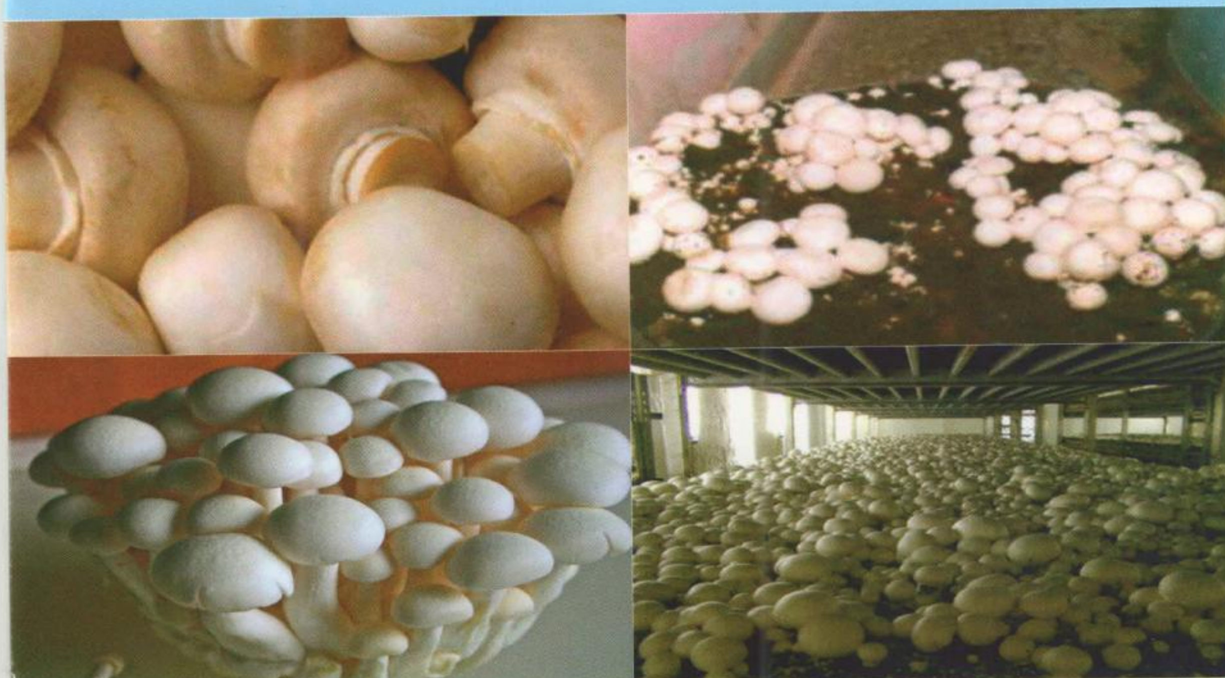
Cultivation Technology and Technical Standards of Components of Integrated Button Mushroom Unit

Protected Production under NHB Scheme
(Technical Standard No. NHB-BM-Type 01-2011)



राष्ट्रीय बागवानी बोर्ड
NATIONAL HORTICULTURE BOARD

National Horticulture Board
(Department of Agriculture & Cooperation)
Ministry of Agriculture, Govt. of India

PREFACE

Due to consumer preference, white button mushroom has become an integral part of our consumption pattern and therefore, its production has recorded rapid growth. Though, button mushroom is widely grown as part of cottage industry during winter season; its hi-tech, commercial production round the year too has gained momentum in recent past. National Horticulture Board has been extending financial assistance for mushroom production units since inception of its credit linked, back-ended subsidy schemes for promotion of commercial horticulture in the year 1999-2000 which has given impetus to the growth of mushroom industry in India.

However, NHB has noticed with concern that a number of production units have not been successful due to multiple reasons. The Board has, therefore, attempted to identify the constraints in quality production of mushroom, its post harvest handling and marketing which ultimately affect the techno-economic viability of the projects.

On one hand, the Board has roped in Indian Institute of Management, Bangaluru to carry out SWOT analysis of supply chain of button mushroom in India whose report is awaited; on the other, it has attempted to firm up and prescribe technical standards / specifications for button mushroom production unit with the help of stake-holders including institutions like Directorate of Mushroom, Solan (H.P.).

This publication entitled "**Cultivation Technology and Technical Standards of Components of Integrated Button Mushroom**" covers not only technical specifications of Integrated Button Mushroom Units but also the production and PHM protocols. The technical standards and recommendations are intended to serve as minimum requirements and are not to be construed as limiting good practices. Attempt has also been made to prescribe cost norms for button mushroom projects to facilitate scheme implementation relating to financial assistance for such projects.

I take this opportunity to acknowledge the valuable contribution made by experts particularly team of scientists of DMR, Solan headed by its Director Dr. Manjit Singh and Shri Brajendra Singh, Zonal Director, NHB and Shri Anil Kumar, SHO, NHB in bringing out this publication.

Last but not the least, contributions made by exporters and growers of Mushrooms by way of their active participation has been of immense value in firming up technical standards and protocol for quality production and post harvest management.

Bijay Kumar

(Bijay Kumar)
Managing Director
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BUTTON MUSHROOM

PART – A

INTRODUCTION

Button Mushroom (*Agaricus spp.*) is the most popular mushroom variety grown and consumed the world over. In India, its production earlier was limited to the winter season, but with technology development, it is produced almost throughout the country round the year in small, medium and large farms, adopting different levels of technology.

Types of Mushrooms

In India, today, commercial grown species are Button and Oyster Mushroom, followed by other tropical mushrooms like Paddy straw mushroom, milky mushroom, etc. The concentrated production areas in India are the temperate regions for button mushroom, tropical and sub-tropical regions for Oyster mushroom, Milky, Paddy straw and other tropical mushrooms. The present production of white button mushroom is about 85% of the total production of mushroom in the Country.

Origin

Cultivation of button mushrooms (*A.bisporus*) started in the sixteenth century in France. India, with its diverse agroclimate conditions and abundance of agricultural wastes, has been producing mushrooms, mainly for the domestic market, for more than four decades. Commercial production picked up in the nineties and several hi-tech export oriented farms were set up with foreign technology collaborations.

