DEVELOPMENTS IN MUSHROOM HARVESTING

Of all horticultural industries, mushroom cultivation is the most tightly controlled. Mushroom growers are not at the mercy of the weather, crop cycles are quick, and everything from moisture to atmosphere to temperature can be tweaked to optimise quality and yield.

Paulette Baumgartl and Dr Jenny Ekman report from the AMGA Conference in Adelaide

Human resources are, however, less predictable. Worldwide, businesses are facing staff shortages, and this is felt particularly in the Australian horticultural industry. Availability of staff is impacted by low unemployment and a post-COVID shortage of seasonal workers. Added to this is a general reluctance to do work which may be physically demanding or uncomfortable. All these factors combined can develop into a perfect storm, leaving beds of unharvested mushrooms in its wake.

One thing growers can control is to create good working conditions that encourage staff retention. Installing ergonomic systems, incorporating technology, and 'back to basics' human resource management, are some of the tools at a grower's disposal.

But what does this look like, how much will it cost and how can it be implemented?

Lucky for the industry, a perfectly curated session at the recent AMGA conference brought together three experts from the Netherlands who showcased their solutions to this problem. These ranged from a system that could be fully automated in the future, to using technology to optimise picking efficiency, and applying considered HR management and training to increase the speed, comfort, and well-being of workers.

THE AUTOMATED DRAWER SYSTEM

Roland van Doremaele from the Christiaens Group provided an amazing vision of what the future of mushroom cultivation could look like.

Roland has been visiting Australia for a long time. His first visit was as an intern, while still at university. He understands our local industry well and believes that robotic technologies have a lot to offer.

Separating pinning from harvesting

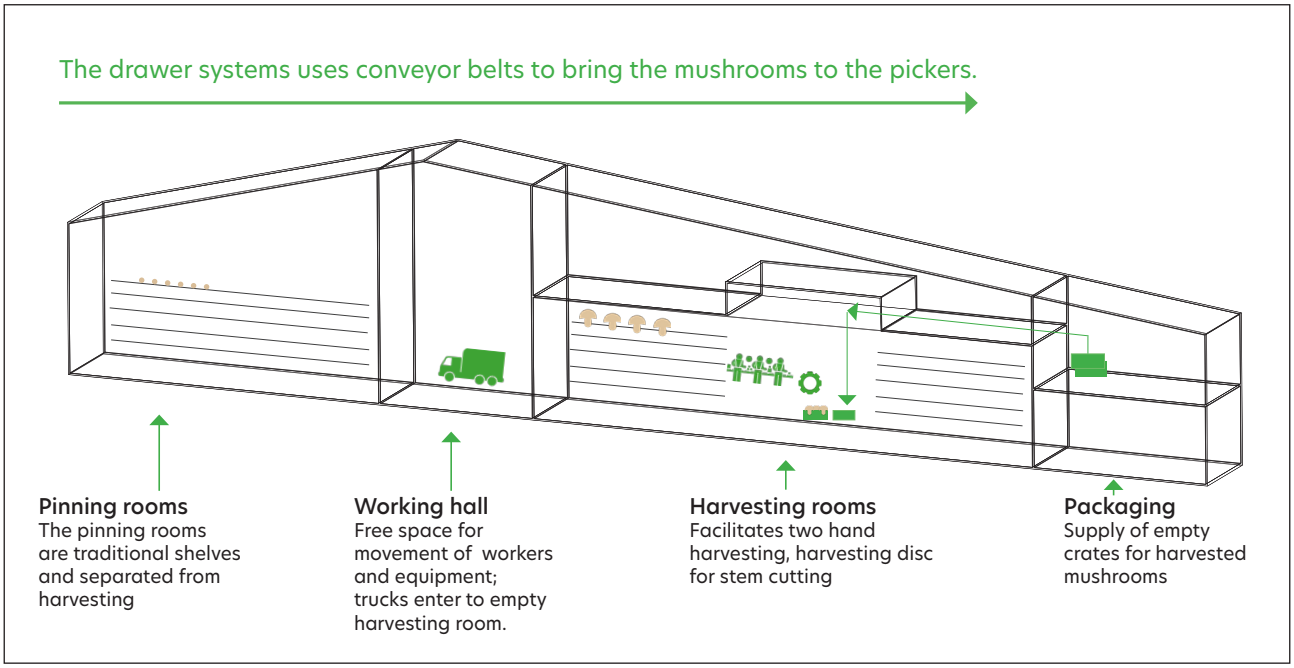
Separating pinning from harvesting has some immediate advantages, notably hygiene and disease prevention. As the pinning stage is more sensitive, keeping that closed off from workers and general farm traffic makes good sense. Moreover, as no one needs to access the mushrooms, the shelves can be more tightly packed in a smaller space – the epitome of vertical farming. Optimised air flow ensures circulation around the closely stacked shelves.

