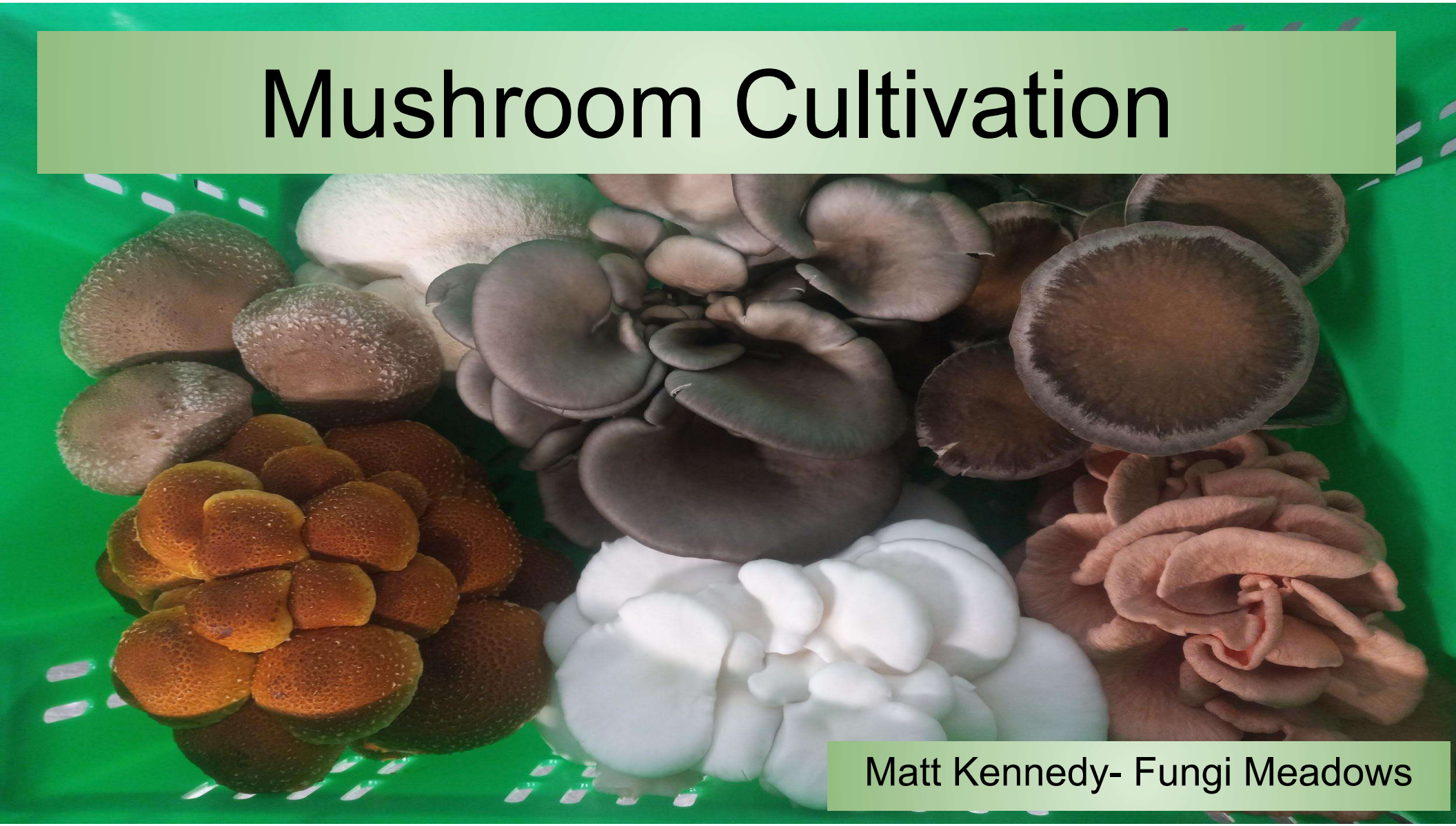
Mushroom Cultivation

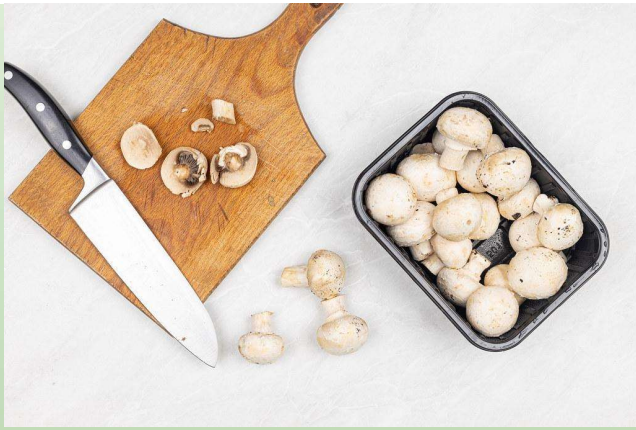


Matt Kennedy- Fungi Meadows

Overview

- Why Grow Mushrooms
- Types of mushrooms
- Space/Environment
- Equipment
- Process
- Cleanliness
- Finding the market
- Questions

Why Grow Mushrooms?



Nutrition

- Ergothioneine an amino acid and antioxidant slows cellular damage reducing risk of cancer by as much as 45%
- Polysaccharides that stimulate the growth of healthy bacteria in the colon
- Immune system support from selenium, vitamin D, and vitamin B6
- Mild cognitive decline, precursor to Alzheimer's reduced by 50%

https://www.uclahealth.org/news/7-health-benefits-of-mushrooms

Economical

- Initial start-up cost can be as little as $1,500 for a small operation
- Once you have a specific culture, through cloning and spore collection, you never have to purchase again
