Name of the Firm/Promoter:

M/s -----------------------------------

{Promoter: ---------------------------------------}

Project Report

For

100 TPA White Button Mushroom Project

Rs. 164.32 lakhs

Prepared by:
Directorate of Mushroom Research
Chambaghat, Solan, (H.P.)-173213

Name of the Firm/Promoter:

Name of the Firm/Promoter:

FEASIBILITY REPORT

INTRODUCTION

M/s --- is a registered company. The promoter is --. The total capital out lay is Rs. 164.32 lakhs. The registered office address is ------------------.

SECTOR BACKGROUND

Mushrooms have been identified as priority item in government's recent programme of promoting production of vegetables and fruits in the country. Though there are many types of mushrooms produced and marketed worldwide and the white button mushroom (*Agaricus bisporus*) contributes 15% of the total world production and more than 73% of Indian production is of this mushroom. Cultivation of mushrooms in India is of recent origin and it started in the year 1962 in the state of HP. Since then country has progressed tremendously at this front, and today we are producing around 1,81,000 tons of mushrooms per annum. However, this much production does not stand anywhere compared to China that is producing around 33 million tons of this mushroom. Mushrooms are very good source of proteins and are having many medicinal values. In India this sector is growing at the rate of 10% per annum.

PROJECT REPORT FOR SETTING UP OF INTEGRATED MUSHROOM CULTIVATION UNIT

BROAD OUT LINE OF THE PROJECT

1.	**Name of the company**	:	M/s -----------------------------
2.	**Registered office and address**	:	-----------
3.	**Proposed location**	:	-------------
4.	**Promoter(s)**	:	---------------------
5.	**Cost of the project**	:	Rs. 164.32 lakhs
6.	**Proposed capacity**	:	Around 100 tons of white button mushroom production
7.	**Future planning**	:	
	The capacity will be doubled to 200 tons in the 5^{th} year of operation by extending the composting yard and adding pasteurization tunnels, phase one bunkers and growing rooms.		
8.	**Raw materials**	:	
	Main raw materials for cultivation of mushrooms and spawn production i.e. wheat straw, paddy straw, chicken manure, urea, gypsum, wheat/paddy grain, calcium carbonates, etc are available throughout the year in the region where project is proposed to be setup. Raw materials needed for canning of mushrooms, tin cans and corrugated boxes are available in the market.		
9.	**Marketing**	:	
	During the past 5 years, the consumption of mushrooms has grown 15 times. Besides the sizable domestic market, which is underfed, there is great demand for mushrooms in USA, France, Germany, Canada, Italy and UK. Besides this, fresh market in the gulf remains untapped. China which is the largest exporter of mushrooms to the American and European countries is facing anti dumping duties on its products. Further Chinese mushrooms are not available throughout the year, and hence it is the right time that India enters billion-dollar global mushroom market to earn valuable foreign exchange for the country. Since the promoters are already in the processing business including canning, they are seeing tremendous potential in this field. They are unable to meet the demand of canned mushrooms as the fresh mushrooms are not available easily and if available they have to pay very heavy price for the same there by eroding the profits. The demand for mushrooms, domestic as well as international is rising at a phenomenal speed. World production of mushrooms was about 12.2		

	million tons in the year 2002 and China remains the main producer and exporter of mushrooms. India is roughly producing around 1,81,000 tons of mushrooms annually of which 60,000 tons is produced by a single unit the Agro Dutch Foods Lalru, Punjab, which boasts of the single largest producer and exporter of mushrooms in the world. Besides this very big unit there are many other small white button mushroom units in Punjab, Haryana, Uttarakhand, Maharashtra, Gujrat, etc cultivating this mushroom all the year round and are running successfully. These units are located in Phagwara, Jullandhar, Bhatinda, Banga, Bannore, Haridwar, Dehradun, Pune, Nasik, Badnagar, etc. In the state of HP, units located at Poanta sahib and Nalagrah are doing exceedingly well and are in for expansion. In Uttrakhand Ms Flex Foods is doing very good and producing around 2000 tons of this mushroom. The promoters don't foresee any problem in marketing their produce. Now with adoption of latest technology of mushroom production under controlled environmental conditions, it is possible to grow high qualities of mushrooms throughout the year to meet the domestic and international demand. The promoters have under taken the market surveys and made inquiries regarding the demand for mushrooms. Besides the big demand in the countries mentioned above there is a fast mushroom market developing in the gulf countries. Domestic market is also expanding at phenomenal rate, which is reflected in the increase in the production. Most important of all for this project is ever increasing demand and lucrative prices for canned mushrooms in India and abroad. Our per capita of mushrooms consumption of the mushrooms is the lowest in the world, which is 60-80 g against the 3 kg in the developed countries. This poor consumption is mainly due to non-availability of mushrooms in most part of the country for most of the year. As such no difficulty in marketing of mushrooms will be experienced.		
10.	**Employment**	:	12 persons
11.	**Power**	:	Rounded Power requirement 70 KW
12.	**Sales**	:	Rs. 120.00 lakhs
13.	**Profit**	:	Rs. 46.60 lakhs

WHY MUSHROOM CULTIVATION

1. Excellent source of good quality proteins to fight protein malnutrition in the Indian masses. Highest producer of protein per unit area and time.
2. Profitable and environmentally sustainable way of recycling abundant agro wastes for food.
3. To reduce pressure on arable land (grown indoors utilizing space also)
4. Excellent medicinal value (diabetes, cardiac diseases anticancer etc.)
5. Labour intensive providing gainful employment.
6. Foreign exchange earner through exports.

TECHNOLOGY ENVISAGED

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 project proposes to adopt the modern technology of mushroom growing under controlled growing rooms with necessary mechanization and automation owing mainly due to large size of the project and handling of the raw materials in bulk on regular basis to achieve uniform and constant production. This shall cut down the cost of production and improve the quality of mushrooms. Low cost of production will boost competitiveness in the national and international market.

MANUFACTURING PROCESS AND DETAIL OF PRODUCTION

The project will have capacity of producing around 100 TPA of button mushroom of which will be sold 100% fresh. Stages of growing and manufacturing details are given below.

PRODUCTION TECHNOLOGY OF *AGARICUS BISPORUS*

Unlike other crops, cultivation of white button mushroom is a complex process and requires special technical skill for raising a successful crop. *A. bisporus* for its growth requires 22-28^{0}C temperature for spawn run and 15-18^{0}C for its fructification. Besides this it requires 85-90% RH and enough of ventilation. Due to low temperature requirement the cultivation is more popular in hilly region. However, due to advancement of the cultivation technology and advent of the controlled facilities its cultivation is now successfully extended to the plains. Cultivation of white button mushroom requires three basic steps

1. **Production or procurement of spawn**
2. **Preparation of selective medium (compost)**
3. **Production of Crop.**

1. Spawn (mushroom seed) production:

In the first phase of implementation of the project, the spawn (seed) will be procured from a reliable source/ laboratory situated nearby or directly from ICAR-DMR, Solan (HP). In the second phase of increasing the capacity of the unit it will be produced in-house.

To get improved yields and quality latest hybrids like S -130, S- 140, A-15, NBS-5 etc. which give optimum production in 30 days of cropping will be used to ensure minimum 6-7 crops per room per year.

2. Preparation of selective medium (compost):

Like other fungi *Agaricus bisporus* is a heterotrophic organism. It required carbon compounds that have already been formed by green plants. Besides carbon it requires nitrogen, essential elements such as phosphorus, sulfur, potassium and iron vitamins such as thiamine and biotin. All the ingredients that contain these compounds when fermented in a set pattern form a substrate, which is very selective in nature. On this selective substrate *A. bisporus* mycelium grows successfully at the practical exclusion of other competing micro-organisms.

About Raw Materials and Formulations of Compost

White button mushroom requires a well composted substrate for its growth. It is a saprophytic fungus and requires carbon compounds, which generally come from the agricultural waste materials. Besides carbon, it requires nitrogen and other essential elements, such as phosphorous, sulfur, potassium and iron, vitamins such as thiamine, biotin, etc. All the raw materials that contain these compounds are mixed in a fixed proportion and fermented in a set pattern to form a substrate, which is known as compost.

A. Raw Material and Ingredients

I. Agricultural base materials

These base materials form the bulk of compost and for this purpose wheat straw is favoured all over the world. However, quality compost can be prepared using variety of other materials including paddy straw, hay, barley, oat, maize stalks and leaves, sugarcane bagasse, sugarcane trashes and leaves, soybean stalks, mustard stalks, etc. These materials should preferably be freshly harvested / procured and should be around 5-8 cm long. These base materials act as a reservoir of cellulose, hemi-cellulose and lignin, which is utilized by button mushroom (*Agaricus bisporus)* during its growth as a carbon source. They also provide a little quantity of nitrogen. Besides acting as a nutrient source, they also add bulk to the compost, impart proper physical structure to the substrate and ensure adequate aeration during composting for the buildup of microflora essential for the composting process and also for the nutrition of mushroom. Rice and barley straw are very soft and degrade quickly during composting. These materials also absorb more water as compared to wheat straw. While using these materials care must be taken regarding quantity of water used for wetting, schedule of turnings and adjustment to the rate and type of supplements.

II. Supplements

Above base materials do not have adequate amount of nitrogen and other nutrients required to start the fermentation process having required C/N ratio. Also the requirement of nitrogen cannot be met with the little nitrogen available in straw. The compounding mixture is supplemented with other materials having nitrogen and carbohydrate sources. These materials can be classified as follows.

a. Animal manure

Horse manure undoubtedly is the best material for compost preparation. However, due to difficulties encountered in procuring good quality horse manure, use of this material has been restricted to few farms only. More and more farms are switching over to easily accessible materials. Chicken manure has proved to be the best alternative of horse manure. Other manures viz., pig, cattle and sheep have also been tried for compost preparation but with limited success. All these manures provide nitrogen to the compounding mixture, little of carbohydrate is also provided. These materials are highly variable in composition and their N-content may vary from 1 - 5 percent and it is released slowly during composting process. In addition to providing nutrients, they greatly increase bulk of compost, which is very important factor under Indian conditions considering the cost of wheat straw and these materials (specially chicken and horse manure). If horse manure is used in composting then it should be used along with bedding and urine, as it will not require any further supplementation. If it is not having enough bedding and urine when collected from a clean stable, supplementation with inorganic nitrogen along with some wheat straw may prove useful. Chicken manure if used, should preferably be a deep litter chicken manure having nitrogen content above 3%. If such manure is not available then the manure from cages can also be tried. Chicken manure is generally used under short method of composting. However, some of the growers are using this under long method and are getting fairly good yields, while some have met with failures. Chicken manure harbours heavy population of pathogenic nematodes and harmful fungi including *Sepedonium maheshwarianum*, *Stachybotrys atra*, *Papulaspora* sp. and *Verticillium* sp. Growers should, therefore, avoid the use of this material under long method of composting.

b. Carbohydrate sources

These materials are essentially required to hasten the composting process, to balance the C/N ratio and also for the establishment of the bacterial flora in the compost. Molasses, wet brewer's grains, malt sprouts, potato wastes, apple and grape pomace can be employed as carbohydrate sources, since these materials provide readily available nutrients to microorganisms.

III. Nitrogen fertilizers

This category includes fertilizers like, urea, calcium ammonium nitrate, and ammonium sulfate. Nitrogen content of these fertilizers is very high (24-46%), which is released quickly, resulting in quick establishment of microflora.

IV. Concentrate meals

Animal feeds are generally kept in this category, which include wheat or rice bran, dried brewer's grain, soybean meal, cotton seed meal, castor meal, sunflower meal, etc. These materials supply both nitrogen and carbohydrates, which as in case of animal manures are released slowly. Nitrogen content may vary from 3-12% depending upon the source.

V. Supplements to rectify mineral deficiencies

In addition to carbon and nitrogen, *A. bisporus* also requires little quantities of potash, phosphorous, calcium and magnesium for its growth. Fertilizers viz., muriate of potash and superphosphate can be kept in this category. Besides this, gypsum and calcium carbonate can also be kept here. Gypsum also has stabilizing effect on ammonium content. An increased ammonium concentration is obtained with gypsum, which is an indicator of productive compost. Furthermore, gypsum serves as a calcium source for the mushroom and also for the oxalic acid produced by the mushroom mycelium, which gets converted into calcium oxalate. Requirement of phosphorous, potassium, and magnesium is generally met by chicken manure or horse manure when compost is produced by short or by indoor method. However, long method compost where chicken manure is not added addition of other materials may be required to meet the demand of these nutrients. For making compost for *A.bisporus* above materials should judiciously be selected keeping in view the nutritional requirement of *A.bisporus*, cost and availability of raw materials.

B. Formulations A large number of formulations are available with the growers and these are based on cost and availability of raw materials in the particular region. To initiate a composting process and to minimize the loss of dry matter during composting, 1.5-1.75 percent nitrogen is generally kept in the compounding mixture. The main objective of computing a formulation is to achieve a balance between carbon and nitrogen compounds. At stacking C:N ratio is adjusted to 25-30:1, which comes down to 16:1 after composting. N level in the compounding mixture at start should not be less than 1.5% as this will give improper compost with high C:N ratio and such compost will be easily attacked by cellulose loving fungi. It should also not be higher than 1.75% as such compost will be easily attacked by yellow moulds fungi and also more time will be required to finish the composting procedure. Known and estimated values of nitrogen and water contents of different materials viz., straw, chicken manure, wheat bran and other chemical fertilizers can be used as guidelines in computing formulations having desired balance of nitrogen and C: N ratio. Different batches of these materials can be tested for nitrogen for their correct estimates so that required quantity of these materials goes in a compounding mixture leading to productive compost. Formulations for white button mushroom compost should be so designed that composting mixture should have under mentioned percentage of different minerals on dry weight basis.

N	1.5-1.8%	CaO	1.5-3%
P2O5	1.2-1.5%	MgO	0.4-0.5%
K2O	2.0-2.3%		

Formulations having horse manure as one of the ingredients is termed as natural compost, while others are termed as synthetic composts. In addition to C and N, various other materials play an important role. Only in recent times importance of these minerals in mushroom cultivation has been realized. Chicken droppings have maximum amount of all the above elements and it should become an integral part of mushroom compost. An example as to how to arrive at standard formulation having desired N value is given in Table below.