Production Status

Large scale white button mushroom production is centred in Europe (mainly western part), North America (USA, Canada) and S.E. Asia (China, Korea, Indonesia, Taiwan and India). The national annual production of mushrooms is estimated to be around 1,00,000 tones with 85 percent of this production being of button mushrooms.

In India the cultivation of white button mushroom throughout the year under controlled condition is restricted to a few commercial units and there is significant production of this mushroom under natural conditions during the winters in hilly areas and plains of North India. Majority of the growers in India do not have pasteurization facility and other sophisticated machinery/infrastructure for round the year production of white button mushroom. As such, button mushroom is cultivated seasonally when climatic conditions are favourable and production expenses are minimum. Many growers in Haryana have revolutionized the cultivation of white button mushroom by adopting very simple and cheap technology of construction of mushroom houses (thatched huts). Seasonal growing of white button mushroom in Haryana and Punjab has many advantages like nearness to market, easy and cheap availability of raw material coupled with utilization of family labour. Many of the growers in HP do not use compost prepared by long method because pasteurized compost is readily available from mushroom projects located at Solan and Palampur.

Economic Importance

Mushrooms are highly proteinaceous and are a health food. The white button mushroom is sold as fresh mushroom or is canned and made into soups, sauces and other food products. It also has medicinal properties. The mushrooms are free from cholesterol, have low sodium high potassium, negligible sugars, high fibre and are the only vegetarian source of vitamin D. Various mushrooms also have anti-viral and anti-tumor properties.

Agro-climatic Requirements

In India, button mushrooms are grown seasonally and in environment controlled cropping houses. White button mushroom requires 24 ± 2^0 C for vegetative growth (spawn run) and $16\text{-}18^0$ C for reproductive growth. Besides that it requires relative humidity of 80-90% and enough ventilation during cropping. Seasonally, it is grown during the winter months in the north-west plains of India and for 6-9 months in a year on the hills. However, with the advent of modern cultivation technology it is now possible to cultivate this mushroom anywhere in India.

The growers can take on an average 5-6 crops of white button mushrooms in a year under controlled conditions. Factors affecting the yield of the crop both in terms of quality and quantity are type of strain used, incidence of pests/pathogens and non-availability of pure quality of spawn.

Selection of Location for establishing mushroom unit

Button mushroom requires cool climatic conditions and hilly areas such as Nilgiris in the South and Shimla in the North were favoured as suitable sites for commercial ventures on button mushrooms. At present mushroom units have come up all across the country and are growing mushrooms almost throughout the year under controlled conditions. Following few points have to be taken into consideration for greater operational efficiency and cost effective production of mushroom at the farm:-

- The site should preferably be nearer to motorable road or road head to reduce cost on transportation of raw materials/finished products.
- Water availability at the site either through a perennial source or should have sufficient ground water.
- Easy availability of raw materials especially straw and poultry manure around the site at cheaper rates in the area.
- Availability of cheap labour.
- Uninterrupted power supply.
- Nearness to the market for the proper disposal of the produce.

Part – B

Cultivation Technology & PHM

Various levels of technologies are available for production of button mushroom – right from cottage industry of China to automated and mechanized technology of the developed countries. The present model proposes to adopt the modern technology of mushroom growing under controlled growing rooms with requisite mechanization and automation. The whole process of mushroom production can be divided into the following steps:

(i) Spawn production

(ii) Compost preparation

(iii) Spawning

(iv) Spawn running

(v) Casing

(vi) Fruiting

Spawn (Mushroom seed) Production

Spawn is produced from fruiting culture/stocks of selected strains of mushrooms under sterile conditions. Stock culture may be produced in the lab or may be obtained from other reputed sources. Fruiting culture is mainly imported from various places including foreign sources which give higher yield and the spawn is produced in the lab.

Compost Preparation

The substrate on which button mushroom grows is mainly prepared from a mixture of plant wastes (cereal straw/ sugarcane bagasse etc.), salts (urea, superphosphate / gypsum etc), supplements (rice bran/ wheat bran) and water. In order to produce 1 kg.of mushroom, 2.2 kg of dry substrate materials are required. The ratio of C: N in a good substrate should be 25-30 : 1 at the time of staking and 16-17 : 1 in the case of final compost.

During the first phase of compost preparation, wheat straw and chicken manure are wetted thoroughly till they absorbed sufficient water (around 75%). Leached water is collected in a goody pits for the purpose is regularly sprayed over the raw material. After through wetting of the substrate and aerobic stakes or a simple heap is made out of such material. After two days the stakes is broken, water is added to the dry portion and again stack is made. For achieving high temperature and more homogenous compost artificial aeration may be provided to this heap by passing 10-15 m^3 of air per ton of wet compost per hour through the stack. To have artificial ventilation in the stake, working floor of the composting yard is provided with under stake aeration ducts connected with the required blowers installed at one end of the yard. These blowers blow small quantities of air regularly or at fixed intervals through GI or plastic pipes. Specific bunkers can also be constructed for this purpose. Pre-wetting and mixing of ingredients is must before starting actual composting preparation on zero days and the stack made during this process are wide with low height of 3-4 ft.

Compost Turner

Bob cat

Zero (0) day:-

On this day the stack is again broken and the entire quantity of other material like urea and wheat bran are added, water is also added if required and a high aerobic stake is made. Turning can be done manually or by compost turner built for the purpose. Similarly the compost is again turned after every two days and gypsum is added at third turning. In all 3 to 4 turnings are given. On 8^{th} to 10^{th} days, the compost is ready for pasteurization to be affected in bulk chamber. This marks the end of phase -1.

