Final Report

Alternate casing substrate – providing review of research to date and an expert forum for future R&D investment

Project leader:

Leah Bramich

Delivery partner:

Australian Mushroom Growers' Association

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MU22009

Project:

Alternate casing substrate – providing review of research to date and an expert forum for future R&D investment (MU22009)

Disclaimer:

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Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

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Public summary

It is estimated that the Australian mushroom industry uses 150,000 tonnes of peat moss every year, a finite resource which is largely imported from Europe. As the Irish government have begun to decommission peatbogs and peat extraction (completed by 2035), and Germany/Western Europe beginning to follow this approach, peat will become more expensive, and potentially difficult or impossible to acquire.

In March 2023, the Department for Environment, Food and Rural Affairs (DEFRA) in the United Kingdom announced a complete ban on peat and peat-containing products being sold through UK retailers, including fresh produce grown using horticultural peat, by 2030. This alarming deadline could potentially set precedence for other countries, including Australia, creating urgency to find a suitable, sustainable 100% peat replacement for the mushroom industry on a global scale.

This project, *MU22009 - Alternative casing substrate – providing a review of recent research to date and an expert R&D forum for future R&D,* was managed by the Australian Mushroom Growers' Association (AMGA), partnering with the International Society of Mushroom Science (ISMS), Teagasc - Agriculture and Food Development Authority (Ireland), Microbiotech (UK), and Dr. Mush Advisory (Australia).

Through the deliverables of *MU22009*, the project team analysed the current situation and emerging threats regarding potential limitations to the supply of peat casing to the Australian mushroom industry and reviewed the current global research into peat blends and peat replacements, to provide firm recommendations for future Australian research and development priorities to find suitable alternatives to deliver a sustainable casing material for Australia.

Key outputs from this project include:

1. Delivery of the ***Future of Casing Report – Review of Casing Materials and Availability for Mushroom Cultivation***
2. A ***Future of Casing Report Symposium*** presenting the findings of the report and obtaining further information from key industry stakeholders from around the world.
3. Recommendations for future research and development investment into sustainable peat alternatives for the Australian mushroom industry.

The outputs of the project have provided the Australian mushroom industry with research and development priorities which will inform the development of a long-term R&D investment program, which aims to alternative casing substrate option(s) that maximises yield, quality, profitability, and sustainability.

This project links to outcome 2 of the Australian Mushroom Industry Strategic plan, relating to industry supply, productivity and sustainability: The Australian mushroom industry has improved profitability, efficiency and sustainability through innovative production systems, reduced costs, and effective risk management.

Keywords

Peat moss; alternative casing substrate; mushroom production systems; waste product development;

Introduction

Background

As Ireland has begun to decommission peatbogs and deep peat extraction (completed by 2035), the Ireland Government has supported a $1.65M Euro project (Beyond Peat and Sustainable Transition) to research alternate casing substrates, which is facilitated by Teagasc Agriculture and Food Development Authority (Ireland).

Germany/Western Europe are also beginning to decommission peatbogs (Eastern Europe still offers supply, but unsure of the timeframes in the long term for worldwide supply), it is forecast that peat will become inaccessible from certain counties, resulting in a drastic increase in product and import costs.

In March 2023, the Department for Environment, Food and Rural Affairs (DEFRA) in the United Kingdom announced a complete ban on horticultural peat. This change in the legislation began in 2011 with a 'voluntary phase out', however, as their set KPIs were not achieved, they have set out further details to the professional horticultural sector, for a phased reduction in the use of peat **by 2026, and a complete ban by 2030.** DEFRA have provided temporary exceptions for the mushroom industry, if casing is applied at 2cm – which is less than half of global mushroom production standards (typically 5cm). 2cm will have a significant reduction in yields.

This UK government ban on peat and 'peat-containing' products will affect more than just the UK producers, with a large portion of mushrooms being imported from Ireland or other European countries. For Australia and other countries, the ban sets precedence with an exigent timeline.

