



Infrastructure and machineries for spawn and button mushroom production

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Mushroom being an indoor crop does not require arable land, except for some non-agricultural land to build the infrastructure for preparation of substrate, raising of crop, preparation of spawn and postharvest handling. Mushroom is grown seasonally and in environment controlled cropping houses and both require building of basic infrastructure. Seasonal growing is done for 3-4 months when outside temperatures are favourable for the crop.

Seasonal cultivation of mushroom is mainly done by traditional methods in the thatched structures employing long method of composting. Environment controlled units are cultivating this mushroom round the year by having suitable infrastructure at their disposal which includes a modern composting yard having bulk pasteurization facilities. Besides these facilities they are having insulated cropping rooms and other ancillary structures required for mushroom cultivation. Few of the bigger units are having their own spawn lab and processing unit as well. Suitable infrastructure including different machineries are required at the farm to carry out different operations to govern the whole process of cultivation in such a fashion so that one gets optimum returns from his farm.

Farm design for environmental controlled cropping:

Selection of site and pre-requisites: Following points have to be taken into consideration prior to selection of site for mushroom production.

- Site should preferably be away from the municipal limits and entrepreneur should purchase sufficient land in one go looking to the future expansion.
- The site should be serviced by a motorable road, or nearer to a road head
- Sufficient water (underground or rain) should be available at the site.
- Availability of straw and poultry manure at cheaper rate around the site.
- Availability of cheap labor in abundance.
- Uninterrupted proper power supply at the site.
- Nearness to the market for the proper disposal of the produce.

Components of a mushroom farm: For round the year cultivation of this mushroom employing environment-controlled conditions a medium size plant would require under mentioned components.

Spawn unit: There are following components required in spawn unit for production of spawn and its selling.

Cooking/autoclaving room: For boiling the grains and



Inoculation room along with laminar air-flow



Production room along with button mushroom

sterilization of substrates

Inoculation room: For inoculation of the sterilized bottles/pp bags

Incubation room: For incubating the inoculated bottles/pp bags

Cold store: For storage of prepared spawn for its further disposal.

Besides above, some ancillary structures like office, small lab space, delivery area, etc. and machineries like Air conditioners, laminar flow system, autoclaves, BOD incubators, boiler, boiling kettles, refrigerators, racks, pH meter, gas stoves, etc. may also be required.

Composting unit: This unit consists of following components.

Pre-wetting area : For dumping of raw materials and their pre-wetting (uncovered).

Composting yard : For making piles out of the wetted materials (covered)

Phase-I bunker : For phase -I composting (in case indoor composting is employed).

Phase -II tunnels : For performing pasteurization and conditioning of the compost.

Casing soil chambers: For pasteurization of the casing soil.

Spawning area: For spawning of the prepared compost.

Besides above certain ancillary rooms like boiler room, underground service room, store room, workers room, etc. would also be required. Machineries viz., boiler, blowers, air handling units, gratings, digital thermometers, compost retaining boards, ventilation system for phase -I bunkers would be required in a medium size farm. Large farm besides above may require a front end loader and other compost handling equipment including turner, filling line, etc.

Cropping unit : A cropping unit will have series of insulated rooms of designated size depending upon the production targets. Besides rooms there will be AC/ compressor room, packing room, central corridor housing air handling units and pipelines. Machineries required: Insulated doors, central chilling station (ammonia based), air handling units, computer based controllers (optional), racks and trolleys, harvesting trays, etc. would also be required. For continuous electric supply to phase-I, phase- II tunnels and cropping rooms, generators of desired capacity would also be required.

Post-harvest handling unit: It consists of following components.

