

# Shipping Container Mushroom Cultivation Basics



**Transfarmation**

 MERCY FOR ANIMALS





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This plan was created in collaboration with Wyatt Bryson, owner of [Mycolab Solutions](#).

Mushroom cultivation is fun, rewarding, and profitable. There are many ways to start growing mushrooms for yourself on any level you would like to begin with. The great thing about mushroom cultivation is its scalability, adaptability, and accessibility. Through the advancement of current cultivation techniques by both large companies and pioneering entrepreneurs, coupled with easy access to quality spawn, mushroom growing is becoming a viable business venture for the small farmer.

In this paper we will look at readily available industrial shipping containers for use in mushroom cultivation as fruiting and inoculation rooms. It will be a basic overview of the buildout and the materials and systems you will need to consider.

Shipping containers have become a popular method for growing mushrooms due to their availability, durability, cost, and ease of transportation. There are two types of containers in a few different sizes. The main types of containers we will discuss are insulated reefers and uninsulated steel containers. There are also aluminum refrigerated box trucks, which usually come on their own trailer or chassis. These containers come in 20- or 40-foot lengths with an eight-foot width and either standard 8' 6" or high cube 9' 6" height. The square footage is 180 and 320, respectively. They are easily modifiable and come with many options. Most commonly they have one main double-door entrance.

Your geographical location, seasonal weather, and budget will help determine which container you will want to use. Insulated containers usually cost more than steel containers, especially with the AC unit included. There are many places to purchase containers, from shipping brokers and harbors to trucking companies and Craigslist.

Here are some general prices found on Craigslist in Northern California. It is worth your time to do some research to find a unit in your area at a good price with cheap delivery. Many companies will help you arrange delivery.

Cargo-Worthy Quality Containers, Current Prices:

- 20' x 8' x 8' standard height: \$3,300.00
- 40' x 8' x 8' standard height: \$4,200.00
- 40' x 8' x 9' 6" high cube height: \$4,300.00

1 Trip, Current Prices:

- 20' x 8' x 8' 6" standard height, tan or white: \$4,750.00
- 40' x 8' x 9' 6" high cube height, tan or gray: \$5,950.00

Ideally you will want to use an insulated reefer container or insulated box truck. You can use an uninsulated one depending on your location and seasonal weather conditions. In extremely cold or hot areas, you will spend more money and energy to maintain the proper temperature through either heating or cooling in an uninsulated container. The better insulated the container, the better you can manage temperature control and energy inputs. If you plan to insulate a thin-wall steel container on the inside, you will lose volume and space. Some companies make a Styrofoam panel that aligns with the interior of a container, but such products can be costly. Other options are spray foam insulation on either the inside or the outside of the container or framing the inside using rigid insulation. [InSoFast](#) makes specialized insulation for the insides of containers.

## Standard Container Size

# 40' HIGH CUBE



Specification		10' high-cube reefer	20' high-cube reefer	40' high-cube reefer	45' pallet-wide high-cube reefer
Dimensions	Outside dimensions	10' x 8' x 9'5"	20' x 8' x 9'6"	40' x 8' x 9'6"	45' x 8'4" x 10'6"
	Internal dimensions	9'3" x 7'7" x 9'	17'10" x 7'6" x 8'5"	38' x 7'6" x 9'4"	43'6" x 8' x 9'8"
Door opening	Width	2.324 m	2.290 m	2.290 m	2.440 m
	Height	2.584 m	2.569 m	2.880 m	2.567 m
Weight	Maximum gross weight	10,560 kg	30,480 kg	34,000 kg	36,000 kg
	Average tare	1,450 kg	3,060 kg	4,800 kg	4,800 kg
	Maximum payload	9,210 kg	27,520 kg	29,450 kg	30,820 kg
Capacity	Nominal	17.5 m <sup>3</sup>	32.3 m <sup>3</sup>	72 m <sup>3</sup>	83.7 m <sup>3</sup>
	Usable under load line	17.2 m <sup>3</sup>	30.5 m <sup>3</sup>	70.4 m <sup>3</sup>	80.4 m <sup>3</sup>
	Height usable for cargo	1.950 m	2.346 m	2.720 m	2.482 m



## Refrigerated Container Size



Dimension*	Standard 40 ft (D4)		40 HC reefer (R5)	
	ft	m	ft	m
Inside length	40	12.03	38	11.58
Inside width	8	2.35	8	2.28
Inside height	8.5	2.39	8.5	2.54
Door width	7.8	2.34	7.8	2.29
Door height	8.5	2.28	8.5	2.56
Capacity	2,390 ft <sup>3</sup>	67.7 m <sup>3</sup>	2,383 ft <sup>3</sup>	67.5 m <sup>3</sup>
Tare weight	7,870 lb	3,570 kg	10,210 lb	4,630 kg
Max cargo (reefer including machine)	63,780 lb	28,930 kg	66,950 lb	30,370 kg

\*Above table illustrates only typical dimensions; actual dimensions may differ according to specs type.

## Selecting a Location for Your Container

Site location is important for your container and will help determine the general workflow of your farm. It is also important to consider easy access to water and electrical hookups, work space, and accessibility. Each situation and farm will be set up differently, but there are some general guidelines to follow. These include choosing a flat and level location where the container will be protected from the elements, easily accessible for workers and vehicles, within easy reach of power and water, and in proper relation to your working spaces.

Site preparation includes ensuring a stable and level foundation. This may require pouring a concrete pad, using pier blocks, leveling the footprint, or laying gravel or base rock. Elevating the container is advised for drainage and reducing rust on the undercarriage.

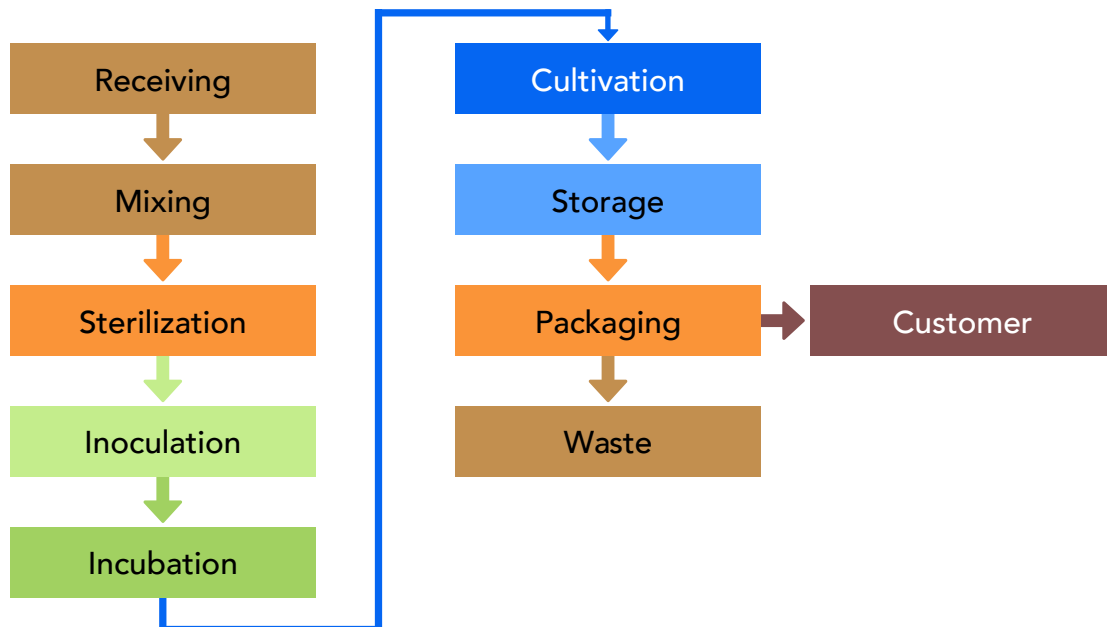
Site location may affect the normal ambient temperature inside, especially for uninsulated steel containers. For instance, if the container is exposed to direct sun for most of the day, it will obviously be warmer inside. If you live in a high-snow area, is the container in a place where it can be hard to remove snow in the winter? These are just a few of the many things to consider when placing your container. To reduce direct sunlight and help protect the container from the elements, you can always add a structure, tent, or other cover, which can also be used to enclose additional work space outside the container.