From an investment perspective, the pinning room is simple, with the new technology concentrated in only half of the rooms. This also means that once the mushroom-filled drawers have left, the rooms can be cleaned and cooked out with no concern about ruining delicate and expensive machinery.

What's new in picking?

When it comes to harvesting, the Christiaens group supply two systems - the drawer system and tilting shelves. In simple terms, in the tilting system the picker goes to the mushrooms, whereas in the drawer system the mushrooms go to the picker.

At the conference, the focus of Roland's presentation was the drawer system. This has been in development for 10 years and uses robots to both help pickers, and partly replace pickers. One of the stand out features of the drawer system is the mesh conveyor belt, which



Simple cross section of a draw system farm, with pinning and harvesting separated. A working hall provides each access for equipment to move product.

Roland van Doremaele at the AMGA conference

Pickers at the harvesting wheel

The conveyer belt moving the shelves

moves the mushrooms from the pinning room to a harvesting room, bringing the mushrooms to the workers on a series of belts.

How does this all work in practice?

Once the pinning room is filled with compost and casing, the cycle starts. It takes approximately two weeks for the first flush to commence. The nets are then pulled into a drawer onto a conveyor belt and sent on their way to the picking area.

On-farm studies have shown that this movement does not adversely influence growth, but actually has some benefit. Disrupting the mycelia seems to promote growth, perhaps due to the extra aeration, creating an energy boost that triggers the mycelium to heal, regrow and reconnect. There is also a suggestion that cracking the mycelium spreads the pins.

The shelves in the harvesting rooms move underneath the pickers. As a single shelf is presented, the pickers can stand up straight, and more easily see which mushrooms are ready for picking. They stand on either side of the shelf, loading mushrooms onto a harvesting disc. The disc rotates, the stems are cut, and mushrooms fall into crates. As pickers are not cutting stems they can use both hands to simply harvest mushrooms, greatly improving speed and efficiency.

A third member of the harvest crew packs the mushrooms into punnets or boxes. When the minimum weight is reached the box is transported on a conveyor that takes the filled boxes or punnets to a separate packing area at the end of the shed. Here they can be wrapped, lidded, and palletised.

The open harvesting area is well lit, making it easier for pickers to see the mushrooms. Furthermore, as the mushrooms come to the pickers (instead of the pickers needing to move) more time is saved, making it easier to do multiple picks over a bed, sometimes up to five in a day. Pickers can focus on the larger mushrooms only, spending less time on sizing.

Picking crews like having a larger, well-lit space to operate, as well as being part of a three-person team who can easily communicate as they work. Good for workers, good for productivity.

And efficiency?

The system has been developed with a focus on low maintenance. As futuristic as it sounds, the actual technology used has been intentionally minimised.

Efficiencies are won via the two-handed picking and multiple passes through the beds, not possible in traditional harvesting rooms.

