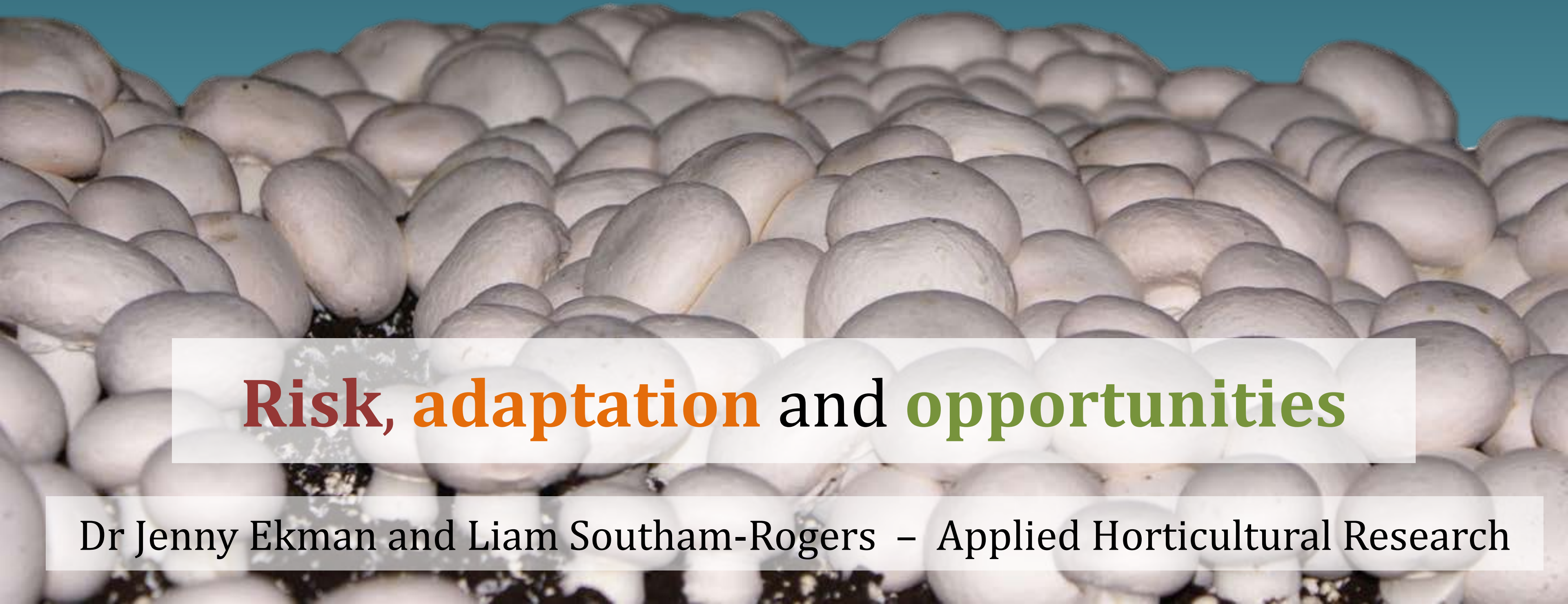
Climate change and the Australian mushroom industry



Risk, adaptation and opportunities

Dr Jenny Ekman and Liam Southam-Rogers – Applied Horticultural Research

This webinar

PROJECT AIM: Understand and minimise the effects of climate change on Australian mushroom production

THIS PROJECT: Why?

TODAYS TALK:

1. Project approach
   - Producer survey, desktop review, forecast changes in composting and production regions
2. Risks from climate change
   - Effects on compost production, cost / availability of inputs and energy
3. Adapting to climate change
   - New substrates for casing and compost, re-use of water, Government assistance
4. Opportunities from climate change
   - Energy generation on-site and the "virtuous circle" of sustainable production

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

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Why did we do this project?

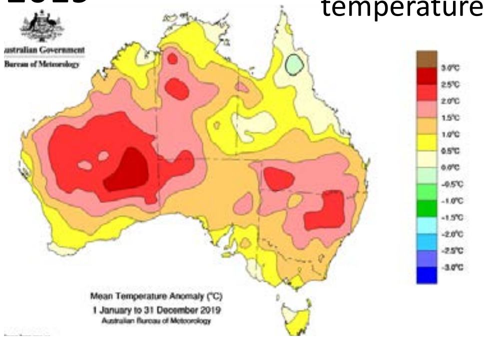
Aren’t mushrooms protected from climate change?