Characteristics of the compost after Phase – I and before Phase -II

- Brownish throughout. Pieces of straw gleaming and wet.
- Straw rather long but can be broken with some force.
- Properly hydrated, around 72-75% moisture; when squeezed drops of water appear between the fingers.
- Very heavy smell of ammonia, pH approximately around 8.2 to 8.5.
- Still sticky and slimy, hands get dirty and wet.
- Actinomycetes (fire fangs) not so apparent.
- Nitrogen content between 1.5 to 2.0%; ammonia concentration around 800-1000 ppm.

Phase – II

The second phase is the pasteurization phase .The compost prepared as a result of microbe mediated fermentation process needs to be pasteurized in order to kill undesirable microbes and competitors and to convert ammonia into microbial protein. The whole process is carried out inside a steaming room where an air temperature of 60^{0} C is maintained for 4 hours.

COMPOST PRODUCTION BY SHORT METHOD - FLOW CHART

Wetting of the straw

1

2

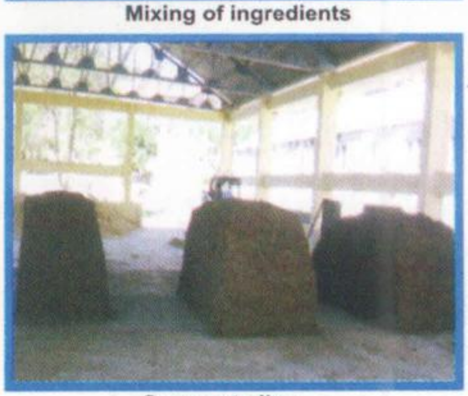
Low stack of wetted straw

Mixing of ingredients

3

4

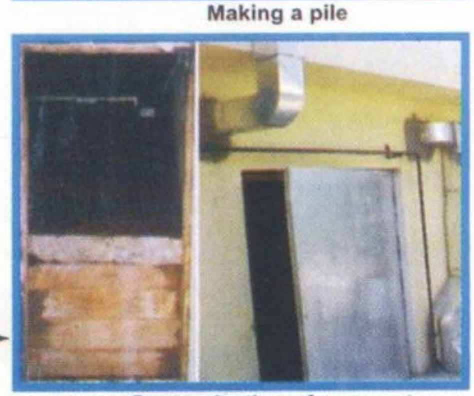
Making a pile



Compost piles

5

6



Pasteurization of compost

Finally prepared compost after Phase II operation

Characteristics of the compost after Phase -II

- Dark brown in colour, full of thermophilic fungi and actenomycetes.
- It is soft, straw breaks rather easily.
- Moisture around 64-66% no liquid oozes out when squeezed firmly.
- Pleasant sweet smell.
- No stickiness. Hand stay clean and dry.
- N contents >2% with pH 7.5.
- Ammonia <10 ppm.

Composting Schedule:-

-4 day:	Mixing and wetting and of the ingredients out doors
-3 day:	Turning, trampling by Bobcat and thorough mixing of the ingredients, addition on water.
-2 day:	High aerobic heap
-0 day:	Filling in the Phase –I bunker
+3 day:	Emptying the bunker, turning and mixing of the compounding mixture and re-filling the compost in another Phase – I bunker
+6 day:	Phase-I operation over and compost transferred to Phase-II tunnel
+12 day:	Phase-II operation over

Spawning

The process of mixing spawn with compost is called spawning. The different methods followed for spawning are given below:

(i) **Spot Spawning:** Lumps of spawn are planted in 5 cm. deep holes made in the compost at a distance of 20-25 cm. The holes are later covered with compost.

(ii) **Surface Spawning:** The spawn is evenly spread in the top layer of the compost and then mixed to a depth of 3-5 cm. The top portion is covered with a thin layer of compost.

(iii) **Layer Spawning:** About 3-4 layers of spawn mixed with compost are prepared which is again covered with a thin layer of compost like in surface spawning.

The spawn is mixed through the whole mass of compost at the rate of 7.5 ml./ kg. compost or 500 to 750 g./ 100 kg. compost (0.5 to 0.75%).

Spawn Running

After the spawning process is over, the compost is filled in polythene bags (56x60 cm) 100-150 gauge thick having a capacity of 10-12 kg. per bag). The compost can also be filled in plastic trays/shelves which are either covered with a newspaper sheet or polythene. The fungal threads grow out from the spawn and take about two weeks (12-14 days) to colonize the entire compost. The temperature maintained in cropping room is 24 ± 2^0 C. Higher temperature is detrimental for growth of the spawn and any temperature below than that specified for the purpose would result in slower spawn run. The relative humidity should be around 90% and a higher than normal CO_2 concentration would be beneficial.

Casing

The compost beds after complete spawn run should be covered with a layer of soil (casing) about 3-4 cm. thick to induce fruiting. The casing material should be having high porosity, water holding capacity and the pH should range between 7-7.5. Peat moss which is considered to be the best casing material is not available in India, as such the mixtures like garden loam soil and sand (4:1); decomposed cow dung and loam soil (1:1) and spent compost (2-3 years old); sand, burnt rice husk and lime are commonly used.

The casing soil before application should be either pasteurized (at 65-68^0 C for 7-8 hours or treated with formaldehyde (2%) and bavistin (75 ppm). The treatment needs to be done at least 10 days before the material is used for casing. After casing is done the temperature of the room is again maintained at 24 ± 2^0 C and relative humidity of 85-90% for another 8-10 days.

Fruiting

Fruiting is induced by slowly lowering the temperature to 17 ± 1^0 C along with moisture (2-3 light sprays per day for moistening the casing layer), humidity (85-90%), proper ventilation and CO_2 concentration (0.08-0.15 %). The fruit body initials which appear in the form of pin heads start growing and gradually develop into button stage.

Pest & Diseases

The insect pests mostly observed are nematodes, flies (phorids, cecids and sciarids) mites and springtails.

The crop is susceptible to several diseases like dry bubble, wet bubble, cobweb, green mould, yellow mould, false truffle (truffle disease), olive green mould, brown plaster mould, bacterial blotch, etc.

Professional help and extension advice will have to sought by the entrepreneur to adopt appropriate and timely control measures against pests and diseases.