Table. Nitrogen computation guidelines

Ingredients	**Fresh wt (kg)**	**Moisture (%)**	**Dry wt (kg)**	**% N**	**N (kg)**
Wheat straw	300.00	10	270.00	0.40	1.08
Wheat bran	15.00	10	13.50	2.00	0.27
Chicken manure	125.00	10	112.50	2.60	2.93
Urea	5.50	-	5.50	46.00	2.53
Gypsum	20.00	-	20.00	-	-
Total wt.	465.50		421.50		6.81

N% = (6.81 x 100)/421.50 = 1.61%)

C. Different Formulations Some of the formulations suggested by different institutions are:

DMR, Solan			
Wheat straw	300 kg	Wheat & paddy (1:1)	300 kg
Wheat bran	15 kg	CAN	9 kg
Chicken manure	125 kg	Urea	5 kg
BHC (10%)	125 g	Wheat bran	25 kg
Urea	5.5 kg	Gypsum	20 kg
Gypsum	20 kg		

Wheat straw Chicken manure Cotton Seed cake Gypsum	300 kg 210 kg 21 kg 15 kg	Wheat straw Wheat bran Cotton seed cake Urea Gypsum	300 kg 21 kg 12 kg 7 kg 15 kg
PAU, Ludhiana			
Wheat+Paddy straw (1:1) CAN Urea Superphosphate Muriate of Potash Wheat bran Gypsum BHC (5%)	300 kg 9 kg 3 kg 3 kg 3 kg 15 kg 30 kg 250 g	Wheat straw Chicken manure CAN Superphosphate Wheat bran Gypsum Lindane BHC	300 kg 60 kg 6 kg 3 kg 15 kg 30 kg (5%) 250 g
Mushroom Research Laboratory, Solan			
(Long method)		**(Short method)**	
Wheat straw CAN Super phosphate Urea Sulphate of Potash Wheat bran Molasses Gypsum	1000 kg 30 kg 25 kg 12 kg 10 kg 100 kg 16.6 lt 100 kg	Wheat straw Chicken manure Brewer’s manure Urea Gypsum	1000 kg 400 kg 72 kg 14.5 kg 30 kg

Many commercial units are making compost using only straw of wheat or paddy and chicken manure. For every ton of straw about 0.7-0.8 ton chicken manure and 0.05-0.15 ton gypsum is used. Gypsum is normally added at third turning but many units add it in the beginning or at second turning. Formulations recommended for long method can also be used under short or indoor methods. However, it is recommended that for short/indoor composting one should use chicken manure based formulations for economic gains. Further, one can go up to 70% addition of chicken manure/ton of straw depending upon its N-content. Other materials can be added to balance the N-level in the desired range.

C. Attributes of a good compost

A good compost should be dark brown in colour, should not be greasy or sticky, should have distinct sweet inoffensive smell, free from ammonia smell, should have 68- 72% moisture and pH 7.2- 7.8. There should not be visible growth of other undesirable organisms except for the fire fangs (Actinomycetes) and it should be free from insects and nematodes. As indicated earlier composting is essentially a fermentation process brought about by the activity of various organisms. Their activity and growth determines the quality of the compost produced since these organisms convert ammonical nitrogen to microbial proteins, which are ultimately utilized by *A.bisporus* mycelium for its nutrition. Beside above, quality and composition of base materials, aeration and moisture also determine the quality of compost. Various factors, which govern the quality of compost, are as follows:

a. Nitrogen content

Nitrogen content of the compounding mixture is very important. It should be 1.5 - 1.75% in the beginning (on dry matter basis). If the N content is kept below 1.5%, compost is not properly fermented and the temperature of the heap may not go beyond 55-600C due to lesser microbial activity. The compost so produced will be yellowish in colour and light in texture and will not be selective to mushroom mycelium. Moulds like *Stachybotrys atra*, *S.alternans*, *Stilbum nanum* and *Doratomyces stemonites* may inhabit such compost resulting in poor yields. On the other hand if N content is kept above 1.75% level, C: N ratio will not be optimum and more of nitrogen will disappear from the pile in the form of ammonia resulting in the wastage of the nutrients. Such compost is invariably infested by *Sepedonium* spp. (yellow moulds), which may drastically reduce the yield. *Coprinus* spp. (Ink caps) and *Chaetomium olivaceum* (olive green mould) are also indicators of high nitrogen in the compost pile. N content of compost at the end of 28 days in long method compost is in the range of 1.75 to 2.0 %.

b. Carbohydrate content

During initial stage of composting free carbohydrates and nitrogen are utilized by the mesophilic flora and heat is generated in the process. Later on thermophilic flora takes over the mesophilic population. When the compost is cooled down, thermophilic flora can no longer grow due to low temperature while mesophilic flora also cannot grow since these organisms have already utilized most of the free carbohydrates. Normally there should not be any free or soluble carbohydrates present in the compost. Their presence is the indication of under composting and such composts are easily attacked by green mould (*T. viride*) or blackwishker mould (*D.stemonits*).

c. pH

This is an important parameter of *A.bisporus* compost. *A.bisporus* mycelium grows best at 7.2 - 7.8 otherwise growth of *A.bisporus* will be slow and white plaster mould (*Scopulariopsis fimicola, S.brevicaulis*) may invade such compost.

d. Moisture content

Optimum moisture content for the natural compost (i.e. compost made using horse manure) is about 65-67% while for synthetic compost it is 68-72%. If it is more than 72% at spawning there may not be proper aeration, as free space will be occupied by water. Under such circumstances anaerobic condition may prevail resulting in killing of *A.bisporus* mycelium. Further, moulds like brown plaster (*P. byssina*), white plaster (*S. fimicola*) may appear in the compost.

e. Quality of raw materials

If raw materials especially wheat or paddy straw used in compost making are of poor quality (old and exposed to rains) it may result in improper compost. On such compost *Sepedonium* spp., *Alternaria alternata* and *Coprinus* spp. may appear resulting in low yield of mushroom.

D. Methods of composting

I) Long method of Composting - an old concept

Many seasonal growers are still preparing compost by Long Method of Compositing (LMC). Compost production by LMC is a very old concept and has been done away by advanced countries many decades back. It is presently in vogue only in few countries like India, China and Indonesia. LMC has following shortcomings.

Since compost is prepared over a period of 28-30 days dry matter loss of ingredients is more. We normally get 1.75 to 2.0 tons of final compost from one ton of dry straw. Compost is produced under outdoor conditions and hence invaded by many pests/competitors/diseases and hence not perfectly selective. Frequent sprays of insecticides and fungicides are required. Most of the ammonia is lost in the atmosphere resulting in low final N content of compost. Low yields. Not environment friendly

II) Short Method of Composting (SMC)

Long method of composting has many shortcomings as already mentioned. Growers in the United States around 1915 found that if compost prepared for *A.bisprous* is kept in shelves in growing rooms and subjected to high temperature (around 60°C) for sometimes gives higher and consistent yield. This process was later termed as “sweating out” and it laid down the foundation of pasteurization of compost.

Based on the above principles/ findings, American Scientist Sinden and Hauser in the year 1950, 1953 proposed a new method of composting, where pasteurization became its integral part, which was termed as the short method of composting (SMC). This method of composting is being followed by most of the growers who are cultivating mushrooms round the year and has since revolutionized the mushroom industry. Short method of composting primarily consists of two phases: Phase-I: Outdoor composting for 10-12 days Phase-II: Pasteurization and conditioning of the compost inside an insulated room by free circulation of air under definite set of conditions. This phase lasts for around seven days

i. Purpose of pasteurization and conditioning

a) It reduces the time of composting
b) It converts ammonia into microbial protein, most of which otherwise goes waste in the atmosphere in LMC
c) It conditions or sweetens the compost under definite set of temperature and aeration uniformly making compost more selective for the growth of *A.bisporus*
d) It kills or inactivates insects/pests/diseases and competitors of *A.bisporus*, which if present hamper the growth of *A.bisporus* thereby reducing the yield
e) Conditioning increases the biomass of thermophilic organisms especially that of *Scytalidium thermophilum*, which later on is utilized by the mushroom mycelium as food
f) Through conditioning more compost per unit weight of ingredients is produced
g) Conditioning and pasteurization increases the yield of mushrooms

During Phase-II steam pasteurization is done in a well insulated room constructed for the purpose. Boiler is required for the production of steam for proper maintenance of temperature inside the compost mass. Blower is required for the supply of fresh air and recirculation of ammonia and other gases for their conversion into microbial proteins. Details of pasteurization chamber are given in next section.

ii. Machinery required

Small farms would not require much mechanization owing to availability of cheap labour in the country. Also they have to handle little quantity of compost at a time, which otherwise can easily be handled manually. However, for a large export oriented unit (around 2000-3000 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. Following machines will be required for an export oriented unit.

a. Pre-wetting 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 into long and wide heaps by tractor and front loaders.

b. 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 rest two is 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.

c. 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.

d. 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. Else, Bob Cat can be employed for the purpose.

e. Oscillating head filling machine
This is made up of two conveyer units mounted upon a self propelled chassis. 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. The head filling machine comes in varying sizes suiting to the size of the tunnel.

f. 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

g. 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. 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 operation, 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 machines, small instruments like multi-probes digital thermometers, oxygen meters, ammonia measuring equipments and computers are also required for a mushroom farm to maintain quality and high productivity of mushrooms.

h. Bunker Filler
These days bunker fillers are available that can perform multiple functions and can be used for mixing ingredients, filling bunkers and even tunnels.

i. Tunnel emptying winch with combination of spawn dosing machine
This unit is employed for emptying the tunnel filled with pasteurized compost by means of a polyethylene glide and pulling nets. The winch is equipped with one net reel for 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.

j. Bag filling machine: For automated spawning and bag filling, this machine can be employed.

iii. Methodology: Compost by short method can be prepared by any formulation given in the text earlier. However, a formulation based on wheat straw and chicken manure is widely used in the country i.e. Wheat straw 1000 kg, chicken manure 500 kg, urea 15 kg, wheat bran 75 kg, gypsum 30 kg.

a. Phase-I or outdoor composting
This phase of SMC also starts with the wetting of the ingredients. Wheat straw and chicken manure are wetted thoroughly till they absorb sufficient water (around 75%). Leached water collected in a goody pit constructed for the purpose is regularly sprayed over the raw materials. After thorough wetting of the substrates an aerobic stack or a simple heap is made out of such materials. After 2 days the stack is broken, water is added to the dry portions and again a stack is made. Growers may provide artificial aeration to this heap and to the stack to be made later on for better results. They may pass up to 10 to 15

m^3 of air/ton of wet compost/hour through the stack. This will result in achieving high temperature and more homogenous compost. To have artificial ventilation in the stack, working floor of the composting yard is provided with under stack aeration ducts connected with the required capacity small blowers installed at one end of the yard. These blowers blow small quantities of air regularly or at fixed intervals through G.I. or plastic pipes, which have small holes running length wise of the yard. Stack is made on these pipes. Pre-wetting and mixing of ingredients is a must before starting actual composting procedure on zero day and the stack made during this process are wide with low height of 3-4 feet.

On zero day, the stack is again broken and the entire quantities of other raw materials like urea and wheat bran are added, water is also added if required and a high aerobic stack is made. Dimensions of the stack are about 5' x 5'. Turnings can be done manually or by compost turners built for the purpose. Similarly the compost is again turned after every 2 days and gypsum is added at third turning. In all three to four turnings are given. On 8th – 10th day the compost is ready for pasteurization to be affected in tunnel. This marks the end of Phase -I.

Phase I can also be done in bunkers (as described in indoor composting) which have arrangement of under stack aeration through pipes or grated floor. After pre-wetting for two days and thorough mixing of all the ingredients, the material is shifted to bunkers where temperature of 75-80°C is achieved inside the compost. Air can be injected regularly or in pulses.

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; if squeezed drops of water appears between the fingers
- Very heavy smell of ammonia. pH approximately around 8.2 - 8.5
- Still sticky and slimy, hands get dirty and wet
- Actinomycetes (fire fangs) not so apparent
- Nitrogen content between 1.5 - 2.0%; ammonia concentration around 800-1000 ppm

b. Phase-II

This phase of composting is generally performed in pasteurization tunnel in bulk. Phase-II process can be divided into two stages namely conditioning and pasteurization.

Conditioning

It can be divided into pre-pasteurization conditioning (PPC) and post pasteurization conditioning (POPC). During this phase of composting, whole of the compost mass is brought to a temperature range optimum for the growth of thermophilic flora (45-52°C). During this phase major part of NH3 gets fixed in lignin-humus complex or as microbial biomass and excess of ammonia is released into the atmosphere. POPC again regenerates the lost thermophilic organisms during pasteurization. It has also been found that maximum ammonia generation takes place at 45-50°C, which corresponds well with optimum temperature range of majority of thermophilic flora. Compost should not be conditioned below 40°C, as some mesophilic fungi may set in at this temperature rendering compost unsuitable for mushroom growth specially *A.bitorquis*. Besides keeping compost at a particular range of temperatures (45-52°C), during this phase enough of oxygen is supplied (O2 concentration above 10%) to the compost mass to maintain fully aerobic conditions. Both pasteurization and conditioning make the compost most selective for the growth of white button mushroom at the expense of other harmful competing organisms.

Pasteurization

Main purpose of pasteurization is to kill or inactivate harmful organisms. They are eliminated when the compost is subjected to a temperature above 55°C for certain period when humidity in the compost and surroundings is high. Therefore, use of live steam to heat up the room and compost sometimes becomes essential. It has been found that compost is pasteurized properly if it is kept at 59°C for 4-6 hours.

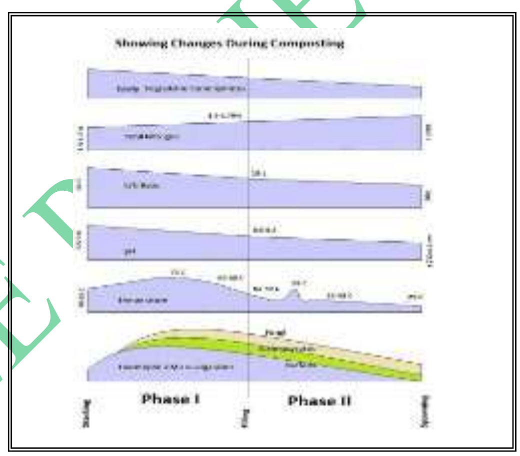
Temperature above 60C is harmful as this temperature may kill all kinds of organisms including thermophilic fungi very essential for governing the phase-II of composting. Activity status of the compost is also very important to achieve pasteurization temperature. If it is active compost, its temperature starts rising immediately after filling and may rise by 1°C per hour and the required temperature of pasteurization can be achieved in few hours only by self-generation of heat. Pasteurization of the compost can either be done soon after room/tunnel filling or after few days.

[redacted]

Process

The compost is treated in bulk inside a specially built chamber known as the tunnel. The compost is filled in the bulk chamber up to the height of 2- 2.2 meters in such a way that one square meter of space occupies approximately 900-1000 kg of compost. Several temperature sensors are placed at different points of the tunnel to measure the temperature. One sensor is placed below the plenum in the ventilation duct below the grated floor, one to three are placed inside the compost mass and one or two above the compost for air temperature. Immediately after filling, all the doors are closed and the blower is switched on to bring the air in plenum, compost and air above the compost at a uniform temperature (around 45-48°C). There will be a little difference in temperature at all the three places and this difference may be 1-3°C. Levelling off may take 4-5 hours and at this stage no fresh air is generally introduced in the tunnel and air introduced through the leakage of the dampers and ducting would suffice the purpose. After levelling that is to say after 4-5 hours (more in case of bigger tunnels >15 tons) of filling the tunnel, we will start Pre Pasteurization Conditioning (PPC). This is to increase the population of thermophilic fungi at this stage, which will demand more oxygen for their growth and multiplication and this may reach above 15% of the total gaseous volume inside the tunnel. Fresh air is therefore introduced in the tunnel through the dampers (10% opening). Now the compost is kept between 45-52°C for two days. Two days after conditioning, the compost is now ready for pasteurization. Now opening of the damper is narrowed down, which will gradually increase the temperature of the compost by approximately 1°C/h. Required temperature (58-59°C) of compost needed for pasteurization may reach in 10-12 h by self-generation of heat. The difference in the temperature above the compost (air temperature), inside the compost and plenum (below the compost) should be as less as possible and may not exceed 3°C. Some quantity of steam can also be used if temperature is not rising. This process is called pasteurization or killing. Duration of the pasteurization is normally 4-6 hours. It will eliminate harmful insects, nematodes and competitor moulds from the compost and at the same time will preserve the nutrients in the compost, which can effectively be utilized by *A. bisporus* mycelium. Temperature can be monitored or regulated through automatic computerized systems available in the international market. A low cost alternative has been developed at the Directorate wherein one can set the minimum and maximum temperature and as soon as the temperature goes above or below the set temperature range, there is siren and corrections in tunnel parameters thereafter can be made manually. After killing, fresh air is again introduced / increased in the tunnel and temperature of the compost is brought down @ 1.5°C/hour and finally maintained between 45-48°C till there is no detectable smell of ammonia (less than 10 ppm) in the compost. This phase is known as post pasteurization conditioning (POPC) of the compost, which is normally accomplished in 3-4 days. Temperature of the compost is gradually brought down to 25- 30°C after conditioning by introduction of fresh air in the tunnel and when this temperature reaches, the compost is ready for spawning.