- Temperature, RH, CO_2 and moisture are all tightly managed….
- Mushrooms are already efficient users of resources

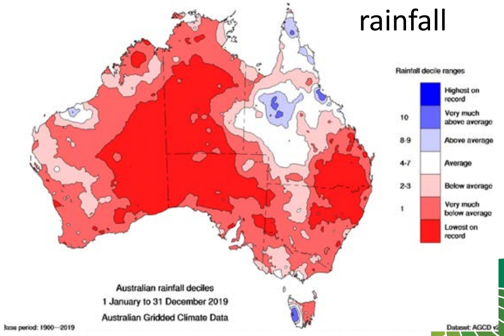
- BUT mushrooms depend on inputs which *ARE* related to climate
  - Straw, manure, water, energy ….
- Weather may affect climate controls, compost production and transport
- Adapt to protect the industry image as good environmental stewards – “*social licence*” to operate

2019

temperature



rainfall

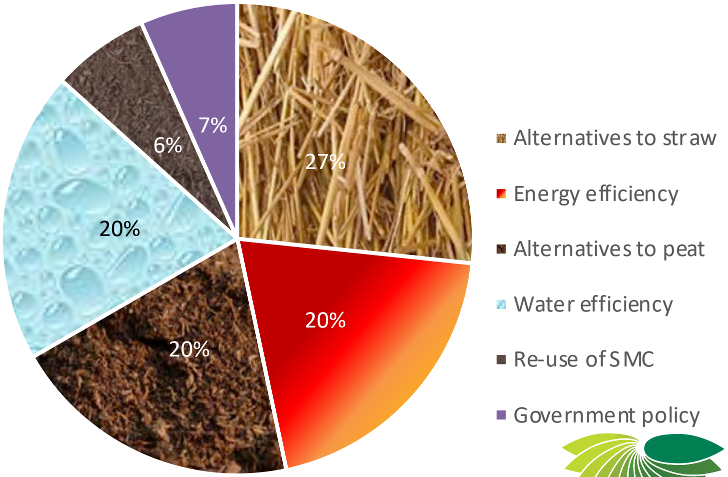


Project approach

PRODUCER SURVEY

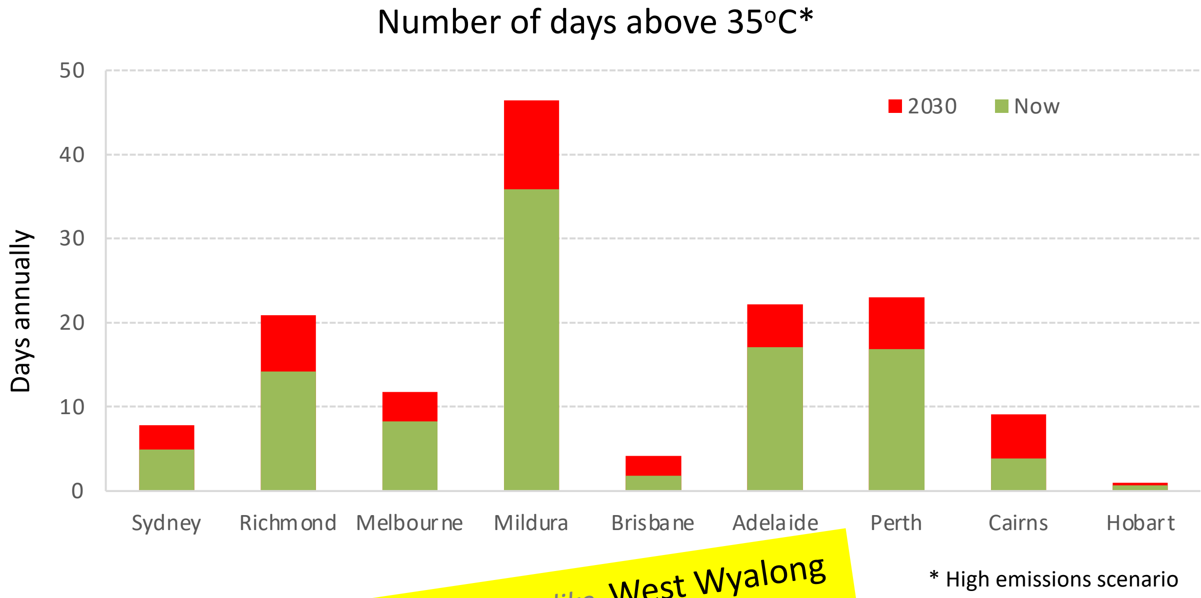
- 20 mushroom farms and 7 composters interviewed in person or via *Zoom*:
  - Represent approximately **70%** of the industry
  - A cross section of size and location; farms producing 265 tonne/week down to <1 tonne /week
- Most mushroom farms are ageing
  - Average farm age is approx. 30 years
  - Only 2 new farms within last 10 years, 4 farms more than 40 years old
  - Five farms with shelf systems

"What do you think needs to be considered in a "climate change action plan?"



