Australian MUSHROOMS JOURNAL

EDITION 2 - 2020

Hort Innovation
Strategic levy investment

MUSHROOM FUND

AMGA

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Australian MUSHROOMS JOURNAL EDITION 2 - 2020

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EDITORIAL

With Australia slowly starting to emerge from the COVID-19 lockdown, I hope everyone is in good health and ready to embrace what everyone seems to be calling "the new normal".

And if you haven't heard enough about COVID-19 to last a lifetime then the article by food safety expert, Clare Hamilton-Bate on Page 42 is the story for you. The clear point of the article is that the current situation has many messages and lessons on good practice that are equally applicable to business operations going forward.

In addition to COVID-19 links found in the story outlined above and in the Hort Innovation Roundup (P46), this edition covers a range of industry investments, so as always I encourage you to sit down and start reading. For those of you who don't have the time to read in the one sitting, can I suggest that you have a quick flick through the following pages, tag those of most interest and lock in a time to come back and read the Journal in more detail.

In this edition, the marketing section examines what is happening in the retail environment, using Nielsen Homescan data to capture consumer behaviour over the first month of the COVID-19 lockdown in Australia. It follows a separate report distribute in late April detailing the changed approach to mushroom marketing.

Over the past few months, some significant projects have concluded, and coverage of two of these projects is included in this edition. The first part of a two-part article on the production waste project appeared previously and, in this edition, we look at the remaining two recommended solutions. Detailed coverage is also provided on the project – Feasibility of compost substrate alternatives for mushroom production. This project has now concluded and has made several recommendations to industry, identifying some carbon sources as potential alternatives to wheaten straw in mushroom composting. While the articles on these projects contain significant detail, the Final Reports will be available shortly on the Hort Innovation website for anyone requiring even more information.

The Pest and Disease project has also delivered plenty of practical advice with an article covering off some critical questions about nematodes and another discussing what happens to Dry Bubble (*Lecanicillium*) spores in your washing machine.

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 Rowley

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,

As we find ourselves living in a "new normal" in the midst of the COVID-19 virus that has affected lives and economies worldwide, I hope you, your family, and the people at your farm are safe and healthy.

Despite the life-changing impacts that the pandemic is bringing to us Australians and the rest of the world, we are fortunate, as mushroom farmers, to be an essential business that allows our farms to continue and to operate.

As restaurants and service industries closed, social distancing has been observed to prevent the spread of the virus. So, with people advised to stay home, families are opting to eat home-cooked meals using fresh ingredients. This presents our mushroom industry with a great opportunity to promote our SUPERFOOD product that is a rich source of Vitamin D and a great way to boost the immune system.

We understand that the health message is strongly supported by all of you in the industry and we are trying our best to have this communicated through to our customer and all consumers.

I'll be communicating information to you in relation to AMGA Board matters through the Association in weeks to come.

Best regards,

Kevin Tolson

AMGA GENERAL MANAGER'S REPORT

I'm writing a very different column to the one I wrote for Edition 1 of the industry journal. To say the world has changed in a way none of us saw coming, is an understatement - with the impact COVID-19 has had on the world - and the impact was swift!

How has COVID-19 affected our growers, apart from the obvious ebb and flow of consumer panic buying, and the loss of food service overnight, and what did your peak industry do to help you in these unprecedented times?

An overview is included below:

COVID -19 MANUAL

In my role as AMGA Relationship and General Manager, I often speak to our growers to check in. So ensuring they were kept up to date with the necessary processes to keep their workers and farms COVID-free in the early days of the pandemic, became paramount in our efforts to continue protecting the mushroom brand.

You should have all received an AMGA COVID-19 processes manual as well as some fact sheets for COVID-19 management, but if you didn't, please reach out to me, and I can ensure you receive a copy.

MARKETING DIRECTION DURING COVID-19:

Hort Innovation held an urgent meeting with the AMGA at the start of the pandemic, to evaluate our marketing spend. With children and their parents now home based, and restaurants closed, we revised our communication channels and shopper focused strategy to re-launch the Mushrooms campaign. Our focus is now on creating healthy recipes at home, and very much bringing the health message home to the consumer. We have also placed all marketing online.

AMGA TESTING

In other news, I want to remind our members that AMGA Testing continues. In April, we reached out to all our growers to remind you that we provide testing. What are the benefits of doing it through your peak industry body? We organise the pick up and management of the testing, but we also have the added benefit of getting a Quality Assurance Risk Management Service to review your results before sending them to you. If there is an issue that could impact the mushrooms brand, we can monitor this and above all, you are provided with a code so you remain anonymous. Contact me anytime if you need a test, and we can organise this all year round.

CONFERENCE POSTPONED

As our AMGA conference 2020 website was about to go live, the AMGA board decided to postpone the signature event, which was scheduled for October this year.

With the uncertainty of how long COVID-19 would impact our lives, it was a decision we simply had to make. Looking ahead, we have managed to secure dates in October 2021, and will start marketing the conference from February.

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

In closing, I'd like to remind you that as always, my door is always open, so please drop me an email or call me.

All the best,

Martine Poulain

Relationship and General Manager
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E: martine.poulain@amga.asn.au

AMGA BOARD

The following directors form the elected Board of Directors of the Australian Mushroom Growers' Association.

Kevin Tolson — Chairman

Kevin Tolson is the Managing Director of Regal Mushrooms, a growing facility which produces 100+ tons of mushrooms per week. He co-owns with his brothers Robert and David, the sales, marketing, and distribution company White Prince Mushrooms which supplies 20% of the entire Australian mushroom industry. The family employs approximately 500+ staff. He also sits at the board of the Tolson Group of Businesses which encompass the supply chain of the mushroom industry - from spawn, compost, growing, marketing, sales & distribution. Since the age of 23 Kevin has served on the Australian Mushroom Growers Association board and taken the role as Chair at least seven times since then. He is currently a member of the Mushroom Strategic Industry Advisory Panel.

Mick Surridge — Deputy Chairman

Mick Surridge studied agricultural science at Dookie College and has a background in mycology and engineering with over 30 years' in the mushroom Industry. He is a co-founder, director and shareholder of ScatoPlus established in 1996. The company has over 70 employees and supplies mushroom compost throughout Australia, Asia and Pacific Island countries. He is a shareholder and Director of Bulla Park, Australia's largest producer of Organic *Agaricus* and *Pleurotis* mushrooms. Mick is a past Chairman (current Deputy Chairman) of the Australian Mushroom Growers' Association and a member of the Mushroom Strategic Industry Advisory Panel.

Dr Geoff Martin — Treasurer

Geoff Martin has been involved in the international mushroom industry for over 37 years; he has managed and directed operations at a range of composting and mushroom companies in the United Kingdom, South Africa, Botswana, New Zealand and Australia. Until recently he was the General Manager of Mushroom Composters based in New South Wales, a position he had held since 2001. In late 2018 Geoff decided to step back from the daily grind of running a composting operation, embraced semi-retirement and set up his own mushroom consultancy business, Dr Mush Advisory.

Geoff has acted as a consultant to mushroom operations in South Africa, Malawi, Zimbabwe, New Zealand and Australia. He holds a PhD in Soil Science from the University of Reading United Kingdom. Geoff is passionate about the mushroom industry and believes that one of his most important tasks is to share his knowledge with fellow growers, facilitate the training of younger people in the industry and promote research and development especially in the field of composting.

OF DIRECTORS

To get to know your representatives and their industry experience and roles, a brief biography has also been included.

Tim Adlington

Executive Director

Tim Adlington, a mushroom industry executive whose credentials span more than 40 years with some of the world's leading producers, is a retired Chief Executive Officer from Parwan Valley Mushrooms in Victoria. In 2011, Tim was chosen to oversee the construction and start-up of its $10 million, 2,600 annual tonne, green field site, due to previous successes with mushroom venture start-ups and financial turnarounds.

His career also includes time as Chief Operating Officer of leading North American mushroom producer, Moneys Mushrooms (an enterprise of some 1,300 employees) while overseeing R&D for both Moneys and Canadian Mushroom Growers Research and Development program concentrated at Vineland Station. During that period he was Chairman of the Canadian Mushroom Growers' Association and Chairman of the R&D committee. Prior to that, he was President of Canada's Leaver Mushrooms, overseeing four mushroom growing facilities spread across Canada and a spawn plant in the United States and the opening of a new tunnel facility.

Tim has a Bachelor of Science (Genetics) and Master of Science (Horticulture) from the University of Guelph (1976-1978), as well as a Master of Business Administration from the University of Toronto (1988-1990).

Michael Toby

Michael Toby has an extensive background in both the public and private sector, having worked at the highest levels of the federal government across a number of portfolios, including workplace relations, aged care and immigration.

He has worked in the civil construction, manufacturing and horticultural industries performing specialist roles covering human resources, industrial relations, finance, administration and corporate affairs.

Michael's role as Costa Group Corporate Affairs Manager includes responsibility for investor, government and community relations.

Robert Tolson

Robert Tolson is the owner of Premier Mushrooms. The farm grows two rooms per week of Phase 3 compost. He is a Director of Sylvan Australia and Director shareholder of White Prince.

Carmine Callisto

Carmine Callisto is the Managing Director of Global Axis Import Solutions Pty Ltd, a successful family owned business that has been operational in Adelaide, South Australia for the past 32 years. The company acts as exclusive agents for a number of international mushroom and horticultural brands and products in Australia and New Zealand - supplying mushroom farms, nurseries, turf producers and potting soil companies in all states of Australia and New Zealand.

Carmine has a strong background in sales, having worked across other industries including the building and automotive sectors, prior to his introduction to the mushroom industry in 1998. He has worked extensively to build solid and strong relationships and connections across the industry, investing time listening to growers and delivering what they need to produce strong yields of quality mushrooms.

Carmine has been passionate about giving back to the industry, and has been a member of the AMGA Conference Organising Committee for the past 16 years and has most recently become a Board member of the AMGA.

Jose Cambon

Jose Cambon was appointed General Manager – Costa Mushroom Category in January 2019.

Jose joined Costa in 2012 commencing in the role of Commercial Manager, Costa Farms and Logistics. He then oversaw the integration of the Adelaide Mushrooms acquisition into the Costa business, before taking on the role of Victorian and Tasmanian State Mushroom Category Manager.

Prior to joining Costa, Jose worked for Visy in their specialty product business as a factory and business manager. He has also been a consultant to the packaging industry on sales strategy, business and product development.

Jose has a Bachelor of Commerce Degree, majoring in Accounting.

Phil Rogers

Phil Rogers commenced his career in the mushroom Industry over 30 years ago, working with Merbein Mushrooms, under the management of Geoff Izard, his father in law. Phil spent the next 15 years totally involved in all aspects of mushroom production, from composting to marketing - with composting becoming his passion. When he later became Director of the company, Phil had major input in the design of the new compost facility at Merbein, and was in charge of all things compost for both Merbein Mushrooms farms.

In 2004, Phil worked as a consultant with Sylvan Inc USA, and spent two years consulting in Phase I, II, III and Growing Techniques in various countries around the world, including Australia. In 2006 Phil and his wife, Linda, were given the opportunity to purchase the South Australian Merbein Mushrooms farm, and so began P & L Rogers Pty Ltd - producing around 24 tonne of mushrooms per week and being supplied compost from the Merbein Farm.

To establish vertical integration, the Rogers then built their our own compost facility. After five years of careful planning and diligence, their Phase I, II and III project commenced in 2017 at Port Wakefield and is now producing 45 tonne of mushrooms per week.

Phil has been a director on the AMGA Board since 2013.


2020
CONFERENCE
AMGA
Australian
Mushroom
Growers'
Association
GROWING
the future, together
POSTPONED
TO OCTOBER 2021

A CHANGING WORLD FOR MUSHROOM CONSUMPTION

The COVID-19 pandemic has imposed a new reality on the world, impacting on how we live and work. And in turn, this has affected consumers and purchasing behaviour.

This article looks at the current state of play in the retail environment, using Nielsen Homescan data to capture consumer behaviour over the first month of the COVID-19 lockdown in Australia.

SETTING THE SCENE

On 12 March 2020, the World Health Organisation declared a pandemic, with restrictions in Australia commencing almost immediately on 13 March. The start of these restrictions saw Australians rush to restock their pantries, in the process stockpiling a range of staples and food with a longer storage life. Naturally enough, this process led to unprecedented retail sales, with reported figures for March coming in 18% higher than for Christmas month in 2019.

So, with sales up and consumers looking to maintain adequate food supplies at home, how are the sales of mushrooms? Well, in the vegetable category (which is where mushrooms are classified in the data) longer life vegetables such as potatoes, carrots and onions contributed significantly to overall category growth increasing by 42%, 16.9% and 14.5% respectively. Within the overall growth of the vegetable category, mushrooms were ranked seventh in terms of contribution, increasing by 2.4% over the period.

CHANGED CONSUMER TRENDS

Since the COVID-19 restrictions have come in place, consumer buying trends have undergone very noticeable changes. For example, in March, consumers were shopping more frequently to stock up on essentials such as toilet paper, hand sanitisers and disinfectants, and other products where retailers were experiencing shortfalls in product supply.

By April, as everyone became more familiar with the restrictions and its impact on product supply, consumers started to ease back on their stockpiling of individual products, shopping less frequently and putting more in their basket with each shop. The restrictions have become the new normal, with consumers now spending more time at home and more frequently feeding the whole family. The impact of this situation is reflected in the sales across the total vegetable category (again, in which mushrooms sit in the data) and in the individual mushrooms category.

MUSHROOM VOLUME UP

Nielsen Homescan data shows that just one month into the COVID-19

Biggest contributor to total category growth were vegetables with longer storage life.

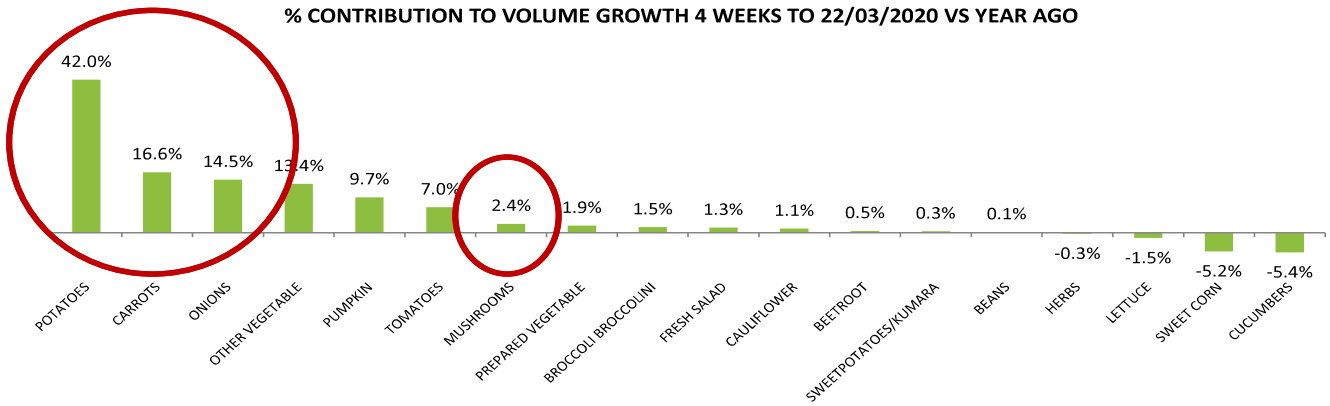

Figure 1. Contribution to total vegetable category volume growth by vegetable type over 4 weeks to 22/03/2020 versus year ago.

Source: Nielsen Homescan

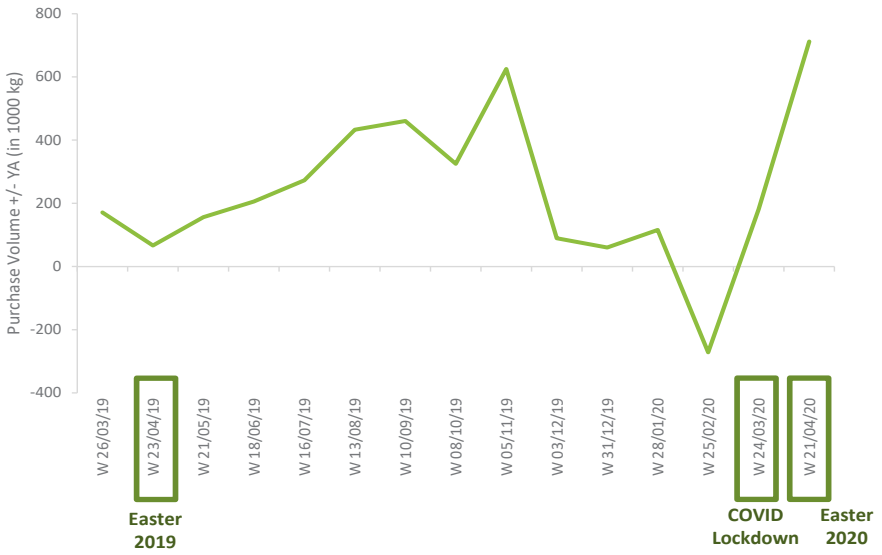

Figure 2. Change in purchase volume of mushrooms, per four weeks ending 21/04/20 compared with year ago.

lockdown, mushroom volume was growing at +13.5% over the four weeks ending 21 April 2020, compared to the same period in the previous year. This growth was driven by an increased number of trips the supermarket per household (up 7%), as well as a pleasing increase in the volume of mushrooms purchased per shopping trip (up 3.2%).