Above method of pasteurization is recommended for the commercial tunnels having more than 15 tons output of the compost. Smaller tunnels while adopting above procedure may require frequent injection of steam during PPC and especially when pasteurization is affected, this increases the cost of production of compost. Such tunnels may resort to traditional pasteurization wherein leveling is done at higher temperature (around 50°C) and after that opening of the damper is so adjusted that compost temperature starts rising and it attains pasteurization temperature mentioned as above. Usual conditioning is done afterwards for 4-5 days or till the period when compost is free from ammonia and spawning done as usual. At the end of c**o**nditioning (at spawning) compost should be dark brown in colour with a full coating of white powdery mass due to abundant growth of actinomycetes. This is a sign that Phase-II was performed in a perfect manner with abundant supply of fresh air. Phase-II process is almost a biological oxidation (90%) and hence here O2 and temperature play very important role. It is advisable to connect temperature probes with a computer or data logger for round the clock changes/monitoring of the temperature. Further, gadgets are available in the market to monitor ammonia concentration and oxygen level inside the tunnels. These can also be installed in the tunnel to monitor above gases round the clock. The fresh air inlets are fitted with 2 micron washable HDPE filters. As the composting proceeds there is loss in biomass. In phase–I there is about 30% loss in weight and in phase –II, 20-25 % loss in weight takes place. As a result from the standard formula of one ton wheat straw and 0.5 ton chicken manure, we can get about 2.5 tons of final compost.



Characteristics of the compost after Phase-II

- Dark brown in colour, full of thermophilic fungi and actinomycetes. It is soft, straw breaks rather easily.
- Moisture around 64-66%. No liquid oozes when squeezed firmly
- Pleasant sweet smell
- No stickiness. Hands stay clean and dry
- N content > 2%
- Ammonia below 10 ppm

Advantages of bulk pasteurization

- More compost per unit size of the room can be treated at a time.
- The cost of pasteurization in tunnel is less.

- Same tunnel can be utilized for spawn run in bulk, which gives effective use of the space.
- Yield per unit weight of compost is generally higher.

III. Indoor Composting

1. Facilities required

a. Composting yard

In indoor composting Phase-I is performed indoors and hence requirement of composting yard is greatly reduced. A small composting platform is required for pre-wetting and mixing of the ingredients, which is mainly performed either by front-end loaders or by pre-heap turners by big commercial units. A platform of the size 60x60x14 ft (h) would suffice the purpose for a medium size farm (250 TPA).

b. Phase-I bunkers

These are specially built non-insulated tunnels having full width opening at the front. Dimension of the bunkers would depend upon the output of the compost required. Generally the bunkers are 1.25 to 1.5 times more the size of the phase-II tunnels. It has a plenum (ventilation duct). A perforated concrete floor is constructed above the plenum, which is serviced by a centrifugal fan having ¼ the capacity of phase -II blower, which means that a ventilator having air displacement of 50 m3/hour/ton of compost at 50mm WG water pressure would suffice the purpose. Alternatively, the bunkers have no plenum and several pipes are buried in the floor along the full length of the bunkers having small holes (5-8 mm dia). These pipes are converged into a manifold, which in turn is connected to a high-speed blower fan (around 1000 pascals). A timer is usually attached to the blower, which pulsates the air in the bunker periodically as per the setting of the timer. A minimum of 2 such phase-I tunnels (bunkers) are required.

c. Phase-II tunnels

Structure and design of these tunnels are the same as required in case of short method of composting.

2. Selection and mixing of ingredients

Selection of the raw materials for indoor composting is very critical and should have the following qualities: (i) High bulk density, (ii) Good structure and texture, (iii) Perfectly mixed raw materials, (iv) Well balanced chemical composition and (v) High level of nutrients

3. Procedural requirements

Two methods, INRA method (double phase high temperature process) and Anglo Dutch method (single phase, low temperature process) are prevalent in most parts of the world giving almost equal yields. This Directorate has developed a method combining the two methods as mentioned above. Methodology developed is presented below: For preparing compost by this improved method of composting, ingredients say – wheat straw 1000 kg, poultry manure 500 kg, wheat bran 70 kg, cotton seed cake 20 kg, and gypsum 40 kg are first thoroughly mixed in dry form. They are then thoroughly wetted so as to achieve around 75% moisture percentage. Runoff water should regularly be collected and sprinkled over the wetted straw. On the following day these wetted ingredients are then spread over the composting yard (around 8-10" height) and trampled hard by running Bobcat several times over the wetted ingredients or by other means so as to increase the bulk density of the ingredients and also to shred the straw. Wetted straw together with other ingredients is then made up into heap and left as such for 48 hours. Temperature in the heap may rise up to 55-600C. On the following day, material is again flipped to bring the uniformity and proper mixing and transferred to phase-I bunker, for phase-I operation. This material will weigh around 4 tons and height of the compost in the bunker is kept up to 1.8-2 meters. Temperature sensors are installed on the top and in the Centre of the pile in the bunker and blower fan switched on @ 5 min/h with the help of a timer installed for the purpose. Temperature will rise to 60-650C after 24 hours in the centre and 48-520C at the bottom, sides and on top of the compost. After 24 hours air flow inside the tunnel is increased to 10 min/hour. This will further increase the temperature in the centre of the compost between 72-75°C while it will remain same in other parts of the compost mentioned as above. No foul smell will be noticed while performing phase-I operation in the bunker, however little bit ammonia smell will be there. After 3 days of partial fermentation in phase-I tunnel, entire compost mass is taken out and a complementary turning is given, more water can be added if required and is transferred to another bunker or to the same bunker at the same sets of conditions mentioned as above for 3-4 days. Total period of phase-I operation in the bunker should normally last for 6-8 days. Afterwards compost is transferred to phase-II tunnel for usual phase-II operations to be completed in 6-7 days.

a. 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 of 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
As temperature inside bunkers sometimes rises above 75C, it may be desirable to add some inoculum in the form of readymade compost to the ingredients at the time of filling the tunnels for phase-II.

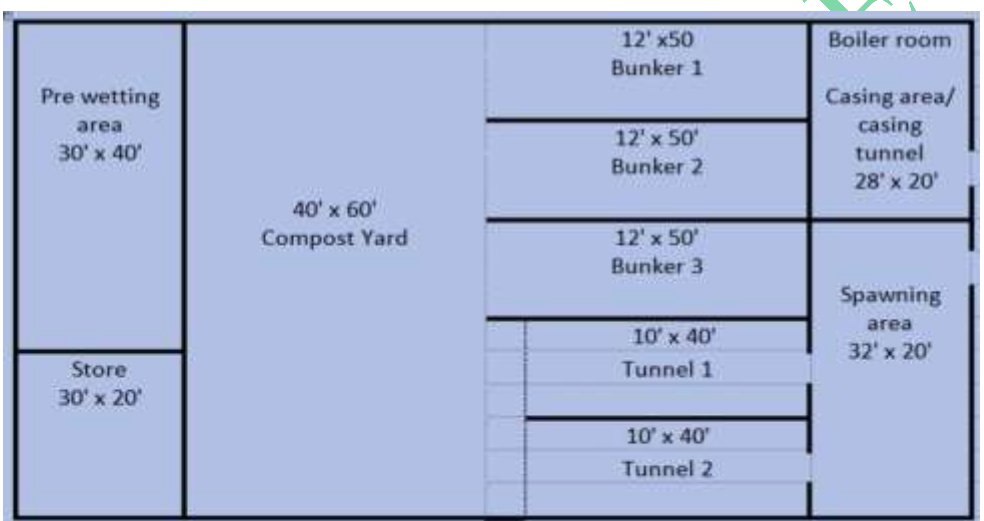
b. Advantages of using bunkers

- Requirement of composting yard is reduced
- No emission of foul smell
- Number of labourers and cost of production reduced
- Duration of composting reduced
- Reduced effects of weather and seasonal variations
- More compost per unit weight of the ingredients
- Higher yields
- Compost turner is not required

Farm Design

White button mushroom is a temperate mushroom requiring cooler climate for its growth. It is an indoor crop and is an ideal tool in converting agricultural wastes in to proteinaceous food. In early days its cultivation was mainly confined to the hills. In the eighties growers realized the potential of this crop and started its cultivation in the northern plains in the winter when the climate was suitable for its growth.

Many entrepreneurs in the plains further ventured and started its cultivation round the year by employing artificial cooling facilities (chilling stations). Today its cultivation is done throughout the country. Some are doing it seasonally while many of them have preferred to go for round the year cultivation. Today India boasts of having world’s biggest farm, the Agro Dutch Foods Ltd, Lalru Punjab and many more environment controlled units exit in different parts of the country cultivating this mushroom round the year. 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. As mentioned above this 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, i.e., during winter months in N.W. plains and from September to April in the hills. Seasonal cultivators of this mushroom are using traditional methods of its cultivation and are mainly cultivating this mushroom in the thatched structures employing long method of composting. They usually take single crop in the entire season and are harvesting 12-15 kg mushrooms/ 100 kg compost.



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. Of late few of them have shifted to indoor composting while new upcoming units have chosen to produce their compost entirely by indoor method. 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. An entrepreneur can start mushroom cultivation modestly using seasonal growing houses and after gaining sufficient experience can shift to round the year cultivation employing suitable climate control facilities. 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 in this competitive environment. The one who designs the farm in most scientific manner looking to the need of the crop and easy accessibility to the different infrastructure for their operation convenience in less space, utilizing less money will gain handsome returns in the years to come. Present chapter would deal in detail the infrastructure and machineries required for the seasonal and environment controlled units.

A. Selection of Site and Pre-Requisites Before selection of site, the following points have to be taken into consideration for greater operational efficiency and cost effective production of mushrooms at the farm: 1. Chosen site should preferably be away from the municipal limits and entrepreneur should purchase sufficient land in one go looking to the future expansion. 2. The site should be serviced by a motorable road, or nearer to a road head to reduce costs on transportation of raw materials to the farm/finished product to the market. 3. Plentiful availability of water at the site either through a perennial source or should have sufficient underground water. 4. Easy availability of raw materials especially straw and poultry manure around the chosen site at cheaper rates in the area. 5. Availability of cheap labour in abundance. 6. Uninterrupted proper power supply at the chosen site. 7. Nearness to the market for the proper disposal of the produce.

B. Components of a Mushroom Farm For round the year cultivation of this mushroom employing environment-controlled condition a medium size plant would require under mentioned components.
Compost production unit will have under mentioned main components:
a Pre wetting area: For dumping of raw materials and their pre wetting (uncovered).
b Composting yard: For making piles out of the wetted materials (covered)
c Phase-I bunker: For phase -I composting (in case indoor composting is employed).
d Phase -II tunnels: For performing pasteurization and conditioning of the compost.
e Casing soil chambers: For pasteurization of the casing soil.
f 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 by a medium size farm (up to 200 TPA). Large farm besides above may require a front end loader (Bobcat) and other compost handling equipments including turner, filling line, etc.

5. General layout/location of various units: The layout is so planned that all the infrastructures required to be built are accommodated in least possible land without over looking mushroom cultivation requirements. The general 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. Wind direction is also kept in mind for choosing the location of the composting facilities. During most of the time of the year wind 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 for their operational convenience and also to avoid heat losses. The bulk chambers are built nearer to the phase-I bunkers. Both these structures are preferably built away form the road at the distant end of the yard so that the distant end of the phase -II tunnels opens nearer to cropping rooms and away from composting yard. 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 or within the composting yard with small platform for preparing the casing soil. Enough space for future expansion of composting yard, construction of more phase-I & II chambers and growing rooms should be left vacant for planned development of a mushroom farm in a phased manner. 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 foundation of the buildings is dug on the firm ground. 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. In areas where land is scarce, double story cropping houses can be built to economize on space. The cropping rooms are generally built in double rows with a path/gully in between for various operations and services.

a. 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 required when one has chosen SMC. Now a day's trend is for indoor compost production due to environment legislation. In such a case a small pre wetting area, and small covered composting yard would be required with minimum of two-phase-I bunkers and one phase-II tunnel. Size of all these structures would depend upon the production targets of the unit and size and numbers of the tunnels.

b. Pre-wetting area (PWA) (lagoon) This area is constructed nearer to the road. It is a simple cemented structure having a saucer like depression in the center so that it looks like a lagoon and water remain collected during the pre-wetting of the compost ingredients. Center of the lagoon should be around 1 ft deep. Excess water of the lagoon is collected in a goody pit built specially for the purpose at a convenient place around PWA for its reuse. Floor of the PWA should be such that it can withstand the load of the front-end loader while performing the wetting operations. It is usually not covered and is open to the sky. PWA terminates in the composting yard. Water connection with 2"-3" dia. pipe should be available in PWA permanently with additional portable hosepipe for use during pre-wetting. One dewatering pump with a hose should be installed in the goody pit to pump out the run-off water for its reuse during pre-wetting. Water in the goody pit may be aerated continuously to avoid foul smell.

c. Composting yard composting yard has to be done as it has to withstand the load of heavy machines. The floor is given a run-off of 1 cm per running meter away from the bulk chamber and towards the goody pit end. The roof of the outdoor composting platform is built on tresses or RCC pillars 16 ft high with a GI or any other suitable roofing. The covered composting yard should be big enough to hold maximum compost stacks for phase-I of composting. When adopting indoor compost production wetted ingredients are just made up into a heap for 3-4 days and do not require rick formation in such a case a small platform can suffice the purpose. However, a large composting yard would be required if SMC is adopted. 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 with 2-3 ft sidewalls on the two sides (length wise) where rain will not interfere in the normal process of composting. The foundation of the composting yard should be laid on a firm ground and it should necessarily be reinforced if mechanization is to be done.

One ton compost occupies about one meter length of the composting yard, with an extra space of 2-3 m left on each side for turning with machines. Two bulk chambers will have a platform with 10-15 m width. For two bulk chambers of 25 tons capacity each, a composting yard of 25 m x 13 m should be good enough to concurrently run phase-I operation at a time for both the chambers. A drain should run on the two sides of the platform to facilitate periodic cleaning. A few 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. The yard should be well lighted with tube lights and strong searchlights to facilitate round the clock operations at the composting yard. An overhead water tank is necessary, particularly where water is scarce, to store water for timely operations. The floor of the composting yard for long method of composting should be simply cemented/brick layered with a low cost roofing of high-density polythene fixed on iron tubular structure or it can also have thatched roof. In practice (90%) of the farms cultivating this mushroom seasonally are preparing their compost in the open fields and do not have any specially built composting yard built for the purpose. However, such growers are facing lot of disease and pest problems. We recommend that the compost by long method by seasonal growers should at least be prepared on a cemented platform- let it be open to the sky.

d. Phase-I tunnels (bunkers) This facility is required when indoor composting is employed at the farm. These are specially built non-insulated tunnels having full width opening at the front. Dimension of the bunkers would depend upon 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 or it has simple RCC /steel gratings having 20% opening to the entire surface area of the tunnel which is serviced by a centrifugal fan having 1/4th the capacity of phase two blower which means that a ventilator having air displacement of 50 m3*I*hour ton of compost at 50 mm WG water pressure would suffice the purpose. A plenum floor involves pressurizing the entire airspace beneath the concrete floor, allowing the air to move up into the substrate through the holes or through series of slates. 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 to 30 cm each. These pipes converge into a manifold, which in turn is connected to a high-speed blower fan (around 1000 Pascal). A timer is usually attached to the blower, which pulsates the air in the bunker periodically as per the setting of the timer. A minimum of 2 such phase-I tunnels (bunkers) are required.