Project approach

- Probable changes modelled for mushroom /compost production regions
  - Higher daily maximums (1-2°C)
  - Increased temperature variability, very likely more frequent and longer heatwaves
  - Warmer nights (especially Sydney, SE Qld and Mildura)
  - Reduced rainfall (especially Perth and Adelaide) but with more heavy rain events e.g. cyclones
  - No data on humidity



Melbourne *more like* West Wyalong
Sydney *more like* Brisbane
Brisbane *more like* Ayr

Risks

IMPACTS OF TEMPERATURE ON COMPOST AND MUSHROOM PRODUCTION

- High temperatures can be encountered during production and transport of Phase III compost
  - Composting time increases due to lack of air circulation
  - Temperatures over 35°C reduce yield; if temperatures remain high for >24 hours, productivity may be reduced by ~60%
- Many farms have cooling systems to cope with temperatures up to 43°C, and even 50°C
  - However, this is affected by the number of successive hot days, overnight minimums and humidity
    - Farms may cope with 40°C for one day, but three is a **disaster**
    - Room temperatures over 40°C will kill the crop

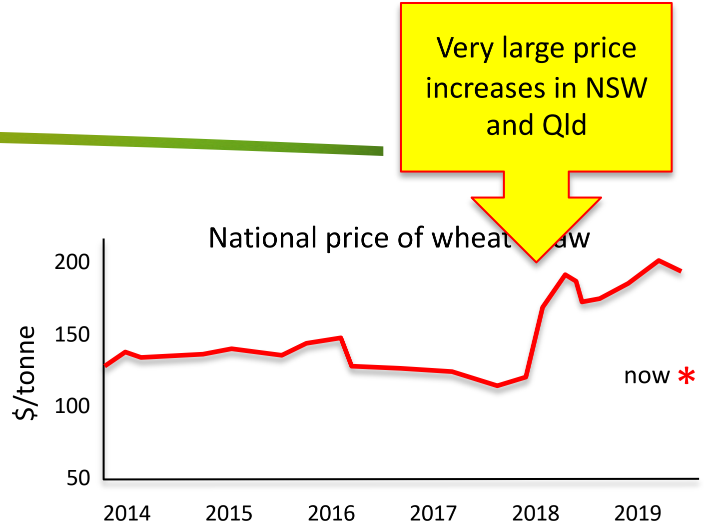
Transport of compost at over 32°C is difficult – last summer we had to add ice to shipments to stop it cooking

More than 40°C is a problem, especially if it's humid. January is the worst month

Risks

AVAILABILITY, COST AND QUALITY OF WHEAT STRAW

- Drought reduces wheat production
  - Climate predictions for lower wheat yields in general
  - During 2018-2019, many composters had difficulty sourcing good quality wheat straw
    - Straw may be lower quality and brittle, or affected by disease
    - Competing demand for straw as stock feed
- Changes in agronomy – adoption of "conservation farming"
  - Crops cut high (60cm); increases harvest speed, reduces fuel/ha
    - Improves carbon levels in soil, water infiltration, wind erosion
    - Reduces volume and length of straw for baling

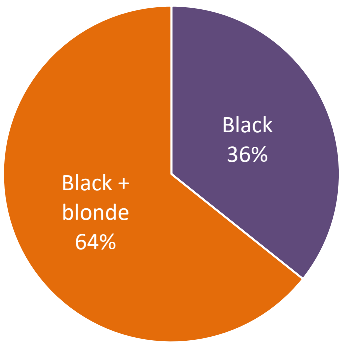


Risks

AVAILABILITY AND COST OF PEAT FOR CASING

- Most farms use a mixture of black and blonde peat, with the remainder using black peat alone
- Peatlands are a major carbon sink, sequestering 0.5 gigatons of CO_2 annually
  - Draining of peatlands responsible for 10% of agriculture related greenhouse gas emissions (N_2O and CO_2)
  - Drained peatlands extremely susceptible to fire
  - Banning peat mining is an easy way for countries to meet emissions targets

Type of peat used

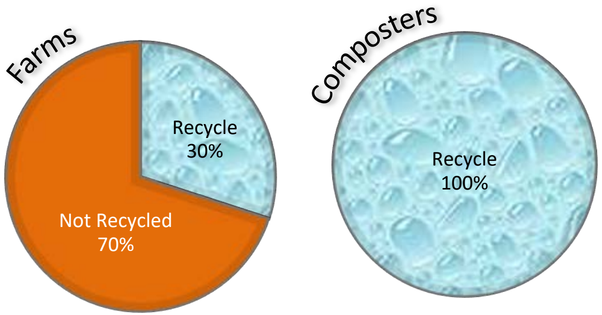


Risks

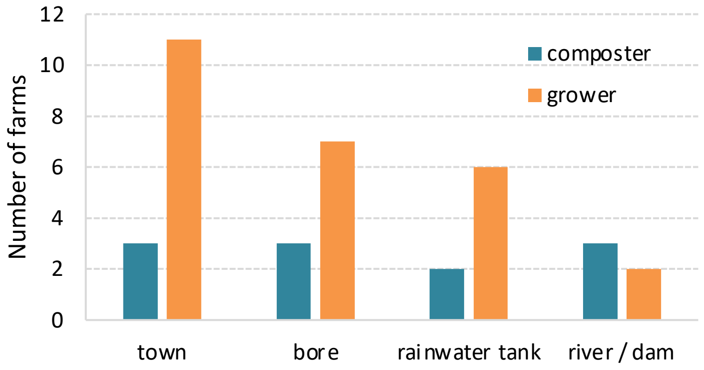
WATER AVAILABILITY, COST AND QUALITY

- Mushroom production requires significant amounts of high-quality water
  - Compost; 800 to 2,000 L/tonne
  - Mushrooms; 8 to 20 L/kg
- Most mushroom growers use town water
  - Potential impact of water restrictions
  - Restrictions on supply can limit production
  - Increased rainfall variability may reduce reliability of other sources

