

*Australian*  
**MUSHROOMS**  
**JOURNAL**

EDITION 1 - 2020



**Hort  
Innovation**  
Strategic levy investment

**MUSHROOM  
FUND**



# Australian MUSHROOMS JOURNAL

EDITION 1 - 2020

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# EDITORIAL

I woke up the other day and thought – wouldn't it be great if the solution to the Coronavirus was simply to eat more mushrooms! With all those great health benefits that we already know about surely we can squeeze in another one.

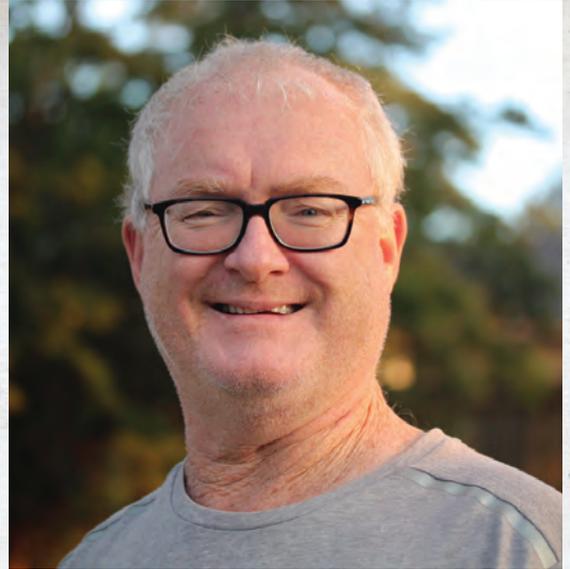
And for this edition of the Journal, we have again squeezed in quite a lot, so I would encourage you to sit down and start reading.

In the marketing section of the Journal, we have a detailed examination of the demographics of Australian mushroom consumers, including a look at the future growth for mushrooms. And if you ever wondered about the foodservice market and what it might hold for mushrooms, we have included a summary of the recently completed levy-funded project examining this component of the market.

The mushroom conference will take place in October in Adelaide, so now is the time to start making plans to attend. A list of speakers that have accepted to attend is included, and there are more yet to be confirmed. An updated speaker list will be included in the next edition, along with details on how to book to attend this event.

Over the past few months, some significant projects have concluded, and this edition includes coverage of two of these projects.

The first of these articles cover the production waste project and highlights two of the four recommended solutions for dealing with production waste. The report includes a look at the business challenges and provides a business case summary. The project makes for some fascinating reading and potentially opens the door for the industry to pursue some solutions to



the waste problem. The further two recommended solutions will appear in the next edition.

The second of the articles covers agri-technology. This project involved the scoping of global agri-technology opportunities and has identified ten priority solutions for further consideration by industry. The item delivers plenty of food for thought and is an opportunity to consider the additional application of technology within the mushroom business.

The Pest and Disease project has also delivered plenty of practical advice with two articles covering off nematodes (further information on this subject is planned for future editions) and the selection of insecticide.

If you have any feedback on the articles or would like to make some suggestions for future editions, please let me know.

Enjoy the read and happy mushrooming everyone.

Chris

**Hort  
Innovation**



This project has been funded by Hort Innovation, using the mushroom research and development levy and contributions from the Australian Government.

# AMGA CHAIRMAN'S REPORT



*Kevin Tolson, Chairman,  
Australian Mushroom Growers Association*

Dear AMGA members and other industry stakeholders,

I imagine like all mushroom producers you are feeling the times at present, with low mushroom pricing, which is putting a real strain on margins.

## MARKETING

The real talking point within industry is the promotions campaign and whether it

is working to maximise sales of Australian mushrooms. From discussions with retailers and growers the consensus is that we need to look carefully at the program and fine tune as far as possible our marketing efforts to drive the highest return from our levy investment.

Major and smaller retailers are seeing some decline and hence price reductions. Complicating this is an increasing supply from industry through some expansions and productivity improvement. So what is being done you may ask to improve consumption. Nothing I can say will relieve the pain in the short term are my thoughts. What I can say is that the AMGA, members of the SIAP and other industry stakeholders are making their views known and looking to work with Hort Innovation to address perceived shortcomings with the current marketing program.

## HORT INNOVATION

Industry has considered the analytical data and are working through the SIAP. The SIAP, at the December 2019 meeting, supported a range of measures to

address the situation including an open tender for the new creative and the consideration of additional funding options for the new campaign elements. It is pleasing to note that Hort Innovation is listening to the industry and is committed to working cooperatively with the industry project group to try and deliver substantial increased demand.

## SIAP

The minutes from SIAP meetings are posted, and so full disclosure on the discussions is there if you care to read them.

High yields, quality produce and good labour efficiency is my greatest focus.

Wishing you good cropping and improved sales.

Best regards,

*Kevin Tolson*

## VALE BRIAN PRATLEY

It is with much sadness we announce that Brian Pratley passed away on March 13, 2020.

Brian was a valued member of the AMGA Board for many years, working in his capacity as AMGA Treasurer and AMGA Chairman [2002-2003].

The AMGA and the wider industry pass on their condolences to his family.



*Brian and Dorothy Pratley*

# AMGA GENERAL MANAGER'S REPORT



*Martine Poulain, Relationship & General Manager, Australian Mushroom Growers Association*

Happy New Year to our Mushroom Growing community. As I sit to write my column today, it's raining outside finally. After several months of watching our country burn, it's a welcome relief!

The pressure of the fires on our industry are yet to be fully felt, but there will undoubtedly be repercussions in increased production costs to businesses – which will add further stress to our farmers, after what has been a tough 2019. From an industry perspective, we hear you, and we are working closely with Hort Innovation and the SIAP, to ensure your voices are heard.

When speaking to our members, their main concerns seem to be our marketing – is it working? Are consumers buying more mushrooms? Hort Innovation invests in industry-specific marketing campaigns across a range of mediums and channels, to ultimately help growers and other industry stakeholders maxim-

ise their returns.

At the last SIAP, it was decided that it was time for a new creative campaign for the mushroom industry, and we hope to roll this campaign out towards the end of 2020. Our aim is to keep you well-informed on the investment of the levies you pay, and the Hort website regularly updates industry. Some updates below on our forthcoming activities this year:

## MARKETING ROADSHOW

As mentioned in my introduction, our growers want to know about marketing. To demystify what marketing is all about – who we reach, and how this has impacted consumer purchasing - we are taking the Hort Innovation marketing team on the road in the first half of the year to meet our growers.

Please look out for updates in your emails regarding dates and locations.

## AMGA WEBSITE

Our AMGA website will be going through a rebuild this year, and with its completion, growers and consumers will have access to up to date, comprehensive industry knowledge and resources.

There will also be a member only portal, so if you are yet to join the AMGA, now is the time to consider the benefits of membership.

In closing, I'd like to remind you that the AMGA encourages our growers to contact the office for their testing requirements. We take our role as the ambassador of the mushroom brand very seriously, and to ensure your growing conditions are up to code, please reach out when it comes time to do your audit.

My door is always open, so please drop me an email or call me.

All the best,

*Martine Poulain*

Relationship and General Manager  
martine.poulain@amga.asn.au  
0457 440 298

## AMGA Board of Directors

The following people form the Board of Directors of the Australian Mushroom Growers Association.

Mr Kevin Tolson  
Chairman  
Regal Mushrooms

Mr Michael [Mick] Surridge  
Deputy Chairman  
Scatoplus

Dr Geoff Martin  
Treasurer  
Dr Mush Advisory

Mr Tim Adlington  
Executive Director  
Analytics Stats Consultant

Mr Carmine Calisto  
Director  
Global Axis Import  
Solutions

Mr Jose Cambon  
Director  
Costa Mushrooms

Mr Phil Rogers  
Director  
P & L Rogers

Mr Robert Tolson  
Director  
Premier Mushrooms

### AMGA Staff

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### AMGA Mailing Address

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Growers' Association Ltd  
PO Box 576, Crows Nest  
NSW 1585  
Phone: (02) 9431 8675

## 2020 CONFERENCE, ADELAIDE: 14 OCT - 17 OCT

Our conference program is almost ready to send out to you all, and we are very excited with the line-up this year and hope to see you attend. The face to face contact with industry domestically and internationally is invaluable!

## MEMBERSHIP DIRECTORY

We are in the final stages of putting together our 2020 AMGA members directory, and these will be sent to our membership in the next few weeks.

# GROWING SALES OF Australian MUSHROOMS

*Melanie Norris*  
Senior Manager, Fresh Analytics

Australia is a nation of mighty mushroom munchers. More than four-in-five (81%) Australian households purchase mushrooms over the course of a year, well above other global markets; in the United States, only half (49%) of households purchase mushrooms.

In contrast to the broader environment of higher prices and decreasing volumes in fresh produce, sales for mushrooms over the past 12 months have grown in volume. Mushrooms grew 4.2% in volume (kg) and were the fourth highest contributor to vegetable volume growth; however, value change in mushrooms was -1.6% due to an average price reduction of 5.6%. This

has been a shift compared to the fourth quarter of 2018 where reduced supply resulted in higher prices and a decline in volume sales (see Figure 1).

## THE AUSTRALIAN BUYER

Mushroom buyers appear to have noticed the lower prices resulting from the abundant supply of mushrooms over the past year, increasing their consumption by an average of 111g per household. Mushroom buyers can be broken down into heavy, medium or light groups, depending on the volume they purchase (see Figure 2).

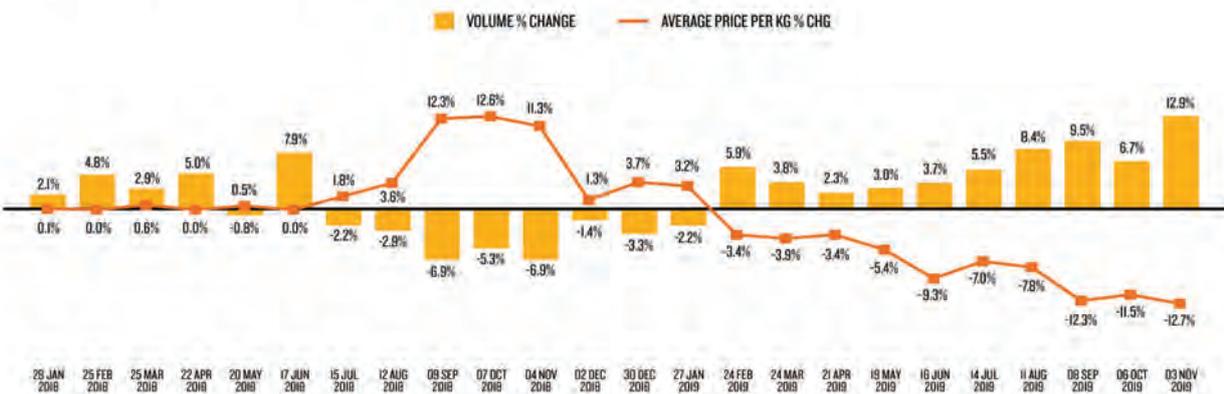
Over the past year, heavy buyers contributed over half the volume of mushrooms and have been the biggest driver of increased volume sales for mushrooms. Heavy buyers also purchased the largest share of loose mushrooms, in contrast to

light buyers who were more likely to choose a convenient pre-packed, sliced format.

Mushroom buyers can also be broken down in terms of demographic groups. Over the past year, all demographic groups were shown to contribute to volume growth of mushrooms. Couples aged 35+ years contributed by far the most to the volume growth of the category, growing 4.1% and representing half the mushroom dollar sales last year.

Families represent a smaller but sizeable portion of consumers, and grew by 5.2% in volume. They were responsible for nearly a third of the dollar sales of mushrooms. Younger adult and single adult (35+) households are the smallest consumer group and grew volume by 2.4% making up 20% of the mushroom dollar sales.