The restrictions in place saw consumers purchasing more groceries to cook at home while in isolation.

The data shows Easter 2020 was more successful for mushrooms than 2019 with an increased volume purchased. The result suggests that consumers bought more mushrooms to cook special meals over this period.

MUSHROOM VALUE UP

In terms of sales performance, the value of mushrooms sold over the four weeks ending 21 April 2020 compared to a year ago increased by 22.7%. This increase in value can be attributed to several factors, including a 2.8% increase in the number of households that purchased mushrooms, and an increase in average household spending on mushrooms of 19.4%. This increase in household spending was driven by both an increase in frequency (up 7%) and in volume (up 3.2%). It should also be noted that supermarket prices were increased over this time by 8.1%, which also contributed to the overall growth in value.

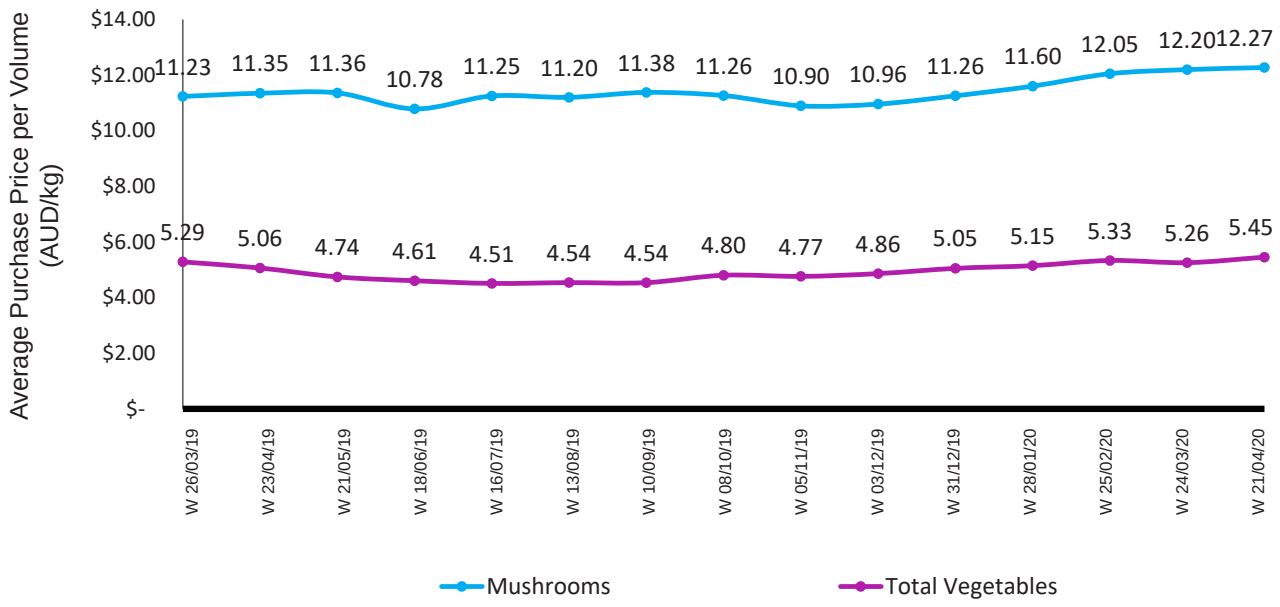

Figure 3. Change in average purchase per volume of mushrooms and total vegetables, week ending 21/04/20 compared with year ago.

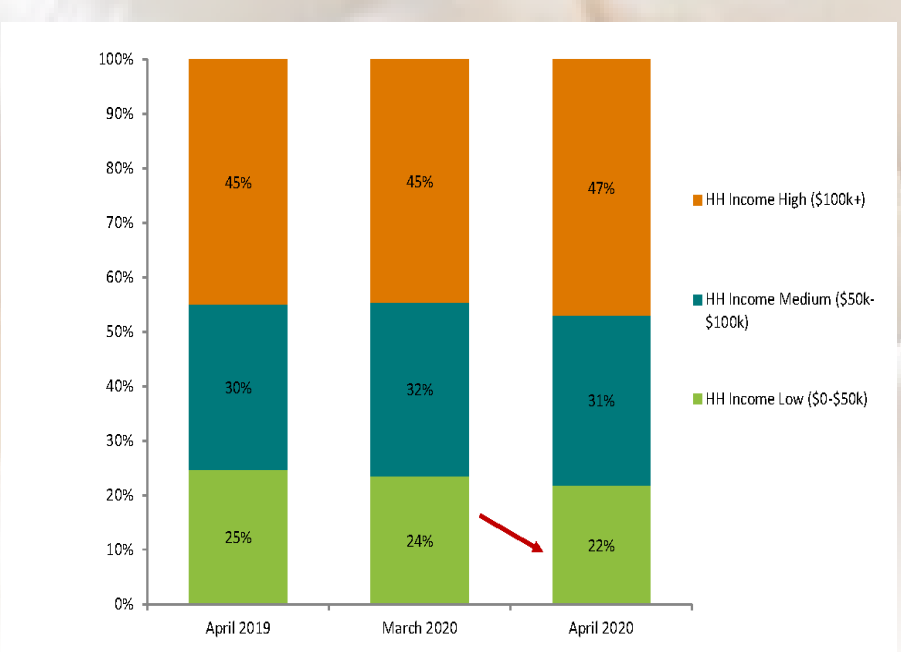

Figure 4. Percentage of purchase volume by household income category across April 2020, compared with March 2020 and April 2019.

WHO IS BUYING MUSHROOMS?

An examination of the purchasing behaviour by household income for April 2020, compared with March 2020 and April 2019 highlights that the mushroom category is losing lower-income households. In April this year, 22% of mushroom purchases were made by households with an income of less than $50,000. This figure compares with 24% in March 2020 and 25% in April 2019. This drop could potentially be due to the pressure on household incomes during the COVID-19 period, combined with the increased price of mushrooms at retail.

An examination of the buying demographics indicates that broadly the same people are buying mushrooms, led by the categories of "Senior Couples" (26%) and "Established Couples" (26%).

RETAIL SHARE OF TRADE

It is interesting to look at the impact of the changed consumer behaviour on the share of trade amongst retailers. As consumers are forced to stay at home, the data shows they have started shopping more locally for mushrooms. This situation has led to non-supermarkets, other supermarkets, ALDI and IGA all gaining market share in the period from March 2020 through until April 2020.

The most significant movement in the retail share of trade has occurred in the "non-supermarkets" category (e.g. green grocers), which increased from 12.1% in March to 16.5% in April 2020. In comparison, both the major supermarkets, Coles and Woolworths have lost retail share of trade in mushrooms dropping from 32.4% to 30.4% and from 28.5% to 25% respectively.

The major retailers have also lost share in part due to cancelling promotions, which has been done to manage the supply chain.

MUSHROOM MARKETING RESPONSE

With the onset of COVID-19, the Australian Mushrooms marketing campaign has re-launched with a 100% digital approach, with the health, taste and ease message delivered through online video, audio and content partnerships. The campaign commenced in April and will continue through until the end of June. The campaign is estimated to achieve a cumulative reach of 18 million.

The changed approach takes into account the current environment, with consumers spending a large percentage of time social distancing at home. The digital channels used for the campaign effectively reach consumers eager for home cooking inspiration and ways to maintain good health.

The media campaign is focused on driving consideration of mushrooms by the identified target audience, inspiring usage through recipes and health benefits, and reminding consumers to enjoy mushrooms regularly.

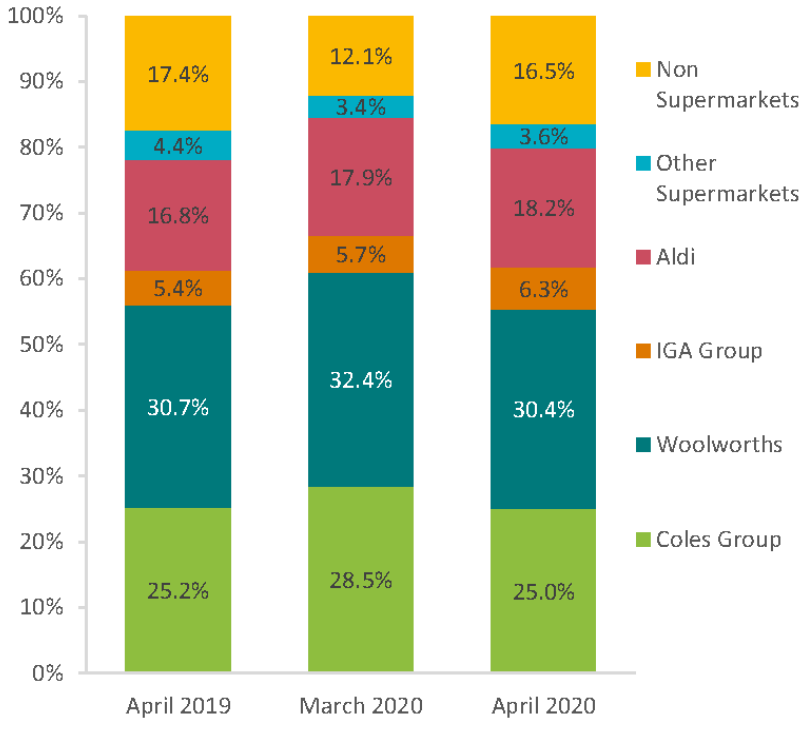

Figure 5. Retailer volume share of trade across April 2020, compared with March 2020 and April 2019.

A CHANGED APPROACH TO *Mushroom Marketing*

The marketing of Australian Mushrooms through to June 2020 has been revised in light of COVID-19, taking into account the changed behaviour and media consumption of consumers. The re-launch of the media campaign targets nearly four million Australians, aged 25-49 who love to cook and who think meals are an important way to connect with family.

The campaign has deliberately been shifted to 100% digital as more Australians are staying indoors. The Australian Mushrooms message will be delivered through three channels – online video, audio and content partnerships – using recipes that inspire usage and highlight the benefits of including mushrooms in family meals. While the campaign will reinforce the "much healthier" and "much tastier" messages, it includes an increased emphasis on the health benefits of mushrooms.

The changed approach has been a cooperative effort, with the Hort Innovation marketing team working with service providers and the Australian Mushroom Growers' Association to refine the campaign delivery.

In addition to the above activities, the "always-on" elements of mushroom marketing, including social media and public relations activities, have also been redeveloped to add further support for the levy investment.

TARGET AUDIENCE - GROCERY BUYERS 25-49
Who love to cook
Think meals are an important way to connect with family

	Channel	Role
Consideration	Online Video	Drive consideration of mushrooms through video content across Catch-Up TV & YouTube
Consideration	Audio	Reach our Target Audience and build frequency whilst listening to Radio, Spotify and Podcast
Inspiration	Content Partnership	Inspire usage of mushrooms and provide the opportunity to leverage the health benefits of mushrooms in a timely manner.

ONLINE VIDEO

There are many good reasons for promoting Australian Mushrooms through online video, with 67% of the target audience watching videos and TV programs online.

In addition, there has been a **43% increase** in viewing compared to the same time last year, allowing broadcast video on demand to provide a TV experience that can assist in building awareness of the Australian Mushrooms brand.

In the case of YouTube, the ability to reach consumers is considerable. As the largest social media platform in Australia, it reaches 15 million unique visitors per month.

This reach, and that of catch up TV, is also likely to further increase in the current social climate, with consumers finding themselves indoors for extended periods and actively seeking more content.

Australian Mushrooms Marketing Update | April 2020 1

A summary of the campaign approach – A Changed Approach to Mushroom Marketing – has been circulated, and industry participants are encouraged to download and read to stay informed on the activities undertaken on their behalf. The summary can be downloaded directly from this LINK in the electronic version of the Journal or from the Hort Innovation website (https://bit.ly/mushroomsummary).

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

HEALTHY Australian MUSHROOMS: A PROJECT UPDATE

Dr Flavia Fayet Moore
Project Leader

When it comes to mushrooms and good health, the two naturally enough go hand-in-hand. For some time now, the Australian mushroom industry has focused attention on ensuring health professionals are updated about ongoing research on the role of mushrooms in a healthy diet. The following is an update on the three-year levy-funded project *Educating Health Professionals about Australian Mushrooms.* It follows on from the previous article in the Australian Mushrooms Journal (2019 – Edition 4).

While COVID-19 restrictions have impacted on the ability to deliver some elements, Project Leader, Dr Flavia Fayet-Moore of Nutrition Research Australia, said the project was progressing well and continuing to develop strong linkages with Australian health professionals.

Dr Fayet-Moore said the team had most recently completed a scientific review of all the health materials on the Australian Mushrooms website, checking them for scientific accuracy and regulatory compliance.

"From an industry viewpoint part of our job is to ensure that everything presented about mushrooms and health is in line with what the science is saying to protect the credibility of the messages being delivered. The recent review of the website follows on from the systematic literature review that categorised some 500 research papers on the latest research on Agaricus bisporus."

"Our team has made some recommendations on what can be said around mushrooms and health, and have now delivered a substantial document to Hort Innovation for their consideration. While the essential core of information used on the site was correct, we found that there were a few claims that need to be modified or deleted, based on the type of supporting information or study. Importantly our approach is to make it accurate and scientifically sound, rather than highlighting a broad overview or statement about the science."

FUN FACTS

As reported in the previous article, the project has used the core information gained through the literature review to develop a Fun Facts document. The approach of the Fun Facts is to create simple to remember messages about mushrooms and health for delivery in a range of communications, such as electronic direct mail (EDM) and in promotions around health-specific events.

Dr Flav's Fun Facts

Tan those Mushies!

Place your mushrooms in the sun gills side up to increase their vitamin D content by up to 30%.

Vitamin D all week!

Sunlight-exposed mushrooms can retain vitamin D in the fridge for up to 8 days.

Squeeze it to keep it

Adding lemon juice to your mushrooms before cooking can help to increase their vitamin D retention.

Dr Fayet-Moore said the team had now developed 48 Fun Facts. The topics range from:

- the nutrient composition of mushrooms;
- probiotic content;
- glucans;
- chitons;
- ergothioneine;
- ergosterols;
- polyphenols;
- vitamin D;
- the effect of metabolic markers;
- immune system;
- satiety;
- cancer;
- patterns of consumption;
- cooking; and
- culinary applications.

"It is quite a lot, and we have communicated 12 of the Fun Facts so far, and have given the Hort Innovation marketing team a range of other messages that can be used as part of this process. The Fun Facts have been developed from things we have come across the science, through the literature review and to other activities we have done like the vitamin D presentation."

"Our role is to support the marketing messages by making sure that any of the communication is scientifically sound and accurate. If a particular message is required, our job is to work with the marketing team to refine it and ensure the delivery is 100% reflective of the totality of the science."

EXCITING HEALTH ASPECTS

Dr Fayet-Moore explained there was a range of exciting health aspects that could be considered in marketing mushrooms to consumers.

"One strong and somewhat unexpected thing that came up in our research was that mushrooms have beta-glucans. Given the fact that beta-glucans from oats and barley have been shown to reduce cholesterol, there is potential for more research in this area to determine where the beta-glucans in mushrooms fit into the picture.

"To take advantage of this we would need to undertake more research to determine what beta-glucans exist in mushrooms, and at what levels (or dose), to potentially undertake clinical trials to show how effective they are in comparison with oats for example, at reducing blood cholesterol. If they are found in mushrooms at a high enough level, the potential is there to align with the oats health claims for beta-glucans and modify the FSANZ schedule to reflect the benefits found in mushrooms," she said.

Dr Fayet-Moore said the outcomes of the completed Systematic Literature Review had now been submitted to the Journal of Nutritional Biochemistry for consideration.

"The benefit of this Journal is that it is very highly ranked in the area of nutrition and dietetics, and so having the research published will provide us with another very high level of credibility both in terms of the research and with health professionals more generally."

She outlined that the project team had received peer-review feedback on the original submission and had made some minor revisions and resubmitted the materials for publication. At this stage, she said, we are just waiting on them to accept the manuscript, although this might not happen for several months, depending on the journal's backlog of articles and final peer-review. Some feedback from the peer-review process included:

"This is a well executed systemic review that nicely describes the details of the human data to support the health effects of edible mushrooms. Overall the manuscript is well done."