Water recycling



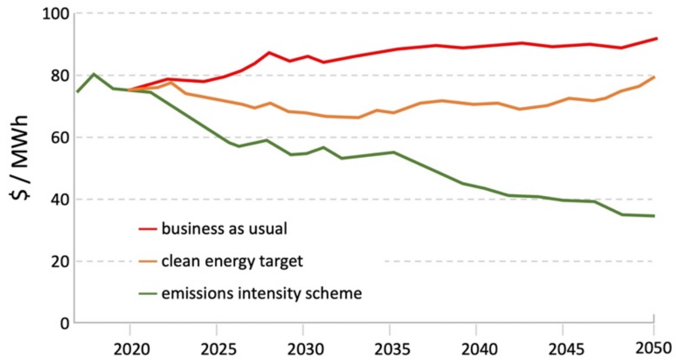
Water sources



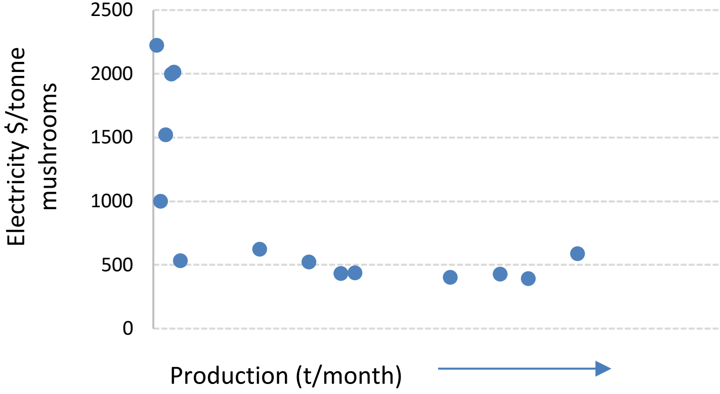
Risks

ENERGY – COST AND RELIABILITY

- Changes in energy prices are strongly affected by Government policy / uncertainty



- Increased energy costs will affect smaller producers most



Farms are already adapting

- Most farms have backup generators, LED lighting
- Half the surveyed farms already had solar systems
- Several had improved insulation, one had installed energy recovery units on the air-conditioning

Risks

MANURE AVAILABILITY AND QUALITY

- Chicken manure has changed (!) as producers adapt to environmental and economic pressures
  - Change from rice hulls to other, cheaper bedding materials for broiler chickens
  - Increased recycling of bedding materials
  - More efficient diets – N levels in manure have dropped
  - Increase in free range egg production

Adaptations

From J. Burdon, presentation 2018

ALTERNATIVE CASING MATERIALS – Spent mushroom compost

- Spent mushroom compost (SMC) widely researched
- Already used commercially in some countries
- EC reduced by weathering / drenching or processing
- Blended with peat up to 50:50 without affecting yield

	Time required	
	Natural weathering	*Processing*
Method		
Windrow / pile / bunker	2 years	3-4 weeks
Leaching	2 years	2 weeks
Draining, pasteurizing and blending	11 days	11 days
Result		

Adaptations

ALTERNATIVE CASING MATERIALS – Recycled organics

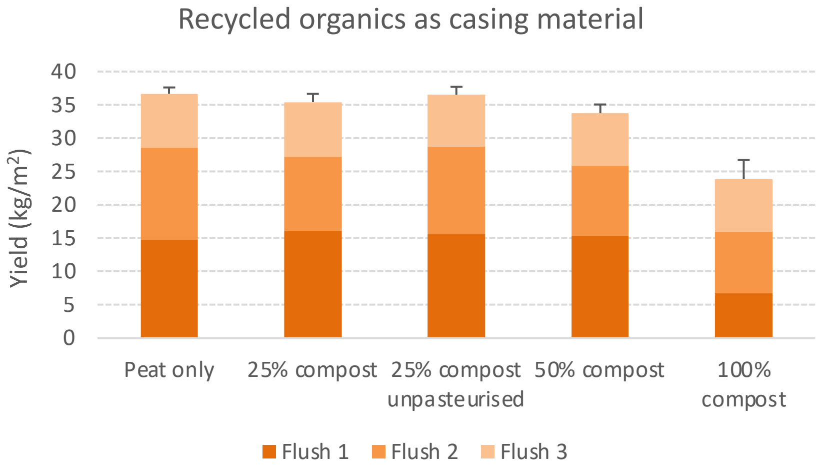
- MLMRU trials
  - Three trials, three different materials…
  - Blends of up to 50:50 with peat did not reduce yield or quality
  - Unpasteurised material as good as pasteurised (or better!)