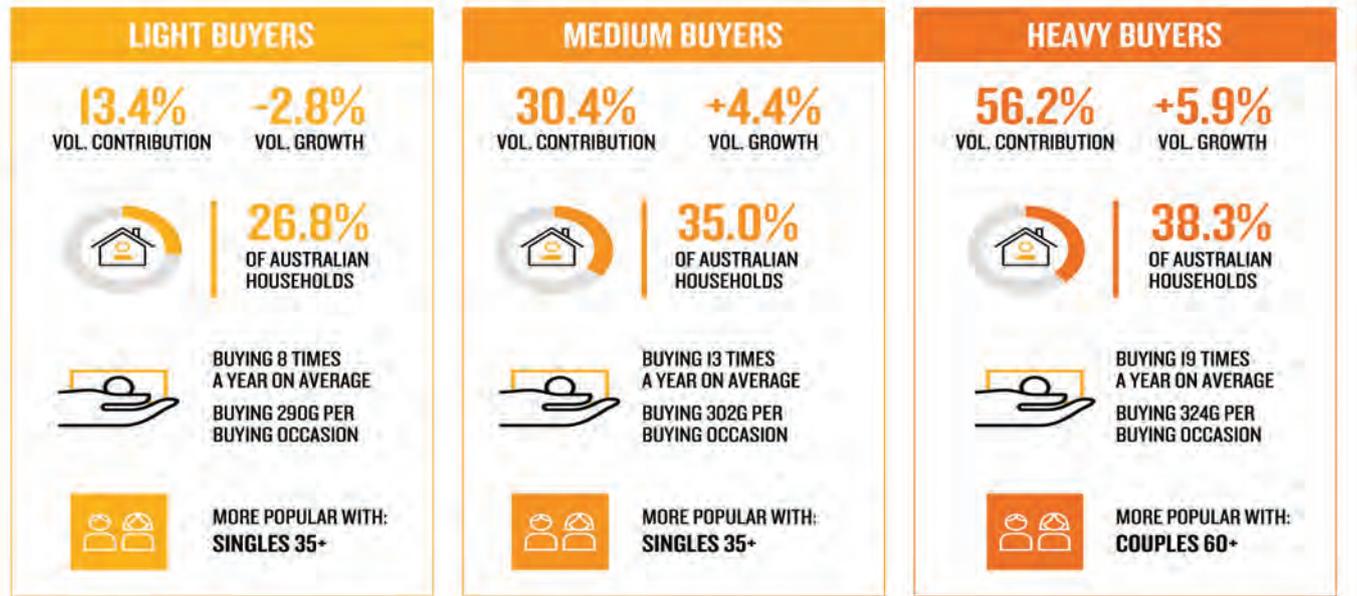
## MUSHROOM VOLUME GROWTH VS AVERAGE PRICE PER KG GROWTH



Source: Nielsen Homescan 4 weekly sales to 03 Nov 2019 vs Year Ago

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Figure 1



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Figure 2

### MUSHROOM RETAILERS

From a retailer perspective, three-quarters of sales were represented by major supermarkets; however, greengrocers and markets drove the biggest increase in loose volume sales.

Greengrocers and markets grew their volume share of trade by four share points to the detriment of major supermarkets. This corresponded with a 1% increase in dollar share of trade indicating that the sharpest mushroom prices could be found at greengrocers and markets last year.

### MUSHROOM FORMATS

Across the different formats of mushrooms, volume growth in the segment came primarily from loose mushrooms.

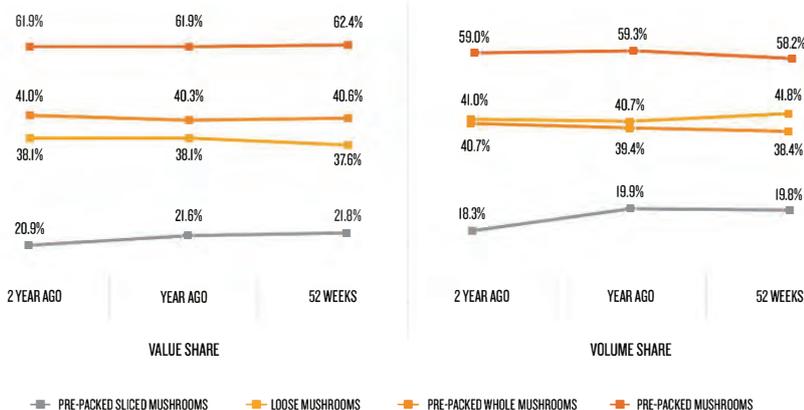
The growth of loose mushrooms resulted from a degree of switching from prepacked whole mushrooms to loose mushrooms, and also a general increase in consumption due to the lower prices [see Figure 3].

For example, low affluence households took advantage of the lower prices and grew their volume consumption by 6.7%.

### FUTURE GROWTH OF MUSHROOMS

With mushrooms already reaching a high percentage of Australian households, the best opportunity for growth is encouraging Australians to eat more. Good supply and lower prices have had the desired impact of increasing consumption among medium and heavy buyers, but not with light buyers. Whilst the opportunity to increase consumption among light buyers is large, it is worth noting they were not as easily convinced to add more mushrooms in to their baskets at the lower price point.

## MAJOR SUPERMARKETS LOOSE & PRE-PACKED SHARE OF MUSHROOM



Source: Nielsen Homescan 52 weeks to 03 November 2019

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Figure 3

Mushrooms remain a popular choice in the weekly repertoire of many Australians. The past year has shown that households can further increase their consumption of mushrooms when persuaded, especially by price. The challenge is to maintain growth even with increases in price, to maintain the popularity and to eventually move this unique and nutritious food to the top of the shopping list.

### SOURCES:

Nielsen Homescan 52 weeks to 03 November 2019

Nielsen Total Food View, Total U.S. xAOC, Cal Yr 2018 W/E 12/29/18 ; UPC-coded and random-weight/Non-UPC data; Nielsen Homescan



# FOODSERVICE OPPORTUNITIES TO MAXIMISE *Mushroom Consumption*

Eating out has become an ongoing love affair in Australia, with consumers regularly going out for work lunches, having brunch on the weekends, or ordering in takeaway for an easy dinner at home. In fact, the opportunities for enjoying food outside of the home are seemingly endless – something that is backed up by data suggesting that almost eight out of ten Australians aged 14 and above eat out at least once a month. The Eating Out in Australia 2019 report points to 4.5 million daily transactions by consumers, leading to a total annual spend per person of \$880 in what has become a \$22 billion market.

For mushrooms, the changing face of foodservice represents opportunity. In 2019 the foodservice sector consumed 9,200 tonnes [approximately 13%] of *Agaricus bisporus* produced in Australia.

A 2019 levy-funded project has examined the foodservice market for mushrooms. The research provides an understanding of the current usage, perceptions and barriers to using mushrooms in the foodservice

industry. The findings are a crucial first step in maximising the use of mushrooms in the foodservice sector.

## RESEARCH METHODOLOGY

The study examined the use of mushrooms in the foodservice market using qualitative interviews, a quantitative survey and primary collected data from a sample of 300 foodservice operators.

This carefully selected sample represents the relative size of each foodservice channel, to as accurately as possible reflect the opinions and behaviours of the total Australian foodservice market.

From this, the results were broken down into commercial [e.g. restaurant, cafe and function caterer] and institutional [e.g. hospital, aged care and daycare centre] foodservice channels to allow further analysis of the potential opportunities.

## MARKET SIZE

The study highlighted that the use of mushrooms in foodservice

is considerable, especially in the commercial channels which account for the majority [91%] of the total purchase of mushrooms in the foodservice market [see Table 1].

Across the foodservice sector whole white button mushrooms are by far the most used mushroom type. It is interesting to note that the study found very low use of sliced mushrooms, suggesting that foodservice operators are not convinced that pre-prepared mushrooms are worth the extra cost.

## INSIGHT - FOODSERVICE PERCEPTIONS OF MUSHROOMS

The research indicated that the foodservice industry has several positive perceptions about mushrooms, including: Australian-grown mushrooms are high quality, with almost all channels rating the quality of mushrooms above 6 out of 7.

Mushrooms are a versatile ingredient that can be used as both a hero and staple ingredient in their menus.

	Total Foodservice Industry	Commercial	Institutional
Grand total volume [kg]	9.2 million	8.4 million	800,000
Grand total value [AUD]	58.6 million	53.1 million	5.5 million

Table 1. Volume and value of *Agaricus bisporus* products in the foodservice industry.

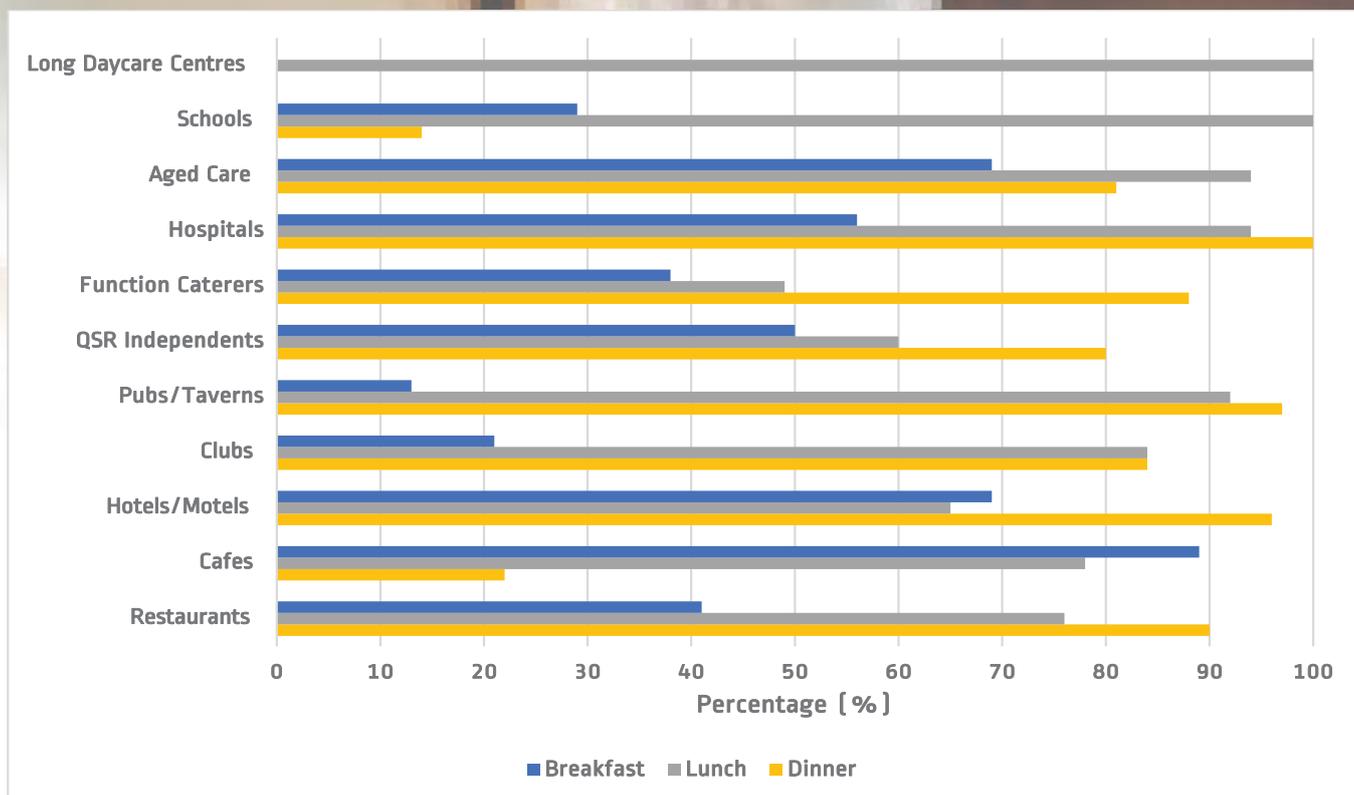


Figure 1. Percentage of foodservice channels serving mushrooms on their menus by eating occasion.

Mushrooms are thought to be flavourful, popular, nutritious and a useful vegetarian option for menus. The most common reason for including mushrooms in foodservice menus was due to flavour, followed by popularity. For institutional channels where health and wellbeing are priority over repeat purchase (such as hospitals, schools and daycare centres), the nutritional benefits of mushrooms were shown to be one of the most important factors in their decision to include mushrooms.

Interestingly the results also highlighted a variety of reasons why mushrooms are not included on menus, with the most common answer (at an average of 13% of respondents) being that the mushrooms are not in season. This

finding indicates a lack of knowledge that mushrooms are available year-round and could also reflect the perception mushrooms are only suitable for certain seasons such as winter. It also highlights a serious need to encourage year-round usage of mushrooms by the foodservice industry.

### INSIGHT - MEALTIMES SERVING MUSHROOMS

The research also looked at mushroom use across all eating occasions in the foodservice sector. Interestingly the data (Figure 1) shows that mushrooms are mostly used in dinners, followed by lunch and then breakfast.

In terms of the foodservice channels,

the top three channels for each meal occasions are as follows:

1. Breakfast – Cafes, Hotels/Motels, and Aged Care.
2. Lunch – Long Daycare Centres, Schools, Aged Care & Hospitals.
3. Dinner – Hospitals, Pubs/Taverns, Hotel/Motels.

With the growth of breakfast in the Australian culture, one promising finding was that 89% of cafes currently serve mushrooms for breakfast. It is also interesting to note that there is a high recognition of the nutritional benefits of mushrooms in the institutional channels of foodservice, with daycare (100%), school (100%), aged care (94%) and hospital (94%) channels all serving mushrooms during lunches.

	Share of Volume by Product [ % ]		Share of Value by Product [ % ]	
	Commercial	Institutional	Commercial	Institutional
White Button – Whole	81	85	80	84
White Cup – Whole	4	10	4	10
White Flat/Large Open – Whole	7	2	8	2
Swiss Brown – Whole	5	<1	6	<1
Portobello/Open Swiss – Whole	2	<1	3	<1
White – Sliced	<1	3	<1	3
Brown – Sliced	<1	<1	<1	<1

Table 2. Share of volume and value by product in commercial and institutional settings.