Pre-cooling chamber (cold room): For storing the mushrooms before canning

Canning hall: For housing the canning line for processing

Laboratory: For quality control of processing

Store: For housing the processed can

Office: For sitting of the staff

Machinery required: Canning line of desired capacity

General layout/Location of various units: The layout of a mushroom farm has to be carefully planned after selection of the site, keeping in view the several factors including accessibility of road to the composting yard as raw materials are to be dumped here for their processing to the compost. As per wind direction, during most of the time of the year it should flow from cropping area to the compost yard and not *vice versa*. Phase-I bunkers are constructed in line nearer to the phase-II tunnels and bulk chambers for their operational convenience. The cropping rooms are built away from composting area for reasons of cleanliness and avoiding contamination by pests and pathogens. The casing pasteurization chamber is built nearer to the composting yard. Spawn unit is built far away from the composting yard and nearer to the cropping area. Processing unit can be a separate entity or can also be built within the building housing cropping rooms. The underground water pipes, electrical cables and sewers are laid well before the actual construction starts. The entire site area should preferably be fenced or brick walled for security reasons. The cropping rooms are generally built in double rows with a path/gully in between for various operations and services.

Composting unit: The components of composting unit will depend upon the method of compost production chosen. If one is going for indoor compost production, in such a case requirement of composting yard will be greatly reduced and it will be 1/3 of the normal yard. For indoor composting, a small pre-wetting area and small covered composting yard would be required with minimum of two-phase -I tunnels and one phase -II tunnel.

Prewetting area (PWA): This area is constructed nearer to the road it is a simple cemented structure having a saucer like depression in the center so that water remain collected during the pre-wetting of the compost ingredients. It is usually not covered and is open to the sky. Water connection with 2"-3" dia. pipe should be available in PWA permanently.

Composting yard: The composting yard is required for phase-I of composting. It is a prerequisite when one is going in for short method. The composting yard should necessarily be a covered shed where rain will not interfere in the normal process of composting. The floor is given a run-off of 1 cm per running meter away from the bulk

chamber and towards the goody pit end. A three phase 15 Amp power connection should also be provided at the composting yard for operating machines like hopper regulator, compost turner, filling lines, etc. An overhead water tank is necessary, particularly where water is scarce, to store water for timely operations. The floor of the yard for long method of composting should be simply cemented/brick layered.

Phase-I tunnels (bunkers): This facility is required when indoor composting is employed at the farm. These are non-insulated tunnels and its dimension would depend on the output of the compost required. Generally the bunkers are 1.5 times more the size of the phase-II tunnels. It has a plenum (ventilation duct) constructed below the actual floor. A perforated concrete floor having around 1 cm openings at a distance of 1ft each to the entire floor area is constructed above the plenum. A plenum floor involves pressurizing the entire airspace beneath the concrete floor, allowing the air to move up into the substrate through the holes.

Pasteurization facility: A modern farm employing either indoor method or SMC essentially requires this facility. The bulk pasteurization chamber is principally used for phase-II of composting for pasteurization and conditioning of the compost. For this purpose, an insulated chamber is built with facility for steam injection and controlled recirculation and fresh air entry in the tunnel through a blower. The insulated chamber is built with purpose of cutting off the external environment and simulating a desired environment inside for controlled fermentation of the compost ingredients. The bulk chamber should be constructed on one end (away from road) of the composting platform. One end of the bulk chamber should open into the platform and the distant end in the clean spawning area.

Air handling units of the tunnel (AHU): For effective pasteurization and conditioning of the compost in the tunnel specific requirements of air and ventilation are to be met, which are generally met by providing/installing AHU in the tunnels (Fig.1). Effective pasteurization and conditioning is attained when 150-200 m³ air per ton of compost per hour is blown through the compost mass. For this purpose high speed centrifugal fan is chosen and is placed on the slope end of the ventilation duct in the underground service area. Since, India is a tropical country where temperature during summer months goes above 45°C. Cooling of compost for spawning during this period becomes difficult by simple introduction of fresh air. Special cooling arrangements are, therefore, required to be made in the

AHU of the tunnel for this purpose.