"I think the data from each study laid out in the tables 2 and 3 are valuable resources for others."

Dr Fayet-Moore said work was also underway to share the information gained through the SLR with the broader industry.

She said the review confirmed that Agaricus bisporus contains a wide range of bioactives including beta-glucans, ergosterols, ergothioneine, vitamin D, chitin, prebiotics, and some unknown antioxidants that are often reported as flavonoids, but may or may not be flavonoids.

"While we know growers are interested in the findings, we also understand that many are not going to read through a very technical, scientific paper. To address this, we have written a Key Points document, a simplified summary of our findings, and this will be made available to industry, once Hort Innovation has reviewed it."

The project is also pushing ahead with a range of other activities, including electronic direct mail to its ever-increasing database of health professionals. The most recent EDM provided health professionals with some topical advice on how to get more vitamin D while living indoors.

Included in the communication was a very clever vitamin D animation that explains everything clearly and concisely (Your Ultimate 2 mins Guide to Tanning your Mushrooms - Nutrition Research Australia).

FUTURE RESEARCH

One of the research opportunities identified as part of the work undertaken to date relates to the beta-glucan content of mushrooms. To advance this requires confirmation from FSANZ on the requirements needed to make a health claim that the beta-glucan content in mushrooms can lower cholesterol. It is likely lab testing would be required to check how much and what type of beta-glucan is present.

Studies would also be vital to investigate dried weight versus cooked weight, how the beta-glucan is available through consumption, and what constitutes a serve. Completing the requirements for a health claim on beta-glucans would position mushrooms as a heart-healthy food.

Dr Fayet-Moore said the team was very excited about the animation and explained that although the target audience was health professionals, it was equally applicable for consumers, who would take home the same strong health message about mushrooms and vitamin D if shared by the healthcare professional.

According to Dr Fayet-Moore, the COVID-19 situation has seen some changes made to the schedule of activities planned under the project.

"In early May we were scheduled to undertake the Dietitians Unite breakfast, but because of the situation, the event organisers moved the event to to the end of October."

Everything we had planned in still in place, so the event – when it does go ahead – will consist of a presentation, a panel discussion, a mushroom chef and a trade stand. In terms of take-home information, we will have a recipe book, a fact sheet produced in collaboration with Simplot (Edgell canned vegetable brand), and some mushrooms so those people attending can cook up a meal when they get home."

She detailed that the overall approach was directed at leaving health professionals with a cross-section of practical information that can be easily applied.

Dr Fayet-Moore said a brochure based around the SLR was initially planned for delivery at the breakfast; however, given the delay, it was now likely to be circulated through a separate communication process in the next couple of months.

"COVID-19 has forced several changes to the timetable for delivery, but not the work being undertaken. For example, the audience sentiment research that was due to be conducted in August has been moved until after the breakfast event."

The project team is also considering how to best conduct the roundtable event currently scheduled for November.

"One suggestion is that we attach the roundtable to the Dietitians Unite breakfast, as it is closed intimate event and many stakeholder may already be attending the DU event. However, if this is not possible, we will look at other options. The program has a webinar scheduled for next year, so it may be possible to bring this forward and swap the roundtable to 2021."

"In addition, we are now planning to produce a document out of the roundtable, kind of a White Paper, to extend the information further and make it available to even more health professionals, over a longer period. The roundtable event is all about the 'how' we should be recommending mushrooms in the diet. Should Fungi be a whole separate food group along with fruits and with vegetables in the dieteary guidelines given its unique nutritional composition?"

Dr Fayet-Moore said the project overall was progressing nicely and building strong relationships with the health professional community.

"The long-term intention is to work with industry and position mushrooms strongly in terms of its health credentials, and I am confident that the work we are doing through this project is helping to do just that," she said.

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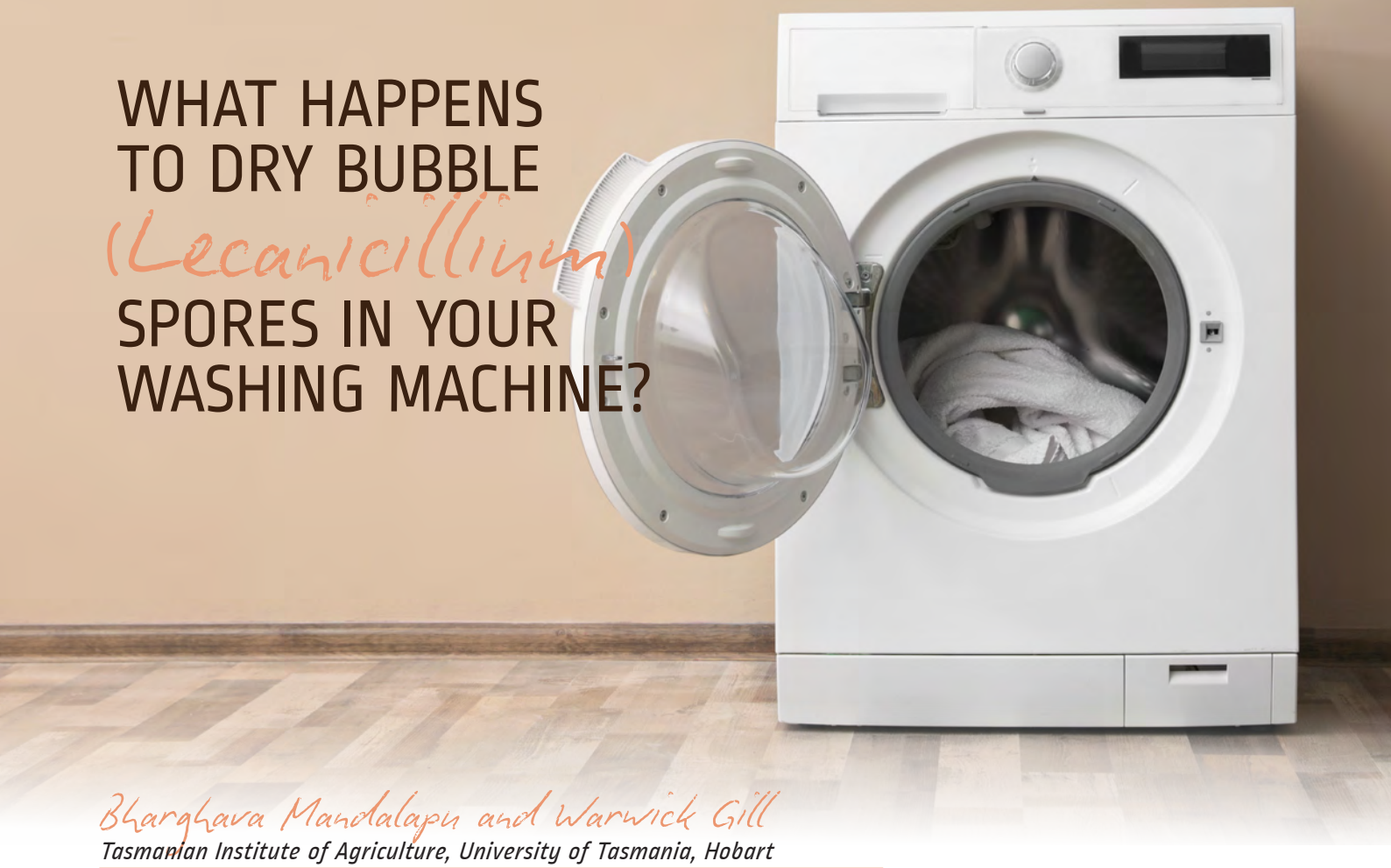
Hort Innovation Strategic levy investment | MUSHROOM FUND

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

COMING CLEAN:

WHAT HAPPENS TO DRY BUBBLE (*Lecanicillium*) SPORES IN YOUR WASHING MACHINE?



Bharghava Mandalapu and Warwick Gill
Tasmanian Institute of Agriculture, University of Tasmania, Hobart

This article reports on work undertaken by Bharghava Mandalapu for the research component for the degree of Master of Applied Science completed in the Tasmanian Institute of Agriculture, 2019.

GROWERS' ACTION POINTS

- To kill *Lecanicillium* spores in your on-farm laundry, wash soiled towels, aprons and other textiles at a minimum of 60°C with any brand of laundry detergent.
- *Lecanicillium* spores are not killed in a cold- or warm-water wash. If you use these cooler cycles, ensure your machine drains into a greywater waste system and not directly onto the premises.
- Inspect the barrel, door and door gaskets of your machine regularly to check for organic build-up and biofilm formation.

Figure 1 Example of an on-farm laundry **a)** a typical domestic front-loading washing machine and tumble dryer on a mushroom farm **b)** *Lecanicillium* was isolated from the lip of the door gasket and **c)** from the inside of the door following a wash cycle. *Photographs: Warwick Gill*

Table 1 Result summary table and on-farm ramifications

	Wash parameters	Observation(s)	Interpretation(s)	On-farm significance
Experiment 1	Cold water only, no detergent	Recovery rate of spores from the distilled water control (no detergent) was much lower than from the detergent treatments in distilled water	Spores in the distilled water control treatment clump and/or migrate to the walls of the wash vessel and adhere. They cannot be recovered from the wash water	Detergent must be used to prevent spores adhering to the walls of the washing machine and contaminating the next load of laundry. Without detergent, there is potential to develop biofilm within the machine
Experiment 2	Cold-water wash (~22°C) with three detergents	Viable spores were recovered from the detergent treatments and the control wash water. There was no significant difference in spore recovery between treatments and control	Spores are held in suspension in the wash water by the action of the surfactants. The detergent has no sporicidal activity. Brand of detergent makes no significant difference	Viable spores suspended in the wash water are drained from the machine and deposited wherever the drain outflow is located. A disease reservoir will form at this point
Experiment 3	Warm-water wash (~40-45°C) with one detergent	Recovery rate of viable spores was significantly reduced in the warm-water wash at 40°C compared to the control at 22°C with the same detergent. No viable spores were recovered from the 45°C wash	Temperature of the 40°C wash is approaching the thermal death point of *Lecanicillium* spores in water; some will be killed by the higher temperature, but a significant number will survive. At 45°C, no spores survived, indicating the thermal death point was exceeded for *Lecanicillium* spores. The detergent has no sporicidal activity	Although some spores will be killed at 40°C, a significant number of viable spores will drain from the machine. Over time, even a small number of spores from each wash cycle will accumulate into a significant disease reservoir at the point where the machine drains. While 45°C may exceed the thermal death point, variables within the machine may not allow water to maintain this temperature. This temperature is too close to the thermal death point to reliably kill *Lecanicillium* spores
Experiment 3	Hot-water wash (~60°C) with one detergent	Viable spores were recovered from neither the control nor the detergent treatment	*Lecanicillium* spores are killed at this elevated temperature	Spores are killed in the wash and no viable spores survive to be potentially released into the farm environment or to form biofilm within the machine
Experiment 4	Hot-water wash (~60°C) with one detergent, and spores introduced on inoculated textile	Viable spores were recovered from neither the inoculated textile and detergent treatment nor the control	*Lecanicillium* spores are killed at this elevated temperature. The presence of textile was not sufficient to buffer the spores against the effect of temperature	The presence of towels, aprons or other textiles will not protect *Lecanicillium* spores from heat. Spores are killed in the hot wash and no spores survive to be potentially released into the farm environment, or to form biofilm within the machine
Experiment 4	Hot-water wash (~60°C) with one detergent. Sterile textile added to spore suspension in wash water	Viable spores were recovered from neither the sterile textile & detergent treatment nor the control	The elevated temperature eradicated *Lecanicillium* spores. There was no evidence of viable spore transfer to uncontaminated textile	Spores are killed in the hot wash and no spores survive to transfer to uncontaminated textiles in the wash or rinse

- Clean the machine at least monthly on a hot wash cycle with an APVMA-approved chlorine-based sanitizer at the manufacturer's recommended rate to prevent biofilm establishing.

BACKGROUND

During previous project MU12007 (development of a pilot mushroom farm disease monitoring scheme) the MU16003 Project Team detected viable *Lecanicillium* on a hand towel and inside a washing machine (Fig. 1) used to launder farm-soiled aprons and towels (textiles) on different farms. These detections have ramifications for Dry Bubble management on mushroom farms, focusing on the washing machine as a potential infection reservoir and vector for disease.

Last year, Bharghava undertook an investigation to determine the fate of *Lecanicillium* spores in a domestic washing machine in a scaled down laboratory simulation. In a series of four experiments, he was able to determine the minimum conditions required to eradicate Dry Bubble from farm laundry. This Growers' Report presents Bharghava's results (Table 1) which are highly significant for laundering effectiveness and Dry Bubble control on mushroom farms. Please refer to the associated Technical Report for experimental details and a comprehensive discussion of the findings.

CONCLUSION

- The minimum effective treatment to kill *Lecanicillium* spores from farm-soiled and contaminated textiles in a domestic washing machine is a hot-water wash at 60°C or above, with any brand of household laundry detergent at the rate recommended by the manufacturer.
- Detergents in cold- and warm-water washes spread viable *Lecanicillium* spores via the wastewater. To prevent the creation of an on-farm disease reservoir, the washing machine must drain into an established grey water treatment system and not out onto the farm premises, an adjacent paddock or into a nearby open drain.
- Because *Lecanicillium* spores survive at the lower temperatures, biofilm formation in the machine is likely. Fragments of mature biofilm will break off when contacted by clothing or by water pressure during a wash cycle, spreading viable spores to clothing in the wash.
- Laundry detergents do not kill *Lecanicillium* spores but their use in on-farm laundries is very important. They are effective cleaning agents which remove soil (casing and compost), other organic material and grease from textiles. In doing so, spores that are buried within the soil are also removed from the textiles. Furthermore, by removing organic material from towels, aprons and overalls, pathogenic propagules that land on the textile after washing will not have a suitable nutrient source to enable them to germinate.
- Although having nothing to do with cleaning, the fragrance (or 'bloom') of the detergent masks any lingering malodours from the textile and conveys a sense of cleanliness. While the textiles may still be contaminated with *Lecanicillium* after a cold- or warm- water wash, the benefit of getting staff in the right frame of mind, particularly on something as important and challenging as farm hygiene, is invaluable.

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Would you like your laundry checked for Dry Bubble contamination? Contact Warwick Gill to organize a hand towel or other article of washed laundry to be sent to him for sampling.

MU16003 - Pest and Disease Management and Research Services

tia TASMANIAN INSTITUTE OF AGRICULTURE

Hort Innovation Strategic levy investment | MUSHROOM FUND

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SO, YOU THINK YOU'VE GOT...
NEMATODES

Judy Allan
Pest & Disease Service

Nematodes, or eelworms, are present in most mushroom beds because both compost and casing are favourable environments for them to live in. They are normally only a problem when they reach high numbers. But, if they are identified early and are well managed, you can still produce good yields and acceptable quality even from heavily infested beds.

HOW DO NEMATODES AFFECT MY MUSHROOMS?

A common indicator of nematodes being present is bare areas with no mushrooms as pictured on the left hand side photo below. The mushroom pictured below on the right hand side is typical of the poor quality that can be directly associated with nematodes on the mushroom cap growing in a bed with extremely high numbers of nematodes.

HOW DO YOU KNOW IF YOU HAVE HIGH POPULATIONS OF NEMATODES?

Individual nematodes are normally only visible with the aid of a microscope as they are colourless creatures about 1 mm long, swimming in a film of water and feeding on bacteria.

When nematode populations become high, they foul the area with their waste products and run out of food. To survive, they must move to fresh compost and this is when they become visible by eye.

Nematodes swarm in wreathing masses as shown on P19. At that point in time they are hoping to hitch a ride with a vector (e.g. a fly) to a new food source.

Experienced growers use a technique of shining their torches across the casing to check for the presence of multiple nematodes. When there are large numbers the beds 'wink' – the masses of nematodes wriggle and squirm to attract a vector and they glisten and sparkle ('wink') in the torch light. This is very hard to describe with words, it's best to ask someone to show you this in infested growing room!

ARE THE NEMATODES NORMALLY PRESENT IN THE AUSTRALIAN MUSHROOM INDUSTRY SAPROPHYTIC (BACTERIAL FEEDING) OR PARASITIC (FUNGAL FEEDING)?

On the limited number of laboratory test results I have had access to over the years there have been no parasitic (or mycophagous) nematodes detected. All detections have been saprophytic nematodes, and these feed on bacteria. The only way to positively identify the type of nematode and the numbers present is to send sample or samples to a testing laboratory.

WHAT DO YOU DO TO MINIMISE THE IMPACT OF NEMATODES?