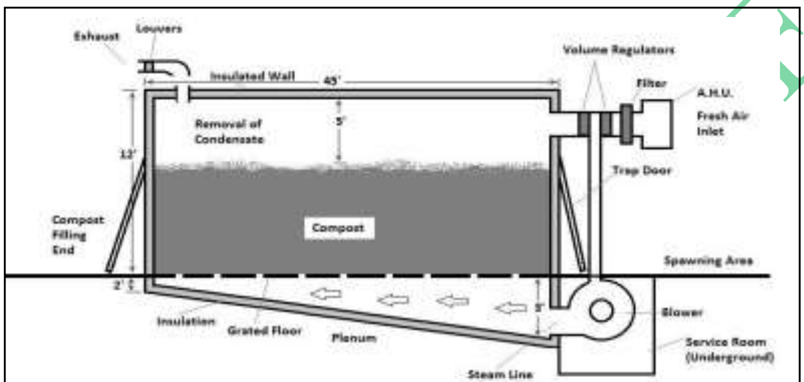
A bunker for 20-25 ton compost output at the time of spawning may have the dimensions 45 x 10 x 8 with 9 pipes of 2.5 m dia. at distance of 1 ft. (6" from the wall). To equalize the pressure either the pore size may be increased or distance between the holes may be gradually decreased from 1.5 ft. to 9". These 9 pipes are linked to a bigger pipe of about 6" dia. which in turn is linked to a centrifugal blower.

i. Phase II pasteurization tunnels: 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. In Bulk pasteurization chamber compost is handled in bulk inside the tunnel or chamber and hence the name bulk chamber.

The compost after phase-I is filled into specially built chamber, which is properly insulated and provided with steam connection and air blowing system for re-circulation. The compost is filled in the chamber on top of its grated floor built over the plenum. The plenum has an air circulation duct used during pasteurization/conditioning. 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. The foundation of the bulk chamber should be dug on a firm base ground. The floor must be laid with a good run-off provided with a drain to facilitate cleaning. It is pertinent here to note that this floor is given a slope towards the service area end (blower end). A large tunnel will be around 90 cm deep towards the blower end while it will be around 15 cm deep towards other end (filling end). Floor should be properly insulated with thermocol/glass-wool 5 cm thick (15 kg/m2 density). The insulation is covered with isolating membrane of PVC sheeting followed by 5 cm cement floor and finally the finish. Such floor is constructed for both cropping room and the chamber. The walls should be 9" thick (one brick lengthwise) built over the concrete foundation.

The length and breadth of the bulk chamber will vary, depending upon the amount of compost to be treated in the chamber, with the height of 13 ft, the roof is made of 4" thick RCC. The walls, ceiling and the floor below the plenum are insulated with 5 cm thick insulating material (15 kg/m2 density) necessary for effective insulating effect during pasteurization and conditioning of the compost. Required K value of the insulating material should be around 0.5-0.6 kcal/ m2/h. Air leakage in bulk chamber must be prevented at any cost. The bulk chamber has two floors one is real insulated floor while another false or grated floor, which is laid above the actual floor or plenum over the ventilation duct. The grated floor must allow the air to pass through, for which approximately 25-30% of the floor area is left in the form of gaps for ventilation/circulation of air and steam. The plenum is divided with a perforated brick wall (one or two) in the centre for supporting the grated floor. The gratings can be made of wood (painted with bituminous paint), coated iron strips mounted on angle iron frame or with concrete beams. Alternatively a concrete floor can be poured over the plenum as in case of phase -I tunnels having openings. If nylon nets are to be used for mechanical filling and emptying, then cemented grated floor with appropriate RCC strength is built specially for the purpose. The doors of the bulk chamber are made of angle iron or wooden frame with 2-3" insulation in the middle and covered on both sides with aluminum sheets, else they can also be made up of puff panels. The chamber will have two exhaust vents, one for recirculation exit and the other for exhaust of gases on introduction of fresh air via dampers. The steam line is also connected at the entry point of the blower. The walls and ceiling can be damp proofed by coating bituminous paint on inside over the cemented surface, which will also serve as an effective vapour barrier. The grated floor inside and the work floor outside should be of the same height for operational convenience especially when tunnel has to be filled mechanically.

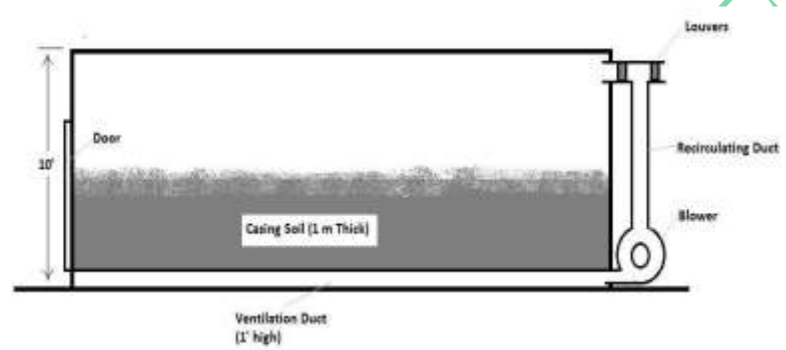
Two types of tunnels (bulk chambers) are in use, two door bulk chambers and single door bulk chambers. In the single door bulk chamber, the same door is used for filling and emptying and the other end is utilized for fixing installations (blower, etc.). In double door bulk chamber, one door is used for filling (which opens into the composting yard) and the other for emptying (opening into the sterile spawning area). The bulk chamber can be filled/emptied manually or by conveyer belts. The uses of machines for filling/emptying are labour saving, time saving and ensure homogenous filling as well as maintenance of absolute cleanliness during operations. For mechanical emptying two nylon nets are used, one fixed over the RCC grated floor (gliding net) and the other moving over the lower net (pulling net). The compost when brought out is fed into the spawn-dosing machine where requisite amount of spawn is mixed with the compost and the seeded compost is then poured into clean polythene bags for transport to the growing rooms. The dimension of the tunnel for producing 20-25 ton of compost is 36' x 9' x 13'. One may replace the plenum with plastic pipes fitted with spigots. The centrifugal fan can be placed at the bottom as well as on the roof depending upon the space and design.



Schematic Diagram of Bulk Chamber
(L - 45' X B - 9' X H - 13')

e. 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. 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. Compost is spread over the plenum on the grated floor in about 2-2.2 meter thick layers. Nylon nets are generally placed under the compost if mechanization is necessary. These together give a resistance of around 60-65 mm WG during pasteurization taking together the resistance of the air ducts, the in and out openings, the perforated floor, etc. the static pressure of the blower fan should be around 100 mm WG at 150-200 m3 air per ton of compost per hour. Blower fan must be well protected internally and should be made up of sheet steel. Aluminum is ideal for air ducts and should at least be 2 mm thick and there should not be any leakage in the duct system. Ducts are generally insulated with glass wool or any other suitable material. Fresh air is regularly required in the tunnels and since this air is drawn from the open atmosphere, chances of fungal spore's contamination are likely and hence the incoming air in the ventilation duct should be filtered and should pass through 2 mm fungal spore filters. The pre filters and filters should be washed at regular intervals. The inlet and exhaust openings must be fitted with a flap valve, which opens only when positive pressure is created inside the tunnel. The dimensions of inlet and exhaust openings should be the same. 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. A ten ton capacity cooling equipment or cooling coils from the central chilling plant is installed at the top of the AHU or such coils can be fitted in the blower section of the AHU. This arrangement is very effective in cooling of the compost in tropical areas during summer months. Installation of such facilities however requires heavy investment. Compost during these months can satisfactorily be cooled during nights when the temperature is low.

f. Casing pasteurization chamber Casing pasteurization chamber is just a mini bulk chamber. It has all the necessary components as required for the tunnel. Only difference is 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 size of the chamber will depend upon the size of the compost chamber and the size of the growing rooms. One chamber load should provide casing for one compost lot from each tunnel. The casing inside the chamber can be treated in the bulk and in such case it is filled up to the height of 90 cm only as against the tunnel where compost is filled up to the height of 2-2.2 meters. Else casing after wetting is filled into the perforated wooden/aluminum trays which are stacked one over the other inside the chamber and steam treated at 65°C for 6- 8 hours. This chamber can be built near to the composting yard or within the composting yard with a separate casing mixing platform.



Side View of a Casing Soil Chamber
(22' X 9' X 10')

3. <u>Crop Production</u>

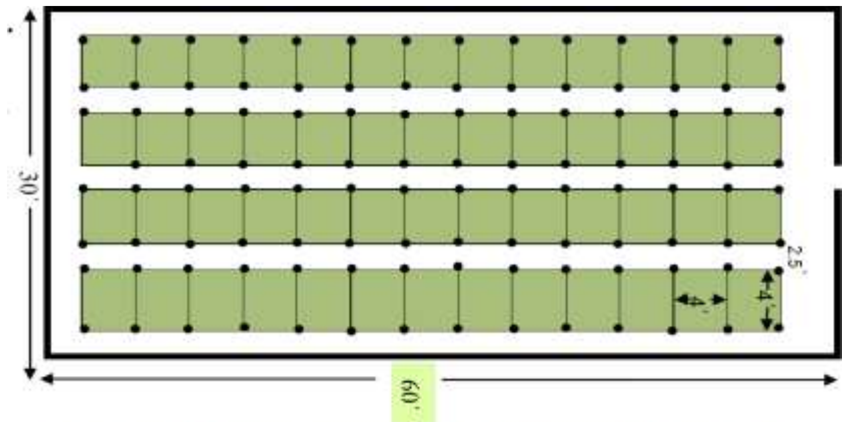
Design of cropping Rooms

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

Seasonal cropping rooms are simple rooms with modifications for maintaining various growth parameters. 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. These simple rooms are used for seasonal mushroom growing, coinciding various phases of growth with prevailing outside temperatures. No energy is generally used for heating/cooling of the rooms under seasonal growing conditions. However few units in plains have installed heavy-duty coolers to bring down the temperature in summer conditions. The cropping rooms for seasonal growing can also be made with a thatched roof and a false polythene ceiling. The door is installed on one end and the exhaust vents on the opposite end of the door. The mushrooms are grown on beds made out of bamboo sticks and sarkanda stems (a plant abundantly growing as a weed in North western plains of

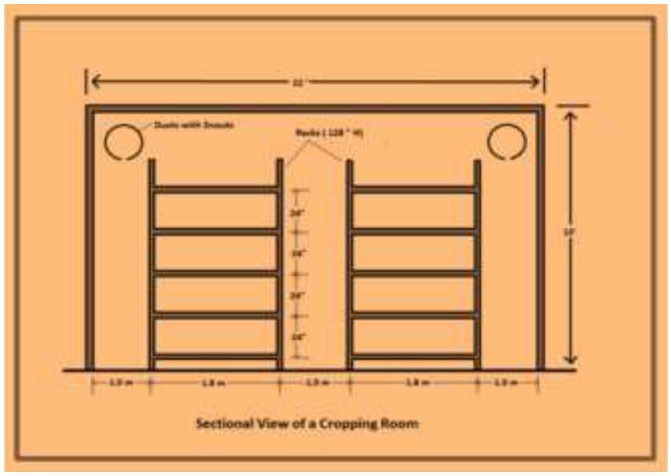
India). These growing rooms can also be built as low cost structure, steel pipe frame with high density polythene covering from outside. The real low cost growing houses built in rural areas are made of walls, roof and door of sarkanda. The mushroom houses made with bamboo frame and paddy straw have given good results conditions for seasonal growing. Design of one such hut is given below



Lay out of mushroom shed commonly used for seasonal cultivation

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. A cropping room, with a capacity to take compost from one bulk chamber, is considered advantageous as one bulk chamber load can straightaway be filled into one cropping room. Further, cropping cycles to be taken will determine the numbers of growing rooms in the unit. Now a day's 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. In this case every room is filled with the spawned compost after every 5 days. Both tunnel and cropping rooms of 20- 25 tons compost capacity are considered to be operationally efficient, as the filling/ emptying operation and spawning can conveniently be done in one day when machines are not to be used. However, bigger units may have the growing rooms handling compost to the tune of 60 tons or more. Growing rooms are such designed that maximum compost can be accommodated in least possible area without over looking to the mushroom growing requirements. To give an example a room size of 57 x 19.5x 12.5 ft can easily accommodate 20-25 tons of compost when cultivation is done in shelves or bags (Two rows of stands with 5 tiers, each 1.5 wide; and 3 paths each one metre = 6 m or 19.7 ft). The foundation of growing rooms should be laid on dry and firm ground. The floor is laid as per normal standards. The walls will be made of one brick thickness (9" thickness) and ceiling made of 4" thick RCC. The growing rooms will have a single insulated door and 2 vents for exhaust on the back wall 2-3 ft above ground level. One opening is provided on top of the door for entry of the Air Handling Unit (AHU) delivery duct or for fresh air intake inside the room through AHU. The walls, ceiling and floor should be insulated with 5 cm thick insulating material (Thermocol). The room should be made airtight and all leaks closed to prevent ingress of heat, flies, etc from outside. The cooling, heating and forced air circulation in the growing room is done via AHU installed for each cropping room individually or for whole of unit. The floor and walls of the cropping rooms should have a smooth finish.



Sectional View of a Cropping Room

j. Structural details special to cropping rooms

i. Floor

The floor must be well 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 of 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 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. 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 finish. Bituminous paint is applied on cement plaster as a vapour barrier. The painting can be avoided in cropping rooms if the cook out is not done by steam. This wall 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. Alternatively, the cropping rooms can also be made up of puff panels. The thickness of puff panel walls facing outside environment including roof should be of 80 mm thickness while the inner walls may be of 60 mm thickness.

iii. Roof

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 (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 roof 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. Alternatively, roofs of the cropping rooms can also be made up of puff panels. The thickness of puff panel walls facing outside environment including roof should be of 80 mm thickness and one shed may be given over roof to prolong the life of the roof panels.