The system also takes clever advantage of the fast-growing rate of a mushroom. The shelves move up and down, starting at the bottom shelf and picking larger mushrooms, before moving upwards. The first cycle takes 2-3 hours; the pickers then return to the bottom shelf and starts again, by which time the remaining mushrooms have increased in size by 8 to 12%.

That's a lot of mushrooms picked in a shorter time.

The system has been designed for future incorporation of a robotic picker. This could be used simply for thinning or even for end harvest.

However, the real magic here is the use of technology to help and optimise pickers, rather than replace pickers. Fewer staff can pick more mushrooms, and retaining these staff is easier when working conditions are optimised for their well-being.

What about smart farming integration?

Big data is the buzz word de jour, but there is a good reason for that. With a little thought, the integration of cameras and other monitoring equipment can greatly improve efficiencies on the farm. With sensors, data loggers and scanners, the growing rooms can become smart farms, detecting disease early and facilitating ongoing tweaks and improvements of the system.

Clean energy technology can also be integrated easily.

Other additions include the automatic cleaning after emptying and automated watering between flushes.

Already three drawer system farms are up and running in Manchester (UK), Vancouver (Canada) and one in the Netherlands.

Roland is excited about the future and believes that a harvesting robot which combines the Internet of Things with artificial intelligence is the next step, reducing labour even further and telling you what to pick and when.

So, what does this all cost?

The drawer system is something to consider for new growing rooms with the estimated cost to be about 30% more compared to a traditional farm.

The return on investment obviously depends on many external factors. However, the Christiaens Group estimates it should be around three years. This return is not based on harvest efficiency alone. Results from existing drawer farms show that there is also a 10% increase in production from the same volume of raw materials.

We look forward to following the future developments of the drawer system.

key points of the drawer system:

- Separation of growing and harvesting rooms
- Mushrooms develop in a smaller and more tightly packed vertical space
- Nets containing the compost, casing and substrate are moved to the harvesting room via a conveyor belt
- Two handed picking and automated stem cutting halves the pickers required, with a harvest team comprising 3 people instead of 7 or 8
- Approximately 60-70 picks/minute per picker
- Pickers cover each shelf multiple times in a day, taking advantage of the rapid growing rate of mushrooms
- Bed comes to picker, not picker to bed
- Generally, not suitable for existing farms
- Big data will have a significant role to play to ensure more evidence (data)-based on farm decisions
- Robots will never pick 100% of mushrooms, but technology can make human workers both more efficient and more comfortable