Once you have selected your container and its location you will need to outfit it and make sure it is properly sealed, rust-free, and properly painted and resistant to the elements, especially if it is outside and not under a cover.

## Workflow

Normally, mushroom production will require three to four different working zones or areas. These include a substrate-processing area, a substrate-pasteurization area, an inoculation room, a fruiting room, a cold storage or packing facility, and a compost or waste area. Except for the substrate-processing area and the waste area, these zones should be set up in a workflow relatively close to each other with the intent to keep everything as sterile as possible. From the moment your clean, pasteurized substrate is ready to be used, contamination will be your biggest enemy. You should set up your workflow from the most sterile area, your inoculation or bag-making area, and expect a higher possibility of contamination every time you move your bags in or out of a growing space. Many setups have multiple containers connected for moving bags from incubation rooms to fruiting rooms in a safe and sterile manner. You can also section off a single container into multiple rooms for the same purpose. Forty-foot containers with doors on each end are great for this, as your workflow will be in one direction with new bags coming in one end and spent bags going out the other.

### General Production Workflow



### Mushroom-Growing Workflow

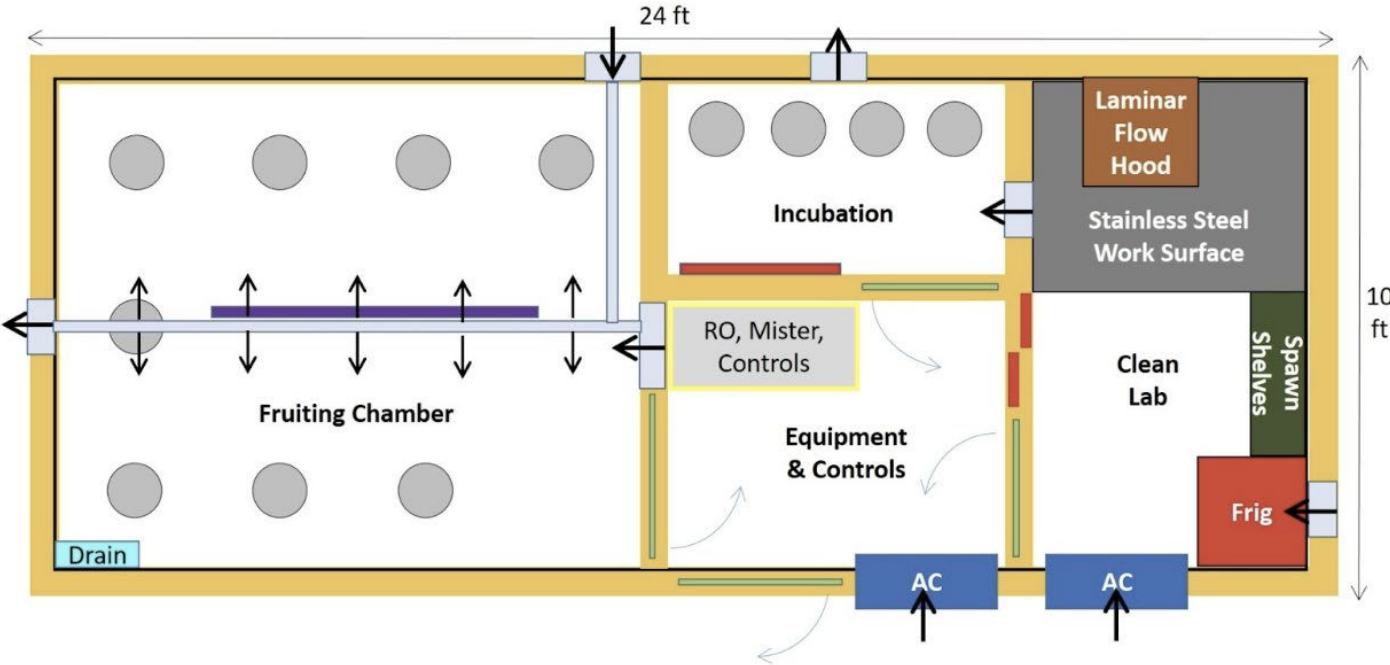


1 Substrate chopping ▶ 2 Substrate sterilization ▶ 3 Spawn inoculation & packing ▶ 4 Spawn running ▶ 5 Putting casing soil on bed ▶ 6 Mushroom production ▶ 7 Harvesting & packing

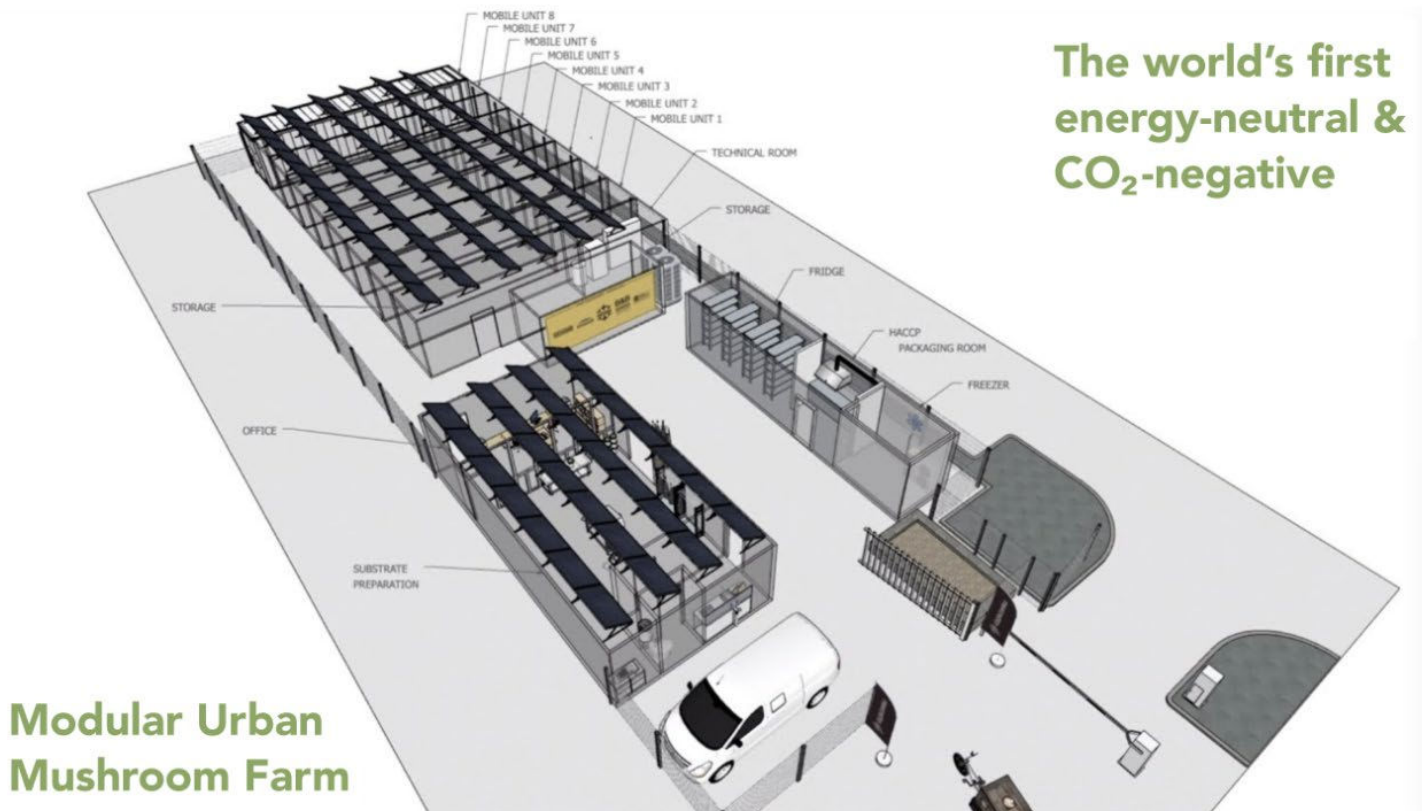
... 0 ..... 20 ..... 40 ...  
**Substrate** **Number of Days** **Mushroom**