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 lights 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 CO_2 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 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. This distance can slightly be narrowed down if cultivation is employed in shelved beds. In such a case all 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 carrying out the various operations. Depth of the compost in shelves is generally kept at 15-20 cm while bags can be filled up to the maximum height of 30 cm. A room of standard size (60 x 17 x 12 ft) can accommodate 2 rows of racks each 4.5 ft. (135 cm wide). This will absorb 9 ft (270 cm) of the room and the rest 8ft can be used to have one central path of 3 ft. and 2 side paths of 2.5 ft. Length of each rack would be 52-55 ft.

ix. 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 aluminum 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 (5-60C) is generally employed in mushroom cultivation. Mushroom generally requires 225 m3 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. Alternatively if the capacity of the growing room is to accommodate around 20-25 tons of compost, then a fresh air fan of 600 mm dia of low pressure can also be chosen for this purpose, but in such case a booster fan of 375 mm dia will also required to be mounted in AHU for extracting fresh air from outside. In AHU cooling coils, humidifiers, heaters, 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 5-6C 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. PVC eliminators, eliminate the free water going inside the growing room. Booster fan in combination with supply air fan supplies fresh air inside the AHU through fresh air dampers. Since fresh air coming from outside atmosphere may contain fungal spores, which may contaminate the crop, this air is generally passed through pre filters and a HDPE micro filter section (2-5 um). The AHU has a mixing chamber with recycling dampers, which can regulate supply of fresh air or room air inside the growing room. Out let of the AHU is connected to the distribution duct in 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 (5 cm 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 CO2 laden air of the growing room is expelled in the atmosphere through an outlet. In such cases back vents are not provided in the growing rooms. Alternatively AHU can be so fabricated having provision to exhaust CO2 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 12 rooms then cooling employing evaporator, inside the AHU can also be chosen. In such a case each AHU will be a self contended cooling unit, employing compressor, condenser and an evaporator. This unit will also have heating and humidifying arrangements.

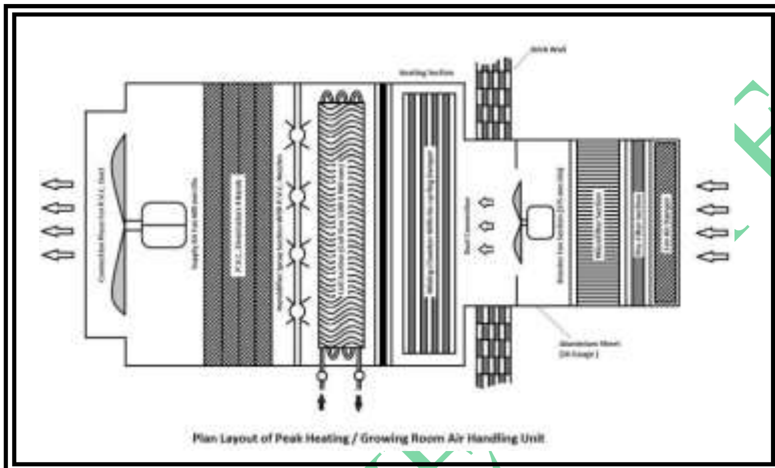


Fig 4. Schematic diagram of AHU

Crop Management

Button mushroom cultivation has two major components, composting (preparation of substrate/compost), and the crop management, (raising of mushroom crop). The substrate preparation has undergone scores of innovations/improvements suiting environment protection laws in many developed countries. At the same time, casing medium has also been standardized with use of peat and its alternative materials (FYM, Spent Mushroom Compost and Coir Pith) with prime objective to improve productivity and quality of mushrooms. Similarly, the crop management techniques have also been improved upon to harvest highest possible mushroom yield over a shortest period of time. All the operations/applications done after completion of composting are handled under the head crop management. These include:

A. Agronomic crop management
B. Environmental crop management

A. Agronomic Crop Management

Agronomic crop management deals with the compost quantity to be filled per m^2 bed area, moisture content of compost, spawning method employed, compost thickness in a bed or bag, casing application

and thickness, watering regimes employed, harvesting of crop and after care, pest management, hygiene maintenance and so on. However, more important among these are
1. Spawning and spawn run
2. Casing materials, casing treatments, casing application, case run and pinhead formation

1. Spawning and spawn run The steps involved are

- Good quality compost with temperature of 25°C
- Mixing of grain based spawn (@ 0.5-0.7% of wet compost weight) under clean conditions (i.e. with clean hands and pre-sterilized area)
- Filling of spawned compost into polythene bags (12-15'' depth) or beds (6-8'' depth)
- Little compressing and levelling of spawned compost
- Loosely closing the mouth of polythene bags filled with spawned compost (Covering with a clean newspaper / plastic sheet if filled in trays/shelves)
- Shifting the compost filled bags in cropping rooms with a temperature of 23 ± 1°C (air temp.), RH of 95% and high CO_2 conc. (1.0-1.5% strain dependent), and keeping the bags under above conditions for 12-14 days
- Completion of spawn run (change of dark brown compost mass in to light brown colour)

Precautions

- Use of fresh pure culture spawn
- Spawning under clean conditions (preferably under positive pressure created using bacterial filters before inlet fans and air curtains at doors)
- Proper treatment of spawning area and tools with formalin, and cleaning of hands with dettol
- Maintaining good hygienic conditions during spawning by keeping all the doors/ windows closed

2. Casing and case run Casing is a 3-4 cm thick layer of soil applied on top of spawn run compost and is a pre-requisite for fructification in *A. bisporus*.
a. Casing materials Earlier sub-soil material or organic matter rich soils were used as casing in button mushroom cultivation. Presently peat is the most desirable casing material used world wide with excellent mushroom yields and superior fruit body quality. However, pest is not available in India. The other alternative recommended materials are,

- Well decomposed Farm Yard Manure (FYM) preferably two years old
- Well decomposed Spent Mushroom Compost (SMC) (two years old anaerobically decomposed)
- Composted coir pith (coir industry waste) (well decomposed & water leached)
- 1:1, 2:1 and 1:2, v/v of well decomposed FYM and SMC
- 1:1, v/v of decomposed FYM or SMC with composted coir pith
- Decomposed powdered bark of some forest trees
- Paper industry waste
- Burnt rice husk is also in use along with decomposed FYM (2:1, v/v) in seasonal cultivation of button mushroom in Hayrana and Punjab with reasonable success

b. Quality of casing materials

- Soft texture
- Light weight
- High water holding capacity
- High porosity
- Deficient in available form of C and N
- Neutral pH (7.0 – 7.5)
- Low conductivity (400-600 μ moh)

c. Casing treatment Casing material should be treated properly before its application on the spawn run compost and the steps involved are:

- Make a heap of casing material
- Wet it up to 50-60% water holding capacity
- Fill in trays and shift them to pasteurization chamber
- Steam pasteurization at 60-65°C for 6-8 hours
- Auto-Cooling

Alternatively,

- Make a heap of casing material on a cemented platform
- Wet it up to 50-60% water holding capacity
- Drench the wet casing with formalin @ 1 litre/m3 (40% formaldehyde) by mixing with shovel
- Cover it with polythene sheet and seal the outer periphery thereafter by pouring sand/soil on outside margin
- Keep the material for 24-48 hours in sun for fumigation effect
- Remove the cover after 48 h and expose the material to open air and sunlight by spreading over with clean tools and permitting the formalin fumes to escape in to air for 2-3 days before it is used as casing (formalin treatment effect decreases at low temperature due to inadequate fumigation)

d. Casing application

- Unfold the fully spawn run bag and make the top surface even by gentle pressing with hands Light spray of water on spawn run compost
- Application of 4-5 cm thick layer of casing uniformly using iron rings of 4 cm height or wooden blocks
- Water spray in instalments immediately after casing application

Precautions

- Casing material should not be sieved but used as such with clumps, which permits more air spaces in casing
- Top casing surface should have small mounts and valleys
- Care should be taken to prevent re-infection of the casing materials
- Store casing material in a sterilized /clean room before use in polythene bags or synthetic cloth bags
- Apply water to casing in a few installments so that water does not run into spawn run compost

e. Case run and pinhead formation

Case run is done at a temperature of 24 ± 1°C, RH-95% and CO_2 > 7500 ppm (strain dependent) for about one week. There is no requirement for fresh air introduction during case run. It is considered complete when mycelia come in the valleys of casing layer. After case run, the environmental conditions are changed by bringing down the temperature to 15-17°C (air), RH to 85% and CO_2 to 800-1000 ppm (strain dependent) by opening of the fresh air ventilation and exhausting CO_2. This change in environmental parameters induces pinhead formation in 3-4 days (strain dependent) time. The pinheads develop into solid button sized mushrooms in another 3-4 days. At this stage, the air inside the cropping room is changed 4-6 times in an hour to maintain appropriate CO_2 conc. as CO_2 production is at its peak during first flush (actually peaks at case run).

3. Supplementation

Supplementation with protein rich supplements such as cotton seed meal, soybean meal, alfa-alfa meal, feather meal, etc. has been found to increase the mushroom yield. Supplementation can either be done at spawning or after spawn run before casing. The later is more useful. Supplement is first grounded coarsely and denatured by treating with 5000 ppm formalin and before its mixing in compost. The practice normally increases the temperature of compost by 4-5°C and if done at the time of spawning or in poor quality compost, it results in killing of mushroom mycelium or increased incidence of moulds. If these problems are overcome supplementation can give 20-25% enhanced yield. Supplementation at casing in spawn run compost also helps in early and higher mushroom yield.

4. Ruffling

Ruffling of compost on completion of spawn run is done just before casing. This practice is particularly useful for round the year cropping when 5-6 crops are taken per year and cropping period is reduced to about 4 weeks, as this practice helps in exhaustion of compost earlier than normal. Ruffling of casing after a 3-4 days or so after casing is done by some growers to get uniform pinning.

5. Watering

Mushroom contains nearly 90% water and that gives us an idea how water is important for the crop. Mycelium gets water from compost during spawn run and compost + casing during case run and from casing during fruit body formation. Water level in casing is maintained in 2 ways. One way is by its regular spray when pinheads are pea sized and then by maintaining RH at 80-85% during cropping. If one of the factors, (water spraying and RH) during cropping is disturbed, it will affect crop productivity. Low RH during cropping will result in drying of beds, lightweight mushrooms, discoloration of mushrooms and crop losses. Drying of casing will seal the casing medium resulting in mat formation, which becomes impervious to water, and results in tremendous crop losses. Water has to be replenished in casing to accommodate the water losses from casing due to mushroom growth and evaporation. Lesser the water loss to room air, better it is. Bed moisture and RH are although two different factors, but are interdependent. Water spraying on mushroom beds at pin breaks should be avoided. The casing should be wet enough when fresh air is brought in and room temperature lowered. The wetness should be sustained till pin heads become pea sized, and that is the stage when bed will require additional watering to allow pea-sized pins to develop into button sized mushrooms. Watering to beds requires monitoring at each stage. RH in the cropping room is monitored by using dry & wet bulb thermometers. Two ordinary stem thermometers are put in the cropping room, placing one in the casing/compost bed and one hanging in the air nearby (few cm apart). Bed temperature is 1-2°C higher than air temperature. Computer control of AHU ensures application of cropping parameters with precision during spawn run, case run and cropping. The water used for irrigation (spraying) on mushroom beds should be clean, neutral in pH and free from salts, heavy metals and other impurities. Water good enough for drinking/watering for vegetables/field crops is also good for mushroom cultivation. It is desirable to test the quality of water before the mushroom growing is started at a particular site.

6. Harvesting and after care

Mushrooms with 4-5 cm dia., with hard pileus and closed veil are ready for the harvest. Mushrooms are harvested by holding them between forefinger and thumb, and rotating in clockwise/anticlockwise direction. The soiled stem portion is cut with sharp edged knife and mushrooms are collected grade-wise in baskets. Dropping of the stem cuttings on the floor or the bed should be avoided, as these will promote the growth of undesirable microorganisms. Cleaning of mushroom beds and floor is recommended after each crop harvest. Fresh casing is applied at places from where mushrooms have been removed. Water is sprayed at the rate the mushrooms have been harvested, i.e. for every kg of mushroom harvested 1 litre of water is added after harvesting. Damaged pins/ mushrooms, if any, are also to be removed from the bed manually. If bunching of mushrooms is observed, then there is a need to address the climate controls for creation of optimal environmental conditions during pinhead formation. Mushrooms after harvest are graded, packed in PP bags/card board boxes and preferably chilled at 4°C for 6-8 hours before sending to the market. The pre-market chilling enhances the shelf life of mushrooms. While harvesting care should be taken to keep the pileus free from casing soil, as it stains the mushrooms. Washing of mushrooms to make them extra white for increased acceptability in the market is undesirable, especially with Potassium metabisulphite solution. Unwashed mushrooms stay fresh for a longer period. Mushrooms should be handled carefully, and not bruised during the harvesting operation. Bruising will damage the mushroom tissue, which will turn the pileus dark/ pink on exposure to air. While packaging mushrooms in PP bag one should not forget to make a small hole (0.2 mm), as it will prevent the development of aflatoxins in transit or storage. Button mushroom can be stored at 4°C for a few days without any deterioration in its quality but it is desirable to consume/market fresh mushrooms. Since button mushroom has a very short shelf life and it cannot be stored for longer periods, hence it requires processing for long storage. Mushrooms are best preserved in brine solution after blanching, either in cans or jars. The properly processed mushrooms stay in good condition for over a period of 1 year. It is possible to transport canned mushrooms over longer distances without any deterioration in their quality. But fresh mushrooms can only be transported short distances in refrigerated vans/by air to reach up to a remunerative market.

B. Environmental Crop Management

Mushroom is an indoor crop, raised in cropping rooms with simulated environmental conditions suiting to a particular mushroom. Hence management of crop environment becomes utmost important. It includes the temperature, RH, CO_2 concentration, air speed/ evaporation rate over crop beds, air changes in the room/oxygen availability and other such factors, which directly influence crop productivity. The environment management in the cropping room includes addressing of the following factors: 1. Temperature, 2. Relative humidity (RH), 3. CO_2 concentration

1. Temperature

Temperature in the room has two areas for monitoring i.e., air temperature and bed temperature. Temperature has direct bearing on crop productivity in synergy with other factors like RH and CO_2 /O_2 conc. in the cropping room. The bed temperature in the cropping room is directly influenced by the air temperature, so it is the air temperature that has to be addressed. The air temperature inside the room can be manipulated with use of cooling/heating coils in an Air Handling Unit (AHU) installed inside or outside the cropping room for climate control. An independent AHU is desirable for each cropping room. The AHU inside contains a set of cooling coils, heating coils, RH fogging jets and a centrifugal blower fan for blowing the conditioned air into the cropping room. The AHU is generally installed on top of the entry door and is joined with a recirculating duct from inside the cropping room. The cooling coils are fed with chilled water from the chiller, while the heating coils are fed with steam from boiler and fogging jets get water from trough placed at the bottom of the AHU by a small pump. The cooling requirement will depend upon compost quantity fed inside the room, outside prevailing temperature, insulation on the walls, etc. The blower fan blows the conditioned air into the room. The fresh air into the room goes in via AHU through a control valve, and during most of the crop raising period fresh air valve is placed at 20-30% and re-circulating at 70-80%. During spawn run the entire air is re-circulated (100%) and no fresh air entry is required.

a. Spawn run

For spawn run air temperature of 23 ± 1°C is maintained inside the cropping room, which corresponds to bed temperature of 24-25°C (1-2°C higher than air temperature). During this phase, the fresh air valve is closed and entire air is recirculated, allowing the carbon dioxide to accumulate to the level of 15000 ppm, desirable for quick spawn run. Higher concentration of CO_2 accelerates the spawn run/vegetative growth of the mushroom. Any increase or decrease in temperature effects the CO_2 production of the compost and the RH of the room. With increase in temperature, RH will tend to fall, and just vice versa with decrease in temperature. The properly insulated room will ensure uniform temperature inside the cropping room at every stage of crop growth. The heat from the cropping room is removed via cooling coils fitted inside the AHU.

b. Case run

The environmental conditions suitable for spawn run, are suitable for case run as well. The same conditions, as for spawn run will be continued for next 7 days for case run, i.e., temperature of 23 ± 1°C in the air and 24-25°C in the bed. The RH/CO_2 will also be same as for spawn run. Under aforesaid conditions the case run will be completed within one week, and at the same time the mycelium is observed in the casing valleys. Valleys are the areas between the peaks as can be seen on top of casing. The CO_2 conc. and RH should also be maintained within the optimum range for quick and effective case run.

c. Cropping

After completion of case run, cooling inside the room is enhanced to bring the air temp. down to 15-17°C in the room within 2-3 days time. Simultaneously, the fresh air vent is opened to 30% and rest of the air is recirculated (70%). This brings down the CO_2 conc. inside the room to 800 to 1000 ppm, desired for pinhead formation. Likewise, the RH is also reduced to 85% from 95%. This facilitates pinhead formation on the casing within a week's time. The pinheads grow into full button sized mushrooms in another 3- 4 days. At this stage fresh air can be slightly reduced to achieve 1000-1500 ppm CO_2 concentration. The environment parameters are maintained as above during entire period of cropping. Since the temperature has influence on RH and CO_2 production from compost hence should be manipulated, keeping in mind its effect on other two factors. All the three parameters work in synergy with each other to induce pinning. The pinning will be affected adversely if any of these factors is not in its optimal range. High temperature for a long period of time during cropping will lead to sealing of casing, and will result in stopping of pinhead formation. The mycelium will continue growing in vegetative phase and will seal the casing, making it impervious to water, thus resulting in serious yield losses. The desired temperature in cropping room can be maintained with good precision by the use of sensors and controlling devices attached to cooling/heating coil inlets fitted inside the AHU. These devices are easily available and are effective in temperature control in the cropping room.