Casing pasteurization chamber : Casing pasteurization chamber is just a mini bulk chamber. It has all the necessary components as required for the tunnel except that the plenum is not having any slope and capacity of the blower for proper steam injection and its uniform distribution inside the casing mass is around 1/4 the capacity of the tunnel. The casing inside the chamber can be treated in the bulk and in such case it is filled upto the height of 90 cm only as against the tunnel where compost is filled upto the height of 2-2.2 meters. This chamber can be built near to the composting yard or within the composting yard with a separate casing mixing platform.

Cropping unit : Since mushrooms are grown indoors under simulated environment specially created for mushroom growth, the cropping rooms are required to be built specially for the purpose. Two types of cropping rooms are built suiting to particular requirement - those required for seasonal growing and those for environment controlled growing round the year.

Seasonal cropping rooms : These cropping rooms will have a cemented floor, cemented walls, cemented ceiling or a false ceiling with arrangement for forced air circulation inside. The seasonal cropping rooms are built of simple brick walls with roof made of asbestos sheets and a false ceiling. The room is more or less made air tight to make the air handling system work effectively for obtaining necessary air changes during growing. No insulation is required for seasonal growing rooms, as it will not allow heat dissipation from the room efficiently. No energy is generally used for heating/cooling of the rooms under seasonal growing conditions. The cropping rooms for seasonal growing can also be made with a thatched roof and a false polythene ceiling. The mushrooms are grown on beds made out of bamboo sticks.

Environment controlled cropping rooms: The environment controlled cropping rooms are built like hermetically sealed chambers where the air movement is controlled either manually or semi automatically with mechanical control systems. These cropping rooms are appropriately insulated and the dimensions of a cropping room are determined by the amount of compost to be filled into the room. Rooms with greater length and narrower width gives better results as far as air handling inside the room is concerned. Now-a-days, 60 days cropping cycle is generally taken and in this manner a minimum of six crops are taken / room in a year. In such conditions a minimum of 12 rooms are required to have constant supply of mushrooms from the unit round the

year. The cooling, heating and forced air circulation in the growing room is done via AHU installed for each cropping room individually.

Structural details special to cropping rooms:

Floor : The floor must be well laid out, insulated and should be strong enough to take the heavy load of metal racks to be kept inside for growing mushrooms. The floor should have slight slope towards the entry point for discharge of cleaning water and placement of formalin trough for foot wash.

Walls : The walls are made of brick 22.5 cm thick, which are given a smooth finish with cemented plaster. The insulation sheets are fixed on the walls (5 cm thick thermocol, glass wool/polyurethane), with the use of hot coal tar.

Roofs : The roof is made of RCC (1:2:4) 12-15 cm thick. The inside is given a cement plaster finish for application of insulation. The roof on the outside is protected by tarring it on top, followed by 10 cm thick loose soil, 5 cm thick mud capping and finally the tiles. This will protect the roof from weathering effects of rain and will ensure longer life of insulation and prevent seepage of moisture into the room in rainy season.

Doors/vents: The doors of the bulk chamber and the cropping room are made of wood or angle iron frame covered on inside and outside with aluminium sheets/GI sheets with insulation of 5-7 cm in the middle. The doors will have a rubber gasket lined on inner periphery so that *the door becomes air tight when closed*.

Lighting arrangement: There should be a provision for tube lights for inspection in each cropping room. The tube lights should be protected with water proof housing. The tube lights should be fitted on all the walls vertically at various heights to facilitate lighting of all beds.

Water connection and sewers: One clean water pipe line (1" or 1.25") with tullu pump installed to it for delivering clean water for spraying should be provided in each room. Underground drainage line for carrying the washings from the room and wash basin discharge should be laid before construction of the building. This waste water line should be connected to the common sewer.

Gallery : The gallery between the rows of cropping rooms should be wide, (12-15 ft) to allow efficient performance of various operations. The height of the gallery should be same as for the growing rooms alternatively it may be about 8' with a false ceiling, leaving another 5 ft above for pipeline and space for AHUs.