### Example of Mushroom Building Workflow

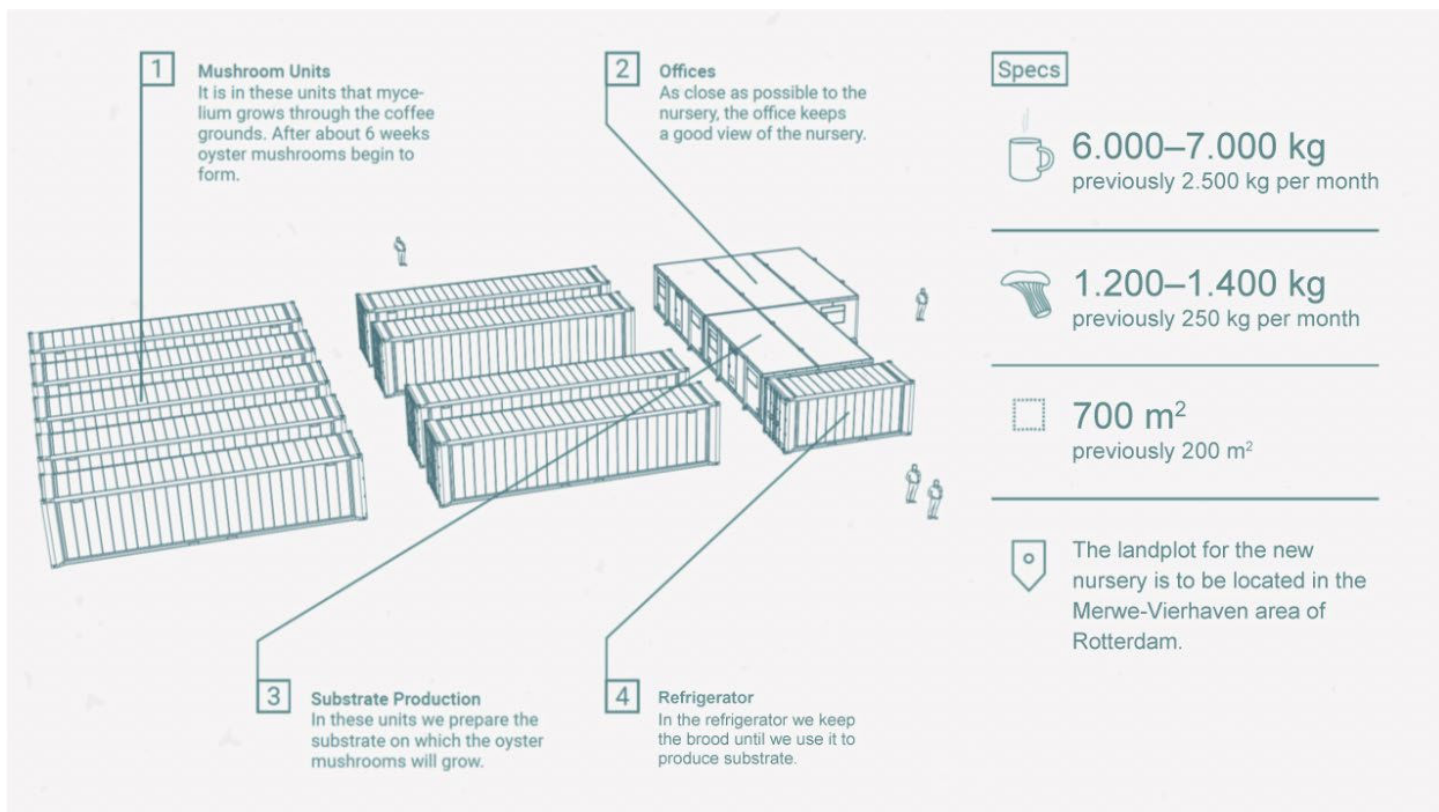
- Electric Heater
- Straw Log
- Vent
- High-Pressure Mister
- Door



## Example of Mushroom Farm Layout



## Example of Mushroom Farm Layout





## Substrate Preparation

First you will need a substrate-processing area where you will be chopping up your straw and pasteurizing it by heat, steam, chemical, or cold-water methods. For straw prep you can use many different methods. For small to medium scale you can use a small wood chipper, trimmer, chainsaw, or container and weed wacker. If using a chipper or trimmer, lay a tarp on the ground or a large bag to collect the finished straw, which should be in pieces 1"-3" long. For larger operations, you can get larger chippers or shredders. This area does not need to be clean and should be a place where it is OK to make a mess and far enough away not to contaminate your bagging area or other zones. Wearing a mask is recommended, as a lot of dust is created. Once the processed straw is collected, you will take it to your pasteurizing setup, which we will go over in more detail. This setup should be close to your clean bagging area, as that is where the substrate will go next.

### Methods for Processing Straw



## Pasteurization Methods

Pasteurization is a partial sterilization. For oyster cultivation it is OK to pasteurize your straw and not fully sterilize. There are a few different methods for doing this. The first is to use heat or steam. You can simply boil the substrate in a 55-gallon drum on a propane burner. You will need to bring the core temperature up to at least 160°F–180°F and leave it for at least an hour but not more than two hours. It helps to build a cage out of wire that will fit in the drum. You will need to weigh down the straw with something heavy. The burners are easy to find (on Amazon, for example, as a deep fryer kit). You want to pick one that looks reinforced to hold the drum. You will need to have a frame and a hoist to pull out the basket, as it is very heavy. There are also many more advances and expensive ways of doing heat treatment, like buying or building a steam chamber. Another method is chemical pasteurization using lime. The process is very simple, safer than using heat, and cheaper. You will need plastic 55-gallon drums or 250-gallon plastic totes. Fill with cold water and hydrated lime, and soak straw for 12–24 hours. The lime will rapidly increase the pH of the water, killing off the mold spores, bacteria, and other contaminants in the straw. You will want to use a hydrated lime that is low in magnesium. Do not use a calcium carbonate lime, which is common in garden supply stores. Cold water fermentation is the last method. It is very simple but takes much longer. You can use the same containers as the lime method, but all you are doing is soaking the straw in cold, unchlorinated water for three or four days, which allows anaerobic microorganisms to flourish and multiply on the substrate, creating a rich biological complexity that kills fungal spores or aerobic bacteria. When you take the straw out and expose it to oxygen, this kills all the oxygen-hating anaerobic microorganisms, leaving you with a blank canvas that you can then inoculate with your mushroom spawn. This method can create quite an unpleasant smell, but that goes away when the straw is taken out of the water and drained. For small scale, heating is fine. As you scale up, the other methods are cheaper and easy to scale. Do some research and find out which way works best for your farm.



## Straw Boiling and Chemical Pasteurization



**CALCIUM HYDROXIDE NOT CARBONATE**

**GUARANTEED DRY WEIGHT ANALYSIS**

Neutralizing value as CaCO <sub>3</sub> eq. min. (%)	125
Calcium (Ca), min. (%)	51
Calcium Carbonate (CaCO <sub>3</sub> ), max. (%)	5
Calcium Hydroxide (Ca(OH) <sub>2</sub> ), min. (%)	95
Magnesium (Mg), min. (%)	0.3
Magnesium Carbonate (MgCO <sub>3</sub> ), min. (%)	0.0
Magnesium oxide (MgO), min. (%)	0.5