## INSIGHT - MENU INSPIRATION AND CHANGES

In terms of making changes to existing menus, the foodservice operators surveyed for the project indicated that they make changes between one and three times a year, with the most common times occurring in March, June, September and November. Surprisingly the foodservice channels highlighted social media, followed by word-of-mouth and personal relationships (between suppliers, chefs and cooks) as being the major sources of menu inspiration for making changes. This finding reinforces the importance of the Australian Mushrooms social media channels in influencing consumption growth.

## SOURCE OF MUSHROOM SUPPLY

When it comes to sourcing mushrooms for the foodservice sector, 53% of respondents indicated that they obtain mushrooms from specialist distributors and wholesalers. A notable weak point in this supply chain is the fact that 40% of commercial operators reported they do not have a secondary source of supply. For these operators, it means that if their primary source (most commonly, wholesalers) cannot meet their demands for mushrooms, they go without mushrooms on the menu. This approach contrasts with many institutional operators (49%) who use supermarkets as their secondary source of supply.



The Foodservice Farm Tour Program developed relationships with foodservice operators

## Where to from here?

The project has highlighted that mushrooms are seen by the foodservice sector to be a high-quality ingredient, offering value in several ways. Disappointingly the perception that mushrooms are a seasonal ingredient, combined with a lack of knowledge on how to prepare mushrooms is limiting the wider use among foodservice operators.

On the positive side however, 27% of operators surveyed in this research wanted further training and education on how to use mushrooms in dishes and identified printed information and online tutorials as being preferred methods of learning.

The receptiveness of the foodservice sector to engage with the mushroom industry is promising and opens the opportunity to build on some of the relationships established through the successful Foodservice Farm Tour program (see <http://bit.ly/2Ua2KP9> for further information) conducted during 2017 and 2018.

The completion of this project, combined with other foodservice initiatives, are helping to build a deeper understanding of the requirements and opportunities that exist within the sector.

These deeper key market insights will now allow the development and implementation of a sharply focused, comprehensive foodservice strategy.

20  
20  
CONFERENCE



Australian  
Mushroom  
Growers'  
Association

GROWING

the future, together

Save the date

14 - 17 October 2020

ADELAIDE

# CONFERENCE PLANNING NOW WELL UNDERWAY

It might only be March but now is the time to start getting prepared to be able to attend the upcoming mushroom conference, designed just for the Australian industry. These conferences only take place every two years, with the 2020 event scheduled for Adelaide from 14-17 October 2020 under the theme – Growing the Future – Together.

If you are a grower or someone with interest in the industry, then this conference is for you, with an extensive range of international and Australian speakers already confirmed and more to come

The event is being developed as a service to members and the wider industry, with the conference focusing on critical issues facing the Australian industry. The conference is funded by the AMGA with support from Hort Innovation and other industry sponsors.

Each speaker represents years of experience and to have them accessible at the one event is a real coup for the Australian mushroom industry. The organisers are currently encouraging everyone to mark down the dates and start preparing to attend what should be an extremely valuable event.

The list of speakers includes international compost experts (also covering recycled spent compost and the use of green waste in compost), a representative from the world's largest mushroom farm, a widely acclaimed Professor of Mushrooms, international mushroom consultants, experts in harvesting and food safety and traceability, and local R&D project leaders.

With the industry facing a range of challenges to stay ahead, the conference is directed at providing a strong level of relevant information on how to address these challenges and help drive the industry to a profitable long-term future. The program will also cover reports on levy-based investment in marketing

and research and development, including a range of key projects including pest and disease management.

A multi-stop farm tour will be offered as part of the conference, taking in visits to SA Mushrooms at Virginia and Revitalise Enterprises new compost facility at Port Wakefield. The farm tours will provide delegates with the opportunity to visit state-of-the-art facilities using the latest technology. The proposed motorbike ride from Adelaide to Darwin will now not go ahead, with several logistical challenges preventing it from proceeding.

Registrations for the conference will be open shortly. Updates on the conference programs will be made available through upcoming editions

of the Journal, the Industry Update e-newsletters and special email conference Alerts.

## ACT NOW

Mushroom industry conferences are only held every two years, so take advantage of this chance to hear international experts address key topics of interest. Act now and:

- Check your diary now and block out the dates.
- Talk to your business associates, workers and others who you think may be interested and help spread the news.
- Stay informed by reading updates provided through this Journal, the Industry Update e-newsletter and special email conference Alerts.

Topic	Speaker
Composting	Ger Hendriks - Sylvan - Netherlands
Recycling of compost and casing...Green waste	Dr Ralph Noble - Microbiotech Ltd – United Kingdom
Marketing and 'The Blend'	Bart Minor - Mushroom Council – United States
Food Safety Issues - climate change and increased food safety risks	Anne Marie Arts - MD The Agrichain Centre – New Zealand
Mushroom picking robotics	Roland van Doremale - Project Engineer Christiaens - Netherlands
Manual harvesting of mushrooms	Brigitte Hendrix – Harvesting consultant
Challenges and opportunities of robotization for the mushroom industry	Jack Lemmen – GTL Europe
Peat and alternatives for casing	Julien Boijmans - BVB Netherlands
Wheaten straw alternatives	Kevin Wilkinson - Frontier Ag & Environment
Value added mushroom waste opportunities	Kyle Kessler - Asymmetric Innovation
Phase 2 Composting project update	Dr Michael Kertesz - University of Sydney
Near Infrared Compost Analysis in action	Jaylon Rogers - Revitalise Enterprises
Pest and Disease Management Service – a project update	Dr Warwick Gill & Judy Allan

# **Diptex**

## **Stops Flies**

Diptex provides effective control of flies in mushroom growing rooms, preventing flies from spreading mushroom diseases.

- APVMA approved for control of both Sciarid and Phorid flies
- Specific mode of action that targets fly larvae and does not harm other beneficial organisms
- No Withholding Period

**(02) 9389 8161**  
**sales@agrocare.com.au**

APVMA Approval Number: 67871/101510

# PRODUCTION WASTE PROJECT IDENTIFIES STRONG FINANCIAL RETURNS

The scope of the production waste streams project is to identify operational costs savings and potential revenue from mushroom waste – the disposal of spent mushroom substrate and subprime, edible mushrooms. And according to the Final Report, the project has met this challenge, identifying solutions with the potential to deliver to the industry up to \$55 million in savings or revenue, by using hundreds of thousands of tonnes of waste.

In total the project team, led by Kyle Kessler from Asymmetric Innovation and Scott Needham from Xinova, examined in depth eight separate “solutions”, before recommending four solutions for further development with industry.

The findings represent an exciting opportunity for industry, with the project finding new technologies, partners and strategies to encourage profitable approaches to dealing with current waste products.

## APPROACH TO THE PROBLEM

Considerable work was undertaken through site visits and interviews to define the overall scope of the project, with the project working through the following phases:

- Phase 1 – Discussion with the Mushroom Industry Strategic Investment Advisory Panel to define areas of interest to be considered.
- Phase 2 – Widespread discussion with growers, industry, supply chain participants and technology owners to determine the availability of potential solutions.
- Phase 3 – Analysing input from academics, experts, enterprises and industry to modify the scope and consider solutions against the criteria of desirability, technical feasibility and economic viability.

The solution criteria that emerged from Phase 3 were developed through additional industry engagement, taking into account the unique

characteristics of the Australian mushroom industry.

Not surprisingly, the desirability of individual solutions focused on the ability to deal with large quantities of mushroom industry waste. In terms of feasibility, the various solutions were assessed on the ability to be implemented at commercial scale, using proven equipment, process or practice in a way that requires minimal changes to current industry practices. The viability of each solution was also assessed in terms of the levels of capital and operational expenditure required and the length of time for any investment payback to be achieved.

While some 30 solutions were collected and assessed, the final eight solutions considered are listed below.

1. Recycling SMS (Spent Mushroom Substrate) – recycling SMS back into the production process as either casing or compost.
2. Pelletiser system - Investment in capital equipment for nonthermal dewatering of SMS for on-site energy or off-site sales into energy and fertiliser markets.
3. Anaerobic digester - Investment in capital equipment to process SMS with an available co-input into biogas for on-site energy usage.
4. Mushroom powder - Drying and powderisation of edible mushroom waste into a shelf-stable powder for the high-value food (HVF) market.
5. Exotic mushrooms from SMS - Reusing the compost component of SMS as the primary substrate for cultivation of oyster mushrooms.
6. Insect bioconversion - Feeding SMS and mushroom stems to black soldier fly larvae for bioconversion into animal feed and soil additive.

7. Recycling CO<sub>2</sub> - Replacing the existing CO<sub>2</sub> supplementation of greenhouses and algae farms with CO<sub>2</sub> emitted during the cultivation of mushrooms.

8. Edible shelf-life extender – Edible coating applied to fresh mushrooms to extend shelf life and reduce costs and spoilage.

A full assessment led the project team to recommend just four of the above solutions for further consideration by industry – recycling SMS, pelletiser system, mushroom powder and edible shelf life extender.

This edition of the Journal will detail the case for two of the solutions with the remaining two outlined in the next edition.

## RECYCLING SMS

The study found that casing and compost comprise 40% of costs for Australian growers, a figure that is significant when compared to the estimated 10-15% of costs in Europe. Recycling SMS back into the production process provides the potential to not only reduce the quantity of input materials but also generate high operational costs savings and deliver positive environmental outcomes. [See Business Case - P13.]

SMS can be recycled in three ways:

1. SMS as casing.
2. Casing as casing.
3. Compost as compost.

In undertaking the analysis, mushroom and compost experts across Europe and Australia were consulted to understand best practice standards for recycling SMS. From this point, the project team devised test protocols, analysed academic literature and coordinated the first Australian industrial scale trial for recycling compost back into Phase 2 and 3 composting processes.

## Business Case in Brief

♥ <b>Desirability</b>	■	■	
📄 <b>Feasibility</b>	■	■	■
💰 <b>Viability</b>	■	■	■

### Cost to implement

- SMS as casing: \$60k OpEx per annum
- Casing as casing / Compost as compost: \$260k CapEx for mechanical separator

### Viability ✔ **Viable**

- At current compost and casing prices, all three recycling options for SMS are viable

### Recommendation ✔ **Proceed**

- Recycling SMS as casing is financially viable, but technical feasibility challenges of re-pasteurising the casing, a lack of available materials and environmental and land availability will limit its adoption in Australia
- Recycling casing as casing & compost as compost both represent good business propositions. To gain maximum benefit and reduce CapEx payback period, both options should be initiated simultaneously

## REQUIRED PROCESS CHANGES

For the recycling to work effectively, several process changes are required. To recycle the SMS for use as casing requires a third of the SMS to be kept at or near the facility and placed into piles for further processing and leaching. As part of this process, an additional cookout step is required, and this requires additional space in the growing rooms to re-pasteurise the recycled SMS. In low rainfall areas (below 75cm) mechanical desalination is also required.

To recycle the casing as casing, or compost as compost, first requires separation, ideally through a mechanical casing separator, and the use of Dutch shelf systems for optimal compatibility.

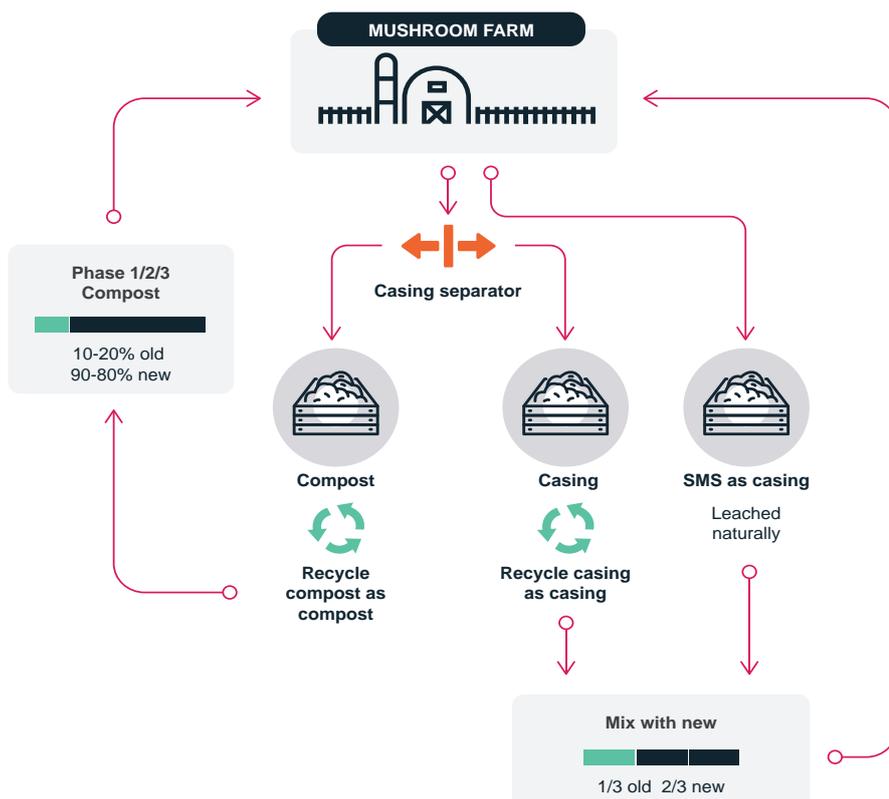
If recycling as casing, space is required for processing, and an additional truck to capture the split casing and compost from the separator. An assessment must also be made of the oxygen uptake rate in the split casing, and if not cooked out in the growing rooms an additional cookout step is required before the recycled casing is re-wet and mixed with fresh casing.