Nematodes are normally managed, not controlled because usually crops can still be harvested from nematode infested beds when the beds are managed to favour the mushroom and not the pest. Managing to favour the mushroom and not the pest largely involves producing a selective compost, avoiding 'over-wet' casing (particularly in the pre-wetting process), and avoiding excessive free water and poor evaporation in the growing room.

Bare patches should be examined for the presence of nematodes.

Poor quality mushroom that was found to have high numbers of nematodes on the cap.

Photo taken by mobile phone of swarming nematodes before first flush (examples arrowed). Note the very wet microclimate. *Photo: Farm supplied*

WHAT PESTICIDES CAN BE USED?

Because nematode numbers are managed, not controlled the pesticide option is only considered when nematodes populations are extremely high. The AMGA is the Permit Holder for PER12847 (version 2) - a Permit to Allow Minor Use of registered products containing 18g/L ABAMECTIN as their only active ingredient. A full copy of the Permit can be downloaded from the Agricultural and Veterinary Permits search database (portal.apvma.gov.au).

There are currently six products containing 18g/L ABAMECTIN listed as registered for mushrooms on the APVMA database.

Below is a screenshot of the Directions for Use:

Directions for Use:

Crop	Pest	Rate
Cultivated mushrooms (*Agaricus bisporus*)	Red pepper mites (*Siteroptes mesembrinae*) Mushroom pygmy mites (*Microdispus lambi*) and soil borne nematodes of the family Rhabditidae	6mL product/50L of casing material. (Incorporate into the casing material during preparation) 3mL product in 1.5L of water/m^2 of growing medium. (Two treatments, watered onto the casing layer as a split application 14 days apart)

Critical Use Comments:

- Apply when pests first appears using a water cart or knapsack spray.
- Repeat depending upon infestation.
- Apply as a casing drench or if in crop over beds.
- DO NOT apply more than 2 applications per crop with a minimum retreatment interval of 14 days.
- Application of abamectin should be made at casing material preparation stage or 2 applications watered onto casing layer as split applications.

Withholding Period:

Harvest: DO NOT harvest for 3 days after application.

Summary table of key action points for nematode infection prevention and management

Location	Action point
Phase II and III operations	Check that the temperature during Phase II pasteurization and conditioning are in range to achieve a selective compost. A well-managed Phase I is a prerequisite for an effective Phase 11. Ensure there are no 'cold', 'wet' or 'dry' spots in the compost. Confirm that spawn run is 'even' and complete before breaking up spawn-run compost. Breaking up an incomplete spawn run increases the risk of nematodes spreading and multiplying.
Filling and casing	Casing ingredients such as peat moss and CAC'ing [Compost -Added -at Casing] should contain no nematodes or very low numbers of nematodes. Make sure casing ingredients are stored and mixed in a clean area. Do not hold mixed casing over from one week to the next. Avoid 'over-wetting' the casing in pre-wet and/or at mixing. Free water and anaerobic conditions favour nematodes. Ensure the casing depth is as even as possible to make watering decisions more straight forward and to best avoid over-watering shallow areas. If high numbers of nematodes are present, consider applying Abamectin as per APVMA permit PER12847: • incorporate 6mL product/50L casing material during casing preparation; and • apply 3mL product in 1.5L water/m^2 growing medium. Two treatments, watered onto the casing layer as a split application 14 day apart.
Grow room	Grow under evaporative conditions. Avoid anaerobic casing and compost from overwatering. Control flies as they can spread nematodes from crop to crop.
Cook out	Ensure an effective cookout temperature is reached. Remove spent compost from the farm to avoid cross contamination.
General	Observe strict hygiene throughout the farm. Once present, nematodes can be readily spread by flies, people, tools and water. Nematodes multiply very quickly.

If you want some assistance in getting a positive identification of the specific nematodes you are dealing with on your farm or managing an outbreak, please contact one of the project team.

More Detailed reading on nematodes can be found in the recent article published in the Australian Mushrooms Journal Issue 1 2020 titled Nematodes -a Fly-In-Fly -Out Pest of Mushroom Crops by Warwick Gill. In addition there are numerous articles in the Nematode section of Agora, the Pest and Disease website [agora.australianmushrooms.com.au].

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MU16003 - Pest and Disease Management and Research Services

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PRODUCTION WASTE STREAM PROJECT

DELIVERS RECOMMENDATIONS TO INDUSTRY

The previous edition of the Australian Mushrooms Journal covered the Final Report of the production waste streams project, highlighting two of the four "solutions" put forward by researchers.

This edition of the Journal concludes coverage of the research detailing the case for the remaining two solutions.

BACKGROUND

The production waste streams project considered over 30 separate solutions in the search for ways to identify operational cost savings and potential revenue from mushroom waste. From this point, the project team, led by Kyle Kessler from Asymmetric Innovation and Scott Needham from Xinova, examined in depth eight separate "solutions" (see list below), before recommending four solutions for further consideration and development by industry - recycling SMS, mushroom powder, pelletiser system, and edible shelf life extender. According to the research, these solutions have the potential to deliver up to $55 million in savings or revenue to the industry, by using hundreds of thousands of tonnes of waste.

As outlined in the previous article, the desirability of individual solutions focused on the ability to deal with large quantities of mushroom industry waste. Each of the solutions was 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 needed and the length of time for any investment payback to be achieved.

PELLETISER SYSTEM

The study found that pelletisation reduced spent mushroom substrate (SMS) moisture content from 60% to under 15%, taking moderate energy use to convert it into a transportable, storable and versatile pellet form.

Using commercially available pelletisation equipment offers three distinct options to add value to SMS, each with different outputs and associated costs to implement. These options are:

1. Dewatering – SMS with 25-30% moisture content can be produced and sold as a soil additive, be further processed or stored longer on-site.

2. On-site energy – SMS pellets with less than 15% moisture can be burnt on-site to supplement existing energy supplies.

3. Off-site sales - SMS pellets with less than 15% moisture, with the addition of a co-input can be sold to third party energy and fertiliser companies.

PELLETISATION PROCESS

For simple dewatering, the SMS is either mechanically separated or fed directly into an auger with a drying chemical. The auger or mixing blender

SELECTED SOLUTIONS

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_2 - Replacing the existing CO_2 supplementation of greenhouses and algae farms with CO_2 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.

then dewaters the material from 65% to under 30%. The dewatered SMS can then either be used further on-site or sold to current purchasers of SMS at a higher price.

To use the SMS for energy, separation is necessary with the post-auger material fed into a pelletiser for further dewatering. This process produces pellets with under 15% moisture at a rate of between one to five tonnes per hour. In the trials conducted as part of this project, pellets with 19% moisture were shown to have an energy content of 13.9 MJ per kilogram (which is equivalent to brown coal and some sub-bituminous coals), which is sufficient to meet substantial on-farm energy needs. It was noted in the report that combining the SMS with a co-input such as coal dust or animal waste would create higher energy pellets with more significant savings.

The research found that pelletisation for off-site sales requires a co-input otherwise the pellets do not possess the necessary calorific value and consist of an ash content that is too high for energy markets. In addition, the use of these pellets for the fertiliser market requires modifications of elemental concentrations. It was suggested that off-site sales of pellets for fertiliser could potentially be explored in partnership with fertiliser companies, with the product formulated on-site. A United States farm – Modern Mushroom Farms – has successfully implemented this approach.

PROCESS CHANGES AND RISK MITIGATION

To undertake a dewatering process, the casing separation is not necessary. However, if further pelletisation for energy is made then separation of the casing from the compost is required, with the SMS or compost component fed from the truck into the auger at the facility. In terms of additional process changes a drying chemical (1-2% of total weight) is required, along with the collection and treatment of water. Further processing is also needed if energy or fertiliser pellets are the desired output.

The research indicated only minimal risk from this process beyond the need to keep the SMS at the facility for a more extended period. The report states that currently available equipment can efficiently process up to 40 tonnes of SMS or separated compost in just eight hours, minimising the time unprocessed SMS remains at the facility. It further indicates that drying chemicals could be customised to meet the needs of individual growers, with collected run-off water also sold alongside dewatered SMS.

The use of waste to meet on-site energy needs requires several process changes, including mechanical separation before pelletisation for energy. The process of pelletisation requires up to two staff to manage the movement of pellets along the conveyor from the pelletiser to the boiler. The method also requires transportation and storage of co-inputs on-site and the replacement of gas and electric boilers by biomass boilers. On-site energy also requires the compost to be split from the casing, which must be managed separately. The burning of pellets at the mushroom farm also requires ash from the on-site boiler to be collected and removed; however, this ash can be sold as a soil additive.

The report details that the management of the pelletisation equipment is a relatively passive process that can be conducted only a few times per week. In terms of new boiler equipment, the report suggests that current biomass systems have a myriad of safeguard systems to enable effective installation and operation within the farm setting.

Using the pelletiser for off-site sales requires finding new customers and partners. The sales process also involves additional regulations and also handling requirements, depending on the selected co-input required. To assist in the financial viability of this approach, a co-input that is free or easily transported to the production site could be used. The question of acquiring customers for off-site sales is also addressed in the report, with the project team indicating that they have formed partnerships with pellet purchasers to assist in the development of pellet off-take agreements.

PELLETISER VIABILITY

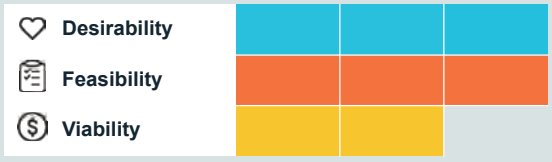
The researchers concluded that all the options with the pelletiser are financially viable, but are dependent on grower size, current SMS sale price and access to a low-cost or free co-input with consistent supply.

Of the three options dewatering SMS is financially viable to the largest segment of the industry. However, this is contingent that it can achieve a higher sale price than unprocessed SMS. The remaining two options are better suited to large farming operations. With the increasing costs of energy and compost inputs, it is expected that the financial viability is likely to improve further over the next five years.

A series of viability assessments were made for each option based on the following considerations:

- Mushroom production - 30t per week;
- Gas price - $16 / GJ;

Business Case in Brief



Cost to implement

- Dewater: $395k
- Pelletise for on-site energy: CapEx $2.4m
- Pelletise for off-site sales: CapEx $1.8m

Viability — Viable

- The most immediate financially viable option is to dewater SMS and sell as a soil additive.
- On-site energy and off-site sale of pellets are more suitable for big players that currently do not have a revenue-generating option for SMS disposal. Government funding and access to a free and reliable co-input improves viability.

Recommendation — Proceed

- There are many technology options, with no company offering a clear advantage. Explore equipment and pricing.
- Government incentives should be explored to subsidise CapEx.
- Consider maximising utilisation of CapEx by processing materials from local businesses.

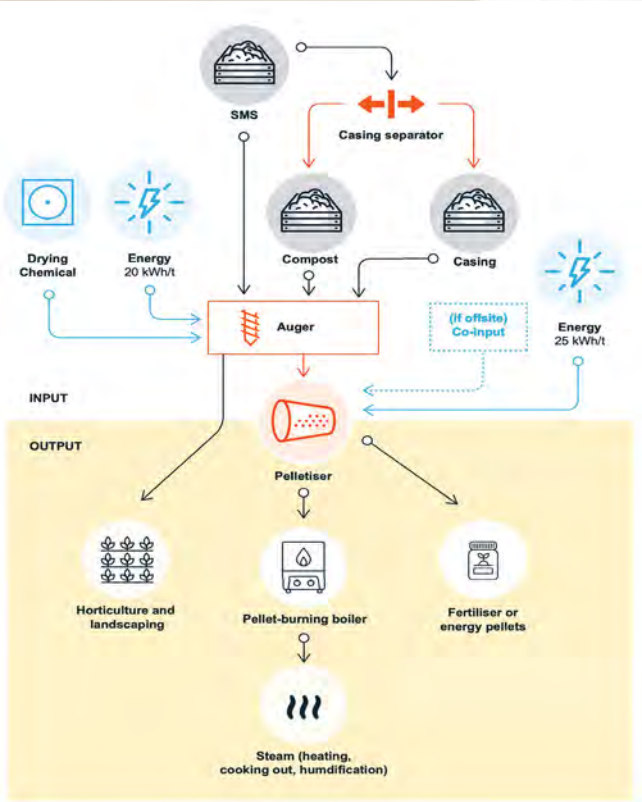
- Dewatered SMS sale price - $31.50 / tonne; and
- Pellet sale price - $165 tonne.

DEWATERING

The research found the basic drying system is viable for most growers if the dewatered SMS achieves a modest premium per tonne relative to the current SMS sale price per wet tonne. Based on initial capital expenditure of $395K and annual operating expenditure of $6K, the dewatering option achieves payback in five years.

While the research highlights a price of $31.50 / tonne, feedback from third-party soil amendment and fertiliser experts is that $35-45 / tonne is achievable for dewatered SMS. The report additionally suggests that, given a high trace element content, the SMS should be considered as a high-value soil amendment, rather than just an input into other compost products.

The dewatering option delivers a range of benefits including minimal capital expenditure, the creation of a more significant revenue stream for mushroom growers and a decrease in operational risks as substantial changes to the production process are not required. The development of long-term guarantees for soil amendment sales could further enhance this option as it would eliminate payback risk.
For each of the options discussed a further assessment was undertaken using three combinations of grower size and SMS sale price to demonstrate the potential payback in less than five years. These assessments are available in the Final Report.



ON-SITE ENERGY

The report suggests that on-site energy, with initial capital expenditure of $2.4 million and annual operational expenditure of $27,000, will become financially viable to a larger number of producers as energy prices increase to above $12/GJ. For smaller growers, the high capital expenditure costs, combined with the relatively low energy content of SMS, make this option a less attractive investment.

From a viability perspective, this option eliminates the dependence on natural gas and electricity, sending a strong sustainability marketing message to Australian consumers. Also, producers can shift pellet usage from on-site energy to off-site sales, depending on the price of energy and pellets. Another advantage is that large quantities of SMS can be processed without leaving the farming facility.
As outlined above the high capital

Equipment to facilitate change

Pelletisation requires the use of specialised equipment. The project team **vetted the capabilities and costs of equipment types and provider** options to inform the financial models and recommendations (*full financial models can be provided upon request*). Below is a high level overview of the most cost effective equipment types required for dewatering, pelletisation and on-site energy.

Mixing Auger

- Drying chemicals (hydrophilic or hydrophobic polymers such as chitosans flocs or PDADMAC) are added to the auger along with the SMS (or separated compost) to facilitate the non-thermal drying process.
- Low CapEx machinery that can easily reduce moisture content to <30% and process 1-5 tonnes per hour.
- The machinery and drying chemicals can be adapted to customer preferences and the desired end product.

Pelletiser

- Non-thermal pelletisers are not novel in many industries. The technology is energy-efficient, averaging <50 kwh/tonne of input processed (product-dependent).
- CapEx and OpEx are relatively fixed regardless of scale (i.e. between 1-5 tonnes/hour, processing cost is about the same).
- A pelletiser can run continuously and be used in conjunction with solar power during non-peak sun hours, providing the flexibility to choose when and how to generate energy and revenue.
- Large pelletisers with higher pelletisation rates can minimise the number of days the pelletiser is operational and thereby decrease OpEx costs.

Biomass Boiler

- Widely used technology in Europe, Japan and Korea for steam generation and heating.
- Biomass boilers are an established technology, readily available in Australia and compatible for integration with current on-farm systems for steam generation.
- Calorific value of SMS is within the necessary input range of most biomass boilers.
- If co-inputs are added to pellets, boilers can be fitted with steam turbines to generate electricity and further reduce costs.
- There are relatively few boilers that utilise a wide range of biomass inputs. Testing of boilers for compatibility with SMS pellets is required in conjunction with technology owners.

and operational expenditure provide a distinct disadvantage for smaller growers, particularly in the absence of government assistance for this type of energy investment.

ON-SITE ENERGY WITH CO-INPUT

The option of on-site energy generation using pellets made from SMS and a free, high-energy co-input was also assessed. The analysis found that this option - using coal dust as a free co-input - is financially viable to a higher proportion of growers at lower gas prices. It also found that this viability is not dependent on the usage of coal dust, with other drier, more energy-dense co-inputs also available to Australian growers. One of the keys to the success of this approach would be for growers to obtain high quantities of available co-inputs at a low to zero cost.

The benefit of this approach is increased energy production and costs savings, which further reduces dependence on electricity. The report does, however, stress that co-inputs such as coal dust could potentially become restricted through changes in government legislation. Whichever co-input is selected, reliable supply is required to ensure that energy output does not constantly fluctuate. This approach also requires the management of logistics and storage of the co-input for use in the operational system.

OFF-SITE ENERGY WITH CO-INPUT

The last pelletiser option assessed by the project is for off-site sales directed towards the fertiliser or energy markets. The research found that this option is financially viable if pellets can achieve prices between $42.50 and $188.20, depending on grower size and the current sale price for SMS.