Racks: Racks are made up of the angle iron for horizontal and vertical support with iron mesh strips used for the

shelves for housing compost. Length (vertical axis) of the racks is generally made up of 5 cm thick angle while horizontal support is made up of 3.5-4 cm thick. Width of the each shelf on the racks should not be more than 135 cm in any case as width more than that creates hindrance in performing various operations during cropping and most important of that is harvesting. Cultivation can be done in bags or in shelved beds. Five to seven rows of shelves (depending on height of the room) can be provided one above the other in the racks keeping a minimum distance of 60 cm in between.

Air handling unit : This unit is employed for creating proper weather inside the growing room specific to white button mushroom. Air handling unit is generally installed in each room at the top of the door, which is made up of aluminium or G.I. Sheets. In certain cases it can also be placed on the top of the floor of the growing room or in the corridor. Indirect cooling of air through chilled water (5-6°C) is generally employed in mushroom cultivation. In AHU cooling coils, humidifiers, heaters, eliminators and other components are mounted on the back of the supply air fan. The AHU has a mixing chamber with recycling dampers, which can regulate supply of fresh air or room air inside the growing room.

Processing unit: Utmost strict hygienic conditions are required to be maintained in the canning hall. The floor must be well laid off preferably having slope at one end. Walls should have ceramic tiles upto the height of 5-6 ft. Height of the canning hall should be not less than 14 ft in any case. Surrounding where this facility is built should be clean and away from the composting yard. Canning hall should be big enough looking to the future requirements or processing of other items. All the doors and windows should have wire mesh shutters to prevent the entry of insects and flies. Cold room should be properly insulated with minimum of 10 cm insulating material and separate product cooler of required tonnage should be installed to it.

Infrastructures for seasonal cultivation:

Composting yard/ space: Compost yard is necessary for outdoor composting for preparation of substrate. In general, outdoor composting is done on clean-cemented platform. If such facility is not available then a simple brick platform can be used. If the grower does not have any of the two facilities than one can prepare compost in an open field or in a area around his house. For a small farm producing daily around 50 kg mushrooms a platform of size 60 x 40 ft is enough. A low cost composting yard has a low cost roofing of high-density polythene fixed on

iron tubular structure or it can also have thatched roof.

Growing rooms : In general, seasonal cultivation is done in thatched houses. Such structures are made up of bamboos, paddy straw/sarkanda grass and polythene sheets. All most all the growers are using such structures for this purpose. Size of such structures depends up on the quantity of mushroom to be produced per season. Generally these houses are of 60 x 30 x 10ft dimensions having four rows of bamboo racks. Two side racks have 3 beds each while two center racks have four beds each. Length and width of each rack should be 55 x 4.0ft leaving a working path of around 2.5 ft. in between. Such structure will hold around 16 tons of compost spread on these beds at a depth of around 4-5 inches. This much compost will yield around 50-55 kg mushrooms daily. However, smaller structure can also be constructed based on quantity of mushrooms to be produced. Small scale cultivation can be started in a simple room/ garage/ store room available with the cultivator. Heavy-duty coolers to bring down the temperature in summer conditions may be installed in such type of structures.

Machinery required: There is no need of much mechanization at small farms. They can handle little quantity of compost manually. However, for a large export oriented unit (around 2000-3000 tonnes per year-TPA), which handles the compost in bulk (around 30-40 tons of straw/day), mechanization of the operations *viz.*, prewetting, turning, filling, emptying, spawning and bagging becomes necessary to hasten the process and to get a quality compost. Such farms also employ computers, which monitor and control the process of pasteurization and conditioning inside the tunnels. Various types of machineries having different uses will be required in a mushroom unit.

Prewetting machine or pre-wet heap turner: This machine is used to blend loose or baled material with other compost ingredients such as chicken manure and horse manure as well as wetting of the mixed ingredients. The primary function of this machine is to turn and restack prewetted materials formed into long and wide heaps by tractor and front loaders.