- After initial infrastructure is in place, maintenance and upkeep cost is low.

Space

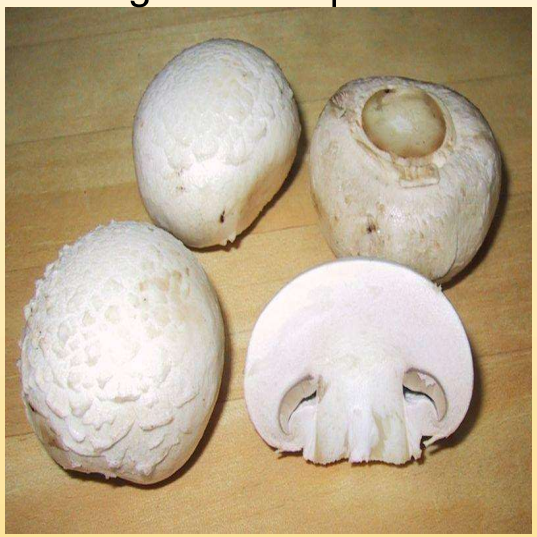
- We have been producing upwards of 120lbs/week in a 120 square foot fruiting room.
- Underutilized, abandoned buildings, basements easily retrofitted.

Types Of Mushrooms

Gourmet

- Agaricus Bisporus- White button, baby bella, portobello
- Pleurotus Ostreatus- Oyster , hiratake, pearl oyster
- Pleurotus Eryngii- King oyster, King trumpet
- Grifola Frondosa- Maitake, Hen of the Woods
- Lentinula Edodes- Shiitake
- Hericium Erinaceus- Lion’s Mane, Lion’s Beard
- Pholiota Adiposa- Chestnut

Agaricus Bisporus



Pleurotus Ostreatus

Pleurotus Eryngii

Grifola Frondosa

Hericium Erinaceus

Pholiota Adiposa

Lentinula Edodes

Medicinal

- Ganoderma Lingzhi/Lucidum- Reishi
- Cordyceps sinensis- Cordyceps (zombie fungus)
- Trametes versicolor- Turkey Tail