An assessment of the fertiliser and energy markets revealed that generally organic fertilisers retail from $525-800/t and fuel pellets from $100-150/t. In terms of fuel pellet prices, the only limitation is the Mj/kg energy content and the relative moisture of the input material. (Further information on the pellet testing and assessment of fertilisers are available in the appendix of the Project Report.)

One benefit of this approach is that it creates a second revenue stream for growers independent of the price of fresh mushrooms. A further advantage is the fact that markets for biofuel pellets already exist in Australia.

The disadvantages of this option are primarily in line with that of pellets used for on-site energy. They include the need for a reliable supply of co-input, potential restrictions on co-inputs such as coal dust, and the requirement to manage logistics and storage.

RECOMMENDATIONS AND NEXT STEPS

The project team recommended that a pelletiser system is both technically feasible and financially viable for the industry to increase revenues and generate operational cost savings. Those producers with the highest quantities of SMS and the lower sale price have the most compelling case to proceed. The most immediately viable opportunity directed at implementing a pelletiser system is the consideration of equipment options for the dewatering of SMS.

The next steps for producers to consider are outlined as:

Dewatering SMS

- Organising an auger and matching the equipment and drying chemicals to the substrate and needs of the business;
- Developing partnerships with affiliated businesses to spread the cost of capital and maximise its use; and
- Applying for alternative funding from ARENA and Bioenergy Australia to subside the capital expenditure (the project team can assist in this capacity).

On-site energy

- Engage with biomass boiler equipment providers, incorporating the results of testing conducted as part of this project; and
- Examining a cost model and adapting the dimensions to meet the needs of the business and available co-inputs.

Off-site energy or fertiliser sales

- Test pelletised SMS with co-inputs for calorific value and elemental composition in order to meet the needs of energy off-take and pellet fertiliser companies in the local area; and
- Map a suitable co-input is available in the local region.

EDIBLE SHELF LIFE EXTENDER

The fourth recommended solution from the project is for an edible shelf life extender. The water-soluble and edible coating creates an invisible barrier to regulate the exchange of oxygen, water vapour and slow microbial growth. The coating was shown to increase shelf life, reduce waste, and decrease operational and storage costs of various fresh fruits and vegetables.

The work undertaken as part of this project examined the effect of the coating on *Agaricus* mushrooms. A review was conducted of current scientific progress in this area, identifying case studies of successful adoption across various industries. As part of this process, a world-first trial with a United States-based technology owner was conducted to explore potential commercial pathways for the technology in the Australian mushroom industry.

WHY EXTEND SHELF LIFE?

The simple reason for examining this area is that despite scientific efforts there has been limited progress in increasing the shelf life of fresh *Agaricus* bisporus mushrooms. The project team adopted a systematic approach, researching and categorising global efforts to extend the shelflife of mushrooms, investigating several new and exciting discoveries in this area of activity. The rationale behind this approach is driven by the fact that over one-third of the world's food is either wasted or lost every year. Taking this into account, and with the world's population expected to reach 10 billion people by 2050, shelf life extending technologies have the potential to assist growers in meeting the increased food demands of the 21st century. These technologies can potentially not only help reduce the need for wax and chemical additives but also help to limit the need for single-use plastics, reducing the

need for investment in biodegradable and compostable plastics and films. The project suggests that specific applications can also reduce the need for cold storage, saving energy and resources for growers and consumers.

HOW DO EDIBLE COATINGS WORK?

Used as a post-harvest treatment, edible coatings form a barrier to gases and moisture and can also serve as a carrier for antimicrobials and enzyme inhibitors. These edible coatings have emerged as an eco-friendly, sustainable technology requiring minimal processing and handling and assisting in the prevention of food spoilage. Given that mushrooms are a rapidly perishable product, edible coatings can be used to form an invisible barrier that helps to retain moisture and slow the respiration rate.

The project team identified the work undertaken by this American technology company as an appropriate entry point for consideration by the Australian mushroom industry. The company, which currently uses a silk fibroin (the protein from silk cocoons) as an edible coating has demonstrated success in the marketplace with applications in whole produce (avocado), ready to eat food, meat and seafood. The coating, which is odourless, flavourless and applied in a layer that is less than 0.01 mm thick, slows respiration, extends firmness, prevents oxidation and the hydration, and prevents microbial growth. The product forms a selective barrier between the perishable item in the environment, extending shelf life and reducing or even eliminating the need for the conventional cold chain management. Application of the coating allows the product to withstand a higher degree of deviation in temperature, moisture, mechanical stress and light exposure. It has also been shown to be effective across a range of products including apples, bananas, tomatoes, berries and grapes.

PROCESS CHANGES

The project team considered the application of this technology for use by the Australian mushroom industry, and in particular, required changes to the process, and the potential risks those changes would pose to the business.

To use the product, it is first powdered and mixed with water to create a shelf life extending solution. This proprietary solution is then applied via spray or bath either immediately before during harvesting, creating an invisible edible coating on the outside of the mushroom. The coating material can be incorporated into the preharvest irrigation or rinse system and sprayed on mushrooms, or if mushrooms are sliced, the coating is applied after slicing. The coating is then allowed to dry the mushrooms for packaging and transportation, with the coated mushrooms subsequently sold through the usual distribution channels with the same temperature requirements.

On the risk side of the equation, the approach incorporates a developing technology into a process that requires commercial scale and capabilities. Other risks relate to the issue of cost. If cost savings cannot be directly captured at a farm level, then a price increase – which would also need to take into account the application and harvesting process – would need to be passed to the consumer. Production would also become dependent on reliably sourcing the silk protein input.

VIABILITY

While the technology partner is still in the process of gaining Food and Drug Administration approval in the United States for the public use of the edible food coating, there is massive growth potential. Work by the mushroom industry to establish regulatory approval in Australia could help insulate growers from potential future international competition.
In preparing the assessment, the Project Team considered several aspects impacting on the viability of the use by the Australian industry. The first consideration is the fact that producers would need to pass along the costs associated with the use of the coating to the consumer. This process is viable only if the retailer or end consumer is willing to accept a higher price for increased shelf life. The next aspect affecting underpinning viability is for the use of the coating to deliver operational costs savings. The report also states that increased shelf life has the potential to expand export opportunities and suggests that exclusive partnership agreements could limit the threat posed by future fresh imports.

The viability is also impacted by regulatory approvals (both in the United States and Australia), acceptance of the coating by consumers and retailers, and technology access and licensing details that would require negotiation with the owner.

A high-level assessment of the cost savings that includes average sale price for mushrooms, labour costs and savings, plastic and energy savings, and coating price is shown below.

Business Case in Brief

Cost to implement

→ Projected cost to utilise the edible coating is $0.10 per kg of fresh mushrooms.

Viability Viable

→ Viability is supported through 3 circumstances in which growers can increase revenues from their product 1. Increased price to purchasers 2. Operational cost savings 3. Expand sales opportunities for P+3 or P+4 mushrooms

Recommendation Inconclusive

→ Promising feasibility, but application to current supply chains, customer demands, regulation and optimal formulation of the product require further investigation.
→ Work with technology owners to further refine product specs to mushroom industry needs
→ Regulatory hurdles represent an existing barrier

MUSHROOM SHELF LIFE TRIAL

The report details a world-first trial of the shelf life extender technology used on Agaricus bisporus mushrooms. The test was conducted in the United States using sliced and whole White Button and Swiss Brown mushrooms. The trial examined the reliability and freshness characteristics of both the control and test group of mushrooms, based on harvesting "grades" provided by Australian supermarkets.

The trial demonstrated an ability to slow the spoilage breakdown in whole and sliced *Agaricus bisporus*. The best result was achieved in sliced Swiss Brown, with an improvement in discolouration, hood splitting and overall rot. The trial highlighted an improvement in the overall marketability in sliced Swiss Brown (33% increase in marketable samples at day 8), sliced white (13% at day 8), and whole white (5% at day 8).

While the results were pleasing and showed evidence of a positive effect, the report cautions that further work is required to tailor the formulation and application to maximise the preservation effect.

High level assessment of cost savings

Mushroom average sale price received by grower, $/kg	$4.50
Labour cost, % of mushroom sale price	33%
Saturday labour cost vs Monday-Friday	1.5x
Sunday & public holiday labour cost vs Monday-Friday	2x
With coating: labour cost saving, $/kg	$0.20
With coating: plastic and energy saving, $/kg	$0.06
Coating price, $/kg of mushrooms coated	$0.10
Net saving for growers, $/kg of mushrooms sold	**$0.16**

Assumptions

1. The coating limits the need for refrigerated storage throughout the value chain
2. Limits the amount of harvesting and transport on weekends at penalty rates.
3. Reduces the need for plastic packaging - benefitting the bottomline, the environment, and generating a positive consumer marketing story.
4. Equal numbers of mushrooms are harvested each day of the week.
5. Coating (Mon-Fri) delays Saturday and Sunday harvesting to Monday
6. Use of the coating results in no changes in mushroom average selling price or transport costs.
7. No new capital cost is required.
8. The only new operating cost is the cost (price) of the coating material. No extra labour is required for mixing or application.

RECOMMENDATION AND NEXT STEPS

The recommendation from the report is that while edible shelf life extenders represent an exciting opportunity, and have shown positive trial results, the pathway to operational costs savings is inconclusive at this point. In terms of the next steps for Australian mushroom growers, the report suggests the following:

- Further collaboration with technology owners to refine the formulation, test new application methods and define supply chain integration.
- Engage with current customers to assess the desirability of a plastic-free, edible shelf life extender.
- Gather regulatory advice on the status of this and other shelf life extender technology.
- Continue to explore other companies and products in this space has consumers continue to seek reductions in plastic packaging.

The articles in the Australian Mushrooms Journal (Editions 1&2, 2020) have been provided as a summary of the final report for this project.

Anyone requiring further information is encouraged to obtain a copy of the Final Report. This report will shortly be available on the Hort Innovation website (www.horticulture.com.au). Copies are also available by emailing: communications@horticulture.com.au.

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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

FEASIBILITY OF COMPOST SUBSTRATE ALTERNATIVES: *A Project Update*

The over-reliance on any one component within the production chain can cause issues if availability becomes strained for any reason. This point was exposed recently when the severe drought across southern Australia reduced the availability of wheaten straw.

The Hort Australia levy-funded project – *Feasibility of compost substrate alternatives for mushroom production* – was established to consider the issue, work through the options and come back to the industry with recommendations.

The project, conducted by Drs Julia Jasonsmith and Jess Drake of Murrang Earth Sciences and Dr Kevin Wilkinson of Frontier Ag & Environment, has now been completed and a final report submitted to Hort Innovation for consideration and release to industry. The following article has been written based on this report.

INTRODUCTION

This project aimed to find alternative sources of carbon for mushroom compost production, with the preferred carbon source for compost wheaten straw, predicted to be more difficult to acquire over time.

The growing substrate for *Agaricus bisporus* is traditionally manufactured from wheaten straw, poultry manure and gypsum via a highly refined and tightly controlled composting process. Other organic raw carbon sources are added in small amounts as "supplements".

Wheaten straw is a good example of a lignocellulose waste stream, containing a combination of cellulose, hemicellulose and lignin. Apart from wheaten straw (and other cereal straws), other examples of lignocellulosic carbon sources include crop residues such as sugarcane bagasse, as well as the biomass of grasses, whole seeds, seed hulls and woody wastes such as sawdust, wood chips and green waste.
The production of mushrooms in Australia has evolved over decades of research, development and commercial practice, with wheaten straw used as the preferred lignocellulosic substrate in Australia. This is due to its unique physicochemical properties that are difficult to replicate - it has the right lignocellulosic content, excellent structural features and excellent water absorbency.

This research study highlights possible alternatives for wheaten straw. It has been based on a literature review, knowledge of the physicochemical properties of the carbon sources, access and cost, hazards, and valuable stakeholder feedback.

METHODOLOGY

The project team considered a range of carbon alternatives for their potential as both partial and complete replacements for wheaten straw. The first step in this process was a literature review to compile a list of potentially viable carbon sources. A period of consultation was also undertaken with industry stakeholders, as well as Australian and international researchers, to capture

Physicochemical properties of various lignocellulosic carbon sources for mushroom composting[1]

Group	Residue	% Cellulose	% Hemicellulose	% Lignin	Cellulose/ lignin	% Ash	% N	C/N	Structure[2]
Wheat	Straw	32–40	21–29	6–15	2.2–5.3	5.6–8	0.4–0.8	49–60	Good
Green waste	Mixed green	25–45	13–30	10–25	2.0–4.0	1.0–4.0	0.5–2.0	28–150	Good-fair
	Grass residues	25–40	13–38	6–18	2.4–3.9	4.2–6.2	1.3–2.5	28–42	Fair-poor
Paper, cardboard	Paper	54–70	12–25	11–30	3.0–6.0	NA	NA	NA	Poor
Spent grain	Brewer's grains	16–18	26–30	27–28	0.6–0.8	4.6–5.0	4.1–4.5	11–12	Poor
Corn stover	Leaves, straw,	36–40	25–29	13–21	2.1–2.3	3.6–.07	0.6–0.9	56–73	Good
	cobs	28–45	35–43	11–17	2.5–2.7	4.4–4.8	0.4–1.1	64–72	Fair
Seed hulls	Rice straw,	23–38	18–29	6–18	3.6–5.9	8.3–18	0.5–1.1	51–58	Fair
	rice husks,	28–43	18–21	22–23	1.3–1.9	17–21	0.3–0.4	100–136	Fair-poor
	sunflower husks	31–43	24–25	23–29	1.1–1.8	3.0–3.3	0.6–0.9	60–72	Poor
Other crops	Cotton trash	52–90	5–20	4–12	5.0–11.0	2.6–8.4	0.3–1.4	40–59	Good-fair
Sugar	Bagasse	27–40	19–30	19–23	1.4–2.2	1.5–5.0	0.2–0.8	120–190	Good
Forestry	Woodchips, sawdust (softwood)	38–50	11–25	26–30	1.4–1.7	0.4–0.5	0.1	310–510	Good-fair
	Woodchips, sawdust (hardwood)	43–45	22–33	24–26	1.7–2.0	0.2–0.3	0.1–0.2	150–450	Good-fair

1. Chemical compositions estimated from the published data compiled by Philippoussis (2009), except for green waste, which was estimated based on the assumption that different sources of green waste can either be grass/leaves dominant (with some wood), very woody (with some grass/leaves), or anywhere in between these extremes
2. Structure grading based on what we know of the physical characteristics of the carbon sources: Good = ideal particle size distribution or porosity for composting. This material will provide good structural support and water holding properties in compost mixes; Poor = carbon sources either too fine or too coarse for use as main structural component during composting; Fair = structural properties between good and poor. This assessment is based on the general relationship between particle size distribution, porosity and water holding capacity. Piles with too many fine particles can be dense and anaerobic, whereas piles that are too coarse can be dry and may not heat up.

opinions on the viability of these carbon sources.

From this, an initial list of potential carbon sources was compiled based on the following:

- Alternative carbon sources used in industry worldwide for mushroom compost production;
- Alternative carbon sources that have been investigated in the scientific literature;
- Other alternative carbon sources available in Australia that have not been previously investigated in research projects or by industry; and
- Other approaches to carbon source management, particular the partial substitution of wheaten straw with different carbon sources.

A three-stage feasibility study was then undertaken. This study involved a technical assessment of the physicochemical characteristics of alternative carbon sources and the potential impact of these characteristics on composting and mushroom yields. Carbon sources making it through this stage were then examined to establish availability in mushroom growing regions and expected costs of procurement, including transport. Any future climate-related limitations were also considered at this stage.

A hazard analysis examined the impact of carbon sources on mushroom worker health and safety, consumer health and safety, compliance regulations and quality standards (environmental, food safety and compost standards) and mushroom farm productivity.

After this process, a gap analysis was conducted to identify future research priorities for the development of compost substrates from alternative carbon sources. The project identified knowledge gaps and barriers to adoption for the shortlisted alternative carbon sources through a review of the literature, and consultation with industry stakeholders. The state of knowledge concerning the biology of *Agaricus bisporus* and the issues associated with substrate use and compost process optimisation as they relate to the development of substrates from alternative carbon sources was also considered. From this overall evaluation, a prioritised list of research and development and further questions were subsequently identified.

IDENTIFIED POTENTIAL ALTERNATIVES

This process initially identified some 24 alternative carbon sources as potential alternatives to wheaten straw in mushroom composting. Of these options, ten carbon sources were identified as being viable replacements and worthy of further evaluation.