Harvesting and Yield

Harvesting is done at button stage and caps measuring 2.5 to 4 cm. across and closed are ideal for the purpose. The first crop appears about three weeks after casing. Mushrooms need to be harvested by light twisting without disturbing the casing soil. Once the harvesting is complete, the gaps in the beds should be filled with fresh sterilized casing material and then watered.

About 18-20 kg. fresh mushrooms per 100 kg. Compost can be obtained in two months crop.

Post Harvest Management

Packing and Storage

(A) Short Term Storage

Button mushrooms are highly perishable. Harvested mushrooms are cut at the soil line and should preferably be packed and marketed unwashed. However, if washing is required then mushrooms may be washed in a solution of 5 g Potassium metabisulphite in 10 litres of water for removing the soil particles. After removing excess water these are packed in perforated poly bags each containing around 250-500 g. The current trend is to market unwashed mushrooms packed in plastic punnets. of mushrooms. Mushrooms can be stored at 4-5^0 C for a short period of 3-4 days and wherever facility of cold room is available mushroom should be shifted to the cold room soon after harvesting.

The mushrooms are usually packed in unlabelled simple polythene or polypropylene bags for retail sale. In developed countries, modified atmosphere packaging (MAP) and controlled atmosphere packaging (CAP) are in vogue.

(B) Long Term Storage

White button mushrooms are not usually dried by common procedures used in case of oyster, paddy and shitake mushrooms. Canning is the most popular method of preserving the white button mushrooms and sizeable quantity of canned produce are exported to international markets. Besides that, freeze drying, IQF and pickling are also practiced by some units.

Part – C

Model for Button Mushroom Unit with Speciffications:-

Various levels of technologies are available for production of Button mushroom, right from cottage industry to automated and mechanized technology. The size of the commercial mushroom units that are being set up in India have production capacities ranging from 200 to 3000 tones of fresh button mushrooms per year. The model has been prepared for an installed capacity of 365 tones of fresh button mushroom production per year which may be produced & can be used for direct sale as fresh mushroom or processing as per requirement. The main objective of the exercise is to present a modern technology based mushroom growing model under controlled conditions for production of 365 MT capacity per annum (Approximately 1 MT/day) by optimum utilization of resources.

The dimensions and no's of cropping room and other civil structure may change depending upon capacity, land availability and other factors but assumptions for calculation of compost and production capacity will be calculated as per formula given in the Part – E of the report.

Components of Mushroom unit and its specifications:

The unit has been designed as per the latest technology of Mushroom Growing. The Following main components are proposed:

1. Land & Selection of Site:-

Land is required for the construction of mushroom houses, composting unit, spawn laboratory, cold room, cannery, office, parking space, etc.

In the present model, which include spawn laboratory, the requirement of about 3-4 acre land has been estimated. It has been assumed to be a developed land. Therefore, no land development work other than internal road and boundary wall has been proposed.

2. Spawn unit components:-

Since this component has not been included in the project cost assuming that, supply of Spawn will be sourced from reputed labs, only cost of Spawn Lab for in house testing has been considered.

However for producing in house spawn for self requirement and for sale to other units, following components would be required and cost of setting up of Spawn Unit, if setup, may be considered separately by NHB in project mode.

Spawn Unit will be divided into different work areas as described below:-

a. **Cooking/autoclaving room:** For boiling the grains and sterilization of the bottles/ pp bags.

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

c. **Incubation room:** For Incubating the inoculated bottles. Insulated and provided with AC.

d. **Cold store:** For storage of prepared spawn for its further disposal. It should be heavily insulated with chilling facilities.

Besides above some ancillary structures like office, small lab space, delivery area, etc, may also be required. Machineries required: Air conditioners, Laminar flow system, Autoclaves, BOD incubators, Boiler, Boling cattles, Refrigerators, racks, pH meter, gas stoves, etc.

3 - Composing Unit :-

The compost making unit may comprise the following components for production of compost:-

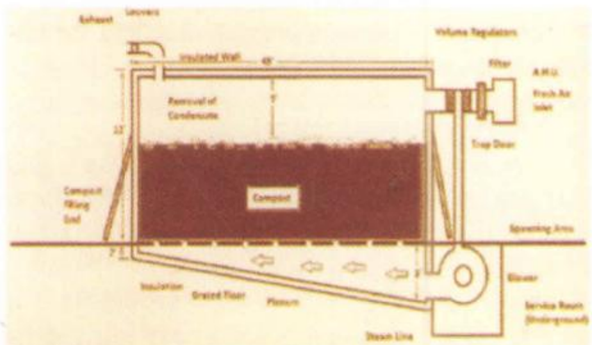
a. **Pre-wetting area:** For dumping of raw materials and their pre wetting, a simple uncovered cemented structure having a saucer like depression in the center is constructed which usually terminates into Composting Yard. The structure looks like a LAGOON and water remain collected during the pre-wetting of the compost ingredients. Center of lagoon should be 1 ft deep and excess water is collected in a goody pits built specially for this purpose at a convenient place around PWA for its reuse. Floor of PWA should be able to withstand the load of the front-end loader. One dewatering pump with a hose should be installed in a goody pit to pump out the run-off water for its re-use during pre-wetting. Under the project, pre-wetting area of 312 m^2 (26m x 12m) has been considered

b. **Composting yard:** For making piles out of the wetted materials (covered). The composting yard should necessarily be a covered shed with 2-3 ft sidewalls on two sides (length-wise). The foundation of composting yard should necessarily be reinforced to withstand load of heavy machines. The floor is given a run-off 1cm per running meter away from the bulk chamber and towards the goody pit end. The roof of the composting yard is built on tresses or RCC pillars 16ft high with a GI or any other suitable roofing. On an average 1 tone compost occupies about 1 meter of the composting yard with an extra space of 2-3 meter left on each side for turning with machine. Drain should run on the two side of the platform to facilitate periodic cleaning. Under the project, **Composting yard** of 424 m^2 has been considered.

