ADAPTING TO CLIMATE CHANGE

02. ALTERNATIVE CASING MATERIALS

Summary

Peatlands are a major carbon sink, sequestering 0.5 gigatons of CO_2 annually. Conversely, draining peatlands is a major source of greenhouse gases, equating to nearly 6% of global anthropogenic emissions. Banning or restricting peat mining is therefore an easy way for countries to meet emissions targets, and this is already occurring in some European countries.

While peat cannot be totally replaced, consumption can be reduced. Up to 50% peat may be replaced by products such as recycled organics, spent mushroom compost, recovered and recycled peat or materials made from bagasse. Research is continuing into these options.

Current practice

The industry sources peat from Germany, Ireland, the Netherlands, Canada and the Baltic states. Most farms use a 90:10 or 80:20 blend of hard, black peat to blonde (Canadian) peat, although at least three use 100% German black peat.

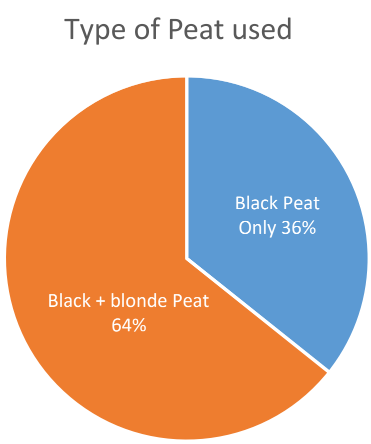

Figure 1. Type of peat used by conventional mushroom farms in Australia.

The supply of peat from Germany and the Netherlands is nominally guaranteed for the next 50 years. However, this could change as concern about climate change increases. Although the supply of peat is unlikely to stop altogether, costs are likely to rise and availability decline.

Alternatives already trialed include coconut coir, brown coal products, spent barley from breweries, composted green waste and spent diatomaceous earth.

Background

Peatlands are the biggest land-based carbon store on the planet. They absorb up to 0.5 gigatons of CO_2 each year, representing 1-5% of human-sourced greenhouse gas emissions globally[1].

Conversely, **10%** of global emissions from the agriculture, forestry and land use sectors is caused by draining peatlands. This equates to almost 6% of global human-sourced CO_2 [2]. This is because allowing oxygen

[1] Friedlingstein PRM et al. 2014. Persistent growth of CO_2 emissions and implications for reaching global targets. Nature Geosci. 7:709-715.
[2] International Union for Conservation of Nature, https://www.iucn.org/resources/issues-briefs/peatlands-and-climate-change

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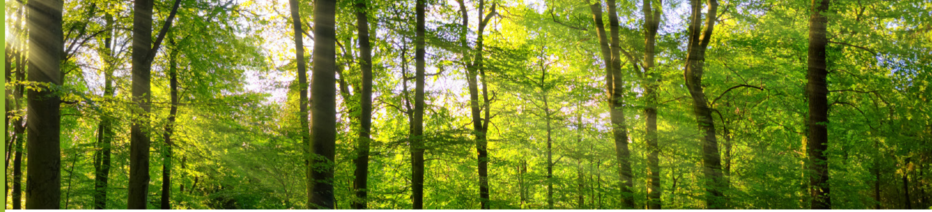

into the anaerobic environment of the peatlands allows it to rapidly decompose, emitting large amounts of both CO_2 and nitrous oxide (N_2O).

Drained peatlands are also extremely susceptible to fire, especially when combined with increasingly hot, dry conditions. Such fires can smoulder underground for weeks. For example, the 2019-2020 underground peat fire near Port Macquarie took 210 days to extinguish, and then only after 260mm of rain was combined with pumping 65 megalitres of reclaimed water onto the wetlands[3].

According to the International Union for the Conservation of Nature (IUCN), "*the protection and restoration of peatlands is vital in the transition towards a low carbon economy*". They further propose a moratorium on peat exploitation, and for peatlands to be included alongside forests in agreements relating to climate change (e.g. carbon credits/debits), geodiversity and biodiversity.

Figure 2. Mining of peat bogs, such as this one in Ireland, is increasingly restricted. *Photo by D. Turner.*

It is likely the European Union will introduce regulations to limit or ban the draining and extraction of peat to reduce European greenhouse gas emissions. According to Achim Steiner, previously the executive director of the UN Environment Program, protecting and restoring peatland is "low hanging fruit", making it one of the most cost-effective options for mitigating climate change[4];

Ireland has already closed 17 peat bogs and plans to close the remaining 45 bogs by 2025[5].

The EU "Peat Life Restore" project aims to restore peatlands in Germany, Estonia, Latvia, Lithuania and Poland to meet the objective of reducing greenhouse gas emissions by 40% by 2030 from 1990 levels.

Peat used for casing is likely to become both more difficult to access and more expensive.