The shortlisted substrates were:

1. Green waste
2. Bedding or litter from the intensive animal industries (e.g. horse, pig and chicken)
3. Paper and cardboard
4. Spent or fresh grain
5. Seed hulls
6. Oilseed waste
7. Corn stover
8. Other straws and crop waste (e.g. rice, cotton, canola, and hay)
9. Sugar bagasse
10. Forestry residuals (e.g. wood waste, woodchips, bark and sawdust

This list was then further refined as part of the feasibility assessment. The first step was to review the physicochemical properties of each of the shortlisted products. The research found that all ten products could be used for the partial, or complete substitution of wheaten straw in mushroom compost on an opportunistic basis.

The next assessment was made based on supply and cost. In terms of supply, some of these substrates were found to be impacted by climate change limitations and were therefore unreliable, while other substrates were found to be subjected to price competition due to their use in other industries, especially the feedstock industry. As a result of this assessment, the majority of carbon sources were eliminated during this stage of the review.

The remaining four-carbon sources that were found to have appropriate physicochemical properties with both viable costs and availability include wastepaper, forestry waste, corn stover and sugar bagasse. An assessment of the hazards and a research and development and gap analysis, was conducted on each of these carbon sources.

The report states that wastepaper (either shredded and soft mixed), while limited by its physical properties, could replace 20% of wheaten straw in compost without negatively impacting the porosity of the mix. Carbon sources that could act as complete substitutes for wheaten straw include forestry residuals such as bark and woodchips (subject to appropriate pre-treatment), corn stover and sugar bagasse.

In terms of availability, a ready supply of these four carbon sources is considered likely to persist even with the predicted climate change.

Wastepaper could potentially replace 20% or wheaten straw without negative impact

It should be noted that while corn stover and sugar bagasse both appear ideal as a substitute, transport distances to composting yards could be a logistical hurdle.

While there are no specific hazards, the biggest issue identified is the lack of knowledge as to the impact of any new carbon source on mushroom yields. The research team have indicated that further investment in research and development is necessary to develop new high performing substrates from any of these alternative carbon sources. This research, it is suggested, should be directed toward process optimisation, taking into account that the current composting process and growing practices for Agaricus bisporus have been optimised for particular commercial mushroom strains growing in carbon sources based on wheaten straw and poultry manure as primary ingredients. Any investigation of the potential use of other carbon sources should consider how the new production system could be optimised to ensure ongoing productivity and business viability.

READY RECKONER

As part of this project a ready reckoner (see below) was developed to help growers assess which carbon sources are available to be used in farming operations, and the costs and benefits of these carbon sources. The ready reckoner was created by summarising the findings of the report.

The ready reckoner contains a range of assessment criteria including chemical quality, physical quality, health and safety risk, commercial risk, transport, price, and the requirement for further research and development. The assessment criteria have been weighted and ranked based on a qualitative assessment of the properties of the carbon sources and the importance of these properties to the commercial operation of mushroom farms.

While the use of the ready reckoner is encouraged, the project team has suggested caution is exercised with on-farm trials. The recommendation contained in the report is to commence by substituting a small amount of wheaten straw for alternative carbon source, increasing the rate of substitution as confidence in the new substrate grows.

In addition, two case studies were also prepared with a focus on the shortlisted carbon sources for the gourmet mushroom industry. The reports are presented in the Final Report as a summary of the relative advantages and disadvantages of the shortlisted carbon sources for the use of growing oyster and growing shimeji mushrooms.

FINAL REPORT

The Final Report will shortly be available through the Hort Innovation website (www.horticulture.com.au), and anyone requiring additional details is encouraged to download the report and consider the implications for their business. Copies are also available by emailing: communications@horticulture.com.au.

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Carbon source	Rate of substitution for wheaten straw (%)*	Rating criteria and weighting (%)									Total score relative to wheaten straw (%)
		Chemical quality	Physical quality	Health and safety risk rating	Commercial risk rating	Transport			Price rating	Research & develop-ment	
						Melbourne	Sydney	Adelaide			
		(10%)	(15%)	(5%)	(30%)		(10%)		(10%)	(20%)	
Wheaten straw	*0*	*5*	*5*	*4*	*3*	*3*	*3*	*3*	*1*	*4*	***100***
Paper waste	<20 only	4	1	3	3	5	5	5	5	2	**75**
Bark and woodchips (blend)	40-100	3	3	5	1	4	3	2	4	1	**55**
	<40	3	3	5	2	4	3	2	4	2	**75**
Sugar bagasse	40-100	4	4	3	2	1	1	1	4	2	**70**
	<40	4	4	3	3	1	1	1	4	3	**85**
Corn crop waste	40-100	4	4	3	2	2	2	1	4	2	**70**
	<40	4	4	3	3	2	2	1	4	3	**80**

*Rate of substitution for wheat affects commercial risk and extent of R&D required. All other factors are the same for each carbon source except for regional variation in transport costs

Rating description	
>60	Potential substitute which requires substantial research and development to address commercial, health or disease risks, or has substantial transport or cost constraints
60+	Potential substitute which requires research and development to address commercial, health or disease risks, or has large transport or cost constraints
70+	Potential substitute with some commercial, health, or disease risks, with some transport or cost constraints
80+	Viable substitute with minimal commercial, health, or disease risks with few transport or cost constraints
90+	Highly viable substitute with negligible commercial, health, or disease risks, with minimal transport or cost constraints

A ready reckoner has been prepared to assist in the assessment of compost substrate alternatives.

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

RECYCLED ORGANICS AS AN ALTERNATIVE TO PEAT IN MUSHROOM CASING TRIALS

THE PROBLEM WITH PEAT

The Australian mushroom industry uses approximately 25,000 tonnes of peat casing every year. Mostly imported from Europe or Canada at a cost of $300 per tonne, peat is both an expensive and limited resource.

Peatlands are the largest natural land based store of carbon on the planet, absorbing 0.5 gigatons of CO_2 each year. Conversely, a massive 10% of all greenhouse gas emissions from agriculture, fishery and forestry are caused by draining peatlands. This is not just due to release of CO_2, but also more potent greenhouse gasses such as nitrous oxide and methane.

It is likely that draining peatlands and extraction of peat will be increasingly restricted as countries attempt to reduce greenhouse gas emissions. Such measures are "low hanging fruit" when it comes to options for mitigating climate change. Therefore, there is a high risk that peat will become more difficult to obtain as well as increasingly expensive.

The NSW Department of Planning, Industry and Environment (DPIE) has funded Applied Horticultural Research to investigate the technical and economic viability of blending locally sourced composted garden organics with peat, as an alternative to pure peat casing.

METHODS

Two recent trials have grown commercially viable white mushroom crops cased with blends of composted recycled organics and peat. Phase III compost bags were cased as per commercial practice, and the crop grown at the Marsh Lawson Mushroom Research Unit, University of Sydney.

Casing materials were made by blending composted recycled organics (supplied by Australian Native Landscapes), with Topterra peat moss. The recycled organics (RO) product was produced according to the AS4454 standard for composts, soil conditioners and mulches. This process ensures there are no food safety issues associated with using this product.

In Trial 1, the RO product was well matured and finely ground, whereas in Trial 2 a younger, coarser fraction was used to help identify whether a coarser product allowed for better water infiltration through the casing layer. Physical and chemical analysis

Trial 1 product – fine and well matured

Trial 2 product – coarser and less mature

Table 1. Physical and chemical characteristics of recycled organic products and peat tested

Characteristic	RO Batch 1 - Fine	RO Batch 2 - Coarse	Peat
pH	8	7.5	7.5
EC (dS/m)	2.3	2.4	0.4
Total available N (mg/kg)	6.8	125.1	6.4
Air-filled porosity (%)	10	35	11
Total water holding capacity (%)	67.9	64	75.6

Table 1. Physical and chemical characteristics of recycled organic products and peat tested

#	Trial 1	#	Trial 2
1	Control (peat only)	1	Control (peat only)
2	25% RO (non-pasteurised) + 75% peat	2	25% RO (non-pasteurised) + 75% peat
3	25% RO + 75% peat	3	25% RO + 75% peat
4	50% RO + 50% peat	4	25% RO from trial 1 + 75% peat
5	100% RO	5	50% RO (leached*) + 50% peat
		6	50% RO + 50% peat

* The RO was leached by soaking in water for 5 minutes, draining and repeating three times.

of the products showed major differences in air-filled porosity (the amount of air space in the product) and available nitrogen. Water holding capacity, pH and electrical conductivity (EC) were reasonably similar.

In addition to pasteurisation during the composting procedure at the production site, the RO product was pasteurised at 60°C for 6hrs immediately before casing, except for samples kept aside for Treatment 2 (non-pasteurised RO) in both trials. Water was added to the RO in order to increase moisture content from 50% to 75%. This ensured all casing materials were similarly hydrated at the start of the trial.

Each treatment was repeated four times in separate growing bags. The treatments were varied slightly between the trials; results for 100% RO in Trial 1 meant this treatment was not repeated in Trial 2. Treatments are summarised as above.

Mushrooms were grown to flushes, and picked by size and maturity, targeting the 40-50mm category at the cup stage.

RESULTS

Adding 25% RO to the casing in Trial 1 produced similar yields to the pure peat control. While a 50:50 mix tended to reduce yield, the difference was not significantly different. Using RO alone reduced yield compared to peat only, as well as tending to slow mushroom development; although the first flush was greatly reduced, the RO only casing treatment 'caught up' to some extent in the second and third flushes, both of which produced excellent quality, dense mushrooms.

Yields in Trial 2 were similar across all of the treatments tested, regardless of whether 25% or 50% RO product was added, or fine (Trial 1) or coarse

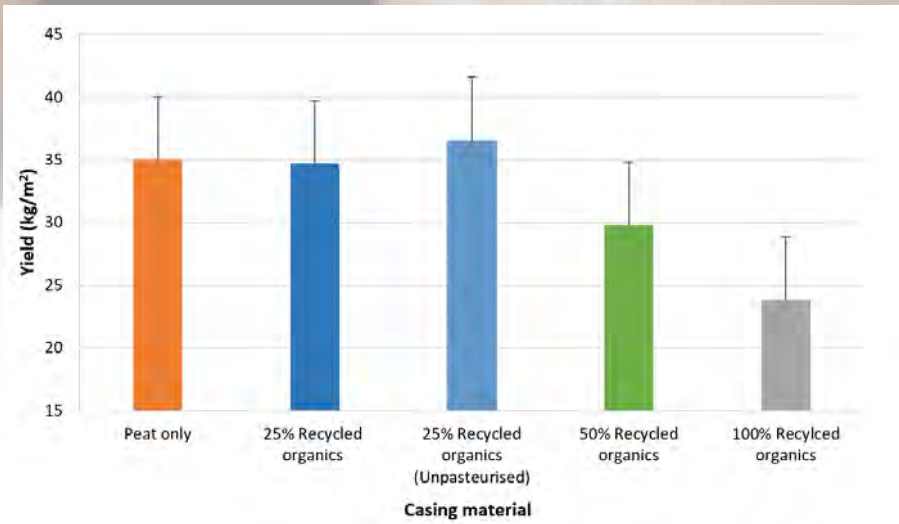


Figure 1. Trial 1 mushroom yields of blocks cased with various blends of peat and recycled organics product. Vertical lines on columns represent the standard error of the mean.

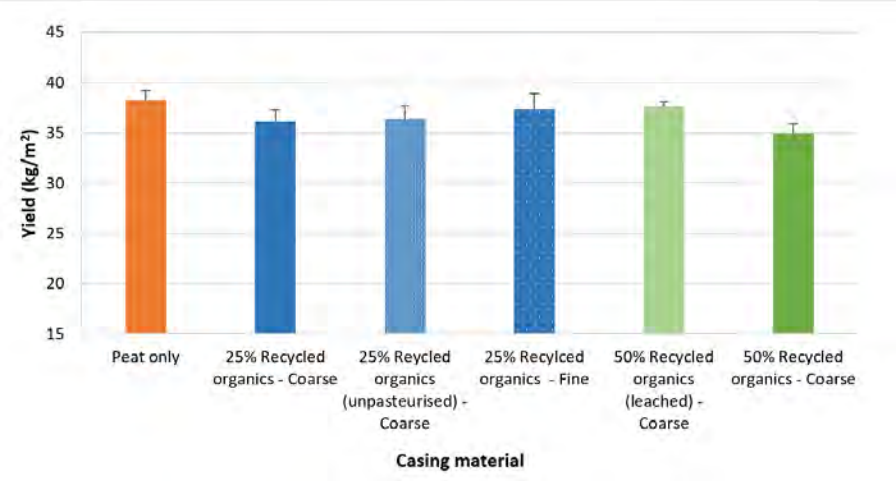
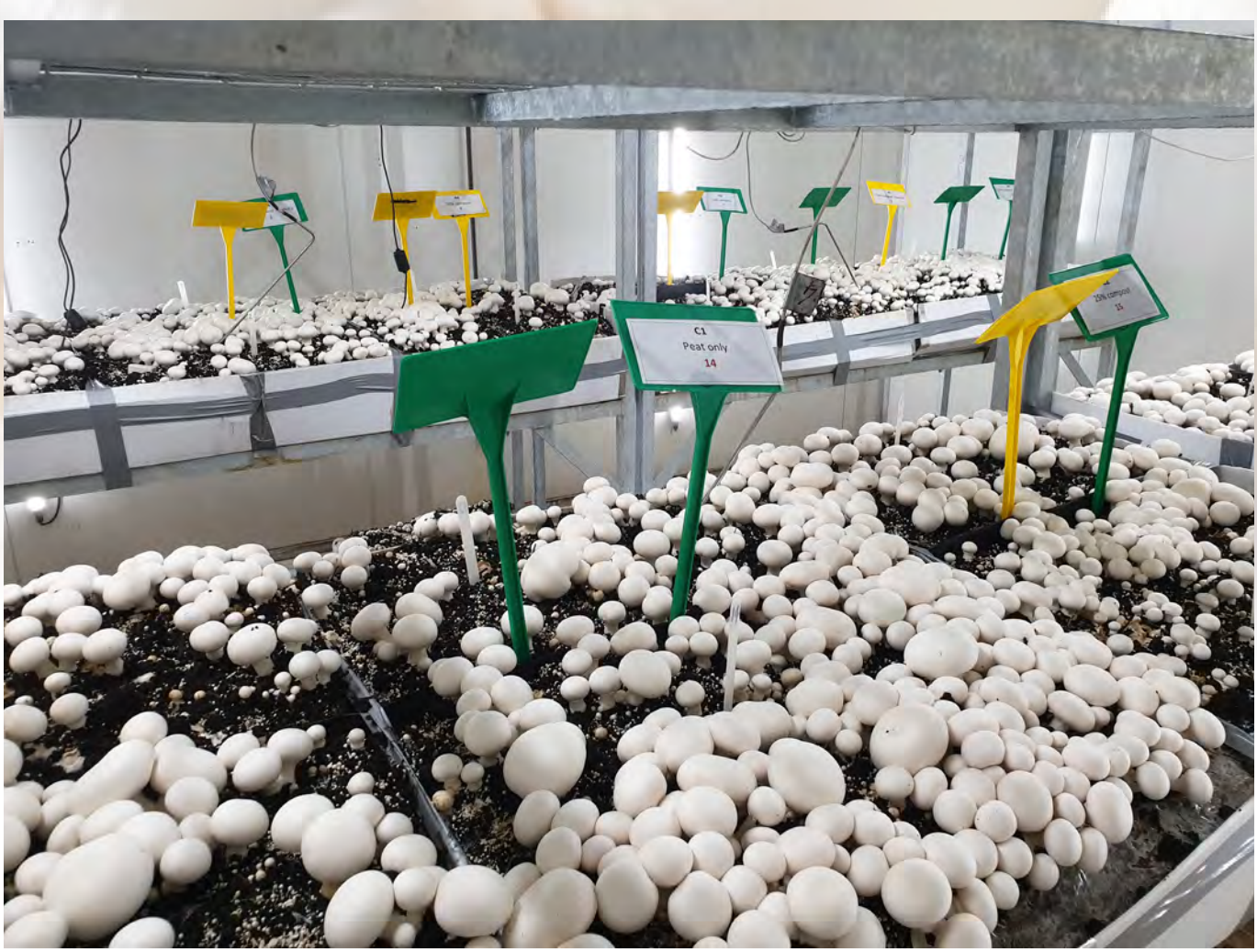


Figure 2. Trial 2 mushroom yields of blocks cased with blends of peat and recycled organics product. Vertical lines on columns represent the standard error of the mean.

Trial 2) RO product was used. Yield tended to be higher when the 50% RO blend was leached with water compared to the un-leached 50% RO mix, although the difference was not statistically significant. Leaching helps to lower salt content and available nutrients as these can reduce mycelium growth through the casing. Interestingly, the coarser RO product incorporated at 25% performed similarly to that of the finer product in Trial 2. That was despite major differences in air-filled porosity, and nitrogen content of the two products. Furthermore, yields from the 50% RO blends (unleached) in both Trials 1 and 2 were both slightly lower than peat alone, although the difference was not statistically significant in either trial. This suggests that variability in the age and particle size profile of the RO products does not have a major impact on performance in mushroom casing materials.