c. **Phase-I bunker:** For phase-I composting (incase indoor composting is employed). These are specially built non-insulated tunnels having full width opening at the front. Dimension of the bunker should depend upon the compost required. Generally the bunkers are 1.5 times more the size of the phase two tunnels. It has plenum (ventilation duct) constructed below the actual

Bunker with aerated pipes

floor. A perforated concrete floor having around 1 cm opening at a distance of 1 ft each to the entire floor area is constructed above the plenum or it has simple RCC/steel gratings having 25% opening of the entire surface area of the tunnel which is serviced by a centrifugal fan having ¼ the capacity of phase two blower. A plenum floor involve pressurizing the entire air space beneath the concrete floor, allowing the air to move up into the substrate through the holes. Alternatively, the bunkers have no plenum and several pipes (5-15 cm dia) are buried in the floor along the full length of the bunkers having small holes (5-10 mm dia) at a distance of 15-30 cm each. Keeping in view the production capacity of 1 Mt per day, three such phase - 1 tunnels (bunkers) each of 12 m x 3m x 3m dimension have been considered under the present model.



Schematic diagram of phase-II bulk Chamber

Bulk chamber

Phase – II – Bunker (Pasteurization/conditioning facility):-

The bulk pasteurization chamber is principally used for phase – 2 of composting for pasteurization and conditioning of compost in an insulated chamber with facility for steam injection and controlled recirculation and fresh air entry in the tunnels through a blower. A large tunnel will be around 90 cm deep towards the blower end while it will be 15 cm deep towards filling end. In many cases 2% slope is provided with 40 cm depth at the filling end. Floors should be properly insulated with thermocol/ glass wool 5 cm thick. Insulation is covered with isolating membrane of PVC sheeting followed by 5 cm cement floor. Wall should be 9 inch thick built over the concrete foundation. The roof is made of 4 inch thick RCC. The wall/ceiling/floor below the plenum is insulated with 5 cm thick insulated material. Required K value of insulated material should be around 0.5 – 0.6 kcal/ m^2/h. Air leakage in bulk chamber must be prevented at any cost. Under the present model two pasteurization chambers each of 20m x 4m x 3m dimensions have been considered.

Tunnel Air Handling System:-

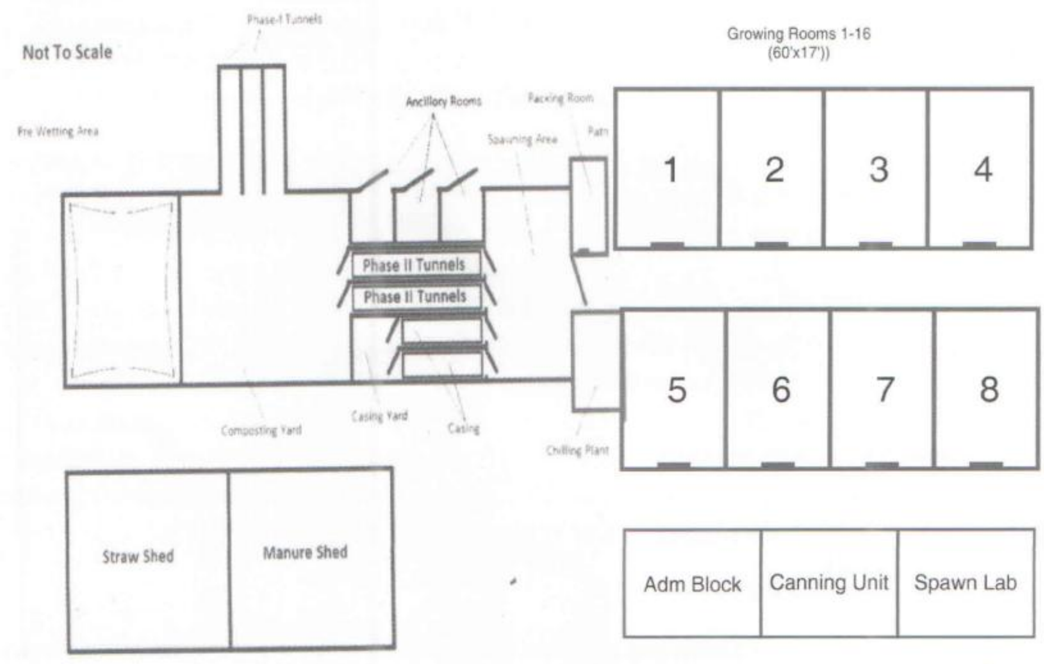
For effective pasteurization and conditioning of compost in the tunnel specific the requirements of air and ventilation are to be met by providing system capable of blowing 150-200 m^3 air per tone of compost per year. For this purpose high speed centrifugal fan is chosen and placed on the slope end of the ventilation duct. 2 mm thick aluminum is ideal for air ducts.

d. **Casing soil chambers:** For spawning of the prepared compost. It is like mini bulk chamber required having necessary components required for the tunnels. Only difference is that plenum is not having any slope and capacity of blower for proper steam injection is ¼ capacity of the tunnels. One chamber load should provide casing for one compost load from each tunnels. For casing the compost is filled up for the height of 90 cm only. Under the present model two Casing soil chambers each of 8m x 3m x 3m dimensions have been considered.

4. Mushroom House/Cropping Unit:-

A- Cropping Room:- Keeping in view the production targets of 1 MT per day (365 MT/annum), unit will have 1536 m^2 area of cropping rooms covering eight insulated room of 24m x 8m x 5m size. Besides room, there will be Working Corridors (272 m^2).

Machineries required: - Insulted doors, central chilling station (ammonia or Freon based), air handing units, blower, environment sensors (for temperature and CO_2 level) and steam supply system. Steel racks, and trolleys, harvesting trays, etc would also be required. It would also require cold storage equipments and complete canning line. For continuous electric supply to phase-I, phase-II tunnels and cropping rooms, generators of 150 KVA have been proposed in the project cost.