100% Peat

25:75 Peat:RO

50:50 Peat:RO

100% RO



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Adaptations

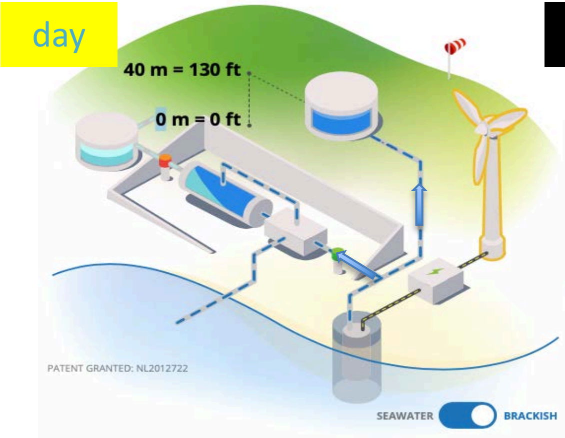
ALTERNATIVE CASING MATERIALS – Recycled peat

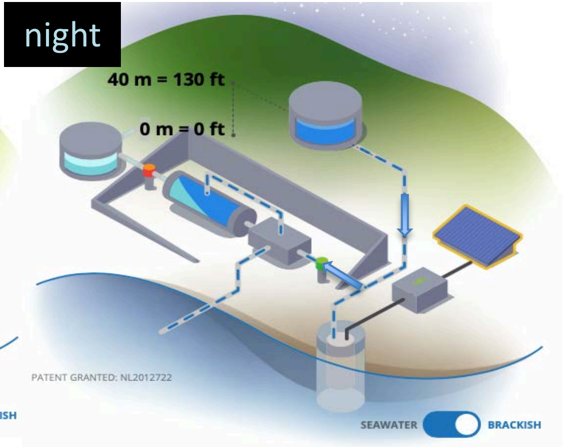
- Recycle casing soil using the “MushComb Separator” – works with the emptying conveyor in **shelf rooms**

Adaptations

EFFICIENT USE AND RE-USE OF WATER

- De-salination and sanitation of bore water or recycled water
  - Reverse osmosis
    - 640m² solar panels + 25m² desal unit yields 100 Kilolitre water/day
    - Combine with UV treatment or other sanitation step
    - Water can pumped to elevated storage
  - Thermal desalination
    - e.g. Sundrop farms



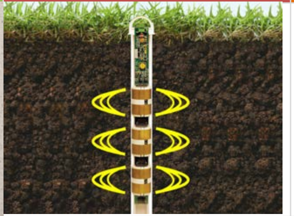


Adaptations

EFFICIENT USE AND RE-USE OF WATER

- Measurement of moisture levels in compost
- Potential to automate irrigation

Vullings-systemen

	Moisture measurement sensors		
	Time Domain reflectometry (TDR)	Capacitance	Standing wave
			
Accuracy	Excellent	Satisfactory	Good
Cost	High	Low	Moderate
Life expectancy	20 years	2 to 5 years	20 years
Needs calibration by soil type?	No	Yes	Yes
Affected by temperature?	No	Yes	No
Recommended for compost?	Yes	No	Yes

Adaptations

EFFICIENT USE AND RE-USE OF WATER

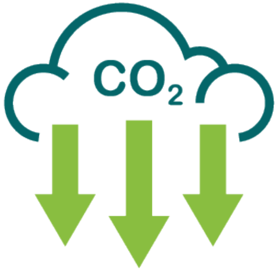
- Drip irrigation – Netafim "Mushroom Master"
  - Fertigation easy
  - No bacterial blotch
  - Constant moisture levels
  - Less casing material
  - Fully mechanised

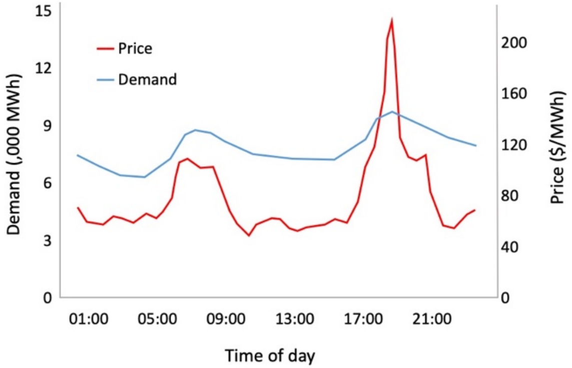
Cost?

Adaptations

GOVERNMENT ASSISTANCE

- Emissions reduction fund
- Large scale renewable energy target
- Clean energy finance
- Energy saving programs
- Wholesale demand response
  - Large energy users paid to reduce demand at peak times
  - Could use backup diesel, gas generator