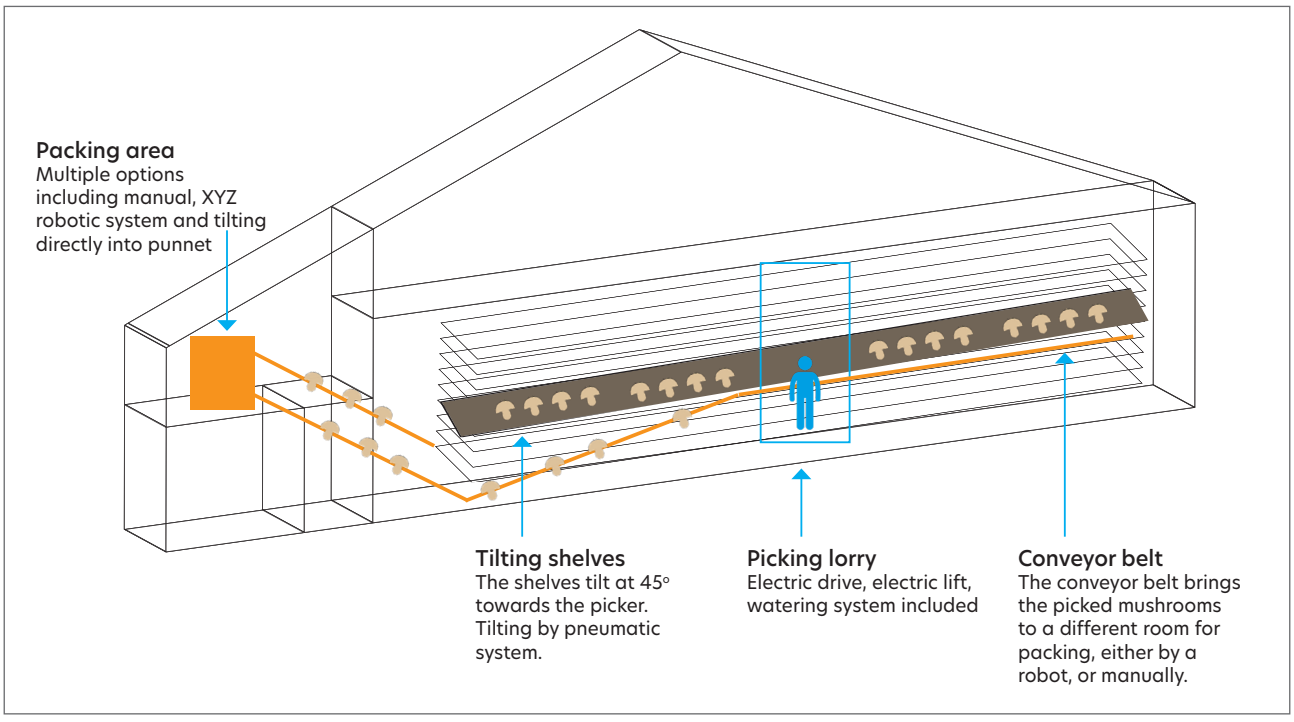
THE TILTING SHELF SYSTEM

Jack Lemmen from GTL Europe has been tinkering away at a solution to the challenges of mushroom harvesting for 30 years. The result is an innovative system of tilting shelves that are picker friendly and facilitate two-handed picking, which increases efficiency by more than 20%. When combined with automated sorting and packing, efficiency goes up by an astonishing 60% or more.

Like the Christiaens Group system, GTL Europe also sometimes separates growth and pinning from harvesting operations. However, Jack made the point that this separation is based on a 14-day cycle with two flushes, so may be less relevant in the Australian context where three flushes are common.

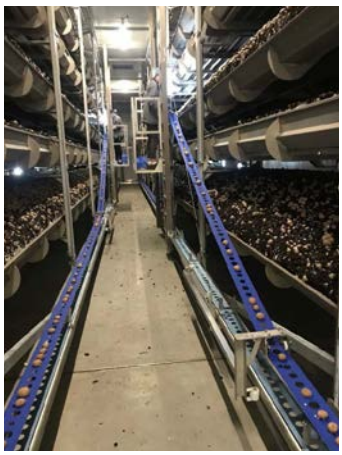
Regardless of this, harvesting is separated from packing, creating a number of efficiencies in operation.

Jack Lemmen at the AMGA conference



Simple cross section of a titled shelf system, with harvesting and packing separated. Mushrooms are moved via conveyor belt to a packing area.





Picking with two hands changes the orientation of the body to face the shelves at 180 degrees.

What's new and how does it work?

The tilting shelf system is all about making it as easy as possible to pick with two hands.

Shelves, controlled pneumatically, can tilt 45 degrees with no disruption to the casing or compost. By tilting the shelves, many challenges of mushroom picking disappear. No leaning over wide beds, no sore back, no straining while trying to reach the 1400mm width, no missing mushrooms hiding in the centre of the shelf.

The mushrooms are more clearly visible to the picker, who can look at them directly instead of at an angle. When combined with improved ergonomics, picking becomes easier, more comfortable and more accurate.

But the improvements do not stop there. Coupled with the tilted shelf is a thin belt which conveys the picked mushrooms away and up to the second level ready for packaging. As the belt sits below the shelf, a picker is placing products downwards, not lifting. Although mushrooms are not heavy, the repetitive action of lifting thousands of mushrooms per day cumulates to a significant strain.