General layout of the firm

B. Structural details/Specifications special to cropping rooms:-

i. Floor

The floor must be will laid out and should be strong enough to take the heavy load of metal racks to be kept inside for growing mushrooms. The floor should be insulated with insulating material 5 cm thick (sheets of thermocol or glass wool or polyurethane). The insulation should be protected by a PVC sheeting, below and above, against moisture. It is then covered with wire mesh and finally 5 cm thick concrete floor is laid on top, which is given a smooth finish. The floor should have slight slope towards the entry point for discharge cleaning water and placement of formalin trough for foot wash. The trough is connected near the wall to an exhaust drain to carry washings from the room. The water discharge hole is protected at this point to prevent leakage of air from the growing room. PUF pads can also be used specially in place of wall between rooms.

ii. Walls

The walls to be 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. Holes are drilled on four corners of the sheet/inside the cement wall for expansion fasteners which are fixed by screwing in the nail with 4:-5" long steel wire tied on its head. The wire hangs out of the sheet to be used for tightening of wire net fixed on top of the insulation, The layer of cement plaster is then applied (2 cm) on top of this and given a smooth finis. Bituminous paint is applied on cement plaster as vapour barrier. The painting can be avoided in cropping rooms if ht cook out is not done by steam. This will be good enough to give a K- value of 0.5-0.6 kcal/m2h, even lesser and will facilitate proper control of climate inside the cropping room.

iii. Roof

The roof is made of RCC (1:2:4) 2-15 cm thick. The inside is given a cement plaster finish for application of insulation (as explained for the wall).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 root from weathering effects of rain and will ensure longer life of insulation and prevent seepage of moisture into the room in rainy season. In hilly areas with a high rainfall index, slanting GI sheet roof over the insulated RCC roof will be excellent and in that case mud capping /tiling of the roof is not required.

iv. 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 aluminum 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. The door will operate on hinges, with a strong locking latch for opening and closing of the door. The exhaust vents are fitted with wire net, louvers and insulated lids. The louvers allow the CO_2 laden air to exhaust under positive pressure created by the blower inside the air handling unit.

v. Lighting arrangement

There should be a provision for tube light and a mobile strong light 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. There should be provision for a few electric points (5 and 15 Amp.) for operation of water spraying equipment and CO2 measuring instruments.

vi. 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. In H.D polythene cropping rooms, sunkun traps on the floor for fresh water and drainage water are provided inside the growing house with each trap of 1' x 1' x 1' dimension fitted with an iron lid on top. It is desirable to lay underground drainage in the central gallery in advance of erecting the structure for carrying away the waste water/ washings from the cropping rooms.

vii. 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.

viii. 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 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 six 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. This distance can slightly be narrowed down if cultivation is employed in shelved beds, In such a case al the four sides of the shelf should be provided with 15-20 cm high iron sheets for housing the compost in the beds. If more than 5 shelves on each rack are kept in the room than there should be provision of trolley running in between two rows of racks just above the fourth shelf for carting out the various operations. Depth of the compost in shelves is generally kept at 15-20 cm while bags can be filled up to maximum height of 30 cm.

Each room (24 m x 8 m) may have two-three rows of shelves that may hold about 52-55 tonnes of compost. There could be altogether 8 such rooms. Brick mortar construction plastered with cement and RCC roof have been envisaged in the model.

Commercial New Mushroom Shelves

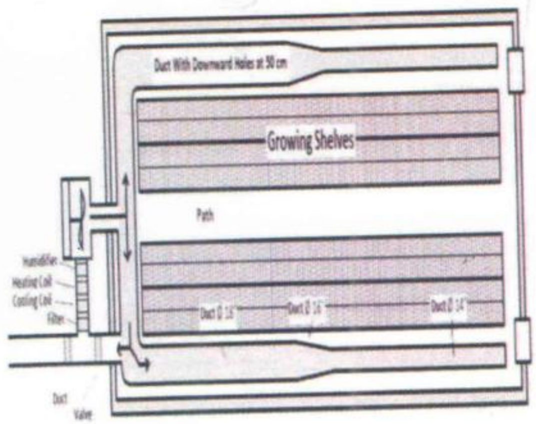
i. Air handling unit

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 f the door, which is made up of aluminum or G.I. Sheets. Indirect cooling of air through chilled water (5-6^0 C) is generally employed in mushroom cultivation. Mushrooms generally require 225 m^3 of air per hour per ton of compost. To meet this requirement a high speed centrifugal fan of required capacity having working pressure around 50 mm WG is generally mounted in the body of AHU. In AHU cooling coils, humidifiers, eliminators and other components of AHU are mounted on the back of the supply air fan. Cooling coils are generally connected to the chilling unit via insulated ducts, which supply chilled water at 5-6^0 C to these coils. This water is generally chilled in an insulated tank or by cooling unit comprising of a compressor, condenser, evaporator and a cooling tower. Heating unit of AHU can employ strip heaters or steam through a low- pressure boiler. Humidifiers can use free steam from the boiler to generate required humidity in combination with air pressure or can employ fine jets, which produce fine mist of water in the humidifier section of the AHU. The AHU has a mixing chamber with recycling dampers, which can regulate supply of fresh air or room air inside the growing room, which is generally made up of PVC sheeting having its end month closed. It hangs below the ceiling in the central corridor of the room. This duct has ports (5cm dia) facing downward at a distance of around 50 cm each. When the air is blown inside the room via AHU a positive pressure is created and CO_2 laden air of the growing room is expelled in the atmosphere through an outlet. Alternatively AHU can be so fabricated having provision to exhaust CO_2 laden air of the growing room in the atmosphere through an out let. In such cases back vents are not provided in the growing rooms.

Central cooling unit can employ ammonia, Freon or vapour absorption machine (VAM) for cooling purpose. If size and capacity of growing unit is small, say 250 MT per annum employing around 10 rooms then cooling employing evaporator, inside the AHU can also be chosen. In such a case each AHU will be self contended cooling unit, employing, compressor, condenser and an evaporator. This unit will also have heating and humidifying arrangements.