Furthermore, DEFRAs ban on all peat and 'peat-containing' products potentially changes the strategy for global research and development, with most organisations and commercial enterprise currently searching for a suitable 'peat blend' as a solution, rather than the more difficult 100% replacement. This very big move from DEFRA, means that we likely need to find a 100% replacement for peat, rather than a blend of peat and other products, and much faster than the global industry anticipated.

With pressures from international governments and environmentalists, this dynamic global situation is rapidly unfolding, with a perceived longer-term risk that the material could eventually not be accessible at all, or due to global retailer sustainability pressures, there is a risk that peat could potentially be prohibited for use within food production by Australian retailers.

Project rationale

MU22009 subcontracted international leaders in the field, from Teagasc (Ireland) and Microbiotech (UK) to help facilitate the research review, leveraging their knowledge from recent and current research projects.

This project reviewed past domestic and international research and current programs relating to peat alternatives for mushroom cultivation, to inform the long-term investment of research in Australia to secure an alternative, prior to loss of peat as option.

This research project, and the new research opportunities identified, will allow for the mushroom industry to diversify, to further explore and develop a new substrate and potentially begin to transition to the new option in a phased approach while peat is still available.

Moving forward there is potential value in linking new Australian levy-funded research with international research projects.

Methodology

The Australian Mushroom Growers Association delivered five (5) key activities within this project:

1. Engaged a suitably experienced research project lead, an Australian compost expert, and a principal author(s) to perform a detailed global situational analysis, and desktop review of past, current, and new research projects.

    a. Greg Seymour, ISMS (Australia) was sub-contracted to lead the research project and connect with key opinion leaders from around the world.

    b. Dr Helen Grogan, Teagasc (Ireland) was sub-contracted as the principal author, with support from Dr. Eoghan Corbett, Teagasc and Dr Ralph Noble, Microbiotech (UK).

    c. Dr. Geoff Martin, Dr. Mush Advisory (Australia), was sub-contracted to provide guidance and context relevant to the Australian mushroom industry.

2. A series of online meetings with 60 global industry experts from 22 countries (six continents). These included scientists, consultants, mushroom growers, casing producers and representatives from other organisations and companies with an interest in peat, growing media and casing.

    The aim of the online meetings was to:

    - gain an understanding of peat accessibility, including accessibility and geopolitical or retailer pressures,
    - define current knowledge base and use of mushroom casing,
    - Identify current and past casing alternative research – both blend and 100% replacements.

    Researchers and the project team also used the international "Mushroom Days' event, held in the Netherlands 10-12 May 2023, for further research and insight. (Researchers and project team funding their travel separately to this project).

    The outcomes of the online meeting series and in-person research insights gained through 'Mushroom Days' provided a defined scope for the desktop review.

3. The ***Future of Casing Report – Review of Casing Materials and Availability for Mushroom Cultivation*** (Appendix 1), a document review of past research, and current practices and research projects globally.

    The aim of this review is to inform the AMGA so that it can make decisions on:

    - The likelihood of disruption to the supply of peat casing to the Australian mushroom industry and the need for remedial action
    - The best options for alternative casings based on current information
    - The effects on the environment of switching from peat to alternative casings
    - The requirements for research and commercial development to deliver a sustainable casing material for Australia.

    The report outlined the science of casing, global use of peat as a mushroom casing, peat alternative casing materials, economics and sustainability of alternative casing materials, changes in mushroom cultivation needed in response to non-peat casing, regulatory impact on the recycling of materials into casing, and future requirements to produce mushroom and non-peat casing in Australia.

4. The ***Future of Casing Report Symposium,*** held on 25 February 2024, in Las Vegas, Nevada USA, prior to the commencement of the joint event; the 20th ISMS Congress and 26th North American Mushroom Conference.

    The purpose of the symposium was:

- for the project team to present the findings of the research review, to align global experts and key industry stakeholders on the situation of peat availability and continuation.
- to present a comprehensive outline of alternative casing materials available and world research.
- and identify future Australian research priorities in peat alternative research and development.
- identify the best approach/es to build on existing alternate casting substrate research through collaboration with Australian and international mushroom industry and research experts.