The second aspect of the system is to take the packing away from the harvesting room. This allows concentration of packing technology on a second floor (or other part of the shed). Another advantage is the reduced risk of contamination as there are fewer people in the harvesting room.

Packing robot on the second floor

Is automatic packing realistic?

The answer is an emphatic yes!

Another exciting development is the early results achieved by the packing robot. Currently, for every two pickers in the harvesting room, there are two packers waiting on the second floor.

The packing robot has the task of placing the correct weight in multiple types of punnets, presented cap upwards. A prototype has been developed which can deal with different size grades in different punnets.

With the capacity to handle 12 mushrooms in 3-4 seconds, the robotic packer is four times faster than a human packer. This means one robot can keep up with two pickers sorting two sizes of mushrooms.

While robotic picking remains elusive, due to the anatomy and growing form of mushrooms, robotic packing is here and impressive.

Sorting and packing robot with belt for moving picked mushrooms

What about efficiency?

As with the drawer system, two handed picking also underpins the genius of the tilting shelves, which improves efficiency by 20% or more just by using two hands instead of one.

However, it is the addition of the robot packer where it really starts to be game changing. When combined with the tilting shelves system, this could potentially achieve efficiency gains of at least 60%.

Anything else?

Glad you asked. Another novel addition to a mushroom farm is the pointing system. While not yet available, this simple light projection system is mounted on the picking trolley. It scans the diameter of the mushroom on the shelf, and projects either a red or green light, highlighting which mushrooms are ready for picking.

It can also take photos and analyse mushrooms on several criteria, facilitating quick feedback to the picker, including speed of picking and size assessments.

The best news is that this device can be installed on regular picking trolleys as a retrofit.

Again, this system makes it easier for the picker to know which mushrooms to harvest now, and which to leave for later. Trialled on a commercial farm, the picker didn't want to give the device back, as it made their job so much easier.

No longer a theoretical concept, tilting shelves and packing robots are real and viable technologies. We

Key points of the tilted shelves system:

- Tilted shelves are ergonomic, reducing back strain
- The tilting system plus conveyor enables picking with two hands instead of one
- Tilting shelves improve visibility, making it easier to decide what to pick
- A conveyer belt sits below the shelf, taking mushrooms to the packing area
- Pickers place mushrooms down, rather than up, reducing arm strain
- Mushrooms are taken to a separate room for trimming and packing, either manually or automated
- Reducing the number of staff in harvesting rooms improves hygiene and decreases risk of disease
- With manual packing, efficiency increases by more than 20%
- With automatic packing, efficiency could increase by more than 60%
- A pointing system will soon be available, beaming coloured light onto the mushrooms ready for picking.

Back to basics -

BEST PRACTICE IN TRADITIONAL GROWING ROOMS

look forward to reporting about their impact on farms in future editions of this magazine.

Brigitte Hendrix grew up on a mushroom farm. She really knows mushrooms, having picked her fair share and supervised the picking of even more.

In her presentation, Brigitte reminded us there is success to be had in taking care of small everyday details.

Picking mushrooms is a whole lot more than putting pickers in a room. Important issues need to be considered, including good planning and scheduling, clear communication, and proper training.

While bonuses are an important way to motivate workers, managing schedules, providing training, and having clear expectations can combine to create a happy, productive and stable workforce.

Organising and planning

As simple as it sounds, letting employees know your expectations for the week is vital.

A plan can could include the kilograms expected in a week, number of pickers needed in each room each day, and where each picker should be.

In her presentation, Brigitte provided an example of weekly and daily plans (Tables 1 and 2). A good plan will also provide the grower with a clear overview of what can be expected on a farm in any given week. Bad planning results in lost yield, reduced quality, disappointed customers, and dissatisfied workers.

