25 March 2021 to outline the review's purpose and process. The pathogens outlined in the TST were then reviewed on the 27 April 2021 and the invertebrates and nematodes on the 5 May 2021. Due to the COVID pandemic these meetings we held online.

Table 1. Members of the Technical Expert Group and/or the initial Biosecurity Reference Group engaged throughout the development of this plan.

NAME	ORGANISATION	AREA OF EXPERTISE	MEMBER OF TEG	MEMBER OF INITIAL BRG	MEMBER OF AMGA CONSULT CMTE.
Geoff Martin	AMGA	Production, Biosecurity	✓	✓	✓
Judy Allan	Consultant	Production, Pest and pathogen management	✓	✓	✓
Warwick Gill	Consultant	Production, Pest and pathogen management	✓	✓	✓
Afsheen Shamshad	Consultant	Entomology	✓	✓	
Leah Bramich	AMGA	Management, Governance			✓
Greg Chandler	Hort Innovation	Biosecurity R D&E	✓	✓	
Fucheng Shan	DPIRD	Entomology	✓	✓	
Elsie Kinnaid	DPIRD	Pathology	✓	✓	
Christine Horlock	DAF QLD	Biosecurity, pathology	✓	✓	
Naomi Diplock	Applied Horticultural Research	Production, Biosecurity		✓	
Anthony Leddin	AMGA	Crop Protection, Industry engagement			✓
Bosibori Bett	Plant Health Australia	Biosecurity	✓		
Maggie Mwathi	Plant Health Australia	Biosecurity		✓	
Victoria Ludowici	Plant Health Australia	Biosecurity	✓		
Trevor Dunmall	Plant Health Australia	Biosecurity	✓	✓	
Stuart Kearns	Plant Health Australia	Biosecurity			✓

Through the technical review process, the information was compiled into several tables of important exotic and endemic pest species. These included:

- **Threat Summary Tables (TST).** An overview including risk assessments of all known exotic pests and diseases known to impact on the *A. bisporus*.
- **High priority Pest lists (HPP).** These species based on the risk assessment process have the potential to cause substantial economic impact on the mushroom industry, either through production losses or market

access issues.

- **Established Pests of Biosecurity Significance.** These species are economically important to the mushroom industry and are considered in the prioritisation of RD&E investment but do not undergo a formal pest risk assessment. They are economically important in at least one of the following ways:
 - currently under quarantine arrangements or restricted to regions within Australia,
 - notifiable by law,
 - have market access implications,
 - able to be prevented from entering a farm through good biosecurity practice.

Once compiled, these lists formed the basis for the Biosecurity Risk Mitigation Plan.

A Recommendation Table was developed with the assistance of a Biosecurity Implementation Group (BIG). The BIG was convened by PHA and again comprised of representatives from each industry and the relevant state authorities (Table 1). The Recommendation Table is a critical component of the Risk Mitigation Plan. The Recommendation Table includes RD&E activities that are underway and those activities that may be addressed in the future. It is developed in accordance with industry priorities and resource availability and aims to improve preparedness and response capability. A number of these priorities are still being addressed by industry.

The Recommendation Table describes the activities within the five strategic priority areas of the [National Biosecurity Strategy](#) and provides industry with a plan with agreed activities and timeframes. The five strategic areas include:

1. Preparedness and Response
2. Capacity and Capability
3. Communications and Engagement
4. Innovation, Research Development and Extension
5. Collaboration and Partnerships

The Recommendation Table was developed over several meetings held on the 3rd August 2021, 12th and 13th April 2022 and the 8th February 2023.

In early 2024, a Consultative Committee was then established which consisted of AMGA's directors and executive and technical experts who reviewed the revised Plan and amended the Recommendations Table prior to the Plan being presented to the Board of AMGA for endorsement. Upon establishment, the Committee assumed the role of the Mushroom Biosecurity Reference Group (BRG).

PHA worked closely with AMGA throughout the first half of 2024 to review and implement amendments and updates to the new Biosecurity Plan. AMGA, PHA and various industry experts worked together over multiple meetings to review and revise the plan for endorsement by AMGA. This process has allowed members of the Biosecurity Plan Consultative Committee to better understand and appreciate the intent and benefits of the consultative process that was used to generate the plan, reviewing HPPs, Established pests of biosecurity significance and the Recommendations Table.

Once the Recommendations Table was completed, the Plan was compiled and draft Plan provided to AMGA for endorsement which was received on the 2nd August 2024.

Results and discussion

The mushroom industry's Biosecurity Risk Mitigation Plan (version 1.0) has been completed and endorsed by AMGA. A copy of this revision of the Plan can be found in Appendix A. The Plan features an analysis of all known exotic pests and diseases of the Australian mushroom industry. These reviews highlighted and reviewed 87 different exotic pests and diseases species that could impact Australian mushroom production. These species' reviews informed the development of risk ratings for each of the identified exotic pests and diseases. The risk ratings focus on the potential of each species to enter, establish and spread within Australia and an estimate of their potential economic impact.