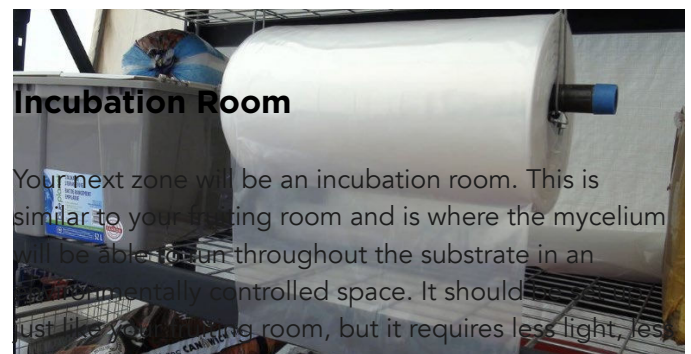
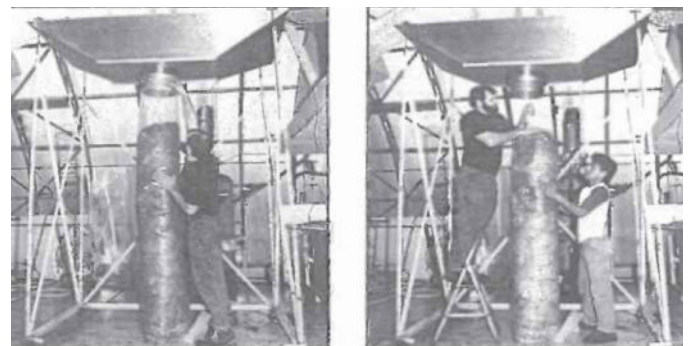
**FINENESS**

Sieve (mm)	% Passing
2.0	100
0.250	98
0.150	95
0.045	75

## Bagging Area

Once your substrate is fully pasteurized or sterilized you will take it into your clean production area where you will make your mushroom bags or columns. This area is where you mix and bag your mushroom spawn and substrate. This area will need to be clean and as sterile as possible to limit contamination before the mycelium has a chance to take hold in your substrate. This area should be in a closed-off space where you can cleanly work with your pasteurized substrate and spawn. You will need a clean mixing and bagging setup, a way to compress or tamper down the substrate and spawn in grow bags or poly tubing, a way to seal up your bags or columns by either tying up the ends or sealing with an impulse sealer. You will also want to compact your bags or columns either by hand or by mechanical means. Once your bags are filled and sealed you will want to poke holes in them so the mycelium can breathe and the fruit bodies can expand. A quick method is to put multiple arrowheads on a board and press the board against the bag.

### Examples of Bag-Filling Machines



## Incubation Room

Your next zone will be an incubation room. This is similar to your bagging room and is where the mycelium will be able to run throughout the substrate in an environmentally controlled space. It should be just like your bagging room, but it requires less light, less



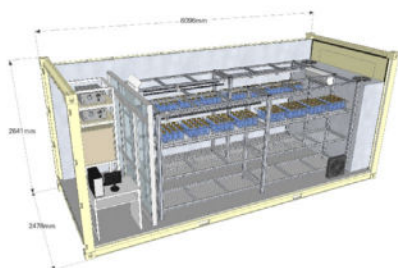
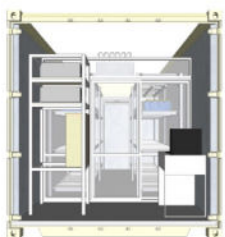


## Incubation Room

Your next zone will be an incubation room. This is similar to your fruiting room and is where the mycelium will be able to run throughout the substrate in an environmentally controlled space. It should be set up just like your fruiting room, but it requires less light, less air circulation, and less physical space between your mushroom bags or columns than the fruiting room. Just like your fruiting space, this room should be insulated, clean, and environmentally controlled with a ventilation system and heating and cooling. Once your mushroom bags are fully colonized you will move them into the fruiting room to grow the fruiting bodies and harvest.

## Fruiting Room

This is where you will grow and harvest the fruiting bodies or mushrooms. In this room you will add light, reduce CO<sub>2</sub> or add O<sub>2</sub>, and provide enough space for the fruiting bodies to develop. You will also need enough space to easily harvest your fresh mushrooms. This room will need to be environmentally controlled at all times, the most important factors being temperature, humidity, and CO<sub>2</sub> levels.



## Elements to Consider in Your Fruiting Room Buildout

- Electrical/Lighting
- Ventilation Intake/Outtake
- Heating/Cooling
- Humidification
- Controllers/Brains
- Shelving/Hooks
- Cleaning/Disinfecting/Pest Management
- Finished-Product Packing and Storing

## Building Your Fruiting Room

When setting up your container you may need to do some prep work depending on what condition it is in and whether any repairs need to be done. This may include sanding or removing rust, painting, and sealing any leaks. You will most likely need to cut out holes or drill through the metal walls for ventilation and anchoring lights, fans, ducting, electrical conduits, or shelving. As a rule, try to look for alternative ways of outfitting the container and limiting the number of holes put in the walls and roof. If you do puncture the container for any reason, make sure to seal with roofing tar or a similar approved product. This is especially important in an insulated container, as any leaks will get

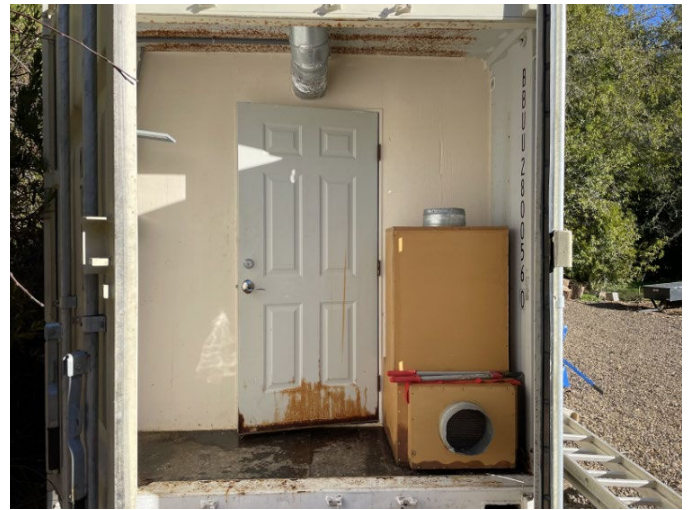


into the insulation or on interior walls. Before you start any construction, make sure to have a solid plan ready, with drawings, a layout, and your materials. If you are doing work yourself, you will need a basic knowledge of construction and tools and someone else to help. If you are hiring someone else to do the buildout, make sure they are confident and licensed.

It is recommended to have an antechamber in the first part of the container by building a wall and door 2'-4' from the main steel-door entrance. This way you can have a buffer room to don coveralls or protective gear and store tools or harvesting carts or bins. This will provide a space to install and protect electrical systems, controllers, and heating/cooling/filtration infrastructure and will allow access to monitoring equipment without the need to enter the room being monitored. The best way to do this is by framing in with a 2' x 4' and using 4" ridge insulation. Encase the wall with plywood. Use expanding foam and caulking to seal any gaps, and use a pre-hung door with weather stripping. Make sure to seal the interior wall with antimicrobial paint or primer, or laminate with contact cement and apply 4' x 8' bathroom-shower-wall material. It's cheap, easy to clean, and highly antimicrobial.

Another option is to use an industrial strip door made of clear PVC plastic, like you will find in a butcher shop or cold storage room. You can buy this in a roll and cut to length or buy a whole kit that is premade with a track. If you buy a roll, you will need to either buy a track system or make one at the top of the strips to hold them in place. Just staple the strips to a painted piece of wood, and then sandwich them with another piece of wood on top. Then screw them together.

The interior should be rust-free and painted, first with a metal primer and then antimicrobial topcoat paint. Proper painting will ensure that the high humidity in the fruiting room will not cause rust or damage. It is recommended to have a floor drain and water hookup on the inside for cleaning and decontamination.



### Materials Possibly Needed for Fruiting Room Wall Buildout

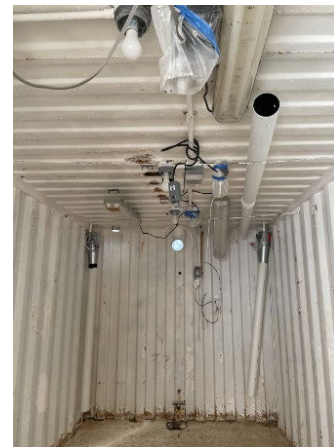
- 2' x 4' lumber for framing in wall
- 4' x 8' sheets 4" ridge insulation
- 4' x 8' sheets antimicrobial bathroom-shower-wall material for interior
- Contact cement to apply wall material
- Screws
- Nails
- Expanding foam to plug gaps and holes
- Mold-proof silicone caulking for cracks
- Pre-hung door
- Door knob/keyset
- Primer paint for base coat
- Antimicrobial or waterproof topcoat paint
- Roll of PVC strip door
- Track for strip door
- Weather stripping

## Electrical/Lighting

Electrical work can be dangerous, and it is always recommended to hire a professional licensed electrician, especially when hooking up your subpanel to the main electrical panel. Make sure you use the proper rated circuit breakers and contact your local electric company or electrician to ensure everything is correct and to code.