Alternative casing materials

While alternative casing materials have been widely researched since the 1980s, South Africa has long been a leader in this field. African mushroom producers were unable to use locally available peat due to high clay content, and it is now also protected from exploitation. Purchasing peat from Europe was initially impossible, and later prohibitively expensive. As a result, South African company Mabu Casing has developed a casing material based on sugarcane waste (pith) that has been processed to make paper. The process is confidential, but results appear to be commercially viable.

A variety of other materials have been investigated as peat replacements including[6]:

- Carpet wool
- Coffee grounds
- Composted mushroom stalks
- Composted vine shoots
- Composted water weeds
- Cotton husks
- Fine particle tailings from coal mining
- Floculated rock wool
- Eucalyptus sawdust
- Lignite
- Loamy top-soil
- Mineral soil
- Palm fibre
- Paper pulp
- Pine sawdust

3 Bungard, M. 2020. Fire near port Macquarie extinguished after 210 days. https://www.smh.com.au/environment/weather

4 https://www.newscientist.com/article/dn13034-peatland-destruction-is-releasing-vast-amounts-of-co2/

5 https://www.theguardian.com/world/2018/nov/27/ireland-closes-peat-bogs-climate-change

6 Pardo A, de Juan JA, Pardo JE. 2003. Characterisation of different substrates for possible use as casing in mushroom cultivation. Food Ag. Environ. 1:107-114.

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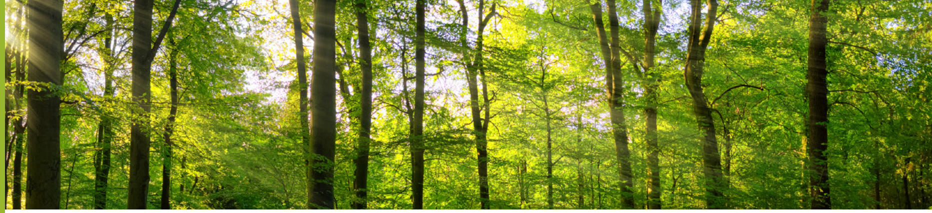

02. ALTERNATIVE CASING MATERIALS

Spent mushroom compost

The casing material that has received most attention is spent mushroom compost (SMC). This is an attractive option as it can reduce both the cost of casing and issues with disposal of spent compost. Numerous research papers detail methods for using SMC alone, or in combination with other materials (including peat), as casing. The main drawbacks of SMC are its variable composition, relatively poor water holding capacity and high salt content[7,8].

However, ageing and leaching have been shown to be effective at overcoming these issues. The electrical conductivity (EC) of SMC can be reduced from approximately 7.0 µS/m to 2 µS/m by either natural weathering or active processing. In Iran, SMC is actively processed by leaching with 3.5 to $4m^3$ of water/tonne over three weeks. Repeatedly immersing and draining the material can achieve the same result within only seven days[9].

Even after leaching and pasteurisation, SMC is unlikely to completely substitute for peat. In Ireland SMC leached to 4µS/m and heat treated at 60°C was successfully mixed 20:80 with peat, but adding more SMC to the peat reduced yields[10]. Similarly, Malard

	TIME REQUIRED	
	Natural weathering	*Processing*
Method		
Windrow / pile / bunker	2 years	3-4 weeks
Leaching	2 years	2 weeks
Draining	6 days	
Pasteurisation	4 days	
Blending	1 day	
Result		

Table 1. Processes and time required to ensure SMC is suitable for inclusion as casing material. From J. Burdon, presentation at 2018 mushroom conference, Sydney.

7 Riahi H, Zamani H. 2008. Use of spent mushroom compost and composted Azolla as an alternative for casing soil. Proc. ISMS. 17:333-339.
8 Barry J et al. 2008. Partial substitution of peat with spent mushroom substrate in peat-based casing blends. Proc. ISMS 17:288-309.
9 Rowley C, Burdon J. 2019. Using spent mushroom compost as a casing amendment. Aust. Mushroom J. 2019: 37-41
10 Barry J et al. 2008. Partial substitution of peat with spent mushroom substrate in peat-based casing blends. Proc. ISMS 17:288-309.

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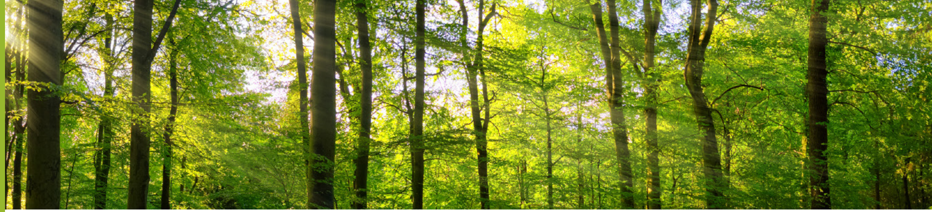

mushrooms in Iran mixes SMC that has been leached to 2µS/m as a 50:50 blend with peat. Although the material is normally pasteurised, trials indicated this may not be necessary (M. Mirzadeh, pers. com.).