Recycling the compost back for use as compost ideally requires close geographical proximity to the composting facilities. The process of recycling back into Phase 1 of the composting process could be aided by floor tunnel fans to alleviate density issues, while Phase 2 requires an additional resting period to allow the mycelium to overtake the blocks. An additional consideration is the increased labour required to manage the processes such as separating the streams to manage recycled compost versus 100% fresh compost. [A simplified explanation of the three processes involved is shown below left.]

## RATIONALE AND CHALLENGES

### SMS as Casing

The background to recycling SMS for use as casing stems from a restricted supply of peat from Europe, combined with the substantial increase in the costs for compost and casing. Both issues are unlikely to improve, with overall costs likely to continue to rise.



The positive aspect of this recycling is that the re-use of SMS has been widely investigated by researchers such as Joe Poppiti from Creekside Mushrooms and Dr John Burden. The fact that SMS casing can accept and hold sufficient water for high flushes - although care is required when watering the crop - is also a positive aspect of this approach.

Despite this, several challenges must be considered in the Australian context. The first of these challenges is that there are no existing stores of aerobically digested SMS available to be tested on Australian farms. It should also be noted that previous success (such as Creekside Mushrooms) was achieved under different operating conditions, with a different substrate that may not be able to be replicated in Australia. Challenges also exist around the fact that leaching is required, which in low rainfall areas could be problematic. If adopted, this could also present environmental issues over the longer term.

### Casing as Casing

The use of financial models has shown the recycling of casing for use as the casing is financially viable, even given the added expense of a mechanical separator.

This form of recycling has been demonstrated successfully, with trials conducted by CNC Grondstoffen (Netherlands) reporting no variance in yield with the use of up to 40% mixed casing. The use of recycled cooked-out casing used at 25% was shown to have no overall effect on mushroom yield according to the report of the trial.

### Phase 3 Recycled SMS Trial\*

Type	Flush 1	Flush 2	Flush 3	Performance
10%	10.46kg	13.36kg	5.32kg	+2.35%
20%	12.32kg	12.47kg	3.7kg	+1.1%
Control	10.37kg	12.8kg	5.29kg	----

\*All results per square metre - m<sup>2</sup>

While the demonstrations have been successful, an immediate challenge for any farm implementing this approach is one of cost, with casing separators requiring capital investment. There is also an additional issue of biosecurity risk as sterile materials with dead mycelium acts as a breeding ground for bacteria in the fresh casing.

### Compost as Compost

A significant driver for considering the option of using recycled compost as compost is the fact that current research into alternative ingredients is progressing slowly with no practical alternatives yet identified.

Encouragingly a study conducted by Ralph Noble and researchers at Penn State University found no significant effect on mushroom yield or quality when spent compost replaced 33% of the wheat straw and poultry manure in the compost formulation. As part of this project, an industrial scale field trial recycling compost into Phase 2 and Phase 3 blocks was undertaken over 2.5 months in collaboration

with Scatoplus and Parwan Valley Mushrooms. The results of the trials are shown below.

### Recycling directly into Phase 3 blocks

- The mycelium initially grew slower in the substrate with 10% and 20% recycled ratios; however, this slower mycelium growth did not affect first yield breaks.
- This room had a below-average first break but a very large second break, in both trial windows and the rest of the room.
- Across all three flushes, 10% recycled substrate outperformed the control and 20% recycled groups – vastly outperforming the control in flush two.
- The yield differences between the control and 20% recycled substrate were negligible. For producers growing only two flushes, 20% recycle ratio could be recommended as this group outperformed the 10% recycle ratio and the control through two flushes.
- It is possible that increased density of recycled groups mitigated the yield drops from lower temperatures during growing.

### Recycling into Phase 2 blocks

- Unlike recycling to Phase 3 blocks, first breaks of both the 10% and 20% recycled ratios underperformed in comparison to the control.

### Phase 2 Recycled SMS Trial\*

Type	Flush 1	Flush 2	Flush 3	Performance
10%	11.15kg	12.46kg	4.3kg	-10.8%
20%	8.31kg	13.02kg	5.49kg	-7.1%
Control	12.48kg	11.62kg	4.77kg	----

\*All results per square metre - m<sup>2</sup>

Assumptions	
SMS sales	\$5/t
Wheaten straw	\$150/t
Casing	\$400/t
Scale pw	30t

Casing as casing (33% rec.)	
CapEx	\$150k
OpEx p.a.	\$85k
Net Savings p.a.	\$60k
Payback	2.5y

SMS as Casing	
CapEx	\$0
OpEx p.a.	\$60k
Net Savings p.a.	\$60k
Payback	0y

Compost as compost (20% rec.)	
CapEx	\$150k
OpEx p.a.	\$85k
Net Savings p.a.	\$238k
Payback	0.6y

The overall viability is reduced because casing represents a small percentage of the total cost when compared with compost.

The project also found it is financially viable to recycle compost as compost. At current wheaten straw prices, it is financially viable to recycle 10 to 20% of compost with mechanical separation.

The report suggests this approach requires \$150K in initial capital expenditure, with an additional \$85K per annum in operational expenditure. This solution is viable for growers who make compost on-site, or at a distance that does not increase the overall cost.

A breakdown on the viability is provided above. The table provides an assessment based on current wheaten straw and casing prizes in the Australian mushroom industry. The report suggests that Australian growers proceed to site-specific trials at their facilities using the expertise gathered as part of this project. The recommendations include:

- Recycling SMS as casing - engage an advocate grower to create 3-4 small piles of SMS to be turned regularly and assessed over 12 months.
- Recycling casing as casing - conduct a trial using manually separated casing to confirm results from academic literature before engaging with casing separator manufacturers.
- Recycling compost as compost - conduct an additional industrial trial of recycling compost for compost to confirm the results at a larger scale and/or for Phase 1 of the composting process.

- The third break yield was the highest in the 20% recycled ratio, suggesting the recycled SMS could add volume to later yields.
- The bio efficiency of fresh compost to kg of mushrooms was essentially neutral for the 10% recycled ratio and improved for the group using 20% recycled ratio.
- If the difference in the value of the straw versus the SMS compensated for the small expected yield, this practice could be a breakeven proposition, improving when mushroom prices are low.
- Results from both trials suggest that filling normal dry weights and adding extra SMS as compost could improve supplemental yield values.

SMS as the casing is somewhat hampered by the current lack of naturally weathered SMS and the feasibility challenges of continual management and re-pasteurisation. For this reason, combining the recycling options of compost and casing provides the best opportunity for rapid payback.

The adoption of either or both of these options will require further trials to weigh the cost reductions against decreases in yield and quality. Recycling SMS as casing has the lowest capital expenditure as a casing separator is not required. It also has the lowest level of operational expenditure [\$60K per annum], with the payback period limited only by the energy and personnel costs required for the re-pasteurisation of the material.

If recycling casing as casing, it is financially viable, at current peat costs, to recycle 33% of the casing using mechanical separation. This viability increases by using naturally leached SMS as casing, as this approach decreases initial capital investment. An analysis of this approach suggests it requires a capital expenditure of \$150K and operational expenditure of \$85K per annum - both of which link to the requirement for a casing separator.

## RECYCLING VIABILITY

The report outlines that recycling SMS back into the production process is one of the few solutions where viability is not driven by the size of the grower or the current sale price of SMS.

It suggests that while all options are financially viable solutions, recycling

## MUSHROOM POWDER

Another opportunity identified through the project is that of mushroom powder. The focus for this is on using “subprime” mushrooms (including stems) to make powders used in a variety of high-value foods (HVF).

From a grower perspective participation could be undertaken in several ways, either by supplying raw product to powder manufacturers or through investing in infrastructure and value chain relationships to establish successful product commercialisation.

The use of subprime mushrooms for powders would potentially provide growers with a new business income stream at the same time as developing product diversity in an area away from the fresh mushroom market. Target markets for mushroom powder include high margin supplements or for use as a food ingredient in a range of high-value products.

To examine the potential of this production waste stream, the project team worked with SJW Mushrooms, who provided over 100kg of subprime product for powdering. Once powdered, this product was analysed by nutritionists and food manufacturers, and work undertaken with companies operating in the natural supplement space to explore business models.

The process highlighted the technical feasibility of creating a powder with enhanced nutritional values - the powder is high in fibre, beta-glucan, proteins, polyunsaturated fats, copper and selenium minerals.

### WHY MUSHROOM POWDER?

Developing powdered mushrooms would provide access to the high margin supplement and meat replacement markets. Turning waste product into powder extends shelflife, concentrates nutrients and provides flexibility in the way the end product can be marketed and used by food manufacturers and consumers.

From an industry perspective, this approach would remove more than 7000 tonnes of waste per year, turning it into a shelf-stable

## Business Case in Brief



**Desirability**



**Feasibility**



**Viability**

### Cost to implement

- Toll manufacturing - +\$0.98/kg of fresh mushrooms (including harvesting and processing costs).
- Collaborative venture- \$100k-150k CapEx investment.

**Viability**



**Viable**

- Feedback from experts and food manufacturers indicates that a viable price per kg of powder is achievable - including the increased harvesting and production costs

**Recommendation**



**Proceed**

- **Low/Moderate risk** - invest and build capability in selected tasks required for successful product commercialisation, e.g. toll manufacturing. (Partner in the value chain).
- **High risk** - invest and build capability and/or relationships that provide the grower with end-to-end product development, supply and distribution. (Own the value chain)

product that aligns with the existing mushroom marketing [tasty, easy and healthy] and has ten times the nutrition of fresh mushrooms by weight.

The report suggests that low-cost toll manufacturing - a practice where a company with specialised equipment processes raw materials or unfinished goods for a different company - is readily available in Australia. Undertaking this approach would allow the industry to follow a process that it is already being used by producers of other fruit and vegetable products to move up the product value chain.

From a value standpoint, an analysis of fruit and vegetable powders

already on the retail market highlights a median price of \$97 per kilogram. This value, combined with an expected annual growth rate in the supplement market of 7.2%, reinforces the statement of one powder manufacturer who said: “commodity foods make cents, supplements make dollars”.

The report has identified that the biggest opportunities exist in the lifestyle area, putting forward examples including protein supplements for muscle development and weight loss and specific nutrients or bioactive compounds that have been shown to address human disease or disease risk factors. It also highlights that global meat alternatives are increasing, with sales

expected to reach over \$200 billion in the next ten years and with large multinational companies already seeking out opportunity within this space.

An example of the versatility of the mushroom as a highly valued, and nutrient-dense product can be seen in the fact that Mars Australia recently invested in companies that are currently transforming imported mushroom stems into meat alternatives.

### REQUIRED PROCESS CHANGES

The process to turn waste into mushroom powder is relatively simple. "Sub-prime" mushrooms, including stems, are collected during harvesting, with this "waste" processed through low-temperature drying and powdering equipment. This processing converts mushrooms to powder at a ratio of approximately 19 kg of fresh mushrooms to 1 kg of powder.

The two options for growers to participate are through a toll manufacturing agreement or collaborative ventures.

Processing the powder through a toll manufacturing agreement would allow the product to either be returned to the grower, who would then manage sales, or distributed as a product within the toll manufacturers existing brand and supply chain. One potential benefit of this approach is that it requires no additional capital

expenditure on the part of the mushroom grower.

A second option is that growers may seek to invest in processing equipment through a collaborative venture with other growers, food manufacturers or other interested parties. The disadvantage of this approach is that some capital expenditure is required to initiate the venture, although this could be offset by co-investment with nearby mushroom growers or other fruit and vegetable growers.

In terms of on-farm process, both approaches require refrigerated storage for the product before transport to the processing facility. If the powder is returned to the grower, this will also require storage, with investment in branding, packaging and distribution required in addition to the establishment of relationships with manufacturers, retailers and end-product users.

Production through a partnership or collaborative venture would require additional investment in equipment and the coordination of processing [including location] among any industry participants, including labour force management and training on the powderisation equipment.

