EXPLORING THE POTENTIAL OF SPENT MUSHROOM SUBSTRATE FOR **SUSTAINABLE AGRICULTURE**

To maintain consumer appeal and a competitive edge, business must strive for that magical triple bottom line of social, economic and environmental sustainability. Striking that balance is an ongoing challenge due to a fickle global economy and increasingly unpredictable weather patterns.

Despite enjoying more controlled and controllable conditions than most horticultural industries, the mushroom industry is still at the mercy of some external factors. For example, the Australian mushroom industry relies heavily on wheaten straw as a key ingredient in the production of mushroom growing substrate. However, the effects of drought, climate change, changed farming practices, and increased competition from the feedstock industry have reduced the availability of wheaten straw to mushroom farmers, driving up prices.

Increasing the value proposition of SMS for the end user, particularly grain growers, is one approach to help offset the increasing costs of wheat straw.

The project

In a R&D levy-funded project, a team of experts has been developing models for the upgrading of spent mushroom substrate (SMS), which would work toward a circular economy that is not only sustainable but improves a grower's economic bottom line.

This project, led by agricultural scientist Dr Kevin Wilkinson, soil scientist Dr Cassandra Schefe, and

Key points

- The Australian mushroom industry relies heavily on wheaten straw, which has become less available and therefore expensive.
- Increasing the value proposition of SMS for the end user will help generate more income from this waste product.
- A levy-funded project is underway with a focus on improving SMS value proposition for end-users, particularly grain growers.
- One of the significant challenges in developing a circular economy for SMS is the geographical disconnect between grain cropping and mushroom farms.
- Strengthening linkages between the mushroom industry and grain growers could have a significant impact on the sustainability of agriculture in Australia if these challenges can be overcome.

agronomist Mr David Hawkey, seeks to equip Australian mushroom growers with an improved understanding of the options available for recycling SMS.

The team has already completed several key steps in the project, including a review of past research, to establish the value proposition of SMS as a value-added product, and mapped potential end-users of SMS – the agricultural producers. Another critical part of the project is the physico-chemical characterisation of SMS to confirm whether boosted SMS is any good as a soil amendment/fertiliser.

The team is in the process of conducting interviews with grain growers to understand what value they place on SMS and their willingness to use a value-added SMS fertiliser product.

Demonstration trials are a potential next step, involving mushroom growers and agricultural producers to showcase the product.

The challenges

For cropping farmers to consider receiving SMS-derived products - either instead or, or in-addition to other farm inputs - a range of issues around product quality/ integrity, transport, logistics and soil/plant benefits need to be addressed.

An analysis of the composition of SMS revealed several shortcomings for use as a fertiliser supplement by grain growers including:

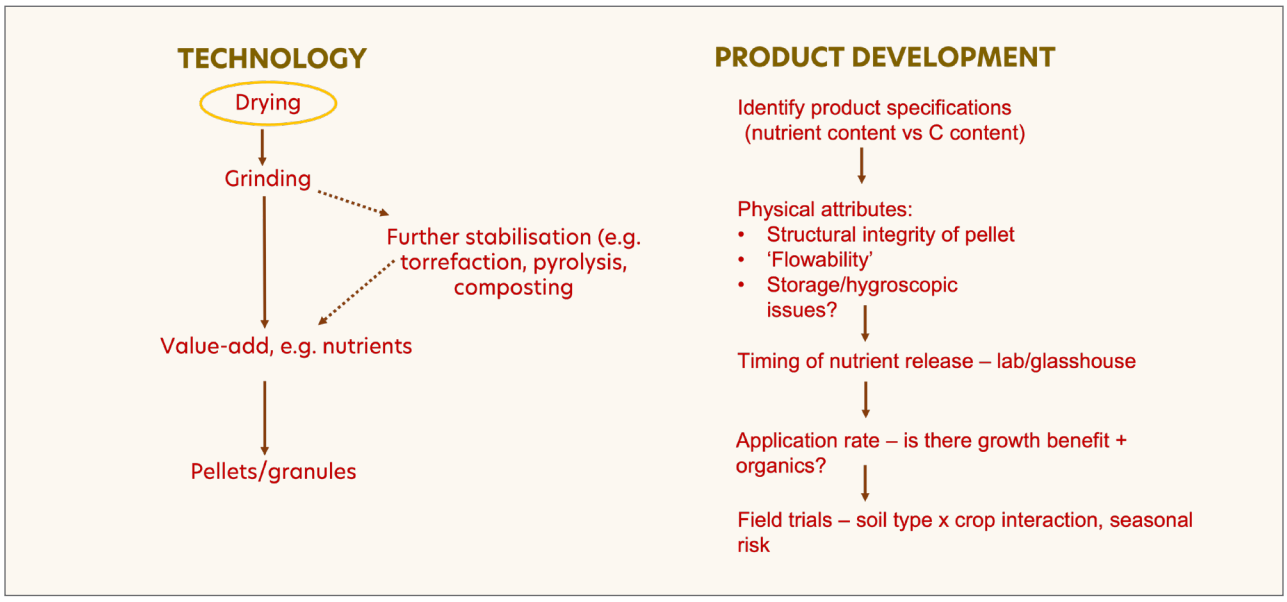
- High moisture content of 50-70%, making it heavy to transport.
- The nutrients are tightly bound by organic matter, so the release of nutrients from SMS is slow and unpredictable.