In both trials, unpasteurised 25% RO blends had slightly higher (Trial 1) or similar (Trial 2) yields to the pasteurised 25% blends. There had been some concern that using RO product which had not been pasteurised immediately before casing could introduce weed moulds or disease, but this was not observed in either trial. It is likely that high temperatures required to meet pasteurisation (>55°C for >3 days, repeated 3 times) in the piles of RO at the production facility are effective at removing pathogens in the material.

While no disease was observed in any blocks by the end of the third flush in Trial 1, in Trial 2 *Trichoderma* had started to appear in one block (out of 24) by the third flush. The pasteurisation step immediately before casing may not have been sufficient to remove *Trichoderma*, or may have increased the likelihood of disease, by creating a microbial vacuum in the pasteurised RO product.

Previous work undertaken by Professor Ralph Noble in the United Kingdom (UK) found that addition of RO at 12.5% had no effect on yield, but adding 25% reduced yield compared to peat casing. Feedstocks, composting techniques and environmental conditions are likely to be very different in Australia compared to the UK, which could explain why addition of RO product at up to 50% has been successful in these initial Australian trials.

The results are very promising for Australian mushroom growers. Compost made from RO is approximately a third the price of imported peat, so incorporation of up to 50% represents a significant saving. Reducing reliance on imported peat also improves the overall sustainability of the mushroom industry.

A third trial will commence shortly, using a new batch of composted recycled organics product, to help confirm these exciting initial findings.

This project is supported by the NSW Government's Organics Market Development program under Waste Less Recycle More, funded from the waste levy.

For more information, please contact Adam Goldwater (Applied Horticultural Research).

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TESTING TO *Prove* OR TESTING TO *Improve?*

Among the seemingly endless list of compliance requirements that all fresh produce businesses face, verification testing is often questioned from both a cost and value perspective. "Why do we have to test" is a common question, and for most the answer would be "because our customers say we have to". While the answer is not wrong, the driver for compliance is misguided.

Anyone in the business of growing and supplying food to consumers, understands those consumers trust the food they buy is safe, and they rely on an integrity of both process and product. The seemingly endless range of testing for heavy metals, chemical residues and microbial contamination won't itself make the product safer. However, it will provide assurance and surety that the processes we follow deliver product that is free from residues and safe to eat, factors that are critically important at a business, industry and ultimately customer level.

For testing to effectively underpin supply, there is a clear assumption of full legal and customer compliance. However, even where that exists, there are still many lessons to be learnt from each and every test result, lessons that will hopefully ensure that producers 'test to improve', rather than simply 'test to prove' compliance.

At an industry level, a proactive approach to verification testing has had significant benefits for the Australian mushroom industry. In recent years, independent, de-identified data has been used on a number of occasions to support and verify compliance at a whole of industry level. This approach not only contributes to the determination of risk classification for whole fresh mushrooms, but can also be used to demonstrate widespread industry MRL compliance and reviewed to establish priorities for research, development and extension.

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LESSONS FROM CHEMICAL AND HEAVY METAL TESTING

Just like the forensic investigators on TV, the review of chemical residue or heavy metal test results can act to provide vital information on inputs such as compost and compost ingredients, supplements and on the process of chemical selection, application and use.

When residues are detected they are usually well below the MRL, but when there are detections it is worth considering at what % of the MRL they are, and to review factors such as inputs, use patterns and application rates to ensure full control of product and process, in the most cost effective way.

The AMGA Verification Testing Program was most recently conducted in April 2020, with details on participation sent directly to members by the Association. While this was an industry-wide collection, verification testing is available all year round and can be organised through the AMGA.

A testing program request form is available from the AMGA (Email: martine.poulain@amga.asn.au). Simply complete and return the form and a test kit/s will be sent out to you.

The test results are reported back to the individual business through the AMGA, with interpretive support and follow up offered as and when required.

The AMGA Verification Testing Program not only offers an easy, cost effective testing mechanism for member businesses, but it also helps the Association continue to defend the industry as part of the AMSafe Program through the use of consolidated test data collected over many years.

Support of the AMGA testing program as both a service to industry and as a mechanism to gather, review and utilise data for the broader industry good, is important to ensure all the customer driven effort can also be a mechanism to protect and improve the reputation of the industry as a provider of high quality, safe product to Australian consumers.

LESSONS FROM MICROBIAL TESTING

Close monitoring of microbial test results can often pre-empt a potential problem, well before it becomes a problem. Indicator organisms detected at low levels in product or inputs can assist in identifying issues with infrastructure, and with cleaning and hygiene practices.

A problem understood is a problem solved, and testing provides the opportunity for this understanding.

SPRINT is Sylvan's newly formulated "Supercharged"spawn carrier.

An innovative grain-based growth medium enriched with a high power nutrient blend and a variety of bioactive ingredients to stimulate enhanced mycelium growth.

SPRINT is available for the following Sylvan products and strains:

Spawn A15 and Spawn SB800
CIM A15 and CIM SB800

COVID-19:

WHY OUR 'NEW NORMAL' SHOULDN'T BE SO VERY NEW

Who could have imagined the current world reality of 2020? The impact of COVID-19 is both very real and highly likely to be long-lived, disrupting the world order at every level, from Government, through business, to everyone on the planet.

Individuals or businesses can do little to correct world order, but operating in our sphere can be part of collective influence and ultimately a collective solution towards a 'new normal'.

As the world moves towards that 'new normal', there are many instances where the broader COVID-19 messages can be applied to improve business operations. Many of those messages and lessons are simply a good practice that applies as much today to day business operations as it does to life under COVID-19.

The diagram below, widely circulating in business articles in recent weeks sets a clear and logical path towards a post-COVID-19 economy. One of the key lessons illustrated is the concurrent nature of the overlapping waves and the importance of adequate resourcing to manage both crisis reaction, day to day business, and proactive forward planning.

MUSHROOM MARKET

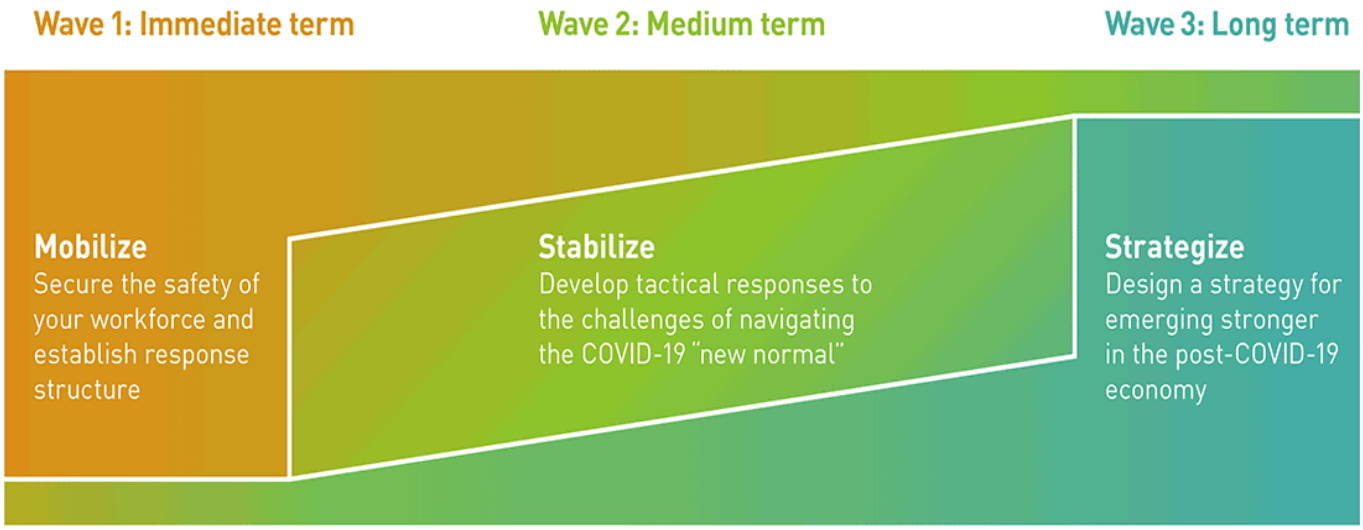
In 2020, COVID-19 has demonstrated not only the fragility but also the resilience of the fresh food supply chain.

While initial panic buying led to supermarket shelves being emptied, most customers have subsequently seen sales demand stabilise and increase, and supply volumes align. With consumers spending significantly more time at home and with an increased interest in home cooking to keep the family occupied, increasing demand for quality fresh ingredients has become part of the new normal.

However, for businesses reliant on supplying the foodservice sector, where demand all but disappeared overnight, things have been and remain tough. This situation reiterates the need for fresh produce businesses to have a balance in terms of customers and certainly not to put all their eggs in one basket.

The three waves of a COVID-19 crisis response

Organizations that successfully accelerate the speed with which they progress through the waves tend to emerge stronger.



Source: PwC

KEY STEPS IN CRISIS MANAGEMENT:

- Assess the risks
- Determine the business impact
- Identify contingencies
- Build a plan
- Familiarise users
- Revisit the plan frequently

There are many useful resources available to assist in developing crisis management plans at an individual business and industry-wide level. For more information and support contact the AMGA.

As the retail and foodservice markets adjust, COVID-19 has also seen an acceleration of online shopping options, as consumers look at different ways to buy food. The online channels have grown strongly in recent years, and COVID-19 is likely to accelerate this market further, as long as logistics and delivery issues can be effectively managed.

Finally, while export markets are a less important channel for the Australian mushroom industry, for many other fresh produce sectors, export is a critical component. With the challenges of COVID-19 impacted markets, closed borders and limited freight availability, for many sectors export trade will be a challenge for the foreseeable future. In contrast, the limitations on import volumes may provide opportunities for increased domestic production in niche products, including many exotic mushroom varieties, traditionally sourced primarily from overseas.

While many elements of the fresh produce market are likely to be challenging and uncertain for a considerable time to come, businesses will find a new level of resilience, there will be new opportunities, and COVID-19 won't last forever.

STABILISING BUSINESS

Crisis management plans have long been included in the certification systems implemented on-farm. Still, for the majority, those plans were written with 'crisis' being just a distant and unlikely event. COVID-19 has seen 'crisis management' put to the test.

As the initial turmoil subsides and businesses stabilise and move towards the new normal, it is well worth revisiting the scope of the crisis management plans and ensuring they provide true value and direction for the future.

Through working with several large fresh produce businesses, experience has shown that the key to preparedness and success is in the ownership of, and commitment to crisis management and broader business planning at all levels of a business.

Historically it's been easy to dismiss crisis management as yet another unnecessary burden of compliance, but with the experience of recent months, taking time now to really focus on risk and risk management will pay dividends into the future.

BUSINESS PROCESS

COVID-19 has focused everyone on socially distancing for a range of extremely good reasons. Despite the need, the requirement remains challenging, particularly as horticultural work often requires large numbers of workers - pickers or packers together in close proximity to each other.

Many useful guides have been produced for the fresh produce industry to manage these changes in the workplace and provide clear and focussed guidance to employees. The PMA-ANZ 'COVID-19 and Fresh Produce' series – '*Protecting your Workforce*' is a useful summary. While the document has been developed in the COVID-19 era, it reinforces information that should already be part of normal operational practice.

But beyond the current need for human 'social distancing' within mushroom production, the need for 'distancing' in many key processes has always been critical to success. The segregation of process in compost production, in room preparation, in harvest management and in post-crop disposal is second nature to the mushroom industry. Perhaps the mushroom industry is ahead in already readily embracing that new normal?

Without appropriate segregation, biosecurity controls and hygiene practices, it would be impossible to produce quality product for the market successfully.

MANAGING PEOPLE

As already discussed, the focus on good hygiene practices for COVID-19 management should be second nature to every mushroom business, with the ability to maximise crop potential contingent on good hygiene at every step in the production process.

Delivering safe food to the consumer is equally reliant on the personal hygiene practices of workers and staff, and again should already be part of the day to day business activities.

The Australian fresh produce sector has been well supported in reinforcing the hygiene message through the COVID crisis, producing resources that will remain valuable in every workplace long into the future.

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PMA Australia + New Zealand Fact Sheets – COVID 19 & Fresh Produce

Protecting your workforce

This checklist has been developed by PMA A-NZ to assist business in the fresh produce industry (fresh fruit, vegetables and flowers) better manage teams in the unique environments of harvesting and packing fresh produce. The document has been developed specifically in response to COVID-19 and provides guidance on how best to manage teams to limit the changes of infection in the workplace and keep them healthy and supporting the fresh produce supply chain.

Checklists include:

- Temperature Checks
- Packing Sheds
- Field Harvest Crews
- Workforce Accommodation
- Transport

Sanitation in the food industry

Under the Australia New Zealand Food Standards Code, food businesses must maintain clean and sanitised facilities and food contact surfaces. This is especially important for ensuring food safety, and meeting consumer expectations at a time when there are concerns about food safety and the transmission of the virus responsible for COVID-19 in the workplace.

Topics include:

- Cleaning and sanitation
- What sanitisers are approved for food businesses?
- Supplies of cleaning and sanitation chemicals
- Alternative sanitisers
- Considerations when using sanitisers

Hand washing and hand sanitisers

Employees in the food industry must practice good personal hygiene and be aware of good hygienic practices. This includes implementing effective hand washing procedures and understanding situations where hand sanitisers are used.

Hand hygiene plays an important role in preventing the transmission of microorganisms to food, to food contact surfaces, and to other people, as well as protecting the individual from becoming ill. This is especially important where transmission of the COVID-19 virus is a potential hazard.

Topics include:

- Hand washing
- Regulation of hand sanitisers
- Shortages

Readers of the electronic version of this Journal can view the Fact Sheets by clicking on the embedded link in the titles of each document as shown above. The Fact Sheets can also be accessed directly at the following website address: https://www.pma.com/global-pma/anz/news/2020/covid-19/resources-covid19

Fact sheets developed by PMA-ANZ in the 'COVID-19 and Fresh Produce' series provide a useful summary of both 'Hand washing and hand sanitisers' and 'sanitation in the food industry'. An outline of the information is provided in the table above.

`As Australia has demonstrated far more effectively than most countries in the world, management of a crisis is possible, but it needs strong adaptive leadership, consistency, and commitment. COVID-19 has presented a range of challenges and will continue to do so as business and community navigate the path to the post-COVID normal. But, it also presents opportunities to build on strong industry and business foundations and embed plans and processes to establish a distinct 'new normal' and guide Australian Mushrooms into an even stronger and more prepared future.

THE IMPORTANCE OF FILLING

To make useful improvements in the growing room, it is vitally important to fill the room correctly. If there is not enough knowledge or attention to the details, then the whole growing cycle will be affected. So, how should the room be filled to maximise production?

The correct amount of Compost added at Casing (CAC) and the even distribution of this CAC is very important to get an even growth of the mycelium throughout the room. The fact is that achieving even CAC'ing is not as easy as it sounds.

Only when the compost layer comes perfectly evenly and smoothly out of the head filling machine before the casing falls on top is it possible to get the job done with the first spinner on the machine. And it is this spinner that is used to get CAC'ing in the casing and spread evenly.

On many occasions, the compost layer is not visible for the operator and it requires a look at the other side of the machine to examine what is causing the problem. The potential problems include an uneven supply of the compost, the swivel belt timing or not enough and uneven compression.

Whatever the issue is, it needs to be resolved before the CAC'ing depth is set.

Another tip is to ensure an even amount of supply is entering the casing hopper. If it is uneven, then too much casing will get pushed through intermittently distributing more casing on some spots, and causing an unequal distribution of CAC across the room. Depending on the structure of the casing, and the desired structure, the speed of the spinner can be adjusted to get the right result.

The purpose of the second spinner is to level the casing. Depending on the structure of the casing, the speed should be adjusted to ensure the spinner is not set too deep. If it is set too deeply, the casing will build up behind the spinner, and as a result, it will throw casing over the spinner, causing an uneven casing layer. Carefully addressing these issues will help to ensure an even level in the casing layer before it goes under the press at the end.

The press provides the final touch to this process. It should press the casing slightly at the end of the machine, just enough to push down the last loose casing on the top but not so much that it causes anaerobic spots on top. If the level is not good enough with the 2nd spinner, too much casing will be pressed, causing anaerobic spots of the casing on top of the beds where no mycelium will grow. It is important to minimise that as much as possible.

Setting the machine in the morning is very important. An important recommendation is always to start the machine on the 2nd shelf, set it up as required and try not to change it too much during the rest of the room. The most critical step is to set the right compost height in the morning to avoid too many changes. Of course, it should always be adjusted if necessary but make sure to minimise the changes and where adjustments are made remember to adjust all the settings. A shift in compost height might change the compost press, height of the spinners and casing press roll. Unless care is taken with these changes, these adjustments can be overlooked, causing a different fill across the room after the compost height is changed.