Reishi

Cordyceps

Turkey
Tail

Space/Environment

Controlled environment agriculture

1. Minimal infrastructure
2. Easily adapt underutilized farm infrastructure
3. Basements, garages, shipping containers
4. Access to water and electricity
5. Easy to clean
6. Requires separate chambers with ability to control temperature, light, humidity, air flow

Lab

- Positive air pressure environment with HEPA filtration.
- Larger farms have a culture lab, and a clean room for grain and sub transfers
- Laminar flow hoods for clean work
- Temperature control

Incubation

- Largest area. Twice as large as your fruiting room
- Temperature control is necessary
- Air flow and exhaust are necessary also
- Shelving or racks to store mushroom bags

Fruiting Room

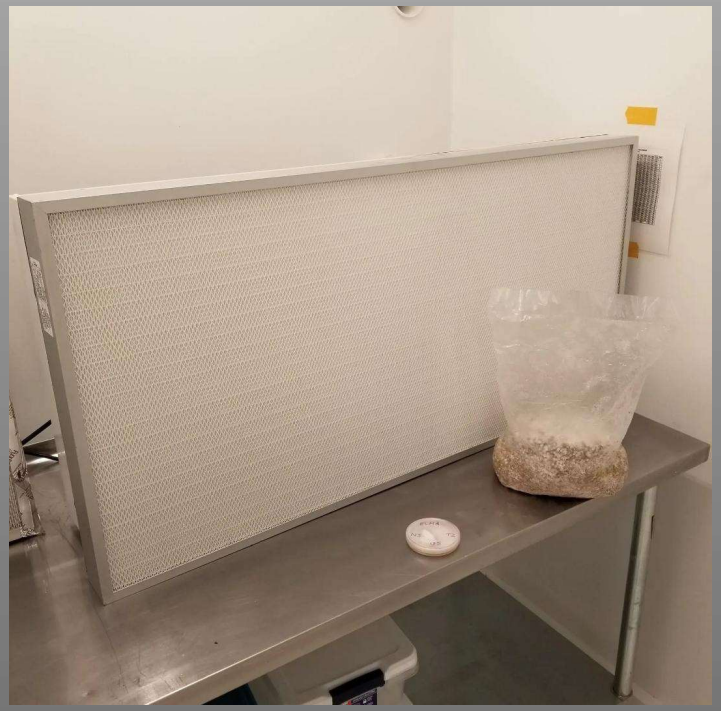
- Must be easy to clean-ceiling, walls, and floors
- Waterproof floor surfaces, preferably with a drain
- Able to withstand high humidity
- Water source for the humidification
- Timer controlled lights
- Ability to exchange the air roughly 6 times an hour
- Temperature management
- Sensors for automated control
- Racks or shelves to hold the blocks

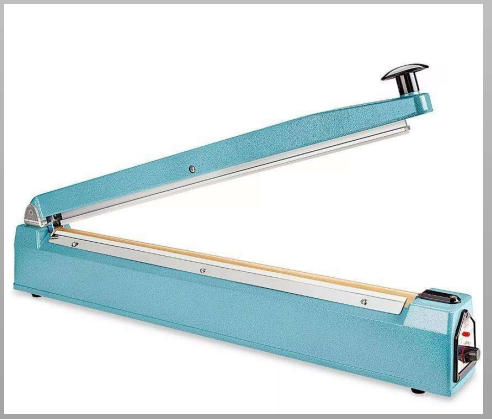
Working space

- Cold storage for finished product
- Tables for harvesting/packaging
- Storage for packaging, raw materials
- Substrate/grain processing
- Storage for cleaning supplies and spare equipment.