2. Relative humidity

Relative Humidity (RH) is the ratio/proportion between absolute humidity (AH) and saturation point of humidity (SPH) at a given temperature, expressed in percentage. Absolute humidity is number of grams of water vapours contained in a cubic meter of air Crop at a given temperature. Saturation point of humidity is the maximum number of grams of water vapours feasible in a cubic meter of air at a given temperature. Relative humidity (RH) of 85% is necessary for obtaining highest pin head formation in synergy with other factors like temperature and CO_2 concentration. RH of 85% permits slow evaporation of water from the crop bed to air in the cropping room and thereby facilitating the upward movement of nutrients in the compost. This exchange of air facilitates loss of CO_2 + heat into the air, necessary for healthy pin head development and crop productivity. In the event of RH falling below 85% inside the cropping room, more moisture from the crop bed will be withdrawn resulting in drying of the casing layer. This will seal the casing and result in crop losses. Lower RH in the room will be indicated by bed temperature falling below the air temperature, an undesirable situation to be avoided at any cost. Under normal circumstances the bed temperature is always higher by 1-2°C than air temperature for development of a healthy crop of mushrooms. For round the clock monitoring of RH, monitoring of the bed and air temperature inside the room is desirable. The incoming air should be humidified enough to prevent loss of moisture from the crop beds. Evaporation of moisture from crop beds has to be taken into consideration for calculating the g of water vapours required per m3 air in a room for maintaining the required RH for cropping. Air in a cropping room contains 9.6 g water vapours per m3 of air at 14°C (A), the saturation point of humidity at 14°C is 12 g/m3 (S). The RH of the room air will be A/S × 100=9.6/12 × 100 = 80%. The ultimate expression is the quantity of water vapours contained per m3 of the air space of the room at a given temperature. 31 g of water vapours gets evaporated from 1 m2 bed area at 17°C/85% RH/hour. The change in room temperature will alter the RH in the room. Use of RH sensors with cut off/starting devices for recording and maintenance of RH in a cropping room is very useful. The sensors will control the fogging jets in the AHU as per the requirement in the room. For obtaining a temperature of 17°C and RH of 85% in the cropping room, air temperature is brought down to 14°C at exit point of AHU with 100% RH. The air on reaching the crop bed will receive some heat from crop bed and raise the air temperature to 17°C with RH automatically falling to 85%.

3. Carbon dioxide

Carbon dioxide concentration is the third important factor in management of environment inside the cropping room. CO_2 is produced by actively growing microorganisms in compost during spawn run, case run and by mushroom mycelia and mushrooms during entire cropping cycle. During spawn run, higher concentration of CO_2 is desirable, which helps in quick and quality spawn run. For spawn run, CO_2 concentration between 10000-15000 ppm is desirable (strain dependent) and it helps in quick spawn run in compost. Higher concentration of CO_2 is also desirable during case run. For pinning and cropping, the CO_2 concentration is lowered around ambient (800-1000 ppm). CO_2 concentration up to 1500 ppm is maintained during pinning & cropping, and this is done by venting/opening of fresh air duct to bring in oxygen and exhaust of CO_2 from exhaust vents under positive pressure. The opening of vent will bring in fresh air, which is conditioned in AHU (heated or cooled/humidified) and then blown into the cropping room via ducts. The CO_2 gets mixed up with the fresh air and is carried under positive pressure towards the exhaust vent and finally exhausted. This also facilitates the exhaust of heat alongwith the CO_2 from the room air. The heat is removed via cooling coils after the room air gets into the AHU via recirculating duct. During air circulation, recommended air speed over the crop beds is 15cm/sec. Ensure that the desired air movement is there in the central shelf in the middle row. This can be checked with the help of a burning incense stick, which will indicate the direction of air movement in the cropping room. Higher concentration of CO_2 during pinning can seal the casing or produce onion shaped mushrooms with a bulbous base & a small cap. During development from pinhead to button sized mushroom, higher concentration of CO_2 will lead to long stiped mushrooms with a small cap (opened), which reduces the crop yields. By gentle movement of air over the crop beds, the CO_2 is carried away from the crop canopy, thus saving the bad effect of CO_2 trapped between the mushrooms in the crop canopy. To ensure healthy crop production, about 6 air changes per hour are recommended from the venting time to completion of first 2 flushes. During this period, CO_2 production is highest (10 g/h/m2) and it requires to be removed at a faster rate. Along with CO_2, heat is also produced @ 10W per hour from one m2 bed area at 17°C and 88% RH. In subsequent flushes, 4 air changes per hour are sufficient to maintain right O_2 content in the cropping room (about 16%). During first two flushes fresh air vent is opened to 30% entry and 70% recirculation, and in subsequent flushes the fresh air vent is put at 20% and recirculation at 80%. Use 2 µm mesh filters on fresh air entry points into the cropping room to restrict the entry of diseases/competitor mould spores. The CO_2 after mixing with the room air, gets exhausted under positive pressure from exhaust vents, thereby helping in heat + CO_2 removal from the room. Maintenance of right combination of casing moisture (about 50 ± 2%), CO_2 concentration, RH and temperature at pinning stage of crop growth helps in obtaining a heavy pin set, thus resulting in a luxurious crop growth and excellent yield of mushrooms. If onion sized mushrooms/drum sticks are observed, correct air circulation for effective CO_2 removal from crop beds is required. Lack of air movement and accumulation of CO_2 creates this type of situation. Long stemmed mushrooms are again the outcome of CO_2 accumulation in the air around crop canopy due to faulty air movement/air circulation inside the cropping room.

C. Airing Procedure for Fruiting Venting or opening of fresh air for induction of fruiting after case run is a critical phase in mushroom growing. Whether to cool first or bring in fresh air first is a question bothering commercial mushroom growers. The airing is done suiting a particular situation, whether one wants to have a heavy first flush followed by moderate flushes later or equally spaced flushes. The airing accordingly is handled under 3 heads: 1. Soft airing 2. Moderate airing 3. Severe airing

1. Soft airing

Soft airing means that we will have severe restriction on venting to get smaller flushes suiting to market demand and the air is opened slowly. The growing parameters to be manipulated for soft airing are listed below: Air temperature : 19°C in 48 hours, 17°C in 72 hours, Compost temperature : 21°C in 96 hours, CO_2 concentration 4000 ppm in 48 hours, 2000 ppm next 24 hours, 1000 ppm after 72 hours, RH 98% to 92% in 48 hours.

2. Moderate airing

Moderate airing means that we will have some restriction on airing/venting to get well spaced flushes of moderate levels. The growing parameters to be manipulated for moderate airing are listed as under: Air temperature 17°C in 24 hours 20°C in 72 hours, Compost temperature 20°C in 72 hours, CO_2 concentration 2000-2500 ppm in 24 hours, Less than 1000 ppm in 48 hours, RH 98% to 92% in 24 hours.

3. Severe airing

Severe airing is done to obtain a heavy first flush and no restriction is put on airing. This results in heavy pin set and large first flush, followed by smaller subsequent flushes. The growing parameters to be manipulated for severe airing are listed below: Air temperature 15°C as soon as possible, Compost temperature 20°C in 48 hours, CO2 concentration, Less than 1000 ppm in 12 hours, RH 98% to 90% in 12 hours.

Action Points

a. Observe strict hygiene throughout the farm
b. Ensure that the temperature during peak heat is satisfactory
c. Make sure that casing ingredients are stored and mixed in clean area and casing is properly pasteurized
d. Make sure that all spent compost is removed from the farm
e. Properly clean the cropping rooms after every crop

Name of the Firm/Promoter:

DESIGN AND DETAIL OF MUSHROOM UNIT

The unit has been designed as per the latest technology of mushroom growing. The following main structures are proposed.

Infrastructure	No.	Length	Width	Height	Area (Sq Ft)
Pre-wetting area/Lagoon	1	40	40	15	1600
Composting yard	1	64	28	15	1794
Phase-I bunkers	1	42	13	11	551
Bulk chamber (inclusive of insulation)	1	40	13	13	520
Spawning area	1	40	13	13	520
Casing soil room	1	13	10	8	135
Cropping Room (Including Insulation)	4	60	20	13	4800
Office	1	20	20	10	400
Packing Room	1	15	15	11	225
Boiler Room	1	12	12	11	144
Labour room	1	20	20	10	400
Corridor	--	40	6	13	240
Total	-	-	-	-	11329

Technical details of the Bunkers

Bunker details				
Length	42	ft	12.9	m
Breadth	13	ft	4.0	m
No of pipes	10			
No of spigots per pipe	33			
Total spigots	330			
Dia of pipe (inner)	10	cm	4	inch
Dia of main i.e. header pipe	35	cm	14	inch
CMH of Fan for normal fill	1100	CMH	650	CFM
Flow rate in orifice=	3.33	CMH	10	CFM
Air velocity required at orifice	40	m/s		
CMH of Fan for max. fill	1700	CMH	1010	CFM
Hole of orifice in spigot	5.5	mm	0.22	inch

Technical details of the Tunnels

Tunnel details					
Length	40	ft			
Breadth	13	ft			
About Plenum					
Min. Depth of plenum in front	1.82	ft			
Slope	0.73	ft			
Min. Depth of plenum in back	1.09	ft			
Normal compost input with 1.9 to2.1 m filling	43	tons			
Normal compost output	31	tons			
Fan and Duct					
CFM of the Fan	5700	CFM			
Pressure of fan	10-12	cm WG			
Type of fan	Backward Curved or Backward inclined				

Min area of duct	2.89	sq ft			
Normal area of duct	3.86	sq ft			
Min. side of square duct	20	Inch			
Normal side of square duct	24	inch			
Air penetration of filter	2.50	m/s			
Side of filter for fresh air	41	inch			
Approx area of filter	1670	sq inch			
L x B (cms)	483343	cm2			
Dia of each vertical pipe in plenum floor	5	cm or	2.0	inch	
Area of each pipe	19.6	cm2			
Percent free area desired in plenum	9	%			
Total free area needed	43501	cm2			
Total no. of holes in floor	2215				
Holes per sq m	46				
Distance between holes (square format)	14.8	cm	5.8	inch	
Gap between two pipes (square format)	9.8	cm	3.8	inch	
Horizontal/vertical distance between two pipes (when diagonal format is used)	20.9	cm	8.2	inch	
Gap between two pipes (diagonal format)	15.9	cm	6.3	inch	

Technical details of the AHU in the cropping rooms

Cropping Rooms		
Number of rows	3	
Air circulation in Cropping room		
Number of main duct	1	
Number of sub ducts	2	
Number of holes per sub ducts	34	
CFM of AHU	3000	
Pressure of Fan	5 to 7	cm WG
Air speed to be achieved	8.0	m/s
Dia of each hole to achieve airspeed 8m/s	58	mm
Air velocity required in main duct	4	m/s
Cross section of main duct	0.35	sq m
Cross section of sub duct	0.18	sq m
Dia of main duct (for 4m/s)	67.16	cm
Dia of sub duct	47.49	cm

Name of the Firm/Promoter:

COST OF PROJECT

	Item	Rs in lakhs
1	Land Cost	Nil. (The promoter possess the own/leased land for the plant)
2	Land and site development	6.00
3	Building	89.92
4	Plant and Machinery	66.80
5	Misc. fixed assets	1.60
	Total	**164.32**

Means of finance

Items	Cost (Rs. In Lakhs)
Total cost of the project	164.32
Term Loan	123.00
Margin Money	41.32
Working Capital	16.43

1. **Land and site development** A piece of land measuring 0.8 acre acres will be required. Land will be leveled and developed including boundary wall/barbed wire making the total cost of Rs. 6.00 lakhs. (Annexure –A)
2. **Buildings:** Design and layout of the buildings to be constructed are given in the figures enclosed and annexure –B (Rs. 89.92 lakhs)
3. **Plant and machinery:** Cost Rs. 66.80 lakhs (Annexure – C)
4. **Miscellaneous fixed assets:** Rs 1.60 lakhs (Annexure –D)

Raw materials:

Main raw materials needed in the project are wheat straw, chicken manure, urea, gypsum, wheat grains, tin cans, corrugated boxes (Annexure –E). Annual requirement of the project are:

Raw material	1 crop x 1room (Tons)	Annual requirement (Tons)
Wheat & paddy straw	10.40	52
Chicken manure	7.28	36.4
Urea	0.16	0.78
Gypsum	0.36	1.82
Wheat bran	0.73	3.64
Casing material	3.90	19.5
Spawn	0.26	1.3
Polythene bags (Number)	2600	13000

Besides above, cotton, polythene bags / sheets, chemicals for spawn production, canning, disinfectants like formaldehyde, insecticides and pesticides will be needed in low quantities. As may be evident that availability of raw materials will not pose any problem, as majority of them are available in plenty in the area or nearby markets where project is to be located at reasonable rates.

Management and consultancy:

The project will be supervised personally by the promoters from the very beginning who will be trained at DMR, Chambaghat, Solan (HP) which is the apex body in the country on mushrooms. Further they will also be guided by the part time contact consultant who will be responsible to give overall guidance on all facets of commercial mushroom cultivation at all stages of crop.

Manpower:

As per annexure E, competent persons are available and shall be employed. Manual laborer at reasonable rates are available in the project area.

Power and fuel:

Power load of Rounded Power requirement 70 KW is required at the unit including composting and cultivation of mushroom, which will be obtained from State Electricity board. Diesel generator sets of 70 KVA have been provided in the project to take care of disruptions / disturbances in the power supply. Details are given in the annexure G.