The risk analysis of the species listed within the TST subsequently identified two HPPs for the mushroom industry (*A. bisporus* virus 16 (AbV16) and Brown Cap Mushroom Virus (BCMV)) both of which are the causal agent for Brown Cap Mushroom Disease (see Appendix 1, page 9). The HPPs identified are those deemed to have a high likelihood of entry, establishment and spread in Australia and the potential to cause substantial economic impact to mushroom production or create market access issues if introduced.

A further suite of 22 pests and diseases (13 fungi, 7 bacteria and 2 viruses) were identified as Established Pests of Biosecurity Significance (see Appendix A, page 10). These pests are economically important to the mushroom and are considered in an effort to prioritise RD&E investment but do not undergo a formal pest risk assessment due to their already being found in Australia but are geographically restricted.

The mushroom industry biosecurity Recommendations Table (see Appendix A, pages 11 - 16) was created in consultation with the BIG and the newly formed Mushroom Biosecurity Consultative Committee to provide guidance into future biosecurity related activities that aim to improve industry preparedness and response capability. The Recommendations Table describes the 24 activities aligned to the strategic priority areas of the National Biosecurity Strategy⁷ and provides industry with an overarching plan with agreed activities and timeframes. The Recommendations Table can be found in the Biosecurity Risk Mitigation Plan in Appendix 1. Many of the activities highlighted within the Implementation Plan are ongoing activities that will continue after this project's completion.

The revised Final version of the Plan, with support from the AMGA executive, was endorsed on 2 August 2024.

Outputs

Table 2. Output summary

Output	Description	Detail
Biosecurity Risk Mitigation Plan for the Australian Mushroom Industry (version 1.0)	Technical review of exotic invertebrate and pathogens that pose a threat to the Australian mushroom industry, an implementation plan describing critical activities that are designed to improve the mushroom industry's biosecurity preparedness and response capability	The Biosecurity Risk Mitigation Plan is a high-level planning document and has been provided to AMGA and Hort Innovation. The Plan will be further disseminated further at AMGA's discretion. See Appendix A.
Factsheets	Four factsheets were developed describing each of the major pest groupings described in the Mitigation Plan; viruses, flies, mites (acari) and nematodes.	These factsheets will be disseminated at AMGA's discretion.
Milestone Reports	Progress reports on the Mitigation Plan's development and the implementation of critical activities that aim to improve the mushroom industry's biosecurity preparedness and	Milestone reports are submitted to Hort Innovation and disseminated at their discretion.

	response capability	
Final Report	Final report reviewing the outcomes of project MU18006.	Final reports are submitted to Hort Innovation and disseminated at on the Hort Innovation website.

Outcomes

In delivering this project, Plant Health Australia (PHA) has provided the mushroom industry with a thorough biosecurity risk mitigation plan that has evolved over the life of the project to accommodate the industry's changing priorities and needs. The plan includes information on high priority mushroom pests, established pests of biosecurity significance and an overview of the status of both industry and government activities that relate to mushroom pest and disease management and biosecurity.

PHA fosters a collaborative environment which involves industry, government, stakeholders, and scientific experts to develop each biosecurity plan. Through this collaborative development process, the priorities of each organisation involved can be openly shared and discussed. Importantly, information gaps can be acknowledged, and future biosecurity RD&E opportunities can be prioritised and supported.

Holding regular reference group meetings has provided an opportunity to document the evolution of industry awareness and acknowledgement of the need for biosecurity and update the risk mitigation plan as new information became available. This important improvement to the biosecurity planning process is evident in the revisions made to the mushroom biosecurity plan throughout the project.

All stakeholders are now acutely aware of the importance of biosecurity. Encouraging a cross-sectoral and integrative approach to biosecurity preparedness and response procedures will bolster the future productivity and sustainability of the mushroom industry in Australia. This plan clearly demonstrates the continuing commitment by both industry and government to biosecurity and Australia's mushroom industry.

Table 3. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
Industry supply, productivity and sustainability	<p>SIP Outcome 2: <i>"The Australian mushroom industry has increased profitability, efficiency and sustainability through innovative R&D, biosecurity and sustainable BMPs"</i></p> <p>Strategy: <i>"Improve industry biosecurity preparedness and resilience to exotic threats."</i></p> <p>KPIs:</p> <ul style="list-style-type: none"> • Maintenance/tracking of the implementation of an industry biosecurity plan • Investigation of risk pathways (e.g., imported fresh mushrooms) 	Enhanced industry understanding of exotic pest threats (invertebrate pests and pathogens) that may, if introduced, have a significant impact on Australian production mushroom industry's production and trade.	Development in consultation with and subsequent endorsement and review of Threat Summary Tables, High Priority Pest list and the Biosecurity Recommendations Table by Australian Mushroom Growers' Association (AMGA).