Farm Design

Mdoifield AHU with fresh air fans



A standard AHU with centrifugal blower and ducts inside the growing room

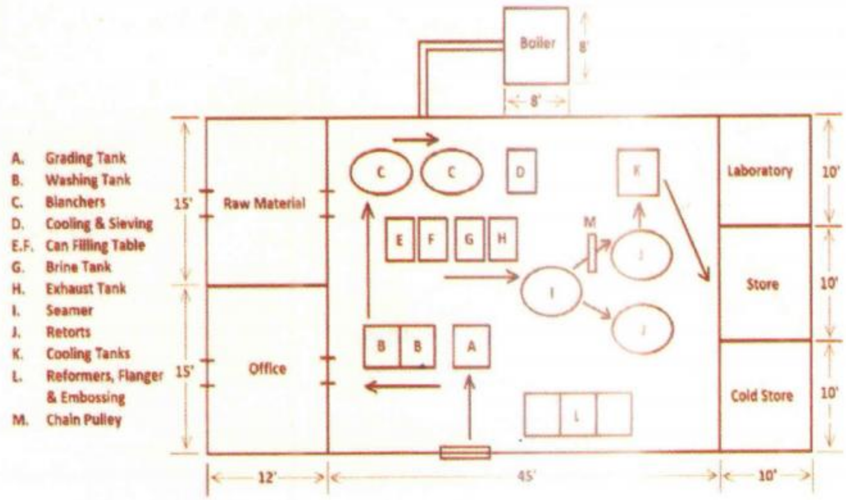
5. Utilities and other Civil Structures:-

- **Pre-cooling chamber (cold room):** For storing the fresh mushrooms as also mushroom before canning (5m x 4m x 5m) capacity of 4.8 MT mushroom.
- **Spawn Laboratory:** For quality control of processing (15 m^2)
- **AC/Compressor room** (60 m^2),
- **Packing room** (40 m^2),
- **Store room** (40m^2).
- **Office** (50 m^2):
- **Specialized transport Vehicle**

PART – D

Processing unit

Utmost strict hygienic conditions are required to be maintained in the canning hall and hence special care has to be given at this front while designing/ constructing canning unit. Under the present model a canning Hall similar to size and dimension of one cropping room i.e. 24m x 8m x 5m have been proposed to be constructed. The floor must be well laid off preferably having Kota stone having slope at one end. Walls



Design of a canning unit

An automatic canning line

should have ceramic tiles up to 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 from the composting yard.

Floor of the canning hall should have enough strength to support the weight of different utilities to be installed required for the canning operation. 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 files. Three–four exhaust fans should be installed in the hall at the appropriate places. 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. FPO license is required for processing purpose.

FLOW CHART FOR CANNING BUTTON MUSHROOM

CLEANING AND WASHING

(in water containing 0.1% citric acid / 0.3% sodium meta bi-sulphite)

↓

BLANCHING

(cooking in steam or hot water at about 98° C for 7-8 minutes in water containing 1% sodium chloride and 0.1% citric acid).

↓

CANNING (FILLING, WEIGHING, BRINING AND EXHAUSTING)

(in brine solution, 1% sodium chloride and 0.25% citric acid or ascorbic acid - Temp 78 -98°C)

↓

SEALING

↓

SEAMING

↓

STERILIZATION

↓

COOLING

(to bring down the temperature to 35°C)

↓

LABELING

↓

PACKAGING

Part – E

Assumptions for production:-

- Eight cropping rooms of (24m x 8m x5m) of 52.5 MT compost handling capacity.
- Five crops will be taken as per availability of advanced hybrids, which give optimum production 16-20 kg/100 Kg compost in 72 days of one cropping cycle.

A- Calculation of requirement of Compost:-

Annual requirement of Compost = (L x B x H in meters) x no of rooms x no of crop cycle/18.3

24m x 8m x 5m x 8 rooms x 5 crops/18.3 = 2098 MT or say 2100 MT /annum =

(52.5 ton/room/crop cycle)

B- Calculation for annual Production/Capacity of Button Mushroom:-

- **Annual production is =**

Qty of Compost/room X no of rooms X no of crop cycle X 0.18 =

52.5 MT x 8 rooms x 5 crops x 0.18 tons = 378 tons

(Accepted 365 MT i.e. 1 MT/day)

C- Calculation of the Capacity of Tunnel:-

- Tunnel size:- Surface area x 0.75 = capacity in MT

80m x 0.75 = 60 MT equal capacity of compost production.

Note: Calculation requirement of Compost of production capacity may be worked out as per above assumption for varying size of cropping rooms.

Annexure - I

Cost Break-up of Integrated Button Mushroom Unit

(Capacity in MT/Day)

Capacity - 365 MT/annum (1 MT/day)							
S. N.	COMPONENTS	No	Unit	Dimension (LxWxH)	Quantity	Unit Cost	Total Cost
1	Land Development (Leveling, Fencing, Guard Room)		Acre				10.00
	SUB TOTAL						10.00
2	CIVIL WORKS						
	Mushroom house	8	sqm	24x8x5	1,536	6500	99.84
	Working corridors in Mushroom house				272	3000	8.16
	Growing racks (Steel) – two rows of shelves having six shelves in eac rows (size 20m x 1.8m) Growing area = 20mx1.8mx12 = 432 M^2				3,456	950	32.83
	Cannery			24x8x5	192	6000	11.52
	Pasteur tunnels	2		20x4x3	160	6500	7.20
	Compost Yard			424 m^2	424	3000	12.72
	Pre-wetting area			26x12	312	1500	4.68
	Straw storage shed			20x15x3.5	300	3000	9.00
	Water recycling pits (Goody)			8x2.5x1.5	20	2000	0.40
	Spawning Room			10x16	160	3500	5.60
	Bunker	3		12x3x3	108	3000	3.24
	Casing soil tunnel	2		8x3x3	48	6500	1.44
	Boiler and generator room and A.C. Room			12x5x5	60	3500	2.10