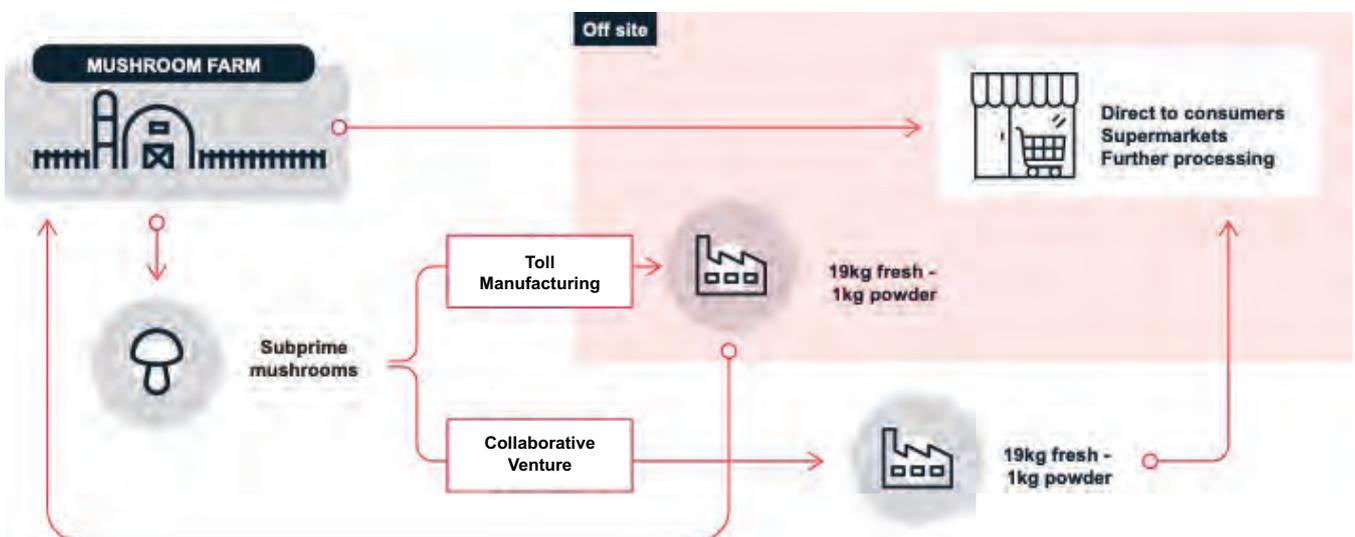
The report has identified some risks and challenges for the industry to invest in the production of mushroom powder. It warns that the first mover in this space faces potential financial losses, although it highlights that it has identified over five potential

partners willing to work with the mushroom industry in this area of activity. Some of the additional identified risks and challenges include:

- The necessity for clean stems is likely to require double cutting, which decreases harvesting efficiency increases in labour costs.
- Without correct refrigerated storage, stems have a shelf life of 2-4 days.
- The need to refine product positioning and marketing potential and the exposure to competition risks during the product development stage.
- The dependence on the scale of production to achieve payoff for investment in processing capability.
- Increased regulatory hurdles for producing a finished food product.
- Relationship management to coordinate production between competitors in the Australian fresh mushroom industry.

### PRODUCT POSSIBILITIES

A range of product possibilities exist including snacks, bulk powders and supplements; however, the ultimate choice is dependent on the distribution channel and the margins that can be captured by the mushroom grower.



The business to business distribution channel facilitates retail distribution and product development and lowers potential marketing costs. Countering this is the difficulty in convincing large players to use the product and the risk of commoditising the mushroom powder. It is also likely that tighter margins would eliminate the viability of low price point snack foods which would require further processing.

The business to consumer model offers additional value back to the grower or growers, who can manage the production timeline and expand the opportunity to create and build value in the brand.

The downsides of this approach, however, include increased capital and operational expenditures to run the manufacturing, packaging, branding distribution and sales of the product. There is also likely to be increased regulatory hurdles selling finished food products to consumers and the challenges of dealing directly with retailers.

## PRODUCT VIABILITY

The report provides an analysis based upon interviews with food manufacturing experts and business owners, research on capital expenditure for equipment, and input from the mushroom industry. This analysis provides a further understanding of the minimum price required to achieve payback and justify changes to current practices. In terms of financial viability, the report suggests there is less financial risk with toll manufacturing as the process can be done cheaply, allowing the grower time to understand the market demand for the product.

There is, however, less price control over the final product, with viability depending on the growers' existing operations, the agreement with the toll manufacturer, the choice of powder product and the market.

The viability of a collaborative venture depends on the production agreement between growers and the powder product chosen.

The report indicates that business to consumer sales through the structure of a collaborative venture is the most viable option; however, it must use effective partnerships to assist in developing the business case. If such an operation were established and running viably, it would present the opportunity for smaller growers to sell their edible waste to powder producers. A breakdown on the viability is provided below (left).

The report suggests that risk-averse growers start with small scale toll manufacturing and risk-tolerant growers pursue collaborative ventures with partners identified through this project.

The recommendations include:

- Aligning interested growers within regions to form alliances.
- Determining venture models and partner capability requirements.
- Engaging in product development within alliances and establishing consumer price points.
- Commence developing brand and marketing strategies.

### Processing through toll manufacturing

Break-even powder sale price for toll manufacturing, \$/kg	<b>\$18.75</b>
Production Cost, \$/kg powder	\$4.50
Break-even powder sale price received by grower, \$/kg	<b>\$14.25</b>

### Production through collaborative venture or partnership\*

The price points below represent the minimum price a mushroom grower would need to receive **per kg of powder** in order to achieve a payback in less than 5 years - this assumes an investment into production of approximately \$100k

<b>100t Mushrooms / week</b>	Price Point per kg	\$18.4
<b>50t Mushrooms / week</b>	Price Point per kg	\$20.4
<b>20t Mushrooms / week</b>	Price Point per kg	\$24.3
<b>10t Mushrooms / week</b>	Price Point per kg	\$36.5

\*Assumes the grower allocates 100% of their stems to powder production and investment into the collaborative venture is \$95k + \$50k OpEx p.a.

## NEXT EDITION

The next edition of the Journal will detail the case for the remaining two solutions - pelletiser system, and edible shelf-life extender - outlined in the report. Industry participants requiring further information are encouraged to read the full report which is available from the mushroom industry section of the Hort Innovation website (<https://horticulture.com.au/grower-focus/mushroom/>).

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# GLOBAL AGRI-TECH OPPORTUNITIES IDENTIFIED

A scoping of global agri-technology opportunities has identified and recommended ten priority solutions for further consideration by the Australian mushroom industry.

The technology search focused on addressing core industry pain points related to input control and costs, staff training, harvesting processes, quality grading and waste. The solutions identified range from drip irrigation, monitoring sensors, autonomous agriculture approaches including artificial intelligence and robotics, automated harvesting, shelving systems, harvesting guides, shelf life indicators, wearable smart glasses, and a mixed reality headset that provides real-time access to work processes and training.

The levy-funded project, undertaken by international professional services firm KPMG, provides insights into the current global landscape of agri-technology solutions being used, or with the potential of being used, in mushroom production.

As reported in a previous article, project leader, Ben van Delden, KPMG's Lead Partner for Agri-food Tech detailed the purpose of the project as understanding global emerging agri-tech innovations and how they relate to the mushroom industry.

He said the project examined available technologies and the broader environment and detailed new insights where opportunities for innovation are greatest, rather than

repeating what growers already know. The following provides a summary of the findings of the project. Further details are available in the Final Report that will be made available on the Hort Innovation website (<https://horticulture.com.au/grower-focus/mushroom/>).

## PROJECT BACKGROUND

The final report suggests the mushroom industry is currently experiencing a period of increased access to digital and technological innovation with a range of agri-technologies emerging with the potential to optimise grower outcomes throughout the mushroom industry supply chain. Tapping into improved technology and innovation would allow the industry to meet some of its current challenges such as lowering costs (labour efficiency, waste, energy), increasing yields (improving substrate quality, growth monitoring, selective harvesting and climate and airflow technology) and improving product quality through fit for purpose technology solutions. The project examined leading agri-technology markets and relevant sectors across the following key priority areas along the supply chain:

- Input supply - chemicals and supplies, input volumes required, composting process.
- Production - airflow, temperature, humidity, labour, harvesting, disposing of waste, training & service.
- Post-harvest - handling (food safety), packaging and labelling, traceability/provenance.

- Post-harvest - handling (food safety), packaging and labelling, traceability/provenance.

Following discussion with the Mushroom Strategic Investment Advisory Panel (SIAP), the project team focused on the upstream stages of the supply chain, and three international markets (China, Japan and Western Europe), taking into account activities across three core sectors (mushrooms, protected horticulture, aviation/aerospace).

## A DETAILED APPROACH

The research for the project was undertaken using a stepped and collaborative approach involving a detailed consultation with mushroom growers and international experts.

The first step in the process was to work with the SIAP and Steering Committee members to determine the scope, core assessment criteria and key priority areas.

The seven core criteria for the assessment of identified technologies were:

1. Has the potential to cut input or production costs.
2. Has the potential to value add/ increase the quality of the product.
3. Has the potential to increase the yield (quantity).
4. Limited capital investment required.

## Key priority areas along the supply chain



5. Low-level training skillset required.
6. Acceptable time frame for adoption.
7. Targeted average ROI within 3-5 years.

Further consultation, including phone interviews and site inspections, led to the identification of key challenges across the supply chain.

The subsequent international market assessment examined potential technology solutions to address the identified pain points and opportunities with a focus on delivering the outcome of a more profitable and sustainable Australian mushroom industry.

The pain points identified during this process as being in scope included:

- Input control and cost - the reduction of costs such as water usage, energy and compost.
- Training staff - mushroom production requires a high level of labour with farms often subject to high staff turnover and training difficulties to optimise efficiency.
- Harvesting process - the harvesting process currently has little automation or technology input, relying on staff judgement to maximise picking efficiencies.
- Quality grading - mushroom quality grading is a manual process relying on appropriate training to undertake the task effectively.
- Waste - food waste is seen as a big issue with solutions required to not only extend the shelf life of mushrooms but also to maximise the use of spent compost.

## POTENTIAL SOLUTIONS

Once these priority areas were identified, the project then moved to the next phase with a process of comprehensive desktop research to look at potential solutions.

This process included patent searching, academic journals,

global databases and insights from international networks. From an overall list of over 150 innovative technologies, 31 were selected for further assessment based on the core criteria, with ten agri-tech solutions recommended to progress to a final stage of assessment and consideration.

The top ten solutions (see inset box)

all scored highly on the established core criteria list and are currently either in use in the mushroom industry globally or could be transferable from other food sectors. Importantly the project team found the solutions have the potential to address identified challenges, with reasonable costs and a highly likely return on investment of between three to five years.

## Prioritised Technologies

The ten technologies that were prioritised for further scoping and progression by the industry, met 5+ core criteria, are interested in Australian opportunities and have a TRL [technology readiness level] of 6+. These included:

1. Mushroom Master by Netafim – Applies drip irrigation through pipes laid within the casings enabling consistent and optimal moisture to the growing substrates.
2. Profarm - monitoring sensors are installed across the soil, power/electricity, lighting, temperature, irrigation and other input systems. Data is collected with real-time tracking and insights of growing conditions provided to the grower.
3. Senseair CO<sup>2</sup> sensors - Measures CO<sup>2</sup> levels with sensors and complementary systems enable tailoring of levels for optimal mushroom growing conditions.
4. Autonomous agriculture – System that integrates sensors, cameras, data collection, artificial intelligence and robotics to provide analysis on size, colour, disease/defects, and automate precise picking, sorting and packing.
5. Automated mushroom harvester - Automated harvesting system applying decision support, computer vision and suction picking. Vineland Research and Innovation Centre is pursuing commercialisation pathways for the technology.
6. Van den Top Zig Zag shelving and harvesting machine - Zig Zag shelving that creates space for easier manual picking and access for mechanical harvesting. Van den Top also has also harvesting machines that can be integrated with the shelving.
7. Smart Harvest - a smart visualisation system that guides manual harvesting through projecting colours onto the mushroom bed providing picking recommendations. Mobile tray systems are required for the visualisation tool.
8. Keep-it® shelf life indicator - A real time shelf life indicator showing the actual degradation of packaged fresh food products based on time and temperature. The indicator constantly monitors temperature over time and so provides insight on cold chain storage and logistics as well as a more accurate expiry date for consumers.
9. Google Glass Enterprise 2 - Wearable smart glasses enable faster, smarter and safer businesses with improved quality of outputs. With customised application, there is the potential to reduce cost of manual labour through real time access to instructions, visualisation tools for grading and harvest readiness, and access to checklists.
10. Microsoft HoloLens2 – Mixed reality headset that provides hands-on workers with virtual reality applications for collaboration, real-time access to work processes, 3D visualisation, and training.

More detailed information on the prioritised ten solutions and a further 21 technologies of interest is provided within the project report.

This detail includes the background of each solution, an explanation of the technology, its relevance for Australian mushroom growers and an assessment of the technology against the core criteria. Links are also provided to external sources of information

such as websites, videos and images – all of which builds on the assessment as to how the technology could potentially apply within the individual farm environment.

As outlined below, the report has also proposed a pathway through which the Australian mushroom industry can engage with and implement the technology to drive growth in the sector.