Other factors which need to be considered in using SMS include the cost of stockpiling SMS by grain growers, cost of application, whether there are any positive impacts on yield, and the timing of supply of SMS versus when it is needed in grain cropping.

Furthermore, while the mushroom industry is reliant on straw, grain growers have many other customers competing for this valuable by-product.

Noteworthy is the increasing use of organic soil amendments in cropping, and in this category, SMS is at some advantage due to it consistent composition as well as being free of contaminants (for example animal waste).

One of the significant challenges in developing a circular economy for SMS is the geographical disconnect



Steps required in SMS value adding, with drying representing a key limiting step in the development of pellets or granules. *Adapted from Wilkinson et al, 2023, webinar presentation*

between the cropping farms from which the straw is sourced, the mushroom compost manufacturers, and the mushroom growers who then generate the SMS. This means that any value-adding process may need to be either mobile or located close to the mushroom producers. And although it may be attractive for mushroom growers to provide SMS back to cropping farmers in exchange for favourable straw agreements, the SMS may be generated by several businesses, across a range of locations, complicating any *quid pro quo* arrangements.

Furthermore, while value-adding SMS through nutrient addition and pelletisation may increase the attractiveness for reuse in broadacre cropping systems, there is significant cost in creating the product.

The to and fro logistics are also complicated by a value imbalance. Transporting wheat straw to compost producers is feasible as the wheat straw has value to the mushroom producer. However, the economics of transporting SMS back to wheat farmers is not equal as the SMS does not have the same significant value to the wheat farmer. And despite empty trucks travelling to wheat farms to pick up straw, they are not the right configuration for transporting SMS. Unless the transport issue can be resolved, the present value of SMS is diminished due to the high cost of transport over large distances.

What next

While strengthening linkages between the mushroom industry and grain growers could have a significant impact on the sustainability of agriculture in Australia, project leader Dr Wilkinson is cautious.

"Given that all mushroom farmers currently have sustainable disposal methods that are either cost neutral or make a small return, it needs to be questioned what the benefit of seeking alternative uses of SMS is at present, given the logistical and economical challenges highlighted by this research," he said.

Nevertheless, given market volatility, understanding the potential of SMS in a mushroom circular economy may be an important part of future-proofing the mushroom industry.

WEBINAR
Recycling spent mushroom substrate (SMS) for fertiliser in a circular economy (MU21006)

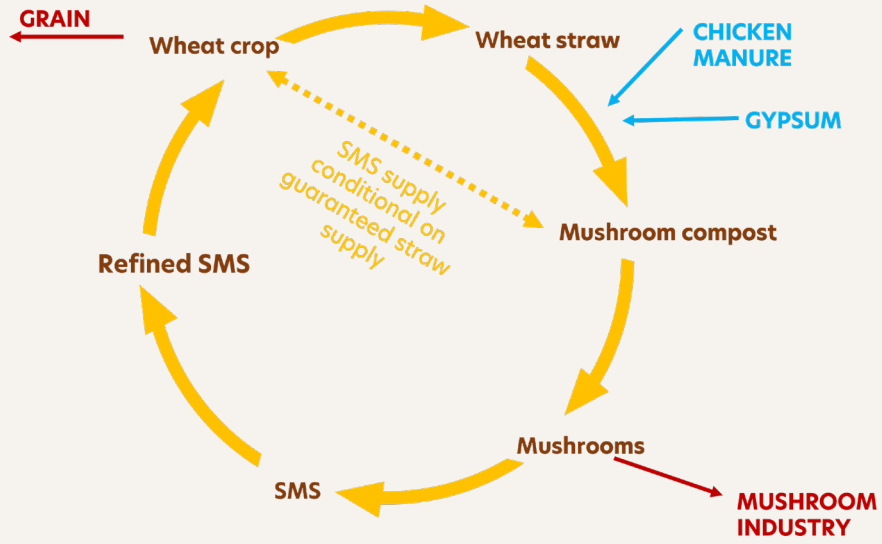
Watch the webinar here: http://bitly.ws/Ha2v