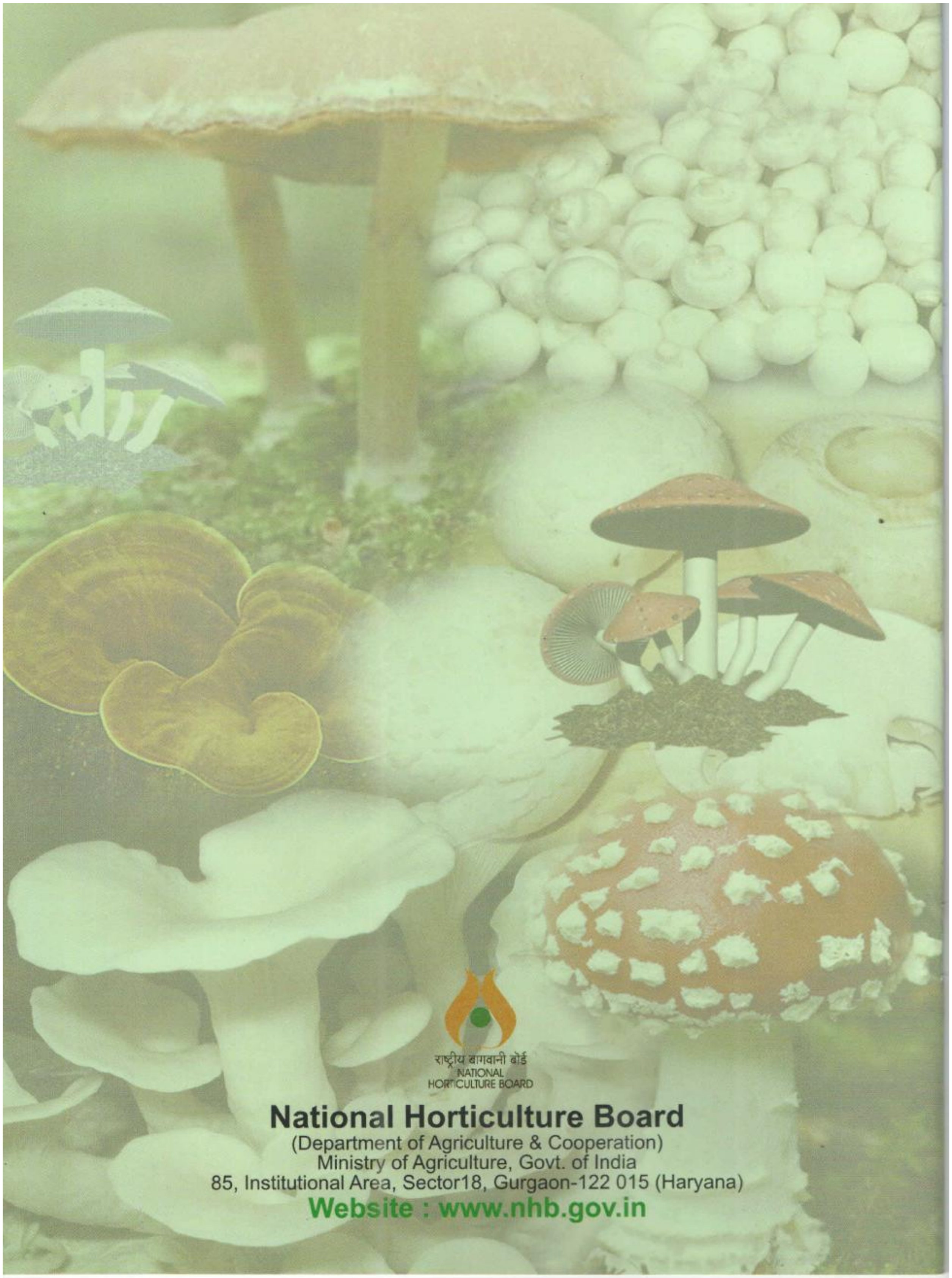
S. N.	COMPONENTS	No	Unit	Dimension (LxWxH)	Quantity	Unit Cost	Total Cost
	Store			10x4x3.5	40	3000	1.20
	Pre-entrance shower			5x4x3.5	20	4200	0.84
	Office			10x5x3.5	50	4500	2.25
	Spawn Lab				100	4500	4.50
	Toilets				15	4500	0.68
	Insulation				4300	500	21.50
	Insulated Doors						0
	i. Mushroom house	8	Pc			8000	0.64
	ii. Pasteur Tunnel	4	Pc			8000	0.32
	iii.Casing soil Tunnel	2	Pc			8000	0.16
	iv. Pre-canning & cold storage	2	Pc			8000	0.16
	SUB TOTAL						**230.98**
3.	Air conditioning of eight mushroom houses, 140-180 tonnes refrigeration capacity (Air handling equipments, cooling coil, air filter, blower, humidifier, still water chilling etc.)						55.00
	Environmental sensors (CO_2,Humidity, Tem with Computer control)						5.00
	Steam system - 450 kg steam/hour Cold storage equipments ((5m x 4m 5m), 4.8 tonnes mushroom, 1 lakh BTU/hour, (harvest temp 16-170C, storage temp 4-5^{0}C)) - Refrigeration capacity required 8 tonnes			5x4x5			4.00 5.00
	Canning line (capacity, tonnes/day)		MT/day				18.00

S. N.	COMPONENTS	No	Unit	Dimension (LxWxH)	Quantity	Unit Cost	Total Cost
	Generator, 150 KVA	2					10.00
	Ventilation system with blowers for bunker, tunnels and casing soil)	7					4.00
	Wiring and Electrical works						2.00
	Transformer, 300 KVA						3.00
	Compost making and handling equipment (front loader, filling line, hopper, etc.						10.00
							0
	Pipelines for water, steam, etc.						3.00
	Spl. Transport Vehicle						5.00
	Sub Total						124
	GRAND TOTAL						**364.98**

Say 1.00 lakh per MT

1. SOURCES OF TECHNOLOGY

Director, Directorate of Mushroom Research, Chambaghat, Solan, Himachal Pradesh-173213 [Tel: (01792) 230451, 230767; Fax 231207; email directordmr@gmail.com]



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