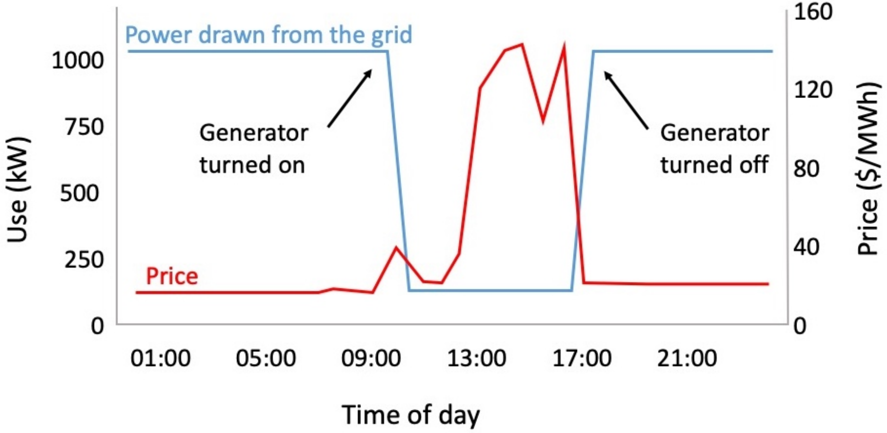


Opportunities - energy

AUTOMATIC LOAD SHEDDING / DEMAND RESPONSE

- On-site generator is automatically started when wholesale spot electricity price is high
- Spot price electricity contract
- Especially useful in volatile markets like South Australia
- Replaces the need for periodic generator tests
- Credits are available from AEMO (large electricity users)
- *Flow Power* is a provider

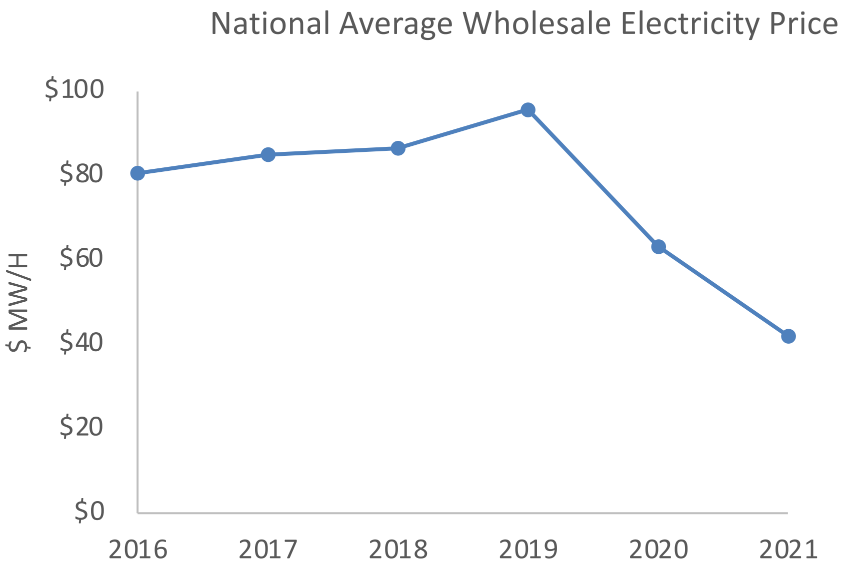
http://flowpower.com.au/powering-demand-response-australia/



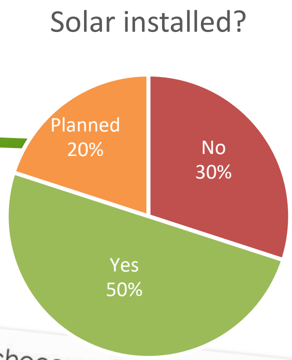
Opportunities - energy

WHOLESALE PRICE OF ENERGY

- Price of electricity has halved since 2019 (source: AEMO)
- Price of 100kW solar has dropped about $2000 since 2019
- Wholesale price of natural gas has fallen to 2016 price ($5 - $6 GJ)
- Future is uncertain. Prices may fluctuate as large coal power stations are decommissioned (eg. Liddell 2023, Hazelwood 2017)

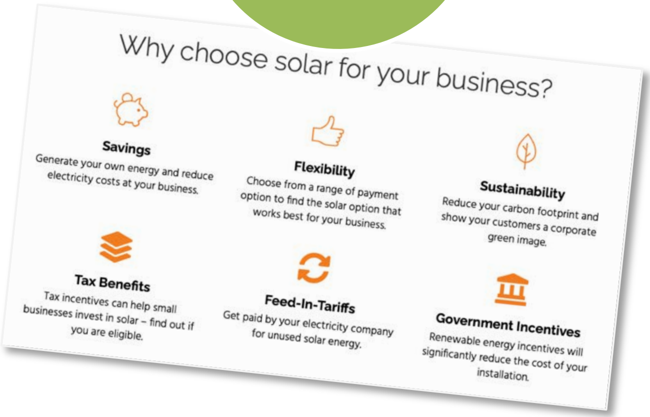


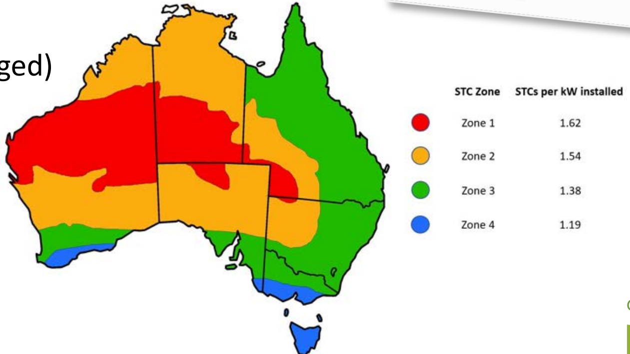
Opportunities - energy



SOLAR POWER

- Mushroom farms appear well suited to solar systems
  - Solar panels are well suited to large roofs, and provide shade
  - Provide energy directly for daytime cooling
  - Cost of batteries and panels is decreasing
  - Half of surveyed farms and one-third of composters already have solar
- Systems up to 100kW attract incentives
  - But depends what zone you are in (recently changed)
    - QLD Zone 1 ➞ Zone 3