The project identified a roadmap for industry to consider in order to progress the 10 priority technologies

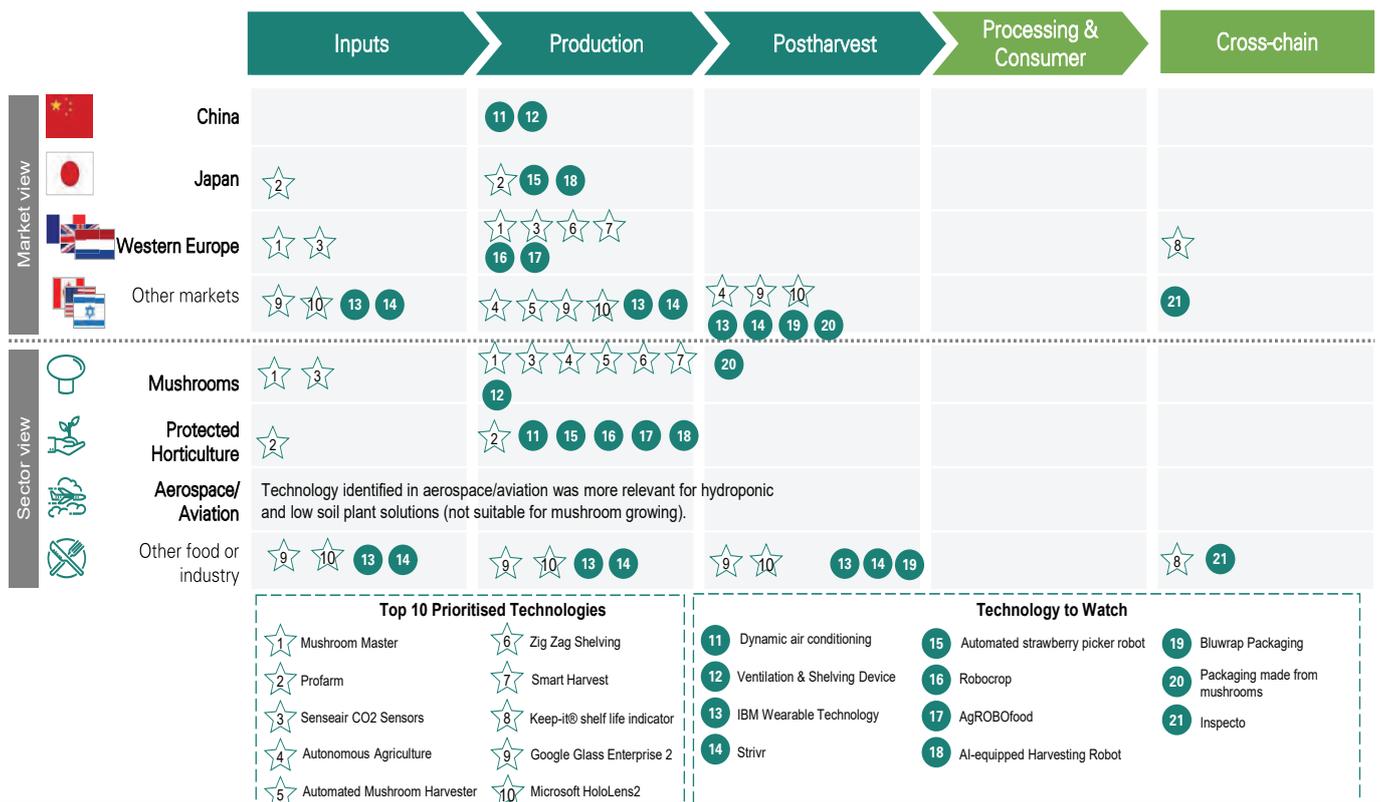
The research has also identified some lower priority technologies that could be considered to be of interest and has classified them as “technology to watch”. While these technologies are typically in the early stages of market and technology readiness, with many requiring adaptation from another sector or industry, they have been assessed similarly with their profiles provided in the report.

**NEXT STEPS**

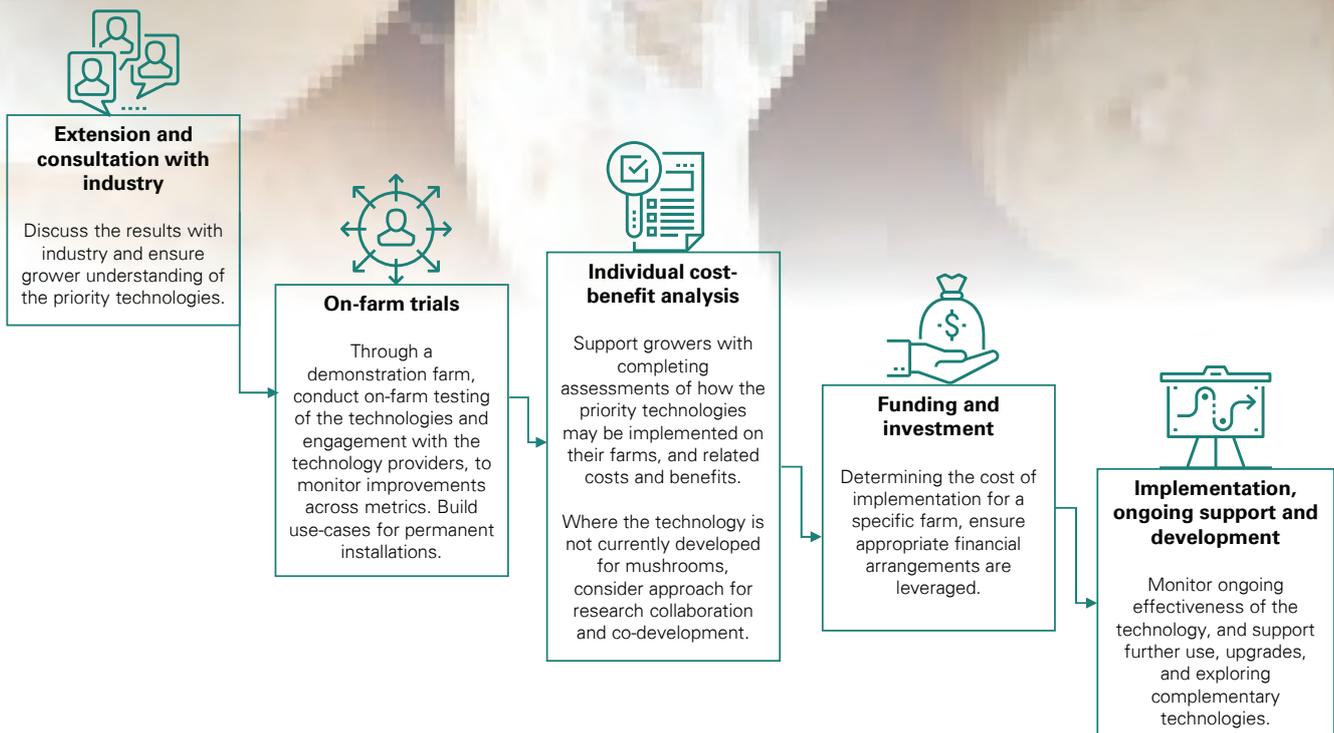
The findings have been presented to the SIAP. In addition to the information provided in this story, a more detailed report will be made available on the Hort Innovation website.

Several key steps have been identified for the industry and Hort Innovation

The technologies explored were mapped out according to their origin and sector, and where in the supply chain is impacted.



# Suggested roadmap to progress the priority technologies



to follow to progress commercial use of the technology in the sector. These steps are shown in the roadmap (see above) and include extension in consultation with industry; on-farm trials; individual cost-benefit analysis; funding and investment; and implementation, ongoing support and development.

Across these next steps, it is suggested several activities should be undertaken by Hort Innovation and industry to extend the outcomes of the study and support the successful implantation of priority technologies. These activities include funding on-farm trials of the technologies to pilot the technology, promote expertise, and develop the basis for further use across industry. The use of technology open days is also put forward for consideration with the suggestion the technology could be taken to the main growing regions for practical demonstrations or virtual reality insights and with explanations provided from technical experts.

It is also suggested the Australian industry could expand networks with international technologies applied to mushrooms and parallel industries to enable future technology to be more easily transferred and/or co-developed for the Australian mushroom industry.

Where technology has been successfully implemented in the Australian context it is recommended that an approach be developed to actively showcase these examples to demonstrate the relevance to other growers.

For more information, please read the Final Report which is available through the Hort Innovation website [<https://horticulture.com.au/grower-focus/mushroom/>].

## FURTHER INFORMATION:

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# NEMATODES: A FLY-IN-FLY-OUT PEST OF MUSHROOM CROPS

*Warwick Gill*

Tasmanian Institute of Agriculture  
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## SUMMARY

Long distance dispersal of nematodes occurs by a process called 'phoresy', the transport of a small animal by a larger animal. In mushroom grow rooms, nematodes attach to Sciarid flies and are transported to fresh mushroom beds to establish new colonies and new infections. This is further evidence demonstrating why effective fly control is highly significant in successful management of mushroom diseases and pests.

## INTRODUCTION

Nematodes are invertebrate pests of mushroom culture that affect the yield and quality of the crop. Saprophytic nematodes feed on the bacteria and moulds which are often associated with a non-selective compost resulting from inefficient Phase II. As communities of

nematodes approach their population thresholds, they deplete the local food source and foul the area with waste products and toxins making it uninhabitable. To survive, they must disperse to a new favourable environment with an abundant food source and establish a new colony. Nematodes are essentially small aquatic animals incapable of long-distance dispersal. In the mushroom grow room they may spread by incidental means such as water splash, attaching to harvesters' gloves and tools or being dropped onto the floor in disturbed casing or on mushroom debris.

They may also form a resting state if the environment becomes too dry and they will be dispersed by air currents. But these incidental methods are very haphazard and, particularly on a farm that practices good grow room hygiene, the chances of the nematode finding suitable conditions to establish a new population are not great. Furthermore, these dispersal mechanisms may only be effective if the population is large enough to withstand the high proportion of

losses sustained.

Flies are recognised as a significant vector of mushroom diseases. They carry spores of pathogenic fungi and weed moulds from grow room to grow room on their legs and body to infect mushrooms and mushroom beds. But less well-known is their ability to carry nematodes from areas of overcrowding and depleted food supply to fresh areas of mushroom bed where the nematodes can establish a new population on an abundant food source.

Because flies inhabit the same environment as nematodes, are highly mobile over relatively long distances and can access all parts of the mushroom farm, the chances of being transported to a favourable environment containing an abundant food source are very much higher. This transportation of nematodes by flies is called 'phoresy'.

## PHORESIS DEFINED

Phoresis is a form of temporary symbiosis found throughout the animal kingdom in which a small individual, the phoront, is transported by a larger organism, the carrier, to new habitats which are favourable for reproduction for the phoront and/or its offspring.

The association may be quite loose so that the phoront can attach to any carrier in a time of need, or it may be a specific relationship determined by chemical, behavioural or physical cues that define a specific carrier.

Therefore, one carrier may host numerous phoront species while a single phoront may have a range of carriers to choose from. Moreover, phoresis may be driven by migratory impulses irrespective of the state of the habitat, or it may happen because of the population size and local environmental conditions.



Figure 1 *Caenorhabditis elegans*. Bar = 0.1mm. Photograph: Bob Goldstein, UNC Chapel Hill

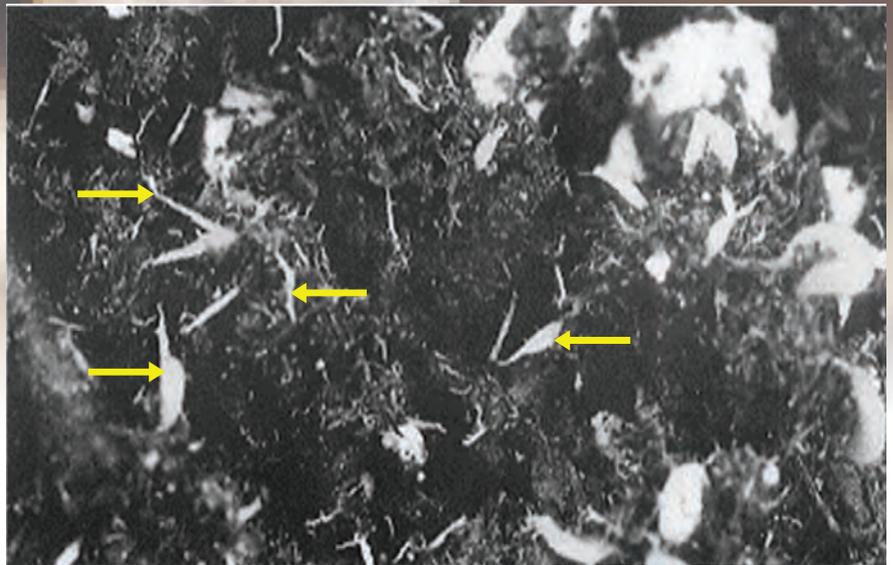
## CAENORHABDITIS ELEGANS AND PHORESY

*Caenorhabditis elegans* is a saprophytic nematode often occurring in Australian mushroom cultivation systems, which feeds on small particles of dead organic material and bacteria within casing and compost. When it occurs in high numbers, *C. elegans* is associated with yield loss and reduction in mycelial growth although the nematode does not directly feed on mushrooms or mushroom mycelium.