	Estimated production (kg)							TOTAL
Room	Mon	Tue	Wed	Thur	Fri	Sat	Sun	
1	250	1250	1500	1700	450			5150
2		200	1000	1550	1750	500		5000
3								
4								
5				50	300	1250	1250	2850
6			75	200	1250	1500	150	3175
total	**250**		**2575**	**3500**	**3750**	**3250**	**1400**	**16175**

Table 1. Weekly plan (example)

At the beginning of a harvest cycle, supervisors should pay particular attention to avoid damage to the mushrooms. For example:

Day 1

- Thinning out to create space and promote better quality of mushrooms
- Carefully supervise pickers at this stage to prevent damage

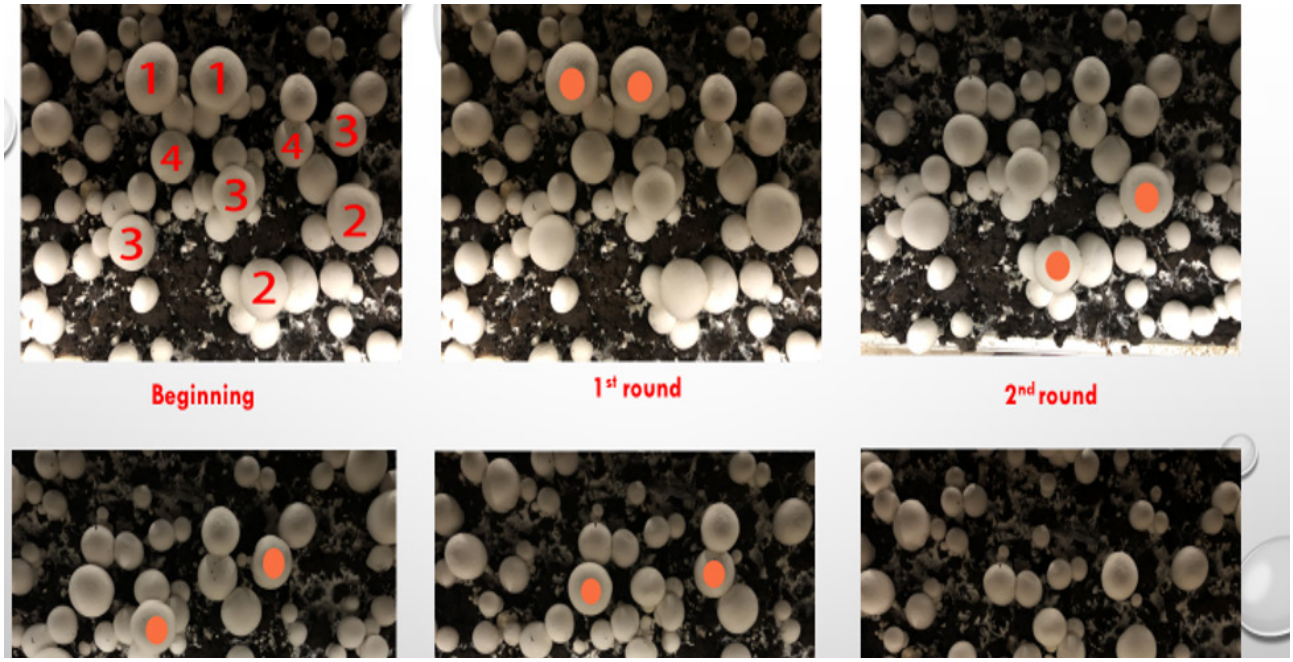
Day 2

- If thinned out correctly on day 1, look on day 2 if further thinning is needed or if picking can begin
- Take a good look at the room, evaluate what you need and clearly communicate this to pickers
- Try to pick a room several times

Clear communication and instructions

Any efforts put into planning will only be effective if they are clearly and regularly communicated. Use signage to be clear about which sizes to pick, which packaging to use and what sort of volume is expetced to be picked by the end of the day.