Using the contacts of ISMS and the project research team, a select invitation list was created, requesting registration for the event. The event hosted a total of 54 attendees, including scientists, consultants, mushroom growers, casing producers and representatives from other organisations and companies with an interest in peat, growing media, and casing from around the world. During the symposium, 15 key opinion leaders were invited to speak to provide their countries position and share current research.

The symposium was filmed and the recording circulated to Australian mushroom levy-payers, Australian researchers, contributors to the report and attendees of the symposium. The recording is also housed on the AMGA and ISMS websites (members areas).

5. **Provide clear recommendations to inform the future, long-term R&D investment:**

Through the outputs of this project, clear recommendations have been identified for future Australian research and development into sustainable casing alternatives, with consideration to materials available in (or available to) Australia.

A list of discussion points for research consideration, and recommended research priorities for Australia is listed on page 9 and 10 of this report. The recommendations include a list of alternative casing materials to undergo proof of concept trials within the Marsh Lawson Mushroom Research Unit (MLMRU), with larger scale efficacy trials on commercial farms, to determine if the materials produce the expected results under 'real farm' circumstances, especially being openly exposed to pest and disease.

It should be noted that food safety of alternative materials was discussed at the symposium as an important consideration, which was not explored in the report.

Projects will consider the possibility of co-investing in international research programs, however as much of the international research into casing alternatives is being conducted by private enterprise, co-investment is likely to be difficult to achieve.

Photos/images/other audio-visual material

Recording of the Future of Casing Report Symposium: https://youtu.be/CymO4pwt7mY

Results and discussion

Summary of the Global situation for peat use and supply:

1. A casing layer is essential for button mushroom fruitbody production in quantity; peat as well as many other materials can stimulate the formation of fruitbody initials.

2. Annually, the global button mushroom industry uses about 4M m3 of peat for casing; the largest volumes of peat casing are used in Poland and the USA.

3. Mushroom casing currently represents about 10% of the peat extracted for growing media and about 5% of the total peat extracted globally; peat extraction for energy continues to decline which will tend to increase the latter percentage.

4. Australia uses around 85K m3 of peat casing annually, about 2% of the global total; most of this peat is imported from Europe with a smaller volume from Canada.

5. The regulatory situation regarding peat extraction and professional use in different European countries is dynamic and is likely to change periodically in the next few years.

6. In Europe, it is becoming increasingly difficult to obtain new permissions for peat extraction and several countries now have phase-out plans for the use of peat in professional horticulture, starting in 2026; there is also pressure from multiple retailers to stop using peat in casing.

7. There is sufficient wet-dug peat from bogs with extraction licences in Europe to supply the mushroom industry for several decades; even if the use of peat casing is banned in Europe, the major casing producers expect to have viable businesses supplying the Southern Hemisphere with peat casing; this will depend on shipping costs.

8. Although the supply of peat from Baltic States, Finland, Sweden and Russia is secure, the quality of the blond peat is less suitable for mushroom casing than the wet-dug black peats from Ireland, Germany and Poland.

9. The supply of peat in North America has been erratic due to unfavourable harvesting and transport conditions rather than environmental pressure.

Summary of peat alternatives, and product research:

10. **There are no 100% peat alternatives which have been shown to produce the same mushroom yields and quality in the same timeframe as wet-dug peat casings;** the discrepancy can be largely attributed to poorer water retention, higher salinity (electrical conductivity) and/or susceptibility to mould growth of peat alternatives.

11. Globally and in Australia, there is currently a plentiful supply of potential peat alternatives for casing, such as bark and wood fibre products and imported coir but the demand for bioenergy and alternative horticultural uses will increase prices and may lead to shortages.

12. There is a large supply of recycled growing media in Australia such as spent peat, bark, coir and rockwool from other horticultural sectors which could be re-used as mushroom casing.

13. Developments such as Cormo's TEFRA from maize stalks, Newfoss's NFF from bioprocessed grass and sphagnum moss are undergoing mushroom cropping trials in Europe; all these raw materials are or could be available in Australia in sufficient quantity for casing.