While it is crucial to get the job of filling done as quickly and efficiently as possible, but the top priority should be a good even filling. If for any reason, it's not possible to get an even fill, then it is recommended to adopt a different approach and get the CAC'ing done manually. On many farms, this is a good solution for those who don't have the right equipment or just never get the CAC'ing even for various reasons. The extra time invested at filling will be paid back later by even growth and the use of the exact amount of CAC'ing required.

One way to approach this task is to throw the CAC'ing into the end of the casing hopper before it goes on to the belt (see image below left). Before it goes onto the compost, the CAC'ing will get a good mix into the casing. If a hopper is not being used, it can also be spread onto the casing belt. In this example, just count the kg used per shelf and ensure all the shelves are treated the same.

A good filling is the head start for every growing room. This article briefly highlights a few of the necessary details that need attention, but there are many more of course. It's not always easy to get the room filled precisely as required, but proper training and of course the right equipment will get the job done and make the rest of the cycle easier to get the maximum result.

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HORT INNOVATION ROUNDUP

COVID-19 LINKS AND RESOURCES

In light of the COVID-19 pandemic, Hort Innovation has been working to adapt its activities and manage the risk for the industry. Hort Innovation CEO, Matt Brand recently outlined this approach in an open letter to the horticulture industry. Activities include:

- Managing R&D investments for risk;
- Shifting the focus of industry-specific marketing program to suit the changing situation;
- Working with industry and government to review current and future market access;
- Maintaining strong links with government and other relevant industry bodies to assist in relevant decision-making affecting the horticulture sector;
- Prioritising industry investments through to 2020/21 and into the future; and
- Trying new things including the whole of horticulture The Good Mood Food campaign (see separate item below).

Industry participants are also encouraged to visit the Hort Innovation website to stay up-to-date on information relating to COVID–19 (www.horticulture.com.au).

GOOD MOOD FOOD LAUNCHED

Hort Innovation has developed The Good Mood Food initiative to support the horticulture sector through the effects of recent times, which are being felt in consumer spending and purchasing behaviour. The bold new marketing campaign is motivating more people to consume more Australian fruit, vegetables and nuts, more often — with the message that when you eat better, you feel better. The campaign is now underway, with

a new TV ad supported by advertising, public relations, increased social media and a range of partnerships. The campaign is expected to reach up to 98% of Australians, with ads appearing across metro and regional TV, as well as in catch-up services, during high-rating programs including Seven News, The Project and more. There will also be placements directly linked to 'good mood moments' in popular shows such as MasterChef Australia, Have You Been Paying Attention?, Farmer Wants A Wife and others.

The campaign is designed to evolve and grow, including the ability to focus on seasonality and occasionality of horticultural products. Further details are available at The Good Mood Food website (https://www.thegoodmoodfood.com.au/).

HANDBOOK AVAILABLE

The latest edition of the Australian Horticulture Statistics Handbook is now live with a new interactive dashboard, improved search functionality and user preferences. The Handbook features data on more than 70 horticultural products including fruit, nuts, vegetables, nursery, turf and cut flowers. The Handbook provides important data for industry, researchers and decision makers; supports policy formation; and contributes to further research to benefit all horticulture industries.

New metrics are now available, reporting information about retail and foodservice distribution for fruit and vegetables. The new interface allows users to dynamically select products 'on demand' and perform a greater range of timeseries analysis on the data which now dates back seven years to 2012/13. Mushroom Statistics for the year ended 2019:

- 72,007 t produced and valued at $438 m with 3% sent to processing.
- The wholesale value of the fresh supply was $534 m, with $387 m distributed into retail and $147 m into food service.
- 69% of Australian households purchased mushrooms, buying an average of 279 g of mushrooms per shopping trip.
- The supply per capita was 2.9 kg, based on the volume supplied.

To access Hort Innovation's Australian Horticulture Statistics Handbook, visit

Mushroom Fund snapshot

20+ investments
Currently underway

15+ resources and reports
Ready for you to use

$4.80 million
Levy collected in 2018/19

$2.15 million
Invested in R&D in 2018/19

$2.83 million
Invested in marketing in 2018/19

$104 million
Potential impact of industry SIP

www.horticulture.com.au/hortstats. The Handbook's interactive dashboard is suitable for viewing on desktop computers, while PDF information can also be viewed on mobile.

NEW PROJECTS UNDERWAY

Hort Innovation has recently confirmed the following project. A summary is included below, and as additional information becomes available, it will be included in upcoming editions of this Journal.

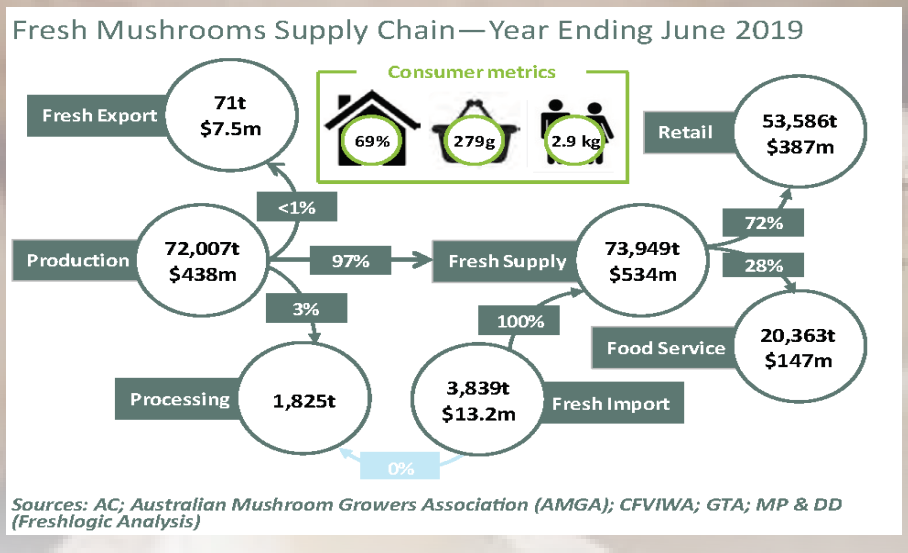
New innovations to improve mushroom whiteness shelf life (MU19005)
Key research provider: Applied Horticultural Research
Project end date: 20 October 2020

This investment is investigating innovations to improve and maintain mushroom whiteness, looking at both pre- and post-harvest factors. It will produce a grower-focused guide that outlines the most effective technologies, techniques and strategies that growers can use on-farm to improve and maintain mushroom whiteness, with information to improve handling and management through the supply chain as well.

Presenting clean, white mushrooms to consumers at retail is a proven method of increasing sales, whereas conversely, browning on mushrooms is negatively perceived by consumers and is associated with the produce being 'at the end' of its storage life. Improving and maintaining whiteness has the potential to boost sales and reduce waste, and ultimately improve the profitability of the mushroom sector.

The project team is first consulting with the domestic mushroom industry to identify what methods are currently used to improve whiteness. A global review will then be conducted (including scientific literature) of pre-harvest and post-harvest practices which are currently used or could be used to improve mushroom whiteness.

This process will also look to identify any knowledge gaps that require further R&D investment from industry, and will rank potential opportunities by the likely benefits and costs of each technique.



Sources: AC; Australian Mushroom Growers Association (AMGA); CFVIWA; GTA; MP & DD (Freshlogic Analysis)

CONCLUDED PROJECT

The following project has recently been completed, and the summary is included below.

Mushrooms attitudinal research (MU19000)
Key research provider: Fifty-Five Five
Project end date: 31 May 2020

This short investment undertook research to increase understanding of consumer behaviour and attitudes towards mushrooms. The project team profiled mushroom consumers and delivered insights into mushroom usage, attitudes and consumption occasions as well as identifying triggers and barriers to purchase, and quality and taste expectations.

By identifying key targets and growth opportunities, this research will be used to inform future Hort Innovation Mushroom Fund marketing activities and will be available as insights for the mushroom industry at large.

STRATEGIC INVESTMENT ADVISORY PANEL

The Mushroom SIAP met in early June to advise Hort Innovation on the investment recommendations contained in the DRAFT Mushroom Investment Plan 2020-2021. A public version of the Mushroom Investment Plan will be made available shortly on the Hort Innovation website for broader communication.

To stay up to date with SIAP activities, please visit the Hort innovation website to view a full list of meeting summaries.

NEW WEBINAR SERIES

The Hort Innovation Insights webinar series is designed to help connect industry with research investments. Each short webinar session features subject matter experts, project delivery partners and Hort Innovation staff discussing key topics, opportunities and challenges for horticulture growers.

You can either attend the events live by registering (and have the opportunity to ask questions of the panel), or you can visit the website and listen to the recordings, which will be loaded after each event. More information is available at: https://www.horticulture.com.au/growers/help-your-business-grow/news-media/2019/insights-webinar-series/

Topics include the following:

- The impact Covid-19 has had on the food services sector, particularly, fresh food and produce (18 June); and
- The consumer market environment for horticulture growers during COVID-19 (28 May).

Hort Innovation Insights

MEET THE AMGA Member

Georgia Beattie
CEO, Bulla Park

1. HOW MANY YEARS HAVE YOU BEEN IN MUSHROOMS?

1.5 years. I am like a little pin on the mushroom bed. So fresh and so much growing to do!

2. WHAT IS MOST DIFFICULT TASK YOU HAVE HAD TO UNDERTAKE WHILE IN MUSHROOMS?

Let me state the obvious with COVID-19 being a total curve ball. Running staggered shifts, morning temperature checks and isolated teams of four have been a challenge. While some industries could take cover at home behind a computer screen it's a bit harder in mushrooms!

3. WHAT IS YOUR GREATEST STRENGTH/ TALENT?

My strength is new product creation and the marketing and sales strategies that goes along with it. My first business was in manufacturing so I still love making things.
My talent is scaling a business, creating collaboration and merger and acquisition opportunities.

4. WHAT IS YOUR FAVOURITE PASTIME?

Rowing. I'm a Non-Executive Director of Rowing Australia which is super exciting in the lead up to Tokyo Olympics next year. I also row competitively for a club on the Yarra River which is where you will find me most mornings at 4.30am.

I love a high performance mindset - I'll often bring strategies on technique and execution to the farm. We have recently taken inspiration from one of Australia's most successful Olympic rowing coaches, and current coach of the Victorian Institute of Sport, Noel Donaldson. I row for Power House Rowing Club where I was lucky enough to fill in for one of the potential Paralympic crews coached by Noel one morning this year. One piece of advice Noel gave us that morning was to think carefully about preparation before execution (placement of the blade in the water). It sounds easy but while you are rating over 30 with a heart rate of 150 plus it's difficult to focus! The same can be said in agriculture where we can be working long physical days, where deciding which metrics and safety we are trying to improve before we step foot on the farm is key to execution.

5. AS A STUDENT, WHAT DID YOU WANT TO DO OR BE AFTER YOUR SCHOOLING?

Well I studied Entrepreneurship in Boston in the United States so if someone had said I'd be running a mushroom farm 10 years later I probably wouldn't have believed them! In all seriousness I've actually had a few college friends that have also jumped out of tech startups to play in agriculture. Food is definitely a good growth segment. It's funny, I'm applying all the high growth tech principles I've learnt in previous business to my team in mushrooms and its actually working.

6. WHAT WAS THE MOST SIGNIFICANT EVENT IN YOUR WHOLE CAREER SO FAR?

Starting an international business from scratch at 21 was definitely significant. I learnt some big lessons (mostly the hard way) in venture capital, innovation, scaling and going global from a young age which

I'm very grateful for. The business went from an idea for a single serve wine glass at a music festival to a scaled manufacturing plant in sunny Dandenong with offices in Singapore, Seoul, Tokyo, Taipei and Shenzhen.

7. WHAT IS THE CRAZIEST THING YOU HAVE EVER DONE?

Moving to Beijing in 2005 when I was 18 pre Google Maps or smart phones WITHOUT ANY MANDARIN. Definitely the dumbest thing I've done. I literally googled a school teaching mandarin and jumped on a plane. I spent six months of my time there just lost. The good news is that by jumping in the deep end I was able to pick up Mandarin and understand the business culture which ultimately lead to me later launching a Chinese office.

8. DO YOU HAVE A NICKNAME AND IF SO WHAT IS IT AND WHY?

I've managed to evade a nickname . Or am I just smart enough not to publish it?

9. WHAT IS YOUR FAVOURITE MOVIE?

Look choosing a movie is too difficult but I have just finished Better Things on Apple TV and Broad City on Netflix. So funny. The rule is definitely escapism over reality for me right now.

10. WHAT IS YOUR FAVOURITE MEAL?

I haven't overdone mushroom consumption yet! I love them. I'm really getting into bread making at the moment so mushroom soup / burgers / pasta with fresh bread is pretty spectacular. I do also wonder if my COVID-19 deprivation is affecting my answers?

I've grown up in the wine industry so pair this with a good wine and the meal will be complete – I'm currently really into natural wines (no coincidence that I'm running an organic mushroom farm!).

11. WHAT IS THE BEST LIFE ADVICE YOU HAVE BEEN GIVEN?

1. Get to the airport early.
2. Never miss a good opportunity to shut up.

12. TELL ME ABOUT YOUR POSITION IN THE BUSINESS?

I'm Co-CEO of Bulla Park. I work closely with the Directors Bill Littleson and Mick Surridge who first started the compost business ScatoPlus and later bought Bulla Park the mushroom farm. They have a wealth of experience in compost, mushrooms and life which I am learning from!

13. WHAT HAVE BEEN SOME OF YOUR FAILURES, AND WHAT HAVE YOU LEARNED FROM THEM?

Look, where do I start... I was temporarily interested in corporate venturing which is basically trying to be entrepreneurial and build a startup within a large corporation. I joined a listed tech company to head up their first internal venture. It turns out risk, innovation and high growth are not straight forward and go against the slow and steady framework that often characterise large business.

14. WHAT MOTIVATES YOU?

I like building and growing things. I'm creative which is why I like the thrill of building new businesses, products or teams. I guess it's the adventure of going into the unknown.

15. WHO HAS BEEN YOUR GREATEST INSPIRATION?

My grandma, she sadly passed away last year. She was always able to get down to the truth of what was presented to her. It didn't matter what the topic – personal challenges, work cultural dramas or international sales strategies.

16. WHAT IS THE ONE PIECE OF ADVICE YOU WOULD GIVE TO OTHERS HOPING FOR A SUCCESSFUL CAREER?

You have to be in it to win it! Just ask, give it a go, throw yourself in the deep end.

INDUSTRY NEWS:

Save The Date

For the first time ever, Mushrooms Canada is hosting both the International Society for Mushrooms Science (ISMS) Congress and North American Mushroom Conference at the Parq Vancouver from 30 May – 3 June 2021.

The events will jointly bring together the most current industry information on mushroom production technology, food safety, and consumer marketing.

The ISMS is now calling for abstracts from mushroom researchers and has announced that the closing date for submitting abstracts is 30 October 2020 (5:00 PM EST). Anyone wishing to submit an abstract is encouraged to read through the conditions for authors which can be found on the website (https://ismscongress.mushroom.evoqueeventmanagement.com/submission/).

Any technical questions should be directed to:

Dr. John Pecchia
E: jap281@psu.edu

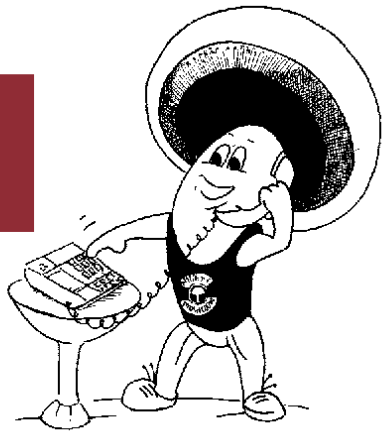
Parq Vancouver
Vancouver, British Columbia

GROWERS COMMUNICATION STRATEGY:

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'

AMSAFE – protecting the assets and wellbeing of the Australian Mushroom Industry!

VIDEO RESOURCES

The Mushroom industry communication program (MU18001) works closely with other projects and industry to produce videos on a variety of topics. When the videos are finslised links are sent via the monthly Industry Update newsletter and through updates in this Journal.

To view any of the videos below just enter the link in your website browser. If you experience any problems in accessing the videos, please contact Chris Rowley (chris.rowley@optusnet.com.au).

https://vimeo.com/293851934/ccdad28442

https://vimeo.com/329256032/561c59a65d

https://vimeo.com/293852092/7b027af401

https://vimeo.com/293853085/6a15fb8c2a

https://vimeo.com/329257664/505eceb63f

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