Due to the high humidity in the fruiting room, it is suggested to set up your electrical and climate-control units in the anteroom or in a weather-protected cabinet on the exterior of the fruiting room. This way you can protect your electronics from moisture and the elements while monitoring the conditions without entering the fruiting space.

Below is our electrical box with additional hardwired timers and variable-speed fan controllers for intake and outtake ventilation. This is located in the anteroom and is accessible without entering the fruiting area. All electrical panels and controllers should be placed outside the fruiting room where high humidity can cause damage and risk of electrocution. If you are not familiar or confident with electrical work, always hire or consult a professional licensed contractor. Lighting in the fruiting room is essentially to provide a direction for the fruiting bodies to grow toward, although species like oyster mushrooms do need more light than other species. Therefore, you do not need any high-intensity lights like you would need for plant production. That said, it is recommended to use a full-spectrum bulb for your lighting. The cheapest and most efficient lighting would be LED or T5/T8 fluorescent with a full-spectrum bulb. Also below is an example of waterproof T8 fluorescent housing with a full-spectrum bulb. Due to the high humidity in the fruiting room, it is recommended to use a housing or enclosed unit rated for such conditions. All wiring should be in approved conduits or metal-clad wire/armored cables with correct fittings and connectors. The importance of correctly wiring your electrical system cannot be overstated. Serious injury or fire can result from not doing the job right.



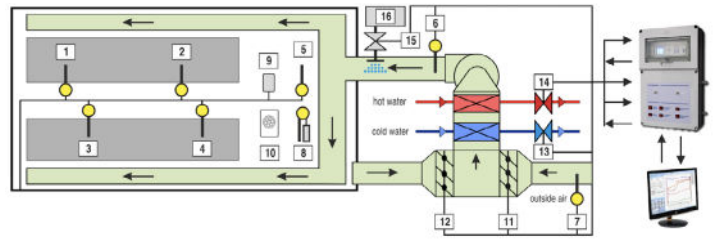
### Materials Possibly Needed for Electrical/Lighting System

- Subpanel box with correct rated amp fuses based on the installed equipment
- Electrical conduit
- Electrical wiring or metal-clad wire/armored cables, 10–12 gauge
- Connector fittings for conduit, boxes/wire
- Wire nuts
- Electrical tape
- Brackets for holding conduit
- Outlets (GFI if needed)
- Outlet boxes (outdoor waterproof)
- Outlet face plates and cover plates (outdoor waterproof)
- Enclosed LED or T5/T8 light fixtures with horticultural light bulbs
- Hot-water timers
- Variable-speed fan controllers

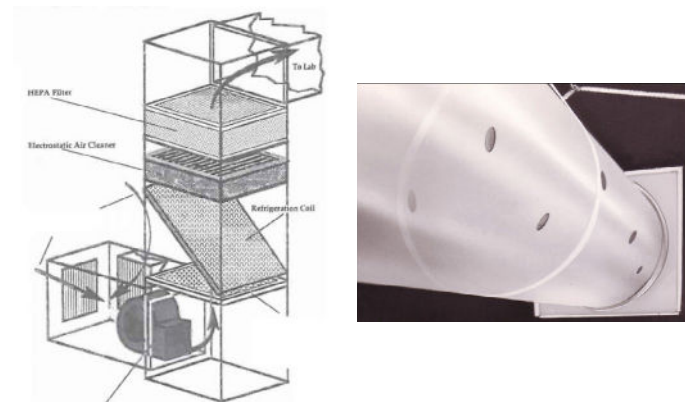
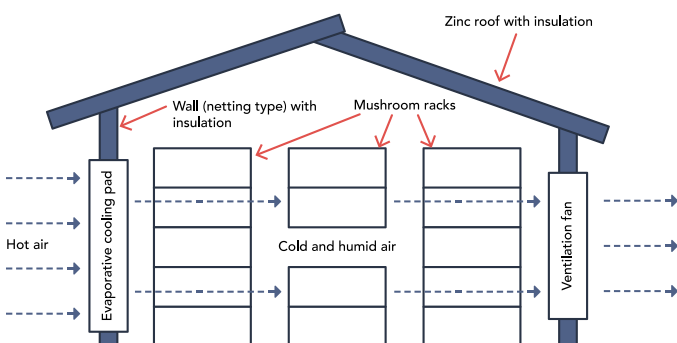
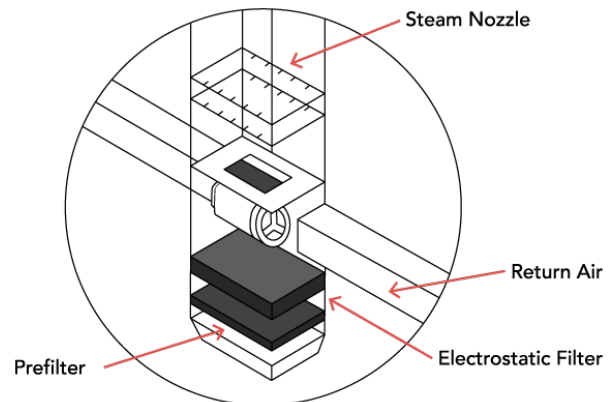
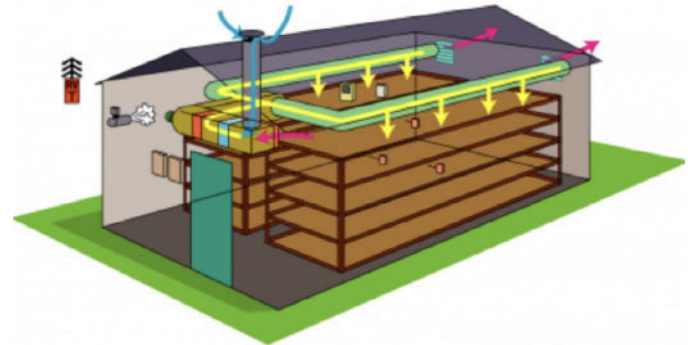
## Ventilation Intake/Outtake

Ventilation is one of the most important systems in your fruiting room. Set up properly, your ventilation system can incorporate your heating/cooling and humidity systems. Like mammals, fungi breathe in oxygen and expel carbon dioxide. Proper ventilation will remove high levels of CO<sub>2</sub> produced by the mycelium and replace it with filtered O<sub>2</sub> for your fruiting bodies to grow. Generally, you want to keep CO<sub>2</sub> levels in the fruiting room below 800 ppm, depending on species. If levels get too high, this will inhibit growth and overall yield. Simple ventilation can also act to cool the room, remove excess humidity, and remove spores or other air particulates. Any fresh air coming in needs to be filtered and clean to cut down on contamination. Advanced systems allow you to circulate the air inside; otherwise it is recommended to have additional wall-mounted fans in the room to create air circulation. There are many ways to set up your ventilation system, and your method will greatly depend on the type of controller you choose and your budget. The main factors to consider with ventilation are removing high CO<sub>2</sub> air out of the room, replacing it with fresh filtered air, maintaining air circulation, maintaining positive pressure, regulating temperature, regulating humidity, and making the cleaning of ventilation ducting easy. New poly tubing ducting systems are great due to their cost and ease of cleaning.

Below is an awesome design for a comprehensive ventilation, heating/cooling, and humidification system. This uses an efficient radiant heating/cooling system.