Summary of sustainability considerations

14. The carbon footprints of peat alternatives are smaller than of peat, even if the energy required for processing and transport for some materials is considered; however, reductions in mushroom production efficiency and recycling of

organic wastes into food production and increase in demand for water (e.g., for leaching and irrigation) will negate environmental benefits of peat substitution.

15. Mushroom substrates (casing and/or compost) have been recycled to produce new casing in some countries although leaching to reduce salinity to an acceptable level would be a significant challenge in Australia.

16. In Australia, there are large supplies of filter-cakes from the quarrying and cane sugar industries which could replace sugar beet lime and some of the wet-dug peat in a casing blend.

17. Green wastes composts have been used experimentally in mushroom casing and they could form a component in a casing blend; however, current quality standards are not sufficiently rigorous for use in mushroom casing.

18. In the recycling of wastes or by-products into casing in Australia, the waste classification and application for a waste exemption from the EPA should be considered.

Australian Research recommendations

19. Research and development for casings in Australia should concentrate on replacing sugar beet lime in imported casing with larger volumes of locally available mineral materials: filter cakes from quarries and sugar mills; the use of these materials with dry milled peat and New Zealand peat should also be examined.

20. There has been a large research effort in recent years into peat 'reduction' rather than complete replacement; this now seems less relevant since a peat ban will make it unavailable for use in mushroom casing; research into 100% peat replacement is a new challenge and will require an evolution of the mushroom production system.

21. Mixing peat (acidic which favours green mould) with organic materials that are susceptible to green mould (bark, green waste compost, coir, wood fibre) increases the risk of green mould; it is better to keep peat and alternatives apart.

22. Current brown mushroom strains are more suited than white strains to dry milled peat and peat alternative casings due to a lower water requirement, less risk of blotch or staining by watering close to harvest and smooth caps which do not attract specks of casing; there is therefore a need for white strains bred for use on dry milled peat and peat alternative casings.

23. Due to the dependence on imported ready mixed casing, the casing mixing infrastructure that was previously present in Australia and other countries has been dismantled; this would need to be reassembled if casings are to be prepared from locally available materials.

24. Food Safety needs to be considered in the development of casing alternatives.

Photos/images/other audio-visual material

N/a

Outputs

Table 1. Output summary

Output	Description	Detail
Engagement of suitably qualified principal author	Authors of the report are Dr. Helen Grogan and Dr. Eoghan Corbett, Teagasc (Ireland), Dr. Ralph Noble, Microbiotec (UK), Greg Seymour (ISMS), with consultation from Australian compost expert, providing context for the Australian mushroom industry, Dr. Geoff Martin (Dr. Mush Advisory)	Delivered MS102. Refer Appendix 1 - The Future of Casing report
Online consultations to define future areas of focus and the current knowledge base of mushroom casing substrates.	Online meetings held with over 60 international/domestic researchers and industry experts from 22 countries across six continents were consulted, including scientists, consultants, mushroom growers, casing producers and representatives from other organisations and companies with an interest in peat, growing media, and casing.	Delivered in MS102 Refer to Appendix 1: The Future of Casing report, Appendix I: List of persons consulted in this review and their affiliations (page 52, 53); Appendix II: Template of invitation email to Zoom meetings, including list of questions asked.
Research Report	The *Future of Casing – Review of Casing Materials and Availability of Peat for Mushroom Cultivation* report was produced. The desktop review included peer-reviewed literature, technical publications, commercial literature, and website links. The report outlined the science of casing, global use of peat as a mushroom casing, peat alternative casing materials, economics and sustainability of alternative casing materials, changes in mushroom cultivation needed in response to non-peat casing, regulatory impact on the recycling of materials into casing, and future requirements to produce mushroom and non-peat casing in Australia.	Delivered in MS102. Refer Appendix 1
Symposium	The *Future of Casing Report Symposium,* to build on the research report and further discuss existing alternate casing substrate research, identify the best approach/es for collaboration with Australian and international mushroom industry and research experts.	Event held 25 February 2024. CLICK HERE to view the recording of Symposium Refer also Appendix 2 and 3
Provide clear recommendations to inform the future, long-term R&D investment	Through the findings of the research report and symposium, the research team have provided a clear list of research priorities for suitable alternative casing substrates for the Australian mushroom industry, including a recommendation of proof of concept trials through the Marsh Lawson Research Unit, and larger scale efficacy trials on farm.	Refer page 14 of this report