Marketing:

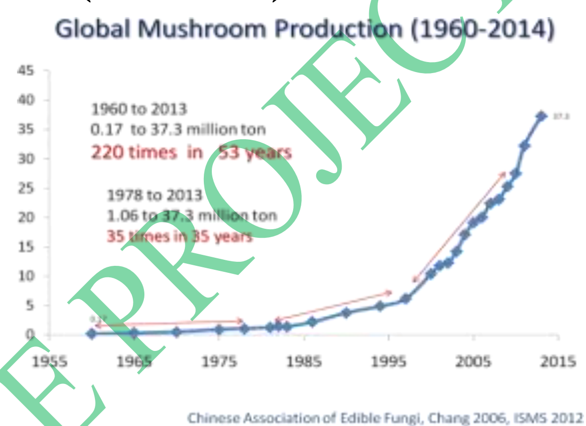
Earlier the consumption of mushrooms was low as many were not aware of food and medicinal values of mushrooms. Mushrooms contain about 90% moisture and are a low calorie food highly suited to those with obesity. They contain about 2.5-3.5 % protein which is of very good quality, contains all the essential amino acids and is essentially rich in lysine. Mushrooms are low in fat but the fat is rich in linoelic acid (PUFA). Cholesterol, the dreaded sterol, is absent which make the choice of the dieticians for heart patients. Due to nil starch and low sugars, these are the delight of the diabetic patients. Mushrooms are highly suited to those suffering from hypertension, hyperacidity and constipation. These are especially rich in vitamin B complex. and vitamin B12 also. Besides, mushrooms have many medicinal properties like anti cancer, hypocholesterolemic and hypolipidimic effects. Justifiably mushrooms are called the " ultimate health food", the neutaceuticals.

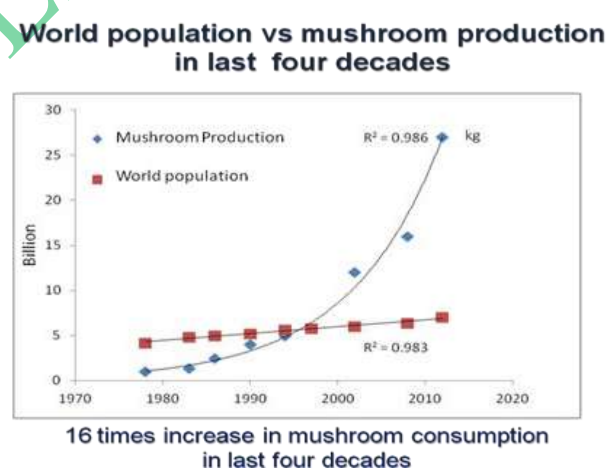
The demand for mushrooms, domestic as well as international is rising at a phenomenal speed. The present world production of mushrooms is about 28 million tons and China remains the main producer and exporter of mushrooms. India is roughly producing around 1,29,000 tons of mushrooms annually of which 85% is of button mushroom. Agro Dutch Foods Lalru, Punjab boasts the single largest producer and exporter of mushrooms in India. Besides this very big unit there are many other small white button mushroom units in HP, Punjab, Maharashtra and Gjrat cultivating this mushroom all the year round and are running successfully. These units are located in Phagwara, Jullandhar, Bhatinda, Banga, Bannore etc. In west Begnal, only a few units of button mushroom are operating producing a meager quantity of mushroom of about 700 tons per anum. However, the demand of mushrooms in the state is quite high and the mushroom is being supplied to the state mainly from Maharashtra. The prevailing retail rates of mushroom in the state range between Rs 150 to Rs 250/kg.

Leading producers of mushrooms are European, American and East Asian countries. The so called G-6 (USA, Germany, France UK, Italy and Canada) are major consumers of mushrooms. China is the leading producer and exporter of the mushrooms to the American, European and Asian countries. China's mushroom production is on seasonal basis employing temporary structures. Mushroom cultivation is not organized on scientific footings in China. In China cultivation is dominated by small scale farmers and they have competitive advantage due to lower production costs. The Chinese Edible Fungi Association estimated that about 95% of mushroom production was grown by small-scale households in the early 1990s. Even in the year 2011, 2012 and 2013 Chinese domestic output by small-scale farmers accounted for 96.15%, 94.63% and 93.49% of the production. Due to its special demand for climate, mushroom cultivation was geographically concentrated in a few places, particularly in the warm humid South and, thus, so is the culture of mushroom consumption. Although most mushrooms are grown seasonally, modernization of mushroom industry is taking place. Technology and equipment from Japan and Korea are spreading rapidly in China, and it is believed that modern farming of *Agaricus bisporus* will be the trend for the next 5-10 years. At present China is leader in the total production and tops the world in growing straw mushrooms, tuckahoe, shiitake, agaric, wood ear, black fungus, white jelly fungus, enoki mushroom, oyster mushroom, King trumpet mushroom and hedgehog fungus. The expanding domestic demand in recent years took a larger share of the market and made China itself the chief mushroom consumption market. More consumers are substituting meat products with mushrooms. In 1980s over 80% of mushroom production in China was exported. In the early 2000s, over 80% of China's mushroom production was consumed domestically and less than 20% was exported. Currently, mushroom export accounts for less than 5% of China's total domestic production. Considering that China is the major producer of specialty mushroom which are consumed more in East Asia, major export destinations from China are Japan, Thailand. South Korea and Malaysia and also Hong Kong and Singapore.

It is the right time that India, with its relatively cheap labour and raw materials, which had made Chinese mushrooms competitive, should enter the billion dollar mushroom market. But as indicated above our annual production is very low because mushrooms are being grown by small farmers seasonally during the winters only and the venture is being taken up by a very few players as a modern technical industry. Now with adoption of latest technology of mushroom production under controlled environmental conditions, it is possible to grow high quality mushrooms throughout the year to meet the domestic and international demand. The promoters have under taken the market surveys and made inquiries regarding the demand for mushrooms. Besides the big demand in the countries mentioned above there is a fast developing mushroom market in the gulf countries. Domestic market is also expanding at phenomenal rate, which is reflected in the increase in the production. Our per capita of mushrooms consumption is the lowest in the world which is 40-50 g against the 3 kg in the developed countries. This poor consumption is mainly due to non-availability of mushrooms in most part of the country for most of the year. The global mushroom production in last 5 decades (FAO STAT) and in India in last 3 decades is as below.

MUSHROOM PRODUCTION IN CHINA AND WORLD
(Unit 1000 tons)





Growth in world mushroom production (all cultivated mushrooms) vis-à-vis world human population

MUSHROOMS PRODUCTION IN INDIA

Year	Production ('000 tons)
1980	3
1985	5
1990	8
1992	15
1995	30
2000	70
2007	100
2016	129
2018	181
2019	201
2020	225
2021	242
2022	272

Brief note on the product, their possible uses and possible competition

Mushrooms have been devoured as food by mankind since time immemorial after collecting from the forests. Though Chinese were the first to do the artificial cultivation of the tropical and subtropical mushrooms about thousand years ago real commercial ventures started when Europeans started cultivation of button mushroom in green houses and caves during 16th and 17th century. The success to isolate pure culture through tissues and spores was the turning point in the process of commercial mushroom production in world. Mushrooms are now getting significant importance due to their nutritive and medicinal values and income generating venture in about 100 countries. At present, world mushroom production is estimated to be around 7 million tons/annum and is increasing @ 7% per annum. In developed countries, particularly in Europe and America mushroom farming is a Hitech industry. The Dutch, Irish and Italian technologies in button mushroom production are worth noticing. These countries, in spite of high wages, could succeed due to large scale production units with 10,000-20,000 tons production/annum. These units are highly mechanized and with computer controlled environmental system. Besides, there are decentralized activities viz, compost producing units, spawn producing units and the processing units. This has resulted in higher productivity with consistency. In recent years, in spite of these factors, cost of mushroom production in these countries and in USA has gone up resulting into stagnation of mushroom production which has opened opportunities for the third world countries to capitalize due to widening gap between demand and supply. It is estimated that in 2006 the demand supply gap was 2,73,971 MT.

Mushrooms are known to have all essential components of a balance food. Besides being rich in highly digestible lysine rich proteins, vitamins and minerals, mushrooms lack fats and are low in carbohydrate (Low calorie food). They are rich in folic acid, phosphorus, potassium, calcium, copper, iron, selenium and vitamin B-complex. In place of starch, mushroom contains sorbitol and linolenic acid (a poly-unsaturated fatty acid). They are excellent source of thiamine, riboflavin, niacin, pantothenic acid, biotin, folic acid and vitamin B_{12}.

Mushrooms are used extensively in cooking, in many cuisines (notably Chinese, European, and Japanese). The most popular amongst edible mushrooms is the white button mushroom the *Agaricus bisporus* though some individuals do not tolerate it well. Several varieties of *A. bisporus* are grown commercially, including whites, crimini, and portabello. Other cultivated species are also now available at many grocers include shiitake, maitake, oyster, enoki etc.

Edible mushrooms show wide variation in protein content. Even varietal and strainal variation in protein contents has been reported. However, their value as good source of protein is never disputed. They are considered as a potential substitute of muscle protein on account of their (i) high digestibility (Digestibility coefficient around 89%), (ii) good amino acid content and (iii) about 1000 times higher production of mushroom protein per unit area. As mushrooms are grown on agricultural waste, hence the cost of production of mushroom protein is also lower than muscle protein. According to an estimate 35000 kg (dry weight) of mushroom protein can be produced from an acre of land during one year. Mushroom protein is not only cheaper but is almost as nutritious as muscle protein. It also contains most of the essential amino acid in sufficient quantity and can prove a good supplement to those cereal diets which lack in some essential amino acids.

In India, per capita consumption is the lowest in the world which is 50-70 g against the 3 kg in the developed countries and 20-22 kg in China. This poor consumption is mainly due to non-availability of mushrooms in most part of the country for most of the year. Thus there is no competition for the product as such in India.

Special Feature of the product (Price, quality) compared to competitive products

There is no competition in the product in respect of price and quality as the supply of the product is limited and there is a huge demand of the product in the market for the want its nutritional quality and flavor.

Assessment of likely competition in future

With urbanization and increased production of agro-waste along with increased food production, there will be need to radically change the way we look at agriculture. High-tech agriculture including mushroom production is going to gain importance in coming decades. Mushroom production in the world has increased rapidly in the last few decades and the trend is likely to pickup in our country as well. Thus, there is no competition in the product is visible in near future as the supply of the product is limited and there is a huge demand of the product in the market for the want its nutritional quality and flavor.

Export possibilities and Export commitments

Now with adoption of latest technology of mushroom production under controlled environmental conditions, it is possible to grow high quality mushrooms throughout the year to meet the domestic and international demand. Besides, the big demand in the European, American countries, there is a fast developing mushroom market in the gulf countries also. Thus the product has a huge export potential. Domestic market is also expanding at phenomenal rate, which is reflected in the increase in the production. As the consumption of mushroom in India is still at minimal level due to non-availability/less availability of the product, we intend to tap the domestic market and there is no commitment for export in this project.

List of principal customers and selling arrangement/agreement

The product is in huge demand in the super markets besides the regular domestic vegetable markets, hence there is no such agreement or selling arrangement has been made. If required we can make agreements with the super markets for the same.

PROFITABILITY PROJECTIONS:

As would be evident from the annexure H, the project is highly profitable, economically viable and bankable.

Name of the Firm/Promoter:

ASSUMPTINS FOR PRODUCTION AND PROFITABILITY

1. 4 cropping rooms of 26.00 tons compost handling capacity
2. 5 crops taken as per standard Dutch plan using cultivation of advanced hybrids which gives 18-22 kg mushrooms / 100 kg compost in 60 days duration.
3. Yield of mushrooms 20 kg / 100 kg compost (though yields of 20 -25 kg are achievable)
4. Annual production = 26.00 tons x 4 rooms x 5 crops x 0.20 ton = 104 tons

   Accepted = 100 tons
   (At 20% conversion)
5. Rate of interest on term loan 11 % and on working capital 11%
6. Depreciation: 5 % on buildings, 10 % on machinery and miscellaneous fixed assets.

SALES PROJECTIONS

Installed capacity	100 TPA
Sales	100 TPA fresh
Sale of 100 Tons fresh @Rs 120/kg	120.00 Lakh

ANNEXURE –A

LAND AND SITE DEVELOPMENT

A total of 0.8 acre land will be required to host this project

	Item	Cost (Rs in Lakhs)
1	0.8 acre of land (Cost not included in project)	-
2	Land development	3.00
3	Leveling, Gate and boundary wall	3.00
	Total	6.00

ANNEXURE –B

BUILDINGS

Infrastructure	Area (Sq Ft)	Unit Cost (Rs)	Total cost (Rs in Lakhs)
Prewetting area/Lagoon	1600.00	300.00	4.80
Composting yard	1794.00	500.00	8.97
Phase-I bunkers	551.20	700.00	3.86
Bulk chamber (inclusive of insulation)	520.00	1100.00	5.72
Spawning area	520.00	700.00	3.64
Casing soil room	135.20	1100.00	1.49
Cropping Room (Including Insulation)	4800.00	1100.00	52.80
Office	400.00	700.00	2.80
Packing Room	225.00	500.00	1.13
Boiler Room	144.00	500.00	0.72
Labour room	400.00	700.00	2.80
Corridor	240.00	500.00	1.20
Total	11329.40		89.92

Name of the Firm/Promoter:

ANNEXURE – C

PLANT AND MACHINERY

Plant and Machinery	Number	Total Capacity	Price (in Lakhs)
Chilling station including AHU'S (Including ducting, piping, and controllers, complete in all respect.) (in Tons)	4	40	20.00
Blowers for the Phase-I bunkers, tunnel and casing chamber	3		1.50
Boiler (steam generation capacity in kg)	1	200	3.00
Tunnel ventilation system	1		1.00
Temp. & Humidity controllers for growing rooms	4		0.80
Multi channel thermometers	1		0.50
Steel racks for the growing rooms	4		16.00
Spray system	1		0.50
DG Set (KW)	1	70	7.00
Transformer (One)	1		3.50
Tractor with trolley/Front head loader	1		10.00
Furniture, fixtures & computers	1		1.00
Miscellaneous	1		2.00
Total			**66.80**

ANNEXURE – D

MISCELLANEOUS FIXED ASSETS

	Rs in Lakhs
Electric fittings	0.80
Water Tank and fittings	0.80
Total	1.60

ANNEXURE – E

RAW MATERIALS

(For one crop for one cropping room)

S.No	Ingredients	Quantity in Tons	Rate (Rs)	Amount (Rs in Lakhs)
1	Wheat & paddy straw	10.40	6000	0.624
2	Chicken manure	7.28	1000	0.073
3	Urea	0.16	5000	0.008
4	Gypsum	0.36	2500	0.009
5	Wheat bran	0.73	16000	0.116
6	Casing material	3.90	2500	0.098
7	Spawn	0.26	80000	0.208
8	Polythene bags (No)	2600	2	0.052
9	Chemicals		1000	0.010
10	Miscellaneous		1000	0.010
	Total (in Lakhs)			1.208
			No. of crops	Total cost
Total cost of raw materials required for crops			**20**	**24.15**

Name of the Firm/Promoter:

ANNEXURE –F

WAGES AND PERKS

Particulars	**Number**	**Monthly Salary**	**Total/year**
Supervisor	1	20000	240000
Watch man	1	10000	120000
Boiler Attendant	1	10000	120000
Electrician	1	10000	120000
Labourers	8	8000	768000
Total	12		1368000
		Total salary in Lakhs	**13.68**

ANNEXURE – G

ENERGY, FUEL,AND OTHER OVERHEADS (PER MONTH)

	Unit	**Rs in Lakhs**
Energy	18000	0.90
Fuel cost	100	0.08
Carriage and transport		0.00
	Total	0.98
	Annual Cost (12 months)	**11.76**