Compost turner: The compost turner comes in varying capacities from 30-70 tons of compost handling per hour. It is fitted with a round stainless steel pick up drum, one spinner and one forming bore. The turner is generally mounted on 4 wheels, two of which are castoring wheels and rests two are powered, large diameter pneumatic wheels. Turner is usually fitted with a full width water spray pipe mounted at the front of the machine with water outlets

over the full input width.

Pile forming case: This machine is used when the pile is formed for the first time. This is usually supported on four castoring wheels and is attached to the front of the compost turner which is pushed by the turner during pile formation.

Front end loaders: Bucket type loaders are employed for various composting operations *viz.*, prewetting and transportation of the compost during pile formation in combination of compost turner and forming case. They are generally attached with a tractor.

Oscillating head filling machine: This is made up of two conveyer units mounted upon a self-propelled chasis. The two conveyers are so designed that one feeds directly into the other from above. Conveyer which is positioned above accepts the compost from the feed conveyers and transfer this compost to the conveyer positioned below. This is an oscillating type which fills the compost loosely in the tunnel over the entire width.

Compost feed conveyers (2-3 units): These are ordinary conveyer systems slightly elevated and can be coupled together to form a single conveyer system feeding one to the other during tunnel filling. The length and width of each conveyer is generally 7.5- 9 m and 0.6 m.

Hopper regulator: This machine is required to feed the compost to the feed conveyers. It accepts the compost from the bucket of the front end loader and provides regulated output of the compost to the feed conveyer.

Tunnel emptying winch with combination of spawn dosing machine: This unit is employed for emptying the tunnel filled with pasteurized or spawn run compost by means of a polyethylene glide and pulling nets. The winch is equipped with one net reel for the pulling the nets, two spinners and a chain conveyer for the discharge of the compost. Spawn discharging unit consists of twin spawn dispensers mounted over the full width of the compost flow on the discharge elevator.

Bag filling machine: This machine is used for filling the bags with spawned compost. The machine is equipped with a conveyer with two filling stations.

One or more of the above machines may be needed depending upon scale of operations, labour availability, type of raw materials used, etc. Front-end loaders, hopper, conveyers and oscillating head filling machines are useful for any commercial unit. Besides the above machineries; small instruments like multiprobes digital thermometers, oxygen meters, ammonia measuring equipment and computers are also required for a mushroom farm to maintain quality and high productivity of mushrooms.

The machines and other tools specially required for

composting and cropping units are:

Blowers: Blowers of different capacities are required in the pasteurization room and cropping rooms for supply of fresh air and steam.

Air handling unit: Air handling unit is required for supply of filtered fresh / hot / cool air inside the cropping as well as the pasteurization rooms.

Spray pumps: For maintaining humidity (80-90%) inside the cropping rooms, the floors, walls and mushrooms beds are to be daily sprayed with clean water with the help of fine nozzle spray pump so as to get misty sprays.

Pile formers or boards: It consists of three wooden planks or steel boards of desired size (4-5x4-4.5x5-6 ft HxWxL) for making the compost pile. It is used every time the compost is turned so as to give support to the pile while stacking.

Long handled pitchfork: These are used for compost turning and handling.

Shovel: Used for handling and filling of materials.

Hose with nozzle: It is for the watering and quick wetting of basic materials in bulk like straw, chicken manure, horse dung etc., when used on a large scale.

Small tractor with a front loader: This tractor will be helpful in turning, transferring and handling of heavy materials like compost, casing and other materials.

Turning machine: It is a machine fitted with rotators which helps in rapid and efficient turning of compost using negligible number of laborers.

Conveyer belts: These are long and moving belt like structures which help in transferring compost or other materials mechanically from one place to other place.

Thermometers: These are required for measuring temperature of the compost heaps on the platform, compost beds in the spawn running, cropping rooms, pasteurization rooms so as to know temperature at every stage of composting and mushroom growing.

Hygrometer: For measuring humidity inside the cropping and spawn running rooms.

pH meter: For measuring pH of compost and casing mixture.

Chaff cutter: It is needed for chopping paddy straw into small bits of 2-3" for easy handling and bed preparation.

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