Equipment

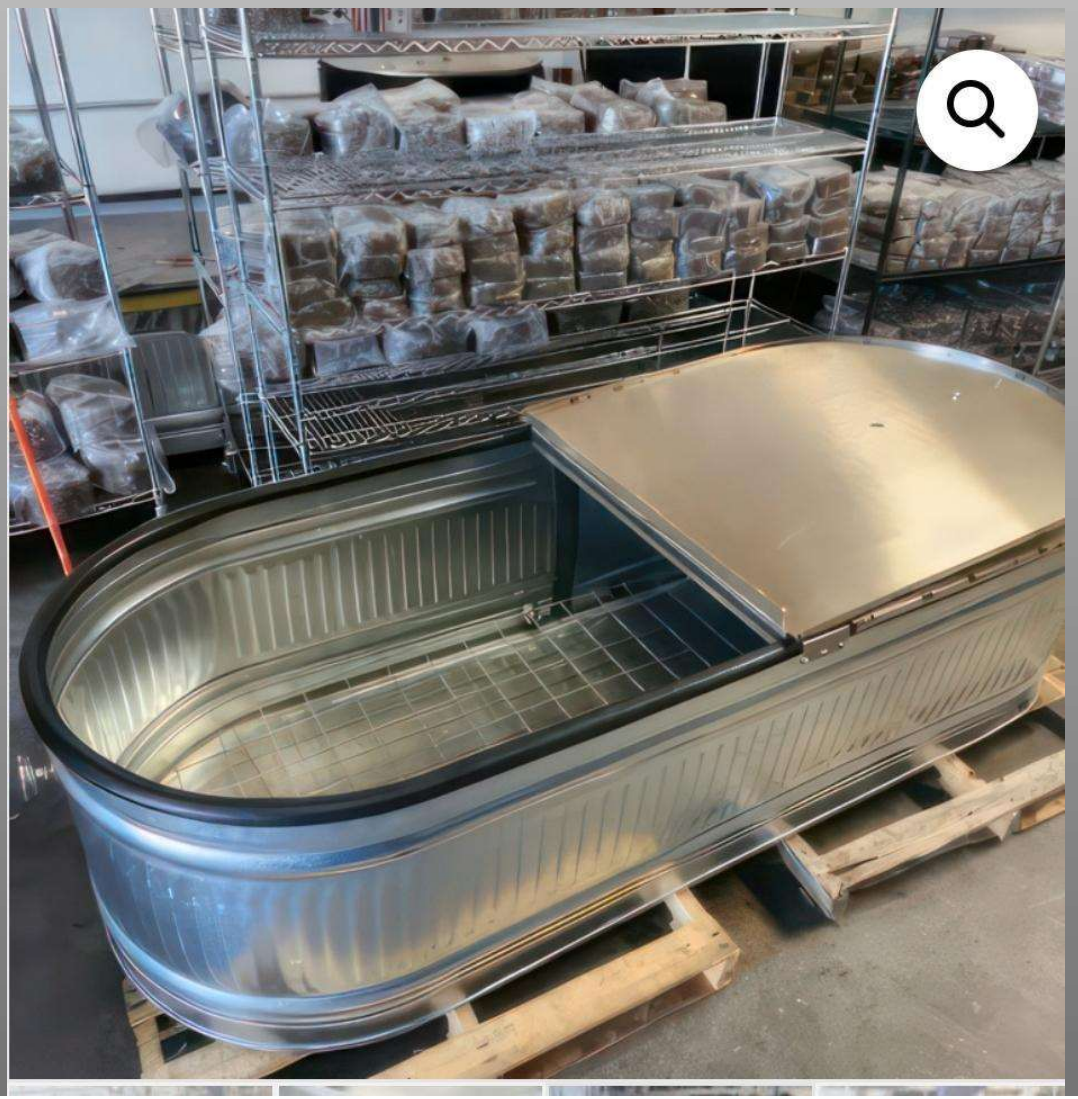
Lab Equipment





Sterilizers

Steam Pasteurizers



Grow Tent with shelving

Automatic bagging equipment

Myers Mushrooms

Mossy Creek Mushrooms

Ultrasonic fogger

Humidity sensor/controller

Bags

Jars

All in one solutions

$150k+ as of 2021

Process Terminology

- Agar- sterilized media in a petri dish
- Colonization- the spreading of mycelium through a medium
- Grain to grain transfer/ expansion- method of using colonized grain to inoculate more grain
- Inoculation- process of introducing mycelium to a new media
- Mycelium- network of fungal threads/ root system
- Fruiting body- mushroom we see and consume
- Incubation- time for colonization to take place
- Sterilization- achieved with steam/ 250 degree F at 15psi
- Pasteurization- reaching a temp between 150-180 for 2 hours.
- Substrate- Media mycelium consume to create fruiting bodies

Mushroom Culture-

- A sample of mushroom mycelium usually suspended in a nutritious broth- often called a liquid culture or LC