Populations of *C. elegans* may establish both in water-logged casing, often the result of an imperfect pre-wet, and in overly-wet compost which has undergone an insufficient peak heat resulting in poor mycelial growth. In both cases, bacteria flourish in the wet environment, providing food for the nematodes. Nematodes can multiply very rapidly – population increasing one hundred-fold in 3 days – because of their ‘virgin birth’ (parthenogenesis) in which an embryo can develop and grow without requiring fertilization. Their existence is dependent upon a localised food source such as a bacterial bloom around a decaying organic particle. But once that food source is exhausted, nematodes have little chance of successfully colonizing new and fertile substrates.

But like many nematode species, *C. elegans* has developed a phoretic association and in mushroom cultivation, with sciarids (*Lycoriella* spp.) in particular. In response to adverse environmental conditions and/or scarcity of available food, the nematode enters a non-feeding, non-ageing, developmentally arrested survival stage, called the ‘dauer’ larva, [derived from the German word ‘dauern’ which translates as ‘to endure’] which protects the nematode from adverse conditions.

Once conditions improve, the nematode emerges from the dauer stage and resumes normal development to reproductive adulthood. It is while in the dauer stage that *C. elegans* is phoretic and undergoes long-distance dispersal. The dauer larvae swarm to a high point of the casing and stand on their tails rhythmically curling and flexing; a movement called ‘nictation’ [Fig. 2]. It is presumed that climbing to a



**Figure 2** Nictating columns of *C. elegans* dauer larvae on the casing surface (some arrowed). The glistening casing surface indicates the presence of free water and very wet conditions. Photograph: Grewal & Richardson (1981)

high point and nictation increases the chance of contact with a fly as it moves over the casing surface. This is also when the massed nematodes become visible to the grower as they glisten in the beam of a flashlight while they are nictating or ‘winking’.

### CONCLUSION

Nematodes can be dispersed around a mushroom farm in a number of ways associated with standard cultivation practices, but there is no guarantee that the nematode will find a suitable location to pioneer and establish a new infestation. Furthermore, a basic level of farm sanitation would prevent successful dispersal of nematodes by these methods.

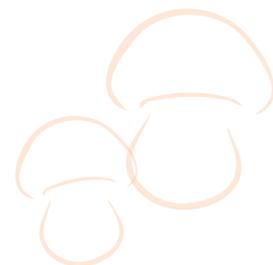
On the other hand, the phoretic association with Sciarid flies ensures that, because the flies are attracted to mushroom compost, phoretic dauer larvae will be delivered to a fresh mushroom bed offering the environment and food supply they require to develop into adulthood and reach reproductive maturity. The key for successful mushroom disease control is to prevent the spread of the pathogen.

In addition to running a drier environment so as to not favour the nematode, a significant step in achieving this aim is fly eradication [refer to *Mushroom Pest and Disease Fact Sheet #2*, accessible on AGORA] which is a crucial component of any rigorous farm hygiene scheme. Likewise, to prevent nematodes from

migrating from room to room and mushroom bed to mushroom bed, it is critical that flies are controlled to prevent phoretic dispersal.

And of course, it goes without saying, hygiene, hygiene, hygiene.

The aim of this article is to introduce an aspect of nematode biology, phoresy, that many growers may not be aware of. Subsequent journal articles will look at the biology, pathology and management of nematode infestations in more depth.



### FURTHER INFORMATION:

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## KEY READING

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## MU16003 - Pest and Disease Management and Research Services



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AGRICULTURE

**Hort Innovation**  
Strategic levy investment

**MUSHROOM FUND**

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](http://horticulture.com.au)

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# CONSIDERATIONS WHEN SELECTING INSECTICIDE

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 Pest and Disease Management  
 Service

## GROWERS' SUMMARY

Effective fly control is dependent on an accurate identification of the target and the selection and correct application of the most appropriate product. There are many products which are APVMA-registered or have a permitted use pattern for activity against flies, but some treatments are species-specific and some target a certain stage of the fly's life cycle. The systematic approach described in the below example will not only help navigate the myriad products available and to select the most appropriate but to select the most economical and the most effective.

- Identify what the flies are. Phorids or Sciarids are the most common seen flying around in

mushroom growing sheds. Adult Cecids are rarely seen, they are normally spotted as larvae on the underside of affected mushrooms.

- Decide if the adult or larvae are to be targeted.
- Determine which chemical groups are active against the target and life cycle stage.
- Decide which formulation is best for the application – casing drench, casing additive, dust, spray, or compost additive.
- Assess the products with the chosen formulation and chemical group by comparing application rates and concentration of active ingredients using the information available from labels, SDS, product leaflets and factsheets supplied on manufacturers' websites.
- Contact the agrochemical supplier to determine cost and availability.

Then select the product that will best fit the on-farm situation and be most economical. Remember that the application of a pesticide alone to manage flies will not be successful

in the long-term. Chemical controls are just part of a farm's integrated pest management strategy and their success depends on effective exclusion and farm hygiene.

## IDENTIFY THE TARGET

Selecting the most appropriate product is a critical step in achieving successful pest management and to do this effectively, it is important to identify the target correctly. This can be done by scanning yellow sticky traps or the contents of electronic fly zapper collection trays with a digital microscope [Gill 2019]. If the majority of trapped or zapped flies are, for example, Sciarids, the control strategy should initially focus on knocking down adult flies to prevent them laying any further eggs particularly at filling and casing [Allan 2017].

## NARROW THE SEARCH

Once the target has been determined, the next step is to identify the registered products that are active against adult Sciarids. A search of the APVMA PubCRIS portal [portal.apvma.gov.au/pubcris] by inserting the search words 'flies mushrooms' in the search field produces a list of 44

### Product list (44 results)

Showing 44 results.

Items per Page 75 Page 1 of 1 First Previous Next Last

No.	Name	Product type	Status	Actives	Has protected	Details
59945	GARDEN PRO ANT KILLER	HOUSEHOLD INSECTICIDE	Registered	PERMETHRIN (25:75:CIS:TRANS)		<a href="#">View details</a> <a href="#">View label</a>
59707	FARMOZ DIAZOL 800 INSECTICIDE	INSECTICIDE	Registered	DIAZINON		<a href="#">View details</a> <a href="#">View label</a>
59005	PERMETHOR INSECTICIDAL DUST	INSECTICIDE	Registered	PERMETHRIN		<a href="#">View details</a> <a href="#">View label</a>
55091	COUNTRY PERMETHRIN 25:75 INSECTICIDAL DUSTING POWDER INDUSTRIAL STRENGTH	INSECTICIDE	Registered	PERMETHRIN (25:75:CIS:TRANS)		<a href="#">View details</a> <a href="#">View label</a>
53794	DAVID GRAY'S PERMETHRIN ANT DUST	INSECTICIDE	Registered	PERMETHRIN (25:75:CIS:TRANS)		<a href="#">View details</a> <a href="#">View label</a>
52336	DRAGNET DUST INSECTICIDAL POWDER INDUSTRIAL STRENGTH	INSECTICIDE	Registered	PERMETHRIN (40:60:CIS:TRANS)		<a href="#">View details</a> <a href="#">View label</a>
50007	BARMAC DIAZINON INSECTICIDE	INSECTICIDE	Registered	DIAZINON		<a href="#">View details</a> <a href="#">View label</a>

Figure 1 Screen shot of part of the PubCRIS search results

registered or permitted insecticides active against flies, as shown in the screen capture of an excerpt of the results table below. Not all 44 listed products are appropriate for knockdown of Sciarid adults, so each chemical group must be examined to find out which ones are active against adult Sciarids.

To help with this process, the AMGA has commissioned the MU16003 Project Team to formulate a summary table containing information extracted from the labels of registered and permitted products which lists and compares the range of activity of each chemical group [Table 1].

The table shows there are three

registered chemical groups [bendiocarb, permethrin and pyrethrin] and two permitted products [Pyzap and bioresmethrin] active against adult Sciarids.

Bendiocarb can only be applied to external walls so is not appropriate for the knockdown of flies inside a grow room. The remaining possibilities can then be separated into insecticidal room sprays [pyrethrin, Pyzap and bioresmethrin] and insecticidal dusts [permethrin].

Both sprays and dusts are effective at immediate knockdown of flies on the wing as both rely on contact to kill, but there are some differences that need to be considered in your selection.

Permethrin dusts have residual activity; their insecticidal effect is sustained for a period of time as long as they remain dry, whereas pyrethrin sprays do not have residual activity.

This property has implications for crop management as dusts have a withholding period of three days while sprays do not require a withholding period. The Maximum Residue Limit [MRL] stated for Permethrin dust is 2.0 ppm whereas the stated MRL for pyrethrin in vegetables is 0.2ppm.

Dust formulations have a 'carrier' component which helps to disperse the active ingredient. The carrier is a fine talc which 'floats', dispersing the permethrin evenly and keeping the permethrin airborne for a time.

**Table 1** Insecticides registered and permitted by the APVMA for use on Australian mushroom farms



TARGET	REGISTERED PRODUCTS							PERMITTED USE PATTERN				
	Bendiocarb	Cyromazine	Diazinon	Diflubenzuron	Fipronil	Permethrin	Pyrethrin	Triflumuron	Abamectin (PER81876)	<i>B. thuringiensis</i> (PER87515)	Pyzap (PER12172)	Bioresmethrin (PER12782)
Sciarid adults	●					●	●				●	●
Sciarid larvae		●	●	●	●	●		●		●		
Phorid adults	●						●				●	●
Phorid larvae		●	●		●							
Cecid adults												
Cecid larvae			●		●							
Mites			●						●			
Nematodes			●						●			
APPLICATION												
Mix into compost		●	●	●				●				
Mix into casing				●	●			●	●			
Casing drench		●	●	●					●	●		
Dust on to bed						●						
Grow room space							●				●	●
External walls	●		●									

● registered use pattern stated on product label

No	Name	Product type	Status	Actives	Has protected	Details
59005	PERMETHOR INSECTICIDAL DUST	INSECTICIDE	Registered			PERMETHRIN
55091	COUNTRY PERMETHRIN 25:75 INSECTICIDAL DUSTING POWDER INDUSTRIAL STRENGTH	INSECTICIDE	Registered			PERMETHRIN (25:75::CIS:TRANS)
53794	DAVID GRAY'S PERMETHRIN ANT DUST	INSECTICIDE	Registered			PERMETHRIN (25:75::CIS:TRANS)
52336	DRAGNET DUST INSECTICIDAL POWDER INDUSTRIAL STRENGTH	INSECTICIDE	Registered			PERMETHRIN (40:60::CIS:TRANS)
48570	OZTEC PERMETHRIN 10 INSECTICIDAL DUSTING POWDER	INSECTICIDE	Registered			PERMETHRIN (25:75::CIS:TRANS)
46589	TARGET DUST TREATMENT FOR INSECT CONTROL	INSECTICIDE	Registered			PERMETHRIN (25:75::CIS:TRANS)
33210	COOPEX INSECTICIDAL DUSTING POWDER INDUSTRIAL STRENGTH	INSECTICIDE	Registered			PERMETHRIN (25:75::CIS:TRANS)

Figure 2 Excerpt of PubCRIS search results table

When the talc settles out onto the floor and beds, carrying the permethrin with it, the area treated becomes visible. This is a good way of determining if your application equipment is performing satisfactorily and if you are achieving the correct coverage. Pyrethrin sprays on the other hand are not visible once they disperse and the effective coverage and performance of the applicator cannot be assessed.

Other than the active ingredient, dust formulations contain non-toxic adjuncts such as talc and quartz but pyrethrin sprays contain toxic piperonyl butoxide [MRL: vegetables 8ppm] and some spray formulations contain petroleum distillates. Both dusts and sprays are toxic to the aquatic environment so in both cases, runoff must be regulated.

It is important to consider these different properties when making a decision about which product to use. If the strategy is to kill off adult flies before the crop is terminated to prevent flies escaping and vectoring diseases to younger crops, then both sprays and dusts are valid options.

On the other hand, if the insecticide is being applied at fill to prevent eggs being laid in the fresh beds, then the withholding period of permethrin dust is not problematic and the long-term residual effect against flies entering the new room after the initial kill will be beneficial.

### SELECT A PRODUCT

Assuming the options have been narrowed down to permethrin dust, searching 'permethrin mushrooms' in PubCRIS, gives you 15 registered permethrin dust products for use on mushroom crops [Fig. 2].

Within the PubCRIS results table, there is information given on the active ingredient present in each product. For permethrin, this information describes the geometric form [isomer] of the active molecule [either cis- or trans-] and the ratio that the two forms occur in.