hellosolar.com.au

Opportunities - energy

SOLAR POWER

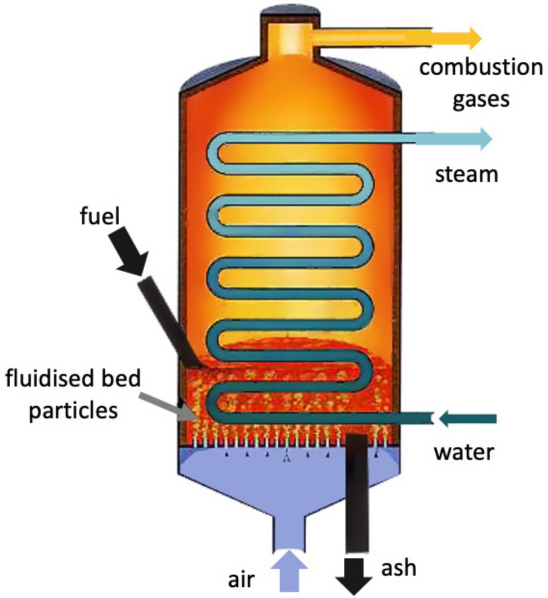
- Economics of solar depend on:
  - The price paid for electricity
    - Payback periods have lengthened as electricity price have fallen
    - Payback period is short on a retail electricity contract
  - Ability to use all electricity on-site
    - Feed in tariffs are low; 10.5c to 12c/kWh
- Reduced peak demand network charge
- East – west facing panels are often more economical on a spot price contract

	NSW	Vic	Qld	SA	average
Wholesale electricity price ($/MWh, 2020)	72	74	53	62	65
Fixed margin ($/MWh)	10				
Electricity used on-site	100%				
System size	100kW				
Purchase price incl. rebate	$92,910	$94,020	$92,550	$96,880	$94,090
Payback period (years)	**7.8**	**8.6**	**9.3**	**8.9**	**8.7**
Internal rate of return	13%	12%	10%	11%	12%

Opportunities - energy

ENERGY GENERATION FROM SPENT MUSHROOM COMPOST

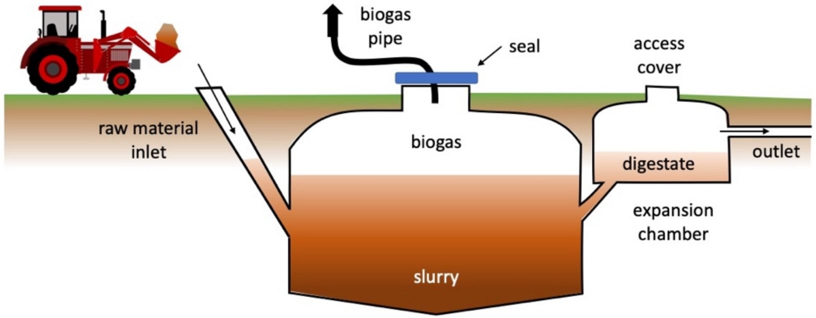
- Biomass combustion
  - Fluidised bed (best) and packed bed combustion using SMC produces useful energy and is self sustaining
  - Pyrolysis (biochar) not efficient
  - Energy yield doubled if casing layer is removed
  - Energy yield improved if SMC mixed with coal tailings and pelletised



Opportunities - energy

ENERGY GENERATION FROM SPENT MUSHROOM COMPOST

- Biogas production
  - Anaerobic digestion produces methane and CO_2
  - Stored, used to generate heat or energy as needed
  - Digestate used as fertiliser
  - Adding hydrogen ➠ biomethane (natural gas) which can power vehicles or run a boiler

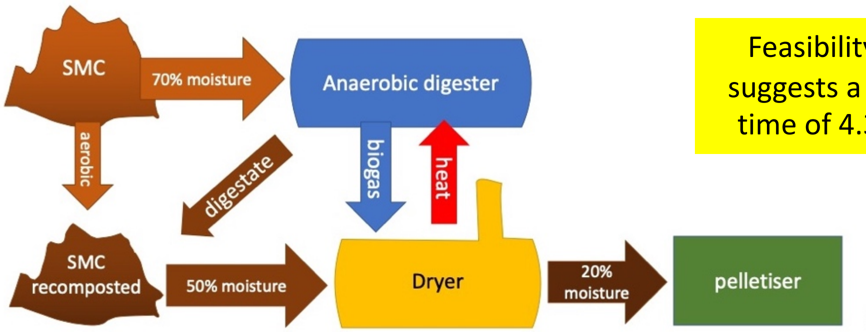


- Biogas feasibility depends on:
  - Suitability of SMC as substrate
  - Quantity of waste available
  - Cost of electricity
  - Capital investment required
  - Cost / benefit of disposal of SMC