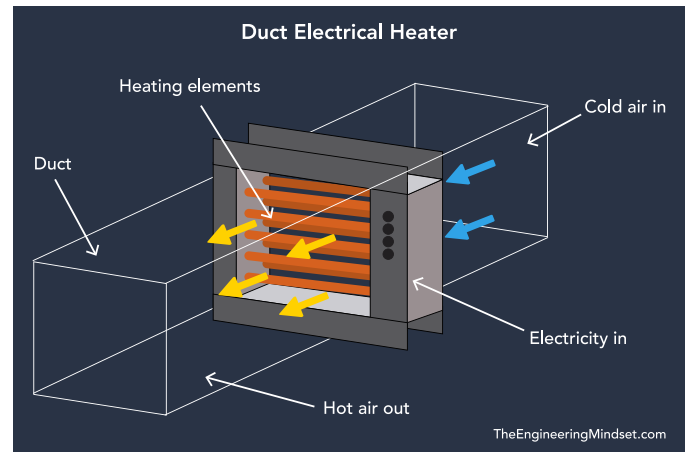
- 1-4 - Temperature bag or substrate probes
- 5 - Air temperature probe
- 6 - Inlet air temperature probe
- 7 - Outside air temperature probe
- 8 - Aspiration psychrometer (wet and dry)
- 9 - Capacitive RH sensor
- 10 - CO<sub>2</sub> transmitter
- 11 - Outside air damper
- 12 - Circulation air damper
- 13 - Cold water valve
- 14 - Hot water valve
- 15 - Humidifier valve
- 16 - Humidifier





## Materials Possibly Needed for Ventilation

- HVAC inline fans 4"–10"
- Squirrel fans 4"–10"
- HEPA filters with housing
- Plastic poly tubing ducting, flexible ducting, or ridged ducting
- Ducting connectors
- Air boxes and dampers
- Mounting hardware
- Wall-mount fans
- Fan-speed controllers



Heater in Ducting

## Heating and Cooling

Temperature control is one of the most important aspects of mushroom cultivation. The better you can dial in your temperature control and keep it within a consistent range, the better your growth rates and yields will be. Heating and cooling needs will vary depending on your location and time of year. The average temperature for oyster mushroom cultivation is 55°F–85°F. To cut down on costs, you can rotate several species for seasonal conditions. For example, you could grow warm-weather pink and yellow oysters (65°F–85°F) in the summer and colder blue and gray oysters (55°F–75°F) in the winter. Heating and cooling can be done in many ways. Ideally you want to incorporate them into your ventilation system, but independent heating units can be used. One of the most economical ways is to use water-to-air (hot and cold water) heat exchangers. Air heat exchangers work by pumping hot or cold water through a radiator like the heat exchanger in your ventilation system, with the fan blowing air over it to either heat or cool the air. For cooling you will use a water chiller, and for heating you will use a tank or tankless water heater. Swamp coolers are also an efficient method and also add humidity to the air. Conventional AC units are another option. For heating you can use induct heat exchangers or electric heaters. You want to remember to try and use a passive heating unit, like an oil heater or something that won't cause fire or electrocution. Many commercial greenhouse heaters are rated for high humidity in the room. Commercial heat pumps are also an option. Please consult an HVAC professional for the best option.



Propane Heater



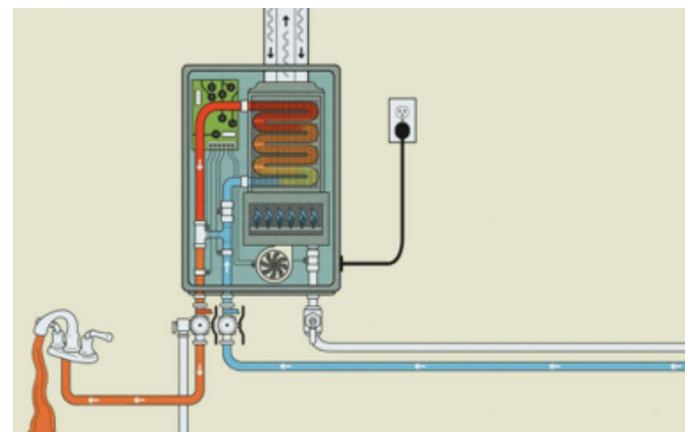
Oil Heater



Water Chiller



Heat Exchanger



On-Demand Water Heater

## Possible Materials for Cooling

- Commercial HVAC
- AC units
- Water chillers with radiant heat exchangers in ventilation system
- Swamp coolers
- Ducting
- Inline fans
- Wall-mount fans
- Water hose
- Water spigot
- PVC piping
- PEX hosing

## Possible Materials for Heating

- Portable oil heaters
- Space heaters
- Tanked or tankless water heaters with radiant heat exchangers in ventilation system
- Radiant floor systems
- Greenhouse heaters
- Traditional wall-mount heaters
- Miscellaneous electrical
- Electrical wiring
- PVC piping
- PEX hosing

## Humidity

Maintaining consistent humidity is important for fruit body growth. Generally, mushrooms are made up of 90 percent water. Fruiting rooms must be kept at around 80 percent relative humidity. The main methods for achieving this are ultrasonic misters and high-pressure misting units. Ultrasonic units can be bought commercially or made at home. Commercial units can run from a few hundred dollars to thousands. You can make your own for around \$300–\$400 by using a 12-head ultrasonic misting disk, a reservoir, or a float switch and fan. High-pressure systems are more complicated and require more insulation. High pressure pumps the water through atomizing nozzles that create a fine mist. You can look at examples in greenhouses. Individual units like the AquaFogger are also available. Whichever system you use, you will need a water hookup in your container.



High Humidity in Room



Ultrasonic Mister Disc



Top left to right: ultrasonic mister disc, professional ultrasonic mister, high-pressure misting nozzle, AquaFog fan misting system.

## Climate Control Systems

Climate control units are the brains of your fruiting room. They tie in your heating, cooling, air exchanges, and humidity. They come in many different configurations and price ranges. They are the hub of the operation and can be fully programmable and automated. Climate controllers can keep extensive logs and data on the conditions in your room. Picking the right controller is not always easy and will depend greatly on your budget and provided features. Simple controllers like INKBIRD run around \$40, while high-end automated units can run in the thousands. (Mushroom-designed controllers are relatively new to the market.) The only difference is the programming. Generally, you want a brain that can control temperature, humidity, and CO2 levels. It will need at least one outlet for heating, one for cooling, one for humidity, and one for CO2; this can be an outtake fan, which will reduce CO2. More comprehensive systems can control fans and air exchanges. You can integrate multiple controllers for each system, but it is nice to have everything in one unit. Every unit will have its own sensors to monitor the different aspects, and you should follow the instructions on where to place sensors in the room. It is also good to put airflow meters in your room so you can have a better idea of air circulation.

## Cleaning, Disinfecting, and Pest Management

Cleaning and disinfecting is an essential protocol for consistent healthy yields. This should happen on a regular basis, between fruiting cycles or after any major contamination or pest problems. A cleaning log should be kept with notes on any major issues of contamination. This way you can review all your production data and isolate possible causes of contamination. To cut down on contamination the container must be sealed and the integrity of the building must be maintained. Openings must be secured with no way for pests or contaminants to enter. Air entering rooms must be filtered, and the movement of people and equipment into the room must be limited. Keeping a positive pressure in the room by constantly blowing air into it is another way to help keep out pests and contaminants. Flies and gnats can also be a problem if they get into the room and can be managed by sticky fly strips. Having a hose hookup and a floor drain in the room is necessary for

washdowns and cleaning. Use a Hudson sprayer with a solution of disinfectant to first spray down all surfaces. Then hose down with clean water, and then mop up or push out any excess. One major issue in fruiting rooms is sporulation, where mature fruiting bodies will put out millions of spores that can clog up fans, ventilation systems, and sensors and generally cover surfaces. Having a ducting system that is easy to take down and clean will save you a lot of time and help maintain a sterile environment. Placing a UV-C light in your ducting system is also a good way to ensure clean, fresh air free of molds and bacteria.