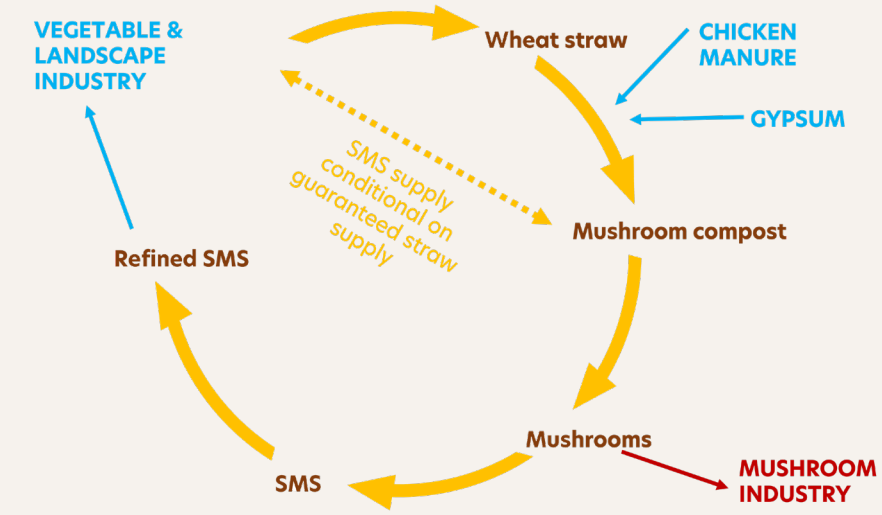
The circular economy and mushrooms

A circular economy gives incentives to reusing products, rather than disposing of them and then extracting new resources. In such an economy, all forms of waste are returned to the economy or used more efficiently.

Globally, mushroom production has increased as demand for sustainable food rises. This will be accompanied by an increase in SMS, which may exceed a trillion kg a year, representing six tonnes of SMS/km^2 global land area[1]. There are different options to use these enormous amounts of SMS, but understanding how it can be used in the most circular way, to the benefit of both the producer and the end-user, relies on modelling studies such as this one.

The research team explored two models, a closed and open loop, and the benefits and shortcomings of both. While the closed loop represents a true circular economy, which may[2] provide compost producers with some certainty on straw supply, the challenge remains in how to make this product valuable to grain growers while overcoming many logistic issues. Sending SMS to the nursery and landscape industry, as some growers already do, overcomes some of the logistic challenges, however in this open loop, the link between the mushroom industry and grain growers is broken.





A closed (top) and open loop (bottom) model for spent mushroom substrate. *Adapted from Wilkinson et al, 2023, webinar presentation*

1 https://doi.org/10.1007/s00253-018-9226-8

2 Note that the dynamics of supplying straw to growers in exchange for a value-added SMS product is based on assumption and would require further investigation as part of any future techno-economic analysis.

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This project has been funded by Hort Innovation using the mushroom research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

The team

Dr Kevin Wilkinson is a composting and compost utilisation specialist. Spanning over 30 years, Kevin's career has touched on many issues such as biosecurity, food safety, soil science and agronomy, as well as the economics of practice change.

Dr Cassandra Schefe has over 20 years of experience in soil carbon and organic amendment research, with a focus on identifying the key functional components in organic amendments for delivering specific soil benefits.

Mr David Hawkey has over 25 years of hands-on commercial agronomic experience, including time as a specialist agronomist in the irrigated cotton and broadacre cropping industries, and as a field research agronomist in the pasture industry.