Opportunities - energy

ENERGY GENERATION FROM SPENT MUSHROOM COMPOST

- SmartMushroom project
  - Pilot plant in La Rioja, Spain, adds jam factory wastewater + glycerine to SMC
  - Current yield 122m^3 biogas/tonne SMS
  - Disposal cost saving of €6 to €10/tonne + €23/tonne income from pellet sales

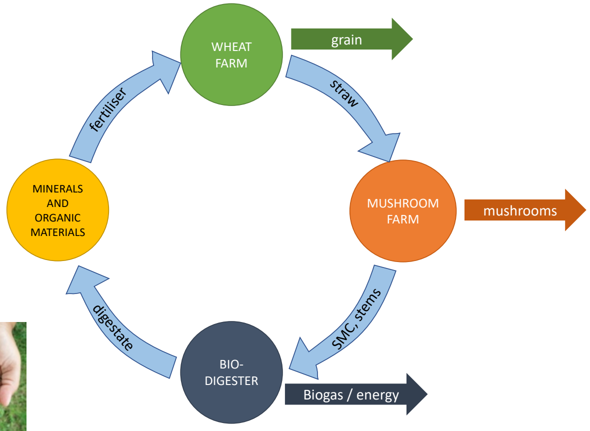


Feasibility study suggests a payback time of 4.3 years!

Pelletised fertiliser

The "virtuous circle"

– sustainable production of biogas from mushroom wastes



Opportunities - energy

EFFICIENT ENERGY USE – COOKOUT

- Cooking out crops *in-situ* at the end of cropping sanitises rooms and prevents spread of disease
  - Overstijns (1998) key reference f… f pests and d…
  - …ries

Testing for pathogens present in the room could allow adjustment of cookout times, but only if there is good information about their heat tolerance.

- How hot for how long?
  - Recommendations vary: 65°C for 8 hours (Pyck & Grogan); 66°C for 12 hours (Beyer); 70°C for 24 hours (Curtis)
  - Thermal load matters: timber trays can take 6x longer to reach 60°C than the substrate, black peat takes longer to heat then blonde peat

		Kill time (hours)			
		50°C	55°C	60°C	68°C
Pests	Most flies		5		
	Nematodes		5		
	Mites		5		
	Cecids	1			
Disease	Cobweb	4		2	
	Dry bubble		4	2	
	Wet bubble	4	2		
	Trichoderma			9 to >36	42
	Bacterial blotch	0.17			

Opportunities - energy

EFFICIENT ENERGY USE – THE FACILITY

- "Smart farming"
  - Systems such as Profarm (Denso Corp, Japan) track the growing environment
  - Sensors in compost, vents, power supplies, atmosphere, irrigation etc identify inefficiencies

- Improving building energy efficiency by….
  - Extra roof insulation
  - Sealing concrete floors against moisture
  - Checking internal panelling for leaks
  - Light coloured roofing
  - Spraying wastewater on the roof to evaporatively cool
  - Maximising structural overhangs on north facing walls
  - Planting trees around the buildings

Wet panelling doesn't work

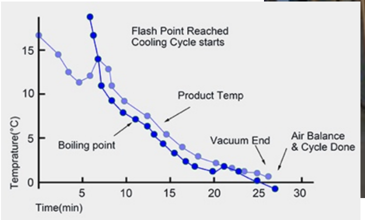
Metal shelving is easier to clean and more energy efficient than wooden trays

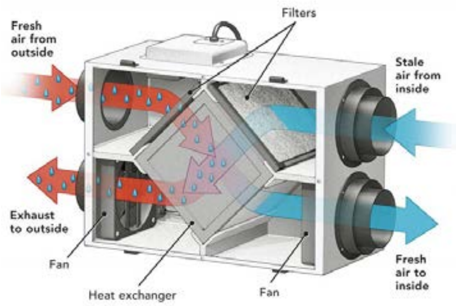
Opportunities - energy

EFFICIENT ENERGY USE – THE FACILITY

- Cooling
  - Vacuum cooling – ~90% of the electricity used cools the product
    - Room cooling uses approx. double the energy
  - Postharvest quality and shelf life are maximised

- Energy recovery ventilators (ERVs)
  - Use energy from the building exhaust air to pre-condition outside air used for ventilation
  - Can help maintain temperature while allowing effective ventilation and flushing of grow rooms
  - Energy savings 9-12%





Conclusions

- While the mushroom industry is generally well-positioned to cope with climate change, **challenges exist**
  - Changes in cost and availability of inputs – straw, peat, water, energy etc
  - Challenges to production due to higher temperatures
  - Impacts of extreme weather events
- Potential to **adapt** to many of these challenges
  - Adoption of different materials, new technologies and on-farm
- **Opportunities** to both
  - Use energy more efficiently **AND**
  - Generate on-farm through renewables or waste products

Thankyou and Questions?

Hort Innovation
Strategic levy investment

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