Photos/images/other audio-visual material

N/a

Outcomes

Table 2. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
The mushroom industry, mushroom SIAP (advisory mechanism) and Hort Innovation are provided with clear priority research areas and recommendations, to inform the RFP as a longer term research investment addressing alternative casing substrates and the opportunities to partner and build on international research.	Mushroom SIP 2022 - 2026 Outcome 2: The Australian mushroom industry has improved profitability, efficiency and sustainability through innovative production systems, reduced costs, and effective risk management. Strategy 1: Enhance the efficiency of mushroom production systems, including casing, compost, labour and energy KPI: - Availability of new knowledge for growers to reduce input costs per tonne of yield	Principal authors engaged. A detailed global situational analysis of the current use of peat for mushroom cultivation around the world. Analysis of the availability and viability of the continuation of access to global peat conducted. The science of casing explained, and documented. A desktop review of past, current and new alternative casing research projects conducted. Key opinion leaders across the globe consulted, 60 via group zoom emails, and 54 via the symposium event. List of peat alternative casing materials and global research identified. Changes in mushroom cultivation in response to non-peat casing explored. Regulatory impacts on the recycling of materials explored. Future requirements to produce mushrooms and non-peat casing in Australia explored.	Appendix 1 – Future of Casing Report
Allowing for the mushroom industry to diversify, to further explore and develop a new substrate and potentially begin to transition to the new option in a phased	Mushroom SIP 2022 - 2026 Outcome 2: The Australian mushroom industry has improved profitability, efficiency and sustainability through innovative production	Through the findings of the research report and symposium, provide a list of research priorities for suitable alternative casing substrates for the Australian mushroom	Appendix 1 – Future of Casing Report The Report provides Hort Innovation and the Australian mushroom industry with priority research and action areas

approach while peat is still available.	systems, reduced costs, and effective risk management. Strategy 1: Enhance the efficiency of mushroom production systems, including casing, compost, labour and energy KPI: - Availability of new knowledge for growers to reduce input costs per tonne of yield	industry, including proof of concept and larger scale efficacy trials. List of viable peat alternative materials identified for the Australian mushroom industry.	informing the long-term research investment to address alternative casing substrates.

Recommendations

While various 'peat blends' are currently being developed in multiple countries, these developments have achieved varying success. No 100% peat alternatives have been shown to produce the same mushroom yields and quality in the same timeframe as wet-dug peat casings usually sought from Ireland, Germany, and Poland.

It is however, recommended that the Australian mushroom industry prioritise research for an alternative 100% peat replacement, due to sustainability pressures.

The Future of Casing Report recommended six Research Priority and Action areas:

1. Watching brief on availability of wet-dug peat and dry milled peat for Australia
2. Watching brief on the commercial development of peat alternatives elsewhere
3. Examine the costs and effects on mushroom yield and quality of replacement of the 15% of imported sugar beet lime in wet-dug peat casing with up to 30% of local materials (mill mud in Queensland and filter cakes elsewhere in Australia)
4. Examine the use of commercially available natural calcium bentonite
5. Examine the use of these mineral materials with dry milled peat or New Zealand peat in casing
6. Examine the use of wood fibre product from QLD.
7. Explore the cost and availability of mixing and wetting facilities for preparing casing blends
8. Test white strain suitability for growing with dry milled peat casing blends.

Refereed scientific publications

None for this project

References

Refer to Future of Casing Report

Intellectual property

No commercial IP was generated in this project

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The AMGA would like to acknowledge Dr. Geoff Martin, while not listed as an author of the final report, he provided in-depth knowledge of the Australian Mushroom industry, compost facilities and growing practices, unique to our country, which were invaluable to the success of this project.