### Possible Materials for Cleaning and Pest Control

- Floor drain and piping for cleaning and water removal
- Hose bib for cleaning and access to water
- Hose and sprayer fitting
- Fly or gnat sticky strips
- Hudson sprayer
- Concentrated hydrogen peroxide
- Bleach
- Disinfectant spray
- Sulfur burner
- Brooms and mops
- Rags and sponges
- Chemical fogger
- UV-C light

## Harvesting and Storing Your Freshly Picked Mushrooms

One of the most labor-intensive parts of mushroom cultivation is harvesting. Now that your mushroom fruit bodies are ready for harvesting, you will need to move about in the fruiting room and handpick each cluster by gently grasping and using a turning, pulling motion to remove. Having a rolling cart with wax veggie cardboard flats to put the fruiting bodies on is recommended. Now you will need to take the product to an area where you will be packaging or storing the product. Mushrooms don't have a long shelf life, and you should plan your deliveries accordingly. Quality of mushroom fruit bodies deteriorates quickly, and you should have your sale deliveries planned on your crop cycle. If you don't sell your product right away, plan on having cold storage and packaging readily available to preserve the product. You can usually get a great deal on a used



walk-in cooler or freezer through Craigslist. It is easy to add your own cooling unit and save a lot of money. You can always find new units through a manufacturer or distributor. Another option is to dry your mushrooms and sell them in bulk or add a revenue stream with a value-added product. Dried mushrooms have an excellent shelf life and can be rehydrated as needed for any application. Drying will greatly increase their price per pound, as it is now a value-added product in a sense. Dried oyster mushrooms can fetch \$20–\$35 or more per pound depending on organic certification and geographical location.

Dehydrators can be expensive, and most states have strict regulations on food production and limit natural sun drying. Fortunately, there are very large and effective electrical and gas dehydrating units on [alibaba.com](https://www.alibaba.com) for less than \$10,000. A seven-foot-long, two-door unit with 48 trays on rolling racks that can dry 200–500 pounds of mushrooms at a time can cost around \$7,500 with delivery. When selling or storing food products, you will need to comply with all FDA and local regulations. Please do your research, and know your local, state, and federal regulations concerning food handling, storage, and selling.



An abstract by authors M. H. Choi and G. H. Kim states:

There is a general trend towards a continuous increase in fresh market sales of mushrooms, and many methods have been examined to improve quality and extend shelf life during marketing. In order to study the effect of modified atmosphere package type on keeping quality of oyster mushrooms (*Pleurotus ostreatus*), whole mushrooms (200 g) were packaged with polyethylene film (PE, 60 mm thickness), ethylene vinyl acetate (EVA, 2%), or ceramic film (containing 5% zeolite) and stored at 0, 5, 10, and 20°C. Weight loss, color, firmness, gas composition (O<sub>2</sub>, CO<sub>2</sub>) inside the film package, respiration rate, ethanol content in the tissue, and sensory evaluation of MA packaged mushrooms were examined. Mushrooms packed unwrapped in a conventional hardboard box (2 kg) lost marketability early in the storage period due to weight loss, shrinkage, browning, and spore formation. The shelf life of oyster mushrooms was about 8–11 days at 0°C, about 4–6 days at 5°C, about 2–3 days at 10°C, and about 1–2 days at 20°C. During storage, film packaging prevented or retarded the deterioration of mushroom appearance, texture, and discoloration. This result was also characterized by a reduced respiration rate resulting from elevated carbon dioxide and reduced oxygen levels in the package.

## Conclusion

Using shipping containers for growing mushrooms is a cheap and viable option. There are many advantages and few drawbacks. Advantages include availability, structural durability, portability, and the lack of required building permits. They are portable, modular, and stackable, and because they are not permanent structures on your land, in most states you will not need a permit. They come with many customizable options and are easy to work on or retrofit. They are easy to outfit, and a number of companies make prefabricated turnkey units. Shipping containers are scalable, and adding additional units is easy. They are self-contained and can maintain stable growing conditions that will enable you to grow mushrooms all year. If you are interested in growing mushrooms, shipping containers may make the best fruiting chambers.

## Web Resources

### Organizations

- [American Mushroom Institute](#)
- [North American Mycological Association](#)
- [Shroomery](#)

### Farm Design

- [Grow Room Design for Home Cultivation](#)
- [Mushroom Farm Design: A Step-by-Step Guide](#)

### Equipment

- [Mushroom Fruiting Room Items](#)
- [Mushroom Growing Equipment](#)

### Directory

- [Mushroom Farms Online](#)

### Consultation

- [Mushroom Consultants](#)

### Additional Reading

- [Growing Mushrooms Commercially—Risks and Opportunities](#)
- [Mushroom Cultivation and Marketing](#)
- [Profitably Growing Mushrooms on a Small Farm](#)
- [Specialty Mushrooms](#)
- [Urban Food Ecosystem Project Report \(May 2019–November 2019\)](#)

## Climate Control Units

### Airflow Sensors

- [30MHz Wireless](#)
- [JF McKenna](#)

### All-in-One Climate Control

- [Alibaba](#)
- [Autopilot](#)
- [Fancom](#)
- [Mushroom Commander](#)
- [Sentinel](#)
- [TERA](#)

## Humidity Control

- [Inkbird](#)
- [JF McKenna](#)

## Temperature Control

- [Inkbird](#)

## Additional Reading

- [Environmental Monitoring and Airflow for Climate Uniformity](#)
- [Instruments for Monitoring the Greenhouse Aerial Environment](#)
- [Mushroom Cultivation Automation](#)

# Ventilation, Heating, and Cooling

## Ventilation

- [Duct Fan System \(AC Infinity\)](#)
- [Tube Fans \(QC Supply\)](#)

## Heating and Cooling

### Water Chillers

- [EcoPlus](#)
- [Two Guys Hydroponics](#)

### Heat Exchangers

- [Air-to-Water \(ChillXChillers\)](#)
- [Water-to-Air \(eBay\)](#)

### All-in-One Climate Control

- [Alibaba](#)

## Additional Reading

- [5 Best Water Chillers for Hydroponics](#)
- [All About Water-to-Air Heat Exchangers](#)
- [Duct Electrical Heater HVAC Heat Exchangers Explained](#)
- [How a Chilled Water System Works](#)
- [How to Grow Mushrooms: Ventilation and Humidity](#)
- [Mushroom Cultivation Room Design](#)
- [Radiant Heating and Cooling Systems](#)
- [Top 5 Best Greenhouse Heaters](#)



## Bagging Equipment

### Poly Tubing

- [Four Star Plastics](#)

### Bag Sealers

- [Automatic Filler and Sealer \(Seller 1, Alibaba\)](#)
- [Automatic Filler and Sealer \(Seller 2, Alibaba\)](#)
- [Foot-Pedal Impulse Heat Sealer \(eBay\)](#)

## Pasteurization

### Sterilization Techniques

- [Cold Sterilization](#)
- [Cold Water Fermentation](#)
- [Cold Water Lime Pasteurization](#)

### Equipment

- [Double-Door Steam Autoclave Sterilizer](#)
- [Substrate Steamer](#)

## Humidity

- [48 Liters per Hour Industrial Humidifier](#)
- [Direct Feed Fog Fan](#)
- [Fog Chiller](#)
- [High-Power 12-Jet Ultrasonic Fogger](#)
- [Multidirectional Humidifier \(Medium-Size Rooms\)](#)

## Insect and Disease Management

### Management Methods

- [18 Ways to Prevent Contamination](#)
- [Cultivating Oyster Mushrooms](#)
- [Damaging Insects, Nematodes, and Fungi](#)
- [Insects and Worms](#)
- [IPM Handbook](#)
- [IPM in Mushroom Production: Exclusion Techniques](#)
- [Maggots, Mites, Springtails, and Sowbugs](#)
- [Mushroom Flies](#)

## Storage

### Equipment

- [Industrial Heat Pump Food Dehydrator](#)
- [Rolling Restaurant Prep Table](#)
- [Three-Shelf Stainless Steel Utility Cart](#)
- [Walk-In Refrigerators, Coolers, and Freezers](#)
- [Wax Produce Boxes](#)

### Additional Reading

- [Quality Changes in \*Pleurotus ostreatus\* During Modified Atmosphere Storage](#)