Recycling casing

It is possible to partially re-cycle casing soil that has been separated from compost. To ensure good separation, mycelium should be allowed to thoroughly colonise the underlying compost under high CO_2 (1%), before the casing is added[11]. At the end of the cropping cycle the casing is removed, ground, steam sterilised and then inoculated with bacteria. This can be blended 30:70 with fresh peat.

This separator system is commercially available as the "MushComb Separator". The separator works with the emptying conveyor and winch in shelf rooms. The separator is placed against the shelving, with the emptying winch on the other side. Casing is unloaded onto a separate conveyor and taken off to the side[12]. The process does not limit the speed of unloading for the room; it can operate at 17m/minute, which is faster than most emptying systems.

Separating wet peat from the underlying compost also facilitates use of the SMC for other purposes – whether incineration, fertiliser production or other uses.

The cost of a single arm separator and additional casing conveyor is approximately 50,000 euro, or

Figure 3. The Mush Comb unit (a) is used to separate the casing from compost during room unloading. The separator is used with a multi-arm emptying machine (b) as the crop is removed after final harvest (c). Conveyors take compost into the waiting trailer, while casing is diverted to a container at one side (d). The separated casing soil (e) and compost can then be recycled or used for other purposes.

Photos by Mush Comb and The Mushroom People.

[11] Oei P, Albert G. 2012. Recycling casing soil. Proc ISMS 18:757-765.

[12] www.mushcomb.com

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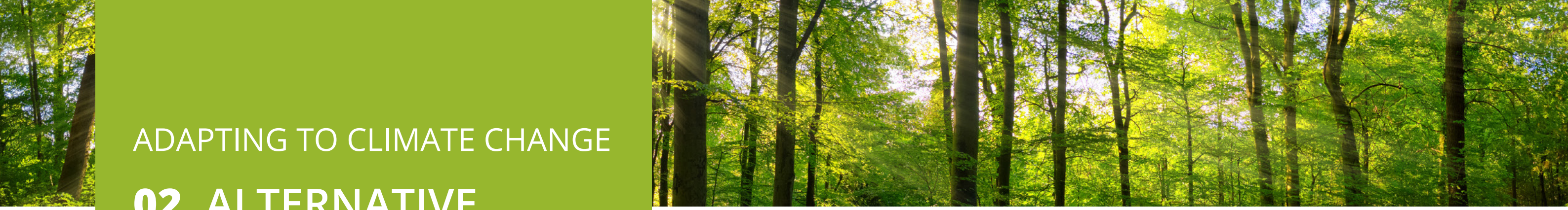

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$A81,500 in June 2020. This is the simplest system, using the existing emptying winch and conveyor. The separator is placed between the shelving and existing winch, with the new conveyor unloading to, for example, an adjacent container. If there is not an existing emptying unit, this can be added for an extra 35,000 euro ($A57,000). A machine which includes the separator, emptying unit and all conveyors into a single unit is approximately 125,000 euro ($A204,000).

Recycled organics

Recent Australian trials conducted by AHR have focussed on using recycled organics from green waste as casing materials. The green waste is prepared from landscape wastes rather than the more variable materials collected from domestic recycling. It is thoroughly composted, ground and aged for 6 to 12 months before use. The recycled organic material has an advantage over SMC in that the initial EC value is low, at 2.2 to 3.2 dS/m.

Blends of up to 50% recycled organics (RO) with peat resulted in similar yield and quality to peat alone. There was no difference between pasteurised and non-pasteurised material. While these are initial trials only, the results appear promising. Commercial trials are now being conducted using a 50% blend of recycled organics with black peat.

Figure 4. Mushrooms cased with; a 100% recycled organics (RO); b 50:50 RO and peat; c 25:75 RO and peat; d 100% peat

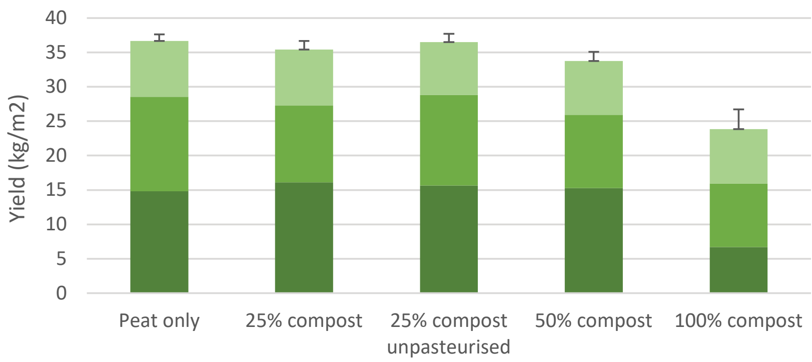

Figure 5. Mushroom yields from blocks cased with blends of recycled organics and peat at the Marsh Lawson Mushroom Research Unit (AHR data). Bars indicate the standard error of each mean 'total yield' value.

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