- Agar plate with a tissue sample or mycelium transfer
- Procured through other growers or from wild specimens
- Should always be started on agar
- Building block for any successful farming/ seed to your operation

Process Overview

- Clean culture on agar
- Culture is added to sterilized grain- inoculation
- Grain is incubated until completely colonized(10-21 days*)
- Colonized grain is then either expanded, or added to substrate
- Substrate is then incubated until colonization is complete(7-14 days*)
- Colonized substrate is then moved to fruiting conditions
- Fruiting can take anywhere from 7 to 21 days*
- Steps can be skipped by purchasing premade grain/substrate.

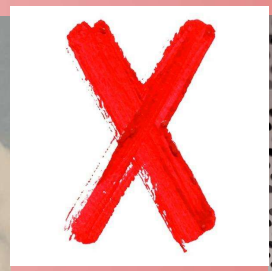
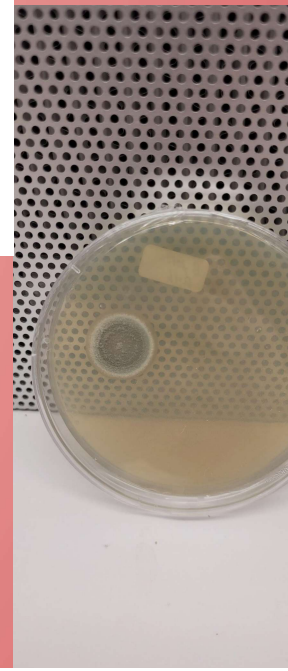
*Species Dependant

Clean culture on agar

- **Most important part of the process!**
- All work should be done in front of a laminar flow hood in a clean environment
- Can clean up dirty cultures by using lower nutrition in your plates
- Petri plates with agar medium can be purchased or made in house.