## Mushroom Growing

### Turnkey Units

- [20-Foot Containerized Grow Room with Climate System](#)
- [Aluminum, Shelf-System Containerized Grow Room](#)
- [Gourmet Container Mushroom Farm](#)
- [Green Grow Ready-to-Grow Service](#)
- [Indoor Farming Systems](#)
- [Portable Mushroom-Growing System](#)

### Additional Reading

- [Shipping-Container Mushroom Farm Sprouts in Yarra Valley](#)
- [Smallhold Mushroom Producers](#)

## Home Cultivation Resources

**Bioculture:** cultures, supplies, cultivation information

**Everything Mushroom:** books, ready-to-grow mushroom kits, dried gourmet wild mushrooms, outdoor garden patches, mushroom logs, mushroom cultures and spawn, gifts, art

**Field and Forest Products:** Home cultivation supplies, kits, spawn, books

**Fungi Perfecti:** Paul Stamets, leader in home cultivation—supplies, books, kits, everything else a mushroom cultivator needs

**Lost Creek Shiitake Mushroom Farm:** shiitake mushroom log kits

**Mushroom Adventures:** button and portobello grow-at-home kits and supplies

**Mushroom Mountain:** bulk spawn, plug spawn, extracts, kits, mycogardening supplies, workshops

**Mushroom People:** online catalog of mushroom spawn, books, and mushroom growing

**Unicorn Bags:** autoclavable plastic bags for spawn

**Wylie Mycologicals:** specialty mushroom facility—mycological laboratory, spawn rooms, and growing chambers

## Commercial Mushroom Cultivation Sites

**American Mushroom Institute:** national voluntary trade association representing the growers, processors, and marketers of cultivated mushrooms in the United States and industry suppliers worldwide

**Canadian Mushroom Growers Association:** voluntary nonprofit organization whose members are dedicated to the production and marketing of fresh mushrooms in Canada

**Forest Mushrooms:** wild mushroom broker (Minnesota)

**Gourmet Mushrooms, Inc:** major producer of specialty mushrooms (Michigan, California)

**International Society for Mushroom Science:** furthers cultivation of edible (including medicinal) macrofungi, disseminates information on new developments and the science of mushrooms, stimulates exchange of new ideas between growers and scientists around the world, nonpolitical and nonprofit

**Modern Mushroom Farms:** suppliers of "whites" (*Agaricus bisporus*) in every shape and form (Pennsylvania)

**Monterey Mushrooms, Inc:** major commercial supplier of specialty mushrooms (California)

**MushroomCompany.com:** publishes *The Mushroom Growers' Newsletter*

**Phillip's Farms:** major commercial supplier of specialty mushrooms (Pennsylvania)

## University Sites

**Agricultural Marketing Resource Center (Mushrooms):** Iowa State University

**Fresh Mushrooms:** Penn State mushroom promotional site

**Penn State Mushroom Spawn Laboratory:** first land-grant college to initiate a comprehensive mushroom research program, developed improved composts and production practices adopted by growers worldwide

**Purdue University Specialty Mushrooms:** Purdue University website

## Mycological Society Sites

**Colorado Mycological Society:** cultivation page

**Kitsap Peninsula Mycological Society:** cultivation page

**Mykoweb:** cultivation page, great overview

**Sonoma County Mycological Association:** cultivation page

## Manuals and Articles on Mushroom Cultivation

**ATTRA, Mushroom Cultivation and Marketing:** excellent, thorough manual on growing and marketing mushrooms

**Cultivation of Oyster Mushrooms:** well-illustrated, 12-page manual from Penn State

**Cultivation of Shiitake on Natural and Synthetic Logs:** another well-illustrated, 12-page manual from Penn State



**Growing Mushrooms the Easy Way: Home Mushroom Cultivation with Hydrogen Peroxide:** manuals describing a method for growing mushrooms with hydrogen peroxide, answers to frequently asked questions, ordering information for literature and mushroom growing kits, and ideas for science fair projects

**Growing Shiitake Mushrooms in an Agroforestry Practice:** excellent booklet on shiitake log cultivation from the University of Missouri Center for Agroforestry

**I Grow Mushrooms:** short article on planting oyster mushrooms

**Introduction to Shiitake: The “Forest” Mushroom:** excellent article from the University of Kentucky Extension on growing shiitake on logs and marketing the mushrooms

**Mushroom Cultivation for People with Disabilities—A Training Manual:** a project sponsored by the United Nations Food and Agriculture Organization (available in its entirety in HTML or PDF formats)

**Mushrooms, Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact:** book exploring the relationship of mushrooms with human welfare and the environment, medicinal properties of mushrooms, and the global marketing value of mushrooms and their products

**Oyster Mushrooms Colourful Cousins:** short paper from Wylie Mycologicals on the colorful *Pluerotus* family

**Ralf Kurtzman’s oyster mushroom cultivation manual:** website of mushroom cultivation consultant Ralph Kurtzman, excellent manual for small-scale commercial oyster mushroom production

**Resources for Shiitake Growers:** resource directory from the University of Kentucky Extension

**Shiitake and Oyster Mushrooms:** short paper from the University of Kentucky Extension

**Shiitake Mushroom Production on Logs:** 30-page manual on shiitake log cultivation and marketing from Alabama A&M Extension

**Six Steps to Mushroom Farming:** discussion of button-mushroom farming from Penn State

**Training Manual on Mushroom Cultivation Technology:** 65-page manual from the UN’s Asian Pacific Centre for Agricultural Engineering covering all aspects of mushroom cultivation for several species

## Additional Resources

**Are Mushrooms the New Plastic?:** TED talk that reveals product designer Eben Bayer’s recipe for a new fungus-based packaging material that protects fragile items, such as furniture and plasma screens, as well as the environment

**Bio-Organics:** mycorrhizal inoculants and organic gardening supplies (United States)

**Fungi for the People:** passionate mushroom cultivators working toward environmental and social justice and empowerment

**FungiFun:** forum on mushroom cultivation

**Mushroom Waste Management Project Liquid Waste Management:** comprehensive scientific paper

**Radical Mycology:** grassroots organization dedicated to sharing open-source, accessible information on the easiest and most effective means of working with mushrooms and other fungi to increase personal, societal, and ecological resilience

**Shroomery:** good information on general mushroom cultivation with a magic mushroom emphasis

**The Mushroom Growers’ Newsletter:** easily navigable website that includes event listings, features from past newsletters, a subscription form, and access to other mushroom growing information online

## Videos

### Getting Started

- [5 Amazing Small Scale Mushroom Farm Examples \(GroCycle\)](#)
- [5 Things I Wish I Knew Before I Started Growing Mushrooms for a Living \(GroCycle\)](#)
- [Growing Mushrooms at Home: My Story and Advice on Startup \(Myers mushroom farms\)](#)
- [Small Scale Mushroom Farm Setup Costs \(Oak and Spore mushroom farm\)](#)
- [The 7 Basic Steps of Mushroom Cultivation \(FreshCap Mushrooms\)](#)

### Design and Equipment

- [Designing a Mushroom Farm \(GroCycle\)](#)
- [Growing Mushrooms Outdoors \(GroCycle\)](#)
- [Growing Mushrooms Outdoors in Greenhouses \(What the Fungus\)](#)
- [How to Control Humidity and Airflow in Mushroom Fruiting Rooms \(Myers mushroom farms\)](#)
- [How to Grow Mushrooms Outdoors \(What the Fungus\)](#)
- [Shipping Container Farms \(GroCycle\)](#)

### Substrates and Kinds of Mushrooms

- [Brain Booster? The Magic Power of Lion's Mane Mushroom \(FreshCap Mushrooms\)](#)
- [Making 95 Blocks of Our Hardwood Sawdust Substrate for Mushroom Cultivation \(SouthWest Mushroom\)](#)
- [Understanding Mushroom Substrates \(FreshCap Mushrooms\)](#)

### Log Cultivation

- [Growing Mushrooms on Logs \(GroCycle\)](#)
- [How to Grow Mushrooms on Logs \(North Spore\)](#)