Systematic picking, correct position of the body, and how to cut need to be part of the training process. Brigitte emphasised that pickers need a little time to get this right, and cannot be expected to master it on day



room	large	medium	small	2nds	total	Kg/hr	hours	Pickers needed	Pickers planned
1	300	700	100	50	1150	32	35	4.4	4
2	700	250		50	1000	37	23	3.3	4
3		150	300		450	15	23	3.75	4
4									
5									
6									
total	**1000**	**1100**	**400**	**100**	**2600**		**81**	**11.5**	**12**
Date				Remarks					

Table 2. Daily plan (example)

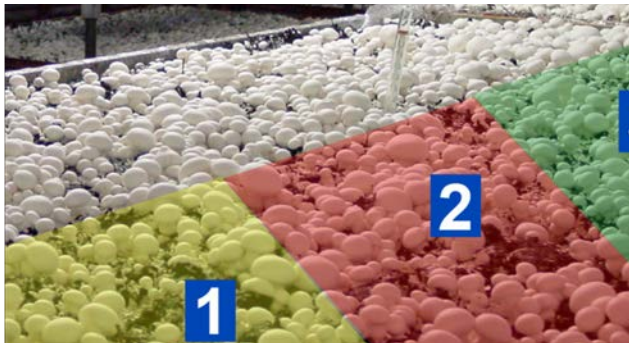
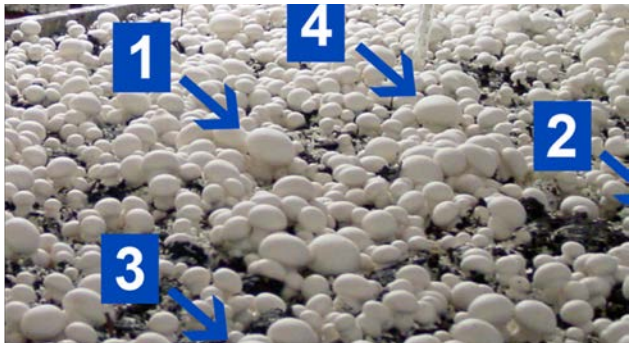
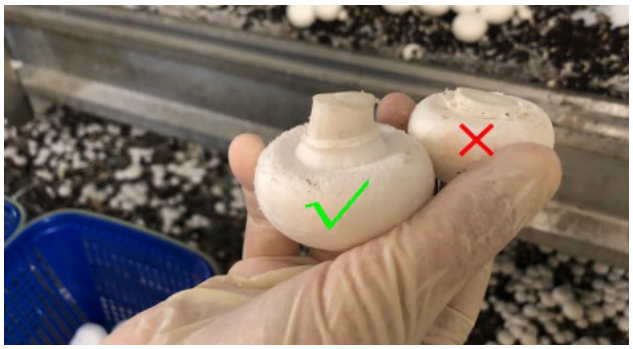
1. Patience and persistence are required when training new staff. The time investment pays for itself.

Multiple studies have shown that after 7 hours, pick rates decline from fatuigue. For optimal efficiency, get the most out of a standard 8-hour day rather than extended shifts of 12 hours.

The best thing about Brigitte's systematic method of organising staff on a mushroom farm is that it can be implemented right away.

As in any workplace, good HR management, where expectation are clear, creates a workplace with less stress, more motivation and therefore happier workers.

Dos and don'ts of picking

CORRECT	INCORRECT
	
	
	

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

International speakers were invited to present at the AMGA conference *Growing the Future Together* with support of the Hort Innovation Mushroom Fund

Key points on back to basics

- Train pickers on thinning out, picking rate, care of the product
- Maintain good supervision, show them how to pick a room
- Plan and be organised
- Communicate your plans and provide clear instructions daily in each room
- Review plans and adjust when need.
- Train pickers in the three-mushroom method, to increase efficiency (look out for a MushroomLink how to video coming soon)

Contact Brigitte for more information:

info@musharco.com