On face value, this information has little bearing on the search for a suitable permethrin dust, but it is important to note that not all registered products within a chemical group are the same.

The product labels, accessible from the PubCRIS results table provide further information relevant to product selection. Fourteen of the 15 listed products contain permethrin at 10g/kg, but one product, contains the active ingredient at 20g/kg.

The concentration of active ingredient will impact on the amount used and is likely to impact on treatment cost so this reinforces why it is important to read the label carefully.

### OTHER SOURCES OF INFORMATION

The Safety Data Sheet [SDS] also contains important information about the ingredients over and above what is required in terms of workplace health and safety and manufacturers often post technical notes on their website along with the product listing. A quick search on websites like Google Scholar can provide authenticated answers to technical questions and of course the MU16003 Project Team are available to assist. While the Project Team will not make recommendations of specific products, we can help interpret information and identify options.

### CHANGE MANAGEMENT

Before application, the label of each newly purchased pack of pesticide ought to be studied to ensure there have been no formulation changes or amendments to the Directions for Use table between batches, particularly if it is a product rarely used and not often purchased.

In addition to possibly compromising staff health and safety, failure to detect formulation changes may have implications for chemical residue detections in product and consequent QA breaches or alternatively, deliver sub-lethal doses to the target, driving resistance development.

Similarly, if changing products within the same chemical group, ensure from the label that both the Directions for Use and the formulations are identical before applying the new product. Care is also required when using materials that are stored and infrequently used. Before dusting the product off, take the time to have look on the APVMA website PubCRIS – check for an updated label and ensure the product is still registered for use on mushroom crops. Product registrations are fluid and may change without notice.

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**FURTHER INFORMATION:**

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## MU16003 - Pest and Disease Management and Research Services



**Hort Innovation** | **MUSHROOM FUND**  
Strategic levy investment

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](http://horticulture.com.au)

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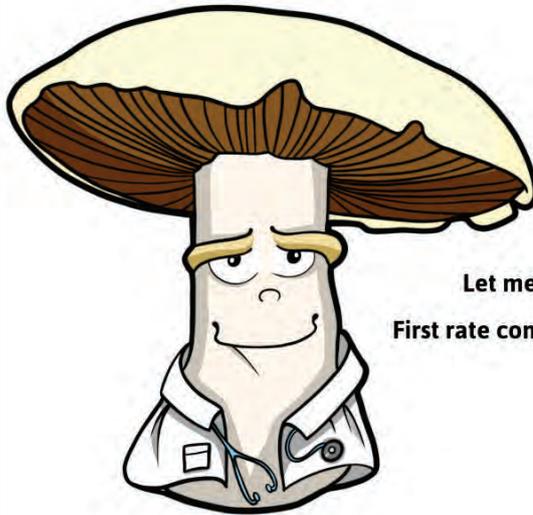
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# HORT INNOVATION

## Roundup

### EXTENSION

Horticulture is growing rapidly as an industry in Australia, with the sector's farm gate production having the potential to increase to between \$20 and \$30 billion by 2030. To support this growth Hort Innovation has launched a new Extension initiative to ensure communication and extension activities truly support business decisions and enhance practices on farm.

Hort Innovation currently funds 80-odd investments dedicated to extension in the form of industry development and communication, and more than 80 investments also involve extension components. The new initiative has been designed to enhance the coordination, communication and application of research and development outcomes. A team of Regional Extension Managers will play a linking role

and bring broad coalitions together to share skills and capacity across industry networks and enable tangible outcomes for growers to use on farm. A booklet highlighting further details of this initiative can be found on the Hort Innovation website (<https://www.horticulture.com.au/hort-innovation/our-work/extension/>).

### FINAL REPORTS

Final reports for Hort Innovation projects – as well as resources such as fact sheets, guides and more – can be downloaded directly from the Hort Innovation website.

The website allows a search by levy industry and categories to easily find the range of available resources. For any queries please contact Hort Innovation ([communications@horticulture.com.au](mailto:communications@horticulture.com.au)). A listing of mushroom levy funded projects is included below.

### INDUSTRY COMMUNICATIONS

In addition to materials covered in this Journal and the Industry Update newsletter, Hort Innovation provides growers and others in the horticultural supply chain to stay up to date. Sign up on the Hort Innovation website (<https://www.horticulture.com.au/growers/become-a-member/>) to receive communications including:

- Project update – Regular updates on every levy fund investment.
- Grower Intel – specific industry news and information.
- Growing Innovation – horticulture news and articles that contains the latest cross sectoral update and media exposure.

Number	Project Title
MT18015	Phenomenom extension project
MU16001	Mushroom crisis management review
MU14000	Communication and education of mushroom nutrition research to health professionals [phase 2]
MU12015	Mushrooms and health global initiative
MU12014	Mushroom industry communication plan
MU12006	Opportunities for mushrooms in food service
MU12005	Analytics for mushrooms
MU12003	Mushrooms, vitamin D and cognition – human studies
MU12001	Mushroom industry knowledge training project
MU11002	Communication and education of mushroom nutrition research to health professionals
MU10021	Improving consistency of mushroom compost through control of biotic and abiotic parameters
MU1570	Mushroom 2016 National Conference
AI13011	Transformational innovation performance analysis
MU15001	Communication program for the Australian mushroom industry 2016-2019

## CHANGES TO THE MUSHROOM MARKETING TEAM

Hort Innovation has announced a revamped lineup to manage the Australian Mushrooms marketing activities. Nicola Schwendler has been appointed the new Group Marketing Manager for the Vegetable cluster, filling in for Samantha Ferguson during her maternity leave. Nicola brings a wealth of knowledge and experience across marketing strategy, brand proposition, consumer research, and media communications.

Support will also be provided through the positions of Marketing Manager and Assistant Brand Manager for Vegetables. The new Marketing Manager Mariannel Azarcon has been the Marketing lead for a number of Hort industries over the last 18 months, previously working on a range of tropical industries and Australian Macadamias. She is excited to now be working on the mushroom program. Assistant Brand Manager for Vegetables, Megan Yap provides additional experience with a background in marketing health foods and nutrition and dietetics.

## UPCOMING PROJECTS

Hort Innovation is currently finalising the commencement for the mushroom industry projects outlined below.

### MU19005 - New innovations to improve mushroom whiteness shelf life

Mushroom whiteness is seen as a beneficial attribute for the sale of some mushrooms in retail markets. While there is a range of pre-harvest factors impacting on a white and blemish-free post-harvest, there is a lack of understanding of these factors and the strategies required to maximise the production of white mushrooms that stay white for extended periods in the market.

The objectives of the project are to:

- Clarify the pre-harvest opportunities to manage mushroom production for improved post-harvest whiteness and post-harvest whiteness persistence and shelf life.
- Identify and prioritise knowledge gaps for future R&D to improve mushroom whiteness.

## SIAP

The Strategic Investment Advisory Panel meets regularly to provide advice to Hort Innovation on levy investment undertaken on behalf of the mushroom industry. The most recent meeting was held in Sydney from 4 – 5 December 2019. A summary of this meeting can be found on the Hort Innovation website [<https://www.horticulture.com.au/growers/mushroom-fund/fund-management/>].

If you have any questions related to the operations of the SIAP please contact Hort Innovation Mushroom Industry Strategic Partner, Mark Spees on telephone 0439 574 173 or via email [Mark.Spees@horticulture.com.au](mailto:Mark.Spees@horticulture.com.au). A list of the Panel members is included below.

Name	Organisation	
Tim Adlington	Australian Mushroom Growers Association [Parwan Valley Mushrooms]	VIC
Matthew Fensom	White Prince Mushrooms	NSW
Sean Hallahan	Costa Group	VIC
Phil Higgins	Parwan Valley Mushrooms	VIC
Elisa Siliato	Costa Group	VIC
Mick Surridge	Australian Mushroom Growers Association [ScatoPlus]	VIC
David Tolson	Elf Mushrooms	NSW
Kevin Tolson	Australian Mushroom Growers Association [Regal Mushrooms]	NSW
Michael Worthington	Chair	

The project is scheduled to commence in March 2020 and conclude in September 2020.

### MU19003: Mushroom price elasticity of demand

Many factors underpin the consumer purchase of fresh produce at the retail level. Understanding the impact that pricing has on the purchase behaviour of fresh produce is a key determinant for effective category management and industry supply.

In simple terms price elasticity of demand determines for a given unit change in price, what is the corresponding change in quantity demanded. Defining the price elasticity of demand will support the industry to understand how price responsive consumers are in purchasing mushrooms and what role price plays in underpinning purchase. This knowledge will support the industry to unlock opportunities for growth.

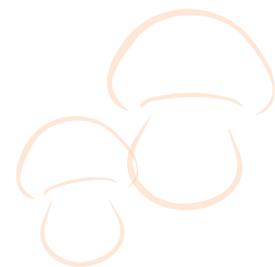
The objectives of the project are to:

- Determine how consumer demand

for mushrooms responds to changes in price across the various category types.

- Identify opportunities for the mushroom industry to unlock opportunities for segment growth through optimal value/volume mix.

The project will commence in March 2020 and conclude in June 2020.



# MEET THE MEMBER

The story below is one of an ongoing series, designed to introduce members of the Australian Mushroom Growers Association to the wider industry. The information is produced by the AMGA Relationship & General Manager, Martine Polulain. If you know of someone that may be suitable to be featured in future editions please contact the AMGA.



*Munya  
Nyanhanda*

*Grower, Parwan Mushrooms, VIC*

**How many years have you been in Mushrooms?**

14 years.

**What is most difficult task you have had to undertake while in Mushrooms?**

The starting out of Parwan Valley Mushrooms had a few challenges. A new farm site with new people, including implementing and monitoring new operational systems.

**What is your greatest strength/talent?**

Patience, I like to fully understand a situation before putting an action plan.

**What is your favourite pastime?**

Gardening and sports, especially playing and watching basketball.

**As a student, what did you want to do or be after your schooling?**

I was interested in biology and chemistry although I liked nature. At one point I wanted to go into the medical field but always had farming at the back of my mind. I grew up raising poultry, so agriculture was in my veins.

**What was the most significant event in your whole career so far?**

Being part of Parwan Valley Mushrooms startup, new modern site with different cultures.

**What is the craziest thing you have ever done?**

I almost touched a wild live warthog thinking it was a sculpture. I was in a national park and around that area there were sculptures of different animals. I thought it was a very unique sculpture until it blinked its eyes when my hand was just about to touch it.

**Do you have a nickname and if so what is it and why?**

Not now, in my childhood I was known as Mutape. It is a Shona - Ndau dialect denoting friendly respect to an individual. My dad gave it to me when I was very young, not sure why...

**What is your favourite movie?**

Blue Streak, Martin Lawrence is one of the main movie stars.

**What is your favourite meal?**

Game meat with Sadza [made out of mealie-meal] and kale vegetables.

**What is the best life advice you have been given?**

In life there are highs and lows, only positive attitudes will sail through.

**Tell me about your position in the business?**

I am the Head Grower.

**What have been some of your failures, and what have you learned from them?**

When I was working in the aquaculture industry, I was accepted into an international Masters program. This program was from a renowned university, but I could not get any scholarship or raise the funds. I was devastated, but around the same time I left my home country for better pastures. This allowed me to broaden my horizons, it finally led me to the mushroom industry. When one door shuts another opens, the later door has led me to better opportunities.

**What motivates you?**

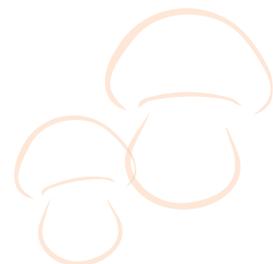
My beliefs, my Christian faith motivates me each day.

**Who has been your greatest inspiration?**

Dr Ezekiel Guti, an African Evangelist, a man who overcame odds to achieve his purpose in life. He leads one of the fastest growing Christian ministries in the world.

**What is the one piece of advice you would give to others hoping for a successful career?**

Never be discouraged by the journey taken to reach your desired goal, use every experience as fuel to reach your destiny, and never let your hopes be limited by others.



# How to proceed in a crisis

AMSAFE safeguarding our future!

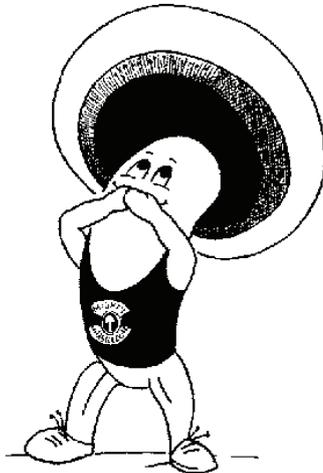
1



**Phone 02 4577 6877**

- If you suspect a possible crisis
- If you are experiencing difficulties that may become a wider crisis
- If you aren't coping with a crisis

2



**Say nothing**

- Refer all enquiries to AMSafe
- Refer the media to AMSafe

3



**Follow the leader**

- Wait for AMSafe to issue you with the 'one message'

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