Monitoring and evaluation

This project had three main objectives:

1. Support Australian Mushrooms in satisfying biosecurity obligations
2. Ensure that Australian Mushrooms and stakeholders have identified exotic pest risks and mitigation actions necessary to managing risks effectively
3. Establish a valid base for decisions on future investment in biosecurity-related RD&E

Table 4. Key Evaluation Questions

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project achieved its expected outcomes?	This project improved biosecurity preparedness of the mushroom industry against exotic pests and diseases through the development of a industry endorsed Biosecurity Risk Mitigation Plan (Objective 2). The planning process also involved the development of range of recommendations and activities, which provides insight and a gap analysis into the mushroom industry's biosecurity preparedness and their future RD&E needs (Objectives 2 & 3).	This project provided in sights regarding the biosecurity planning process namely the development of Threat Summary Tables (TST). This has led to improvements in the format of the TST, which are currently being implemented in new Hort Innovation funded projects.
How relevant was the project to the needs of intended beneficiaries?	<p>The representative of AMGA interviewed at the end of the project believed that the project met industry need in improving their biosecurity preparedness through the generation of a Biosecurity Risk Mitigation Plan including the development of the TST, HPP, Other pests of biosecurity significance and Implementation tables and therefore improved their biosecurity preparedness.</p> <p>Although AMGA are not signatories to the EPPRD and therefore have limited biosecurity obligations, this project did address their obligations under the premise of a shared responsibility in maintaining biosecurity obligations as it did raise the mushroom industry's biosecurity understanding.</p> <p>This project was required to generate 4 factsheets. However, the mushroom industry is well resourced</p>	<p>This project has provided the mushroom industry with a thorough biosecurity risk mitigation plan that has evolved over then life of the project</p> <p>It is recommended that the future projects be less prescriptive regarding extension outputs and/or be required to liaise with other extension projects to ensure future biosecurity projects meet industry need.</p>

	due in part to other Hort Innovation-funded projects such as MU21003 and MU21007. After consultation with industry, it was evident that other forms of extension resources may have better serviced industry need.	
How well have intended beneficiaries been engaged in the project?	As Biosecurity Plans are a high level, peak-body facing documents therefore industry engagement was monitored through attendance of key industry stakeholders at the TEG and BIG meetings.	As stated above, the industry partners were adequately engaged throughout the project through both TEG (year 1) and BIG/BRG meetings (years 2-5).
To what extent were engagement processes appropriate to the target audience/s of the project?	The project's key industry stakeholders (AMGA) were engaged throughout the project including during the TEG (3 times in year 1) and during the annual BIG meetings. Ongoing consultation with the AMGA executive occurred to develop the Plan and a review of the final draft of the Biosecurity Plan by the AMGA Biosecurity Plan Consultation Committee	As stated above, the industry partners were adequately engaged throughout the project through both TEG (year 1) and BIG/BRG meetings the Consultative Committee. It was noted by AMGA that the extended BRP review process gave an opportunity to provide time to consider the findings of the Plan and resources that facilitated its continual improvement.
What efforts did the project make to improve efficiency?	Efficiencies were largely borne through reducing the PHA salary component and meeting costs via the adoption of online meetings formats, which reduced travel and the drafting of documents (i.e., Recommendations Table) prior to stakeholder meetings to speed up this the development of the components of the Biosecurity Plan.	These learnings - including improvements in the TST format (see above) - are already being implemented in new Horticulture Innovation-funded projects.

Recommendations

During the development of the Biosecurity Risk Mitigation Plan and throughout the associated consultation processes there were several issues identified. The following recommendations have been developed improve the outcomes for future production nursery biosecurity planning projects:

1. **Leverage Community and Stakeholder Knowledge:** Understanding of pests and diseases within Australia's wild *Agaricus* mushroom populations is limited. These wild mushroom populations have the potential to harbour both established and exotic pests and disease and therefore pose an incursion pathway for commercial *A. bisporus* producers. It is recommended that AMGA partner with local industry groups, research teams, and community groups to extend biosecurity reach and improve knowledge and networks to support better biosecurity decision-making.
2. **Target High-Risk Sites for Surveillance:** Prioritise general surveillance and preparedness activities at high-risk sites for pest entry. This involves identifying high-risk entry sites based on historical events and conducting site risk mapping to target resource allocation effectively.

3. **Enhance General Preparedness:** Improve biosecurity for mushroom production facilities through general preparedness activities such as general surveillance, and response simulations, especially in high-risk locations.
4. **Develop Generic Response Plans:** Create generic response plans for commercial production facilities to facilitate rapid decision-making and effective response during emergency pest incursions. These plans should identify control methods, resources, and key groups for consultation.
5. **Increase Public Awareness and Engagement:** Government and industry should increase public awareness activities and engage with local groups to highlight biosecurity threats and encourage ownership of biosecurity responsibility. This includes developing public awareness campaigns and expanding surveillance programs.
6. **Formalise Diagnostic and Biosecurity Roles:** Formalise and clarify biosecurity roles and responsibilities within state agencies and ensure adequate diagnostic capacity for mushroom and fungi pests. This includes engaging with SPHD to ensure diagnostic capabilities are appropriate.

Refereed scientific publications

None to report.

References

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Intellectual property

No project IP or commercialisation to report

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Appendices

- Appendix 1 – Biosecurity Risk Mitigation Plan for the Australian Mushroom Industry (Version 1.0)
- Appendix 2 – Fact sheets