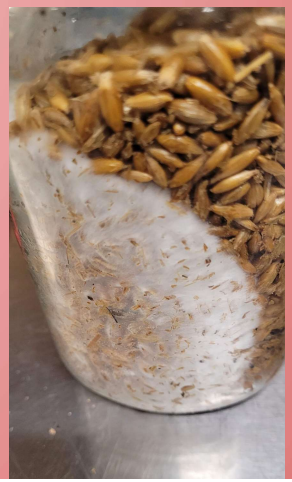




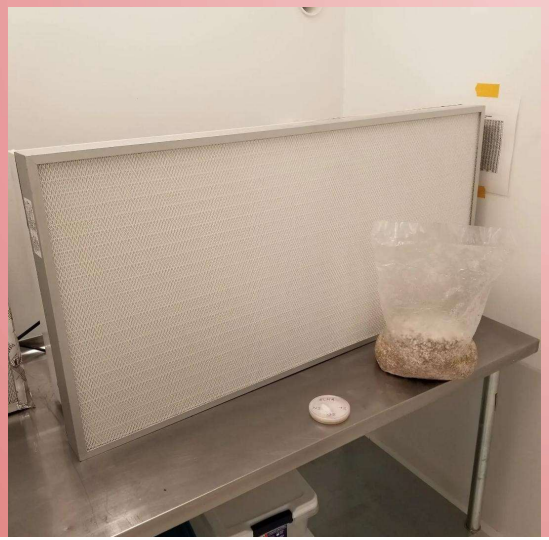
Sterilized Grain

- Grain is easily obtained at feed mills
- Many types can be used-oats, millet, wheat, rye, wild bird seed, and even popcorn
- Must be hydrated and sterilized prior to use. Clean room/lab work.
- Usually processed in jars, or unicorn bags
- 1 pound of spawn will inoculate 20 lbs of supplemented substrate



Inoculation and Incubation

- Fully colonized culture on agar is opened in clean room, and pieces are added to a sterilized grain.
- After inoculation of grain, the first incubation period begins.
- Incubation can take 14-21 days. Temperature needs to be steady in the 70’s
- Plenty of companies sell colonized grain spawn



Substrate

- Hardwood sawdust can be used if available
- Most use hardwood heating pellets due to ease of storage, and proper hydration
- Commercial growers use nitrogen supplements- soy hull pellets, wheat bran
- Straw is used in many countries to grow oysters
- If supplements are used the substrate needs to be sterilized, or super pasteurized. Work must be done in a clean room.
- Hydration needs to be in the 55-65% range ideally
- Easy formula for basic substrate is 2 lbs. pellets / 3 pounds of water

Substrate Inoculation and Incubation

- When substrate has cooled from being sterilized/pastuerized
- Supplemented substrate requires less grain spawn ¼ pound per 5 lb
- Unsupplemented requires ½ pound per 5
- After grain is added, bag is sealed and shaken to mix
- Incubation periods vary by species from 1 week for oysters to 3 months for Shiitake
- Temperatures should be maintained close to 70 degrees
- Airflow is important, as carbon dioxide levels will get high in closed spaces
- Ready for fruiting when substrate is completely white with mycelium
- Ready to fruit blocks can be purchased.

Fruiting

Conditions

- 12 hour light cycle
- Humidity 85-95%
- Air exchange every 3-5 minutes
- Ideal temperature for most varieties is in the 55-65 degree range, but different species like colder, and some tolerate higher temps.
- Keep it clean!

Fruiting cont.

- Exposure to available air, and surface evaporation are what initiate pinning.(mushroom starts)
- Higher humidity is vital at the pin stage
- Most species will start to pin within a week, and finish fruiting within 2 weeks
- After harvest, substrate will continue to produce mushrooms, but with less each subsequent harvest. Sometimes up to 3 total harvest




Cleanliness

Between 2,000 - 50,000 spores per cubic meter of air

- 70% Isopropyl is your friend. Sterilization is supreme, but sanitizing is key for hands, surfaces, and tools that cannot be sterilized.
- Every plate, bag or jar that is opened after sterilization, is sprayed with isopropyl before work starts.
- Airflow needs to be controlled. Positive pressure in lab, negative pressure in the fruiting room
- Filter patches on bags or jars should be 2 micron for grain/ up to 5 micron for substrate
- Laminar flow hood and hepa filtration are necessary
- We clean fruiting room weekly-walls,floor, ceiling, racks, humidifiers, exhaust fans, everything with bleach, quat, or other disinfectant
- Bacterial blotch and fungus gnats are common issues if cleanliness is not maintained

Finding the Market

Hardest part of the process!

- Once process is learned, and with adequate space, producing large amounts is easily attainable
- Full time job if you do all work in house
- We visited our local farmers markets, and saw no vendors.
- Social media and word of mouth have been our biggest marketing assets
- Get creative!
- Chefs appreciate the work and know how to use these specialty mushrooms
- Attend every event and get as much exposure as possible.
- I spend hours scouring restaurant menus for possible customers
- Walk into restaurants with product, leave samples with contact information.
- Co-ops and online marketplaces

Questions