ANNEXURE – H

PROFITABILITY PROJECTIONS

Items	**Cost (Rs. In Lakhs)**	**Rs in Lakhs**
Raw materials		24.15
Power and fuel		11.76
Salary and wages		13.68
Interest on term loan (11%)	98.40	10.82
Interest on working capital (11%)	16.43	1.81
Depreciation		-
Plant and Machinery + Misc Fixed Asset	68.40	6.68
Buildings	89.92	4.50
Income Tax @0%		0.00
Total expenses		73.40
		-
Sale	100	120.00
Profit	**(Sale - expenses)**	**46.60**

* *Project would be generating around 500 tons of spent compost annually, which is very good manure for field crops and can be sold @ Rs. 5000 per ton. An additional profit of Rs. 25 lakhs is envisaged on its sale to the farmers.*

Financial Calculations

Name of the Firm/Promoter:

List of Annexure	
Annexure No.	
	Summary
I	Infrastructure
II	Plants and Machinery
III	Recurring expenses
IV	Cost of Project
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Name of the Firm/Promoter:

Summary

Production and Cost

PRODUCTION AND COST		
Production capacity	**100**	
Compost /room/crop	**26**	ton
No. of cropping rooms	**4**	
No of crops/year in each room	**5**	
Biological efficiency (kg mushroom/100 kg compost)	**20%**	
Selling price per kg of fresh mushrooms (Rs)	**120**	Rs
Income tax rate as percent of total income	**0%**	
Mushroom production per year **(TPA)**	**100**	ton
Total cost of the project	**164.32**	lakh
DEPRECIATION		
Depreciation rate Buildings	**5%**	
Depreciation rate Equipments	**10%**	
LOAN		
Months after which loan re-payment will start	**12**	months
Rate of interest on loan	**11.00%**	
Percent of total admissible as loan	**75.00%**	
Max loan that can be taken from bank	**123.24**	lakh
Total admissible loan from bank out of Rs 123.24 lakh	**123.00**	lakh

SUMMARY					
	1st Year	2nd year	3rd year	4th Year	5th Year
Annual installment (in Lakhs)	35.42	32.72	30.01	27.31	24.60
Pay back period	2 years 6.5 months		-	-	-
Discounted PBP	3 years 1 months		-	-	-
Break Even Point (1st year)	18%	-	-	-	-
DSCR (1st year)	1.94		-	-	-
NPV	202.68	lakh	-	-	-
IRR	32.00%	-	-	-	-
IRR/NPV	15.56	-	-	-	-
Discounted IRR	21.75%	-	-	-	-
BC Ratio	2.23	-	-	-	-
Current Ratio (1st Year)	0.94	-	-	-	-
Debt to Equity Ratio (1st Year)	1.12	-	-	-	-
Discount rate	10.00%	-	-	-	-

Name of the Firm/Promoter:

Annexure-I

Infrastructure

Fixed cost	Unit	Qty	Rate	Cost (in Lakhs)
Land (acre)	acre	0.8 acre	0	0
Land Development				3.00
Leveling & Fencing				3.00
Total				6.00

Infrastructure	No.	Length	Width	Height	Area (Sq Ft)	Unit Cost (Rs)	Total cost (Rs in Lakhs)
Pre-wetting area/Lagoon	1	40	40	15	1600	300	4.80
Composting yard	1	64	28	15	1794	500	8.97
Phase-I bunkers	1	42	13	11	551	700	3.86
Bulk chamber	1	40	13	13	520	1100	5.72
Spawning area	1	40	13	13	520	700	3.64
Casing soil room	1	13	10.4	8	135	1100	1.49
Cropping Room	4	60	20	13	4800	1100	52.80
Office	1	20	20	10	400	700	2.80
Packing Room	1	15	15	11	225	500	1.13
Boiler Room	1	12	12	11	144	500	0.72
Labour room	1	20	20	10	400	700	2.80
Corridor	--	40	6	13	240	500	1.20
Total					**11329**		**89.92**

Annexure-II

Plant and Machinery

Cost of machinery	No	Total capacity	Rate (per ton)	Cost in lakh
AHU for cropping rooms	4	40.00	0.50	20.00
Racks	4		4.00	16.00
Baby boiler	1	200 kg	3.00	3.00
Blowers for the Phase-I bunkers, tunnel and casing chamber	3		0.50	1.50
Tunnel ventilation system	1		1.00	1.00
Temp. & Humidity controllers for growing rooms	4		0.20	0.80
Multi channel thermometers	1		0.50	0.50
Spray system	1		0.50	0.50
DG Set (KW)	1	70.00	0.10	7.00
Transformer (One)	1		3.50	3.50
Tractor with trolley/Front head loader	1		10.00	10.00
Furniture, fixtures & computers	1		1.00	1.00
Miscellaneous fixed assets				
Electrical fittings	1		0.80	0.80
Water tank	1		0.80	0.80
Other Miscellaneous	1		2.00	2.00
Weighing balance, CO2 meter, Thermometers, Ducting, Insulated doors, Air curtains, Trolleys, Coats, Gloves, caps, footwear (Gum boots), masks, First aid box, Fire safety equipment, vacuum cleaner, etc, Misc like knives, punnets, parafilm, chemicals, Data logger, VFD, HEPA filters, Humidity meters, humidifiers, Non contact printing machine, Communication system, etc				
Total	--			**68.40**

Name of the Firm/Promoter:

Annexure-III

Recurring expenses (Salary, Raw material and Energy)

	Amount/month (Rs)	No	Months	Cost (Rs)
Labour	8000	**8**	12	768000
Skilled labour	10000	**3**	12	360000
Total Wages				**1128000**
Technical Assistant	20000	1	12	240000
Manager	30000	0	12	0
Total Salary				**240000**
Total Salary & wages				**1368000**
	Quantity (tons)	**Rate (Rs.)**		
Raw materials /annum				
Wheat & paddy straw	208	6000		1248000
Chicken manure	145.6	1000		145600
Urea	3.1	5000		15600
Gypsum	7.28	2500		18200
Wheat bran	14.56	16000		232960
Casing material	78	2500		195000
Spawn	5.2	80000		416000
Polythene bags (No)	52000	2		104000
Chemicals	20	1000		20000
Miscellaneous	20	1000		20000
ELECTRICITY				
Energy consumption/year (units)	216000	5.00		1080000
Fuel cost (lts)	1200	80		96000
Total				**3591360**
Total recurring expenditure				**4,959,360**
Wages		11.28	lakh	
Salary		2.40	lakh	
Raw materials, electricity, etc		35.91	lakh	
	Total	**49.5936**		

Name of the Firm/Promoter:

Annexure-IV

Cost of Project

COST OF LAND, BUILDINGS & MACHINES		
Land	Owned/leased	
Land development	**6.00**	Lakh
Building	**89.92**	Lakh
Machinery	**66.80**	Lakh
Misc. fixed assets	**1.60**	Lakh
Total Cost of Project	**164.32**	Lakh
Working Capital	**16.43**	Lakhs
MEANS OF FINANCE		
Proprietor's Capital	**41.32**	Lakh
Term Loan	**123.00**	Lakh
Total	**164.32**	Lakh
CROP- PRODUCTION AND SALE PRICE		
Compost/Room/Crop	**26**	ton
Number of Cropping Rooms	**4**	
Number of Crops/year	**5**	
Mushroom Production/Year	**100**	Ton

Annexure-V

Repayment of term loan and interest calculation

Particulars	Opening Balance	Interest Capitalized	Repayment Principal	Closing Balance	Interest (11%)	Total Repayment
Year	123.00			123.00		
1st Year	123.00		24.60	98.40	10.82	35.42
2nd year	98.40		24.60	73.80	8.12	32.72
3rd year	73.80		24.60	49.20	5.41	30.01
4th year	49.20		24.60	24.60	2.71	27.31
5th year	24.60		24.60	-	-	24.60

Annexure-VI

Depreciation (in Lakhs)

Year	**Depreciation**	**Building**	**Plant & Machinery**	**Total WDV**	**Dep. For Year**	**Total Dep**
		5%	**10%**			
	Value	**89.92**	**66.80**	**156.72**		
1st Year	Depreciation	4.50	6.68		11.18	**11.18**
	WDV	**85.42**	**60.12**	**145.54**		
2nd year	Depreciation	4.27	6.01		10.28	**21.46**
	WDV	**81.15**	**54.11**	**135.26**		
3rd year	Depreciation	4.06	5.41		9.47	**30.93**
	WDV	**77.10**	**48.70**	**125.79**		
4th year	Depreciation	3.85	4.87		8.72	**39.65**
	WDV	**73.24**	**43.83**	**117.07**		
5th year	Depreciation	3.66	4.38		8.04	**47.70**
	WDV	**69.58**	**39.44**	**109.02**		
6th year	Depreciation	3.48	3.94		7.42	**55.12**
	WDV	66.10	35.50	**101.60**		
7th year	Depreciation	3.30	3.55		6.86	**61.98**
	WDV	62.79	31.95	**94.75**		

Name of the Firm/Promoter:

Annexure-VII

Revenue from Sale of Mushroom

	Year 1	Year 2	Year 3	Year 4	Year 5
Total mushroom sold/annum (ton)	100	100	100	100	100
Selling price/kg (5% increase)	120	126	132	139	146
Revenue from sale of mushroom (Rs in lakhs)	**120.00**	**126.00**	**132.30**	**138.92**	**145.86**

Annexure-VIII

Profitability Estimates

						lakhs
Sr. No.	**Particulars**	**1st Year**	**2nd Year**	**3rd Year**	**4th Year**	**5th Year**
A	**Sales (Revenue)**	120.00	126.00	132.30	138.92	145.86
	Total (A)	**120.00**	**126.00**	**132.30**	**138.92**	**145.86**
B	**Cost of Production/ Expenses**					
	Variable					
	Raw Material	24.15	25.36	26.63	27.96	29.36
	Fuel & energy	11.76	10.80	10.80	10.80	10.80
	packing cost	0.00	0.00	0.00	0.00	0.00
	Wages	11.28	12.13	13.04	14.01	15.06
	Direct Operating Exp.	**47.19**	**48.29**	**50.46**	**52.77**	**55.22**
	Fixed					
	Total (B)	47.19	48.29	50.46	52.77	55.22
	Gross Profit (A-B)	**72.81**	**77.71**	**81.84**	**86.14**	**90.64**
	Salary	2.40	2.52	2.65	2.78	2.92
	Admn. Expenses	0.00	0.00	0.00	0.00	0.00
	Depreciation	11.18	10.28	9.47	8.72	8.04
	Total	**13.58**	**12.80**	**12.11**	**11.50**	**10.96**
	Profit before Interest and tax	**59.23**	**64.91**	**69.72**	**74.64**	**79.68**
	Interest on term loan	10.82	8.12	5.41	2.71	0.00
	Interest on working capital	1.81	0.00	0.00	0.00	0.00
	Profit before Tax	**46.60**	**56.79**	**64.31**	**71.93**	**79.68**
	Income Tax@0%	0.00	0.00	0.00	0.00	0.00
	Net Profit after Tax	**46.60**	**56.79**	**64.31**	**71.93**	**79.68**
	Depreciation	11.18	10.28	9.47	8.72	8.04
	Cash Accruals	**57.77**	**67.07**	**73.78**	**80.66**	**87.72**
	Cumulative Profit	**46.60**	**103.39**	**167.70**	**239.63**	**319.31**
	Operating profit	**70.41**	**75.19**	**79.19**	**83.36**	**87.72**
	Net Profit ratio	38.83	45.07	48.61	51.78	54.62
	Interest Coverage Ratio	4.31	7.00	11.88	26.58	0.00
	Payback period=	**2 years 6.5 months**				
	Discount rate=	10%				
	Discounted PBP=	**3 years 1 months**				

Name of the Firm/Promoter:

Annexure-IX

Calculation of Break Even Point

(Based on 1st Year Working Results)

		Amount (In Lacs)				
		1st Year	2nd Year	3rd Year	4th Year	5th Year
Sales		120.00	126.00	132.30	138.92	145.86
Less: Variable Exp.		47.19	48.29	50.46	52.77	55.22
Contribution		72.81	77.71	81.84	86.14	90.64
fixed Expenses						
Salary Expenses		2.40	2.52	2.65	2.78	2.92
Administration Expenses		0.00	0.00	0.00	0.00	0.00
Interest		10.82	8.12	5.41	2.71	0.00
Total Expenses		13.22	10.64	8.06	5.48	2.92
Total Expenses (Fixed in Nature)		13.22	10.64	8.06	5.48	2.92
Break Even Point(Cash, Operating B.E.P)						
	(At Sales Value)	**21.60**	**17.64**	**13.23**	**8.33**	**4.38**
	(At Capacity Level)	**18.00%**	**14.00%**	**10.00%**	**6.00%**	**3.00%**

Annexure-X

Projected Debt Service Coverage Ratio (DSCR)

	Particulars	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
	Profit after tax	46.60	56.79	64.31	71.93	79.68
Add:	Depreciation	11.18	10.28	9.47	8.72	8.04
	Cash Profit	**57.77**	**67.07**	**73.78**	**80.66**	**87.72**
Add:	**Interest**					
	Interest on Term Loan	10.82	8.12	5.41	2.71	0.00
	Cash Available to (Repayment Interest & Installment)	**68.61**	**75.19**	**79.19**	**83.36**	**87.72**
	Repayment					
A.	**Principal**					
	Repayment of Term Loan	24.60	24.60	24.60	24.60	24.60
B.	**Interest**	10.82	8.12	5.41	2.71	0.00
	Total Repayment(A+B)	**35.42**	**32.72**	**30.01**	**27.31**	**24.60**
	DSCR	**1.94**	**2.30**	**2.64**	**3.05**	**3.57**
	Avg. DSCR Ratio	**2.70**				

Name of the Firm/Promoter:

Annexure-XI

Calculation of Internal Rate of Return and Net Present Value

Particulars	1st Year	2nd Year	3rd Year	4th Year	5th Year
CASH INFLOWS					
Net Profit after Tax	46.60	56.79	64.31	71.93	79.68
Depreciation	11.18	10.28	9.47	8.72	8.04
	57.77	**67.07**	**73.78**	**80.66**	**87.72**
CALCULATION OF IRR	**Interest rate (10%)**				
			Yr	**cash flow**	
Year o (cash outflow)			**0**	**-164.32**	**-164.32**
1st Year (cash inflow)			**1**	**57.77**	**57.77**
2nd Year (cash inflow)			**2**	**67.07**	**67.07**
3rd Year (cash inflow)			3	73.78	**73.78**
4th Year (cash inflow)			4	80.66	**80.66**
5th Year (cash inflow)			5	87.72	**87.72**
NPV (check)					202.68
NPV					**202.68**
INTERNAL RATE OF RETURN (IRR)					**32%**
BC Ratio or PI					**2.23**
IRR/NPV					15.56%
Modified IRR					
Discount rate of reinvestment		10%			
Discounted IRR					**21.75%**
IRR/BCR					**14.12**

Annexure-XII

Projected Balance Sheet

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5
Sources of Fund					
Owner's Funds	41.32	87.92	144.71	209.02	280.95
Profit & Loss a/c	46.60	56.79	64.31	71.93	79.68
Closing Capital	87.92	144.71	209.02	280.95	360.63
Loan Funds					
Term Loan	98.40	73.80	49.20	24.60	0.00
Total	**186.32**	**218.51**	**258.22**	**305.55**	**360.63**
Applications Of Funds					
Fixed Assets					
Gross Block	164.32	164.32	164.32	164.32	164.32
Less:-Depreciation	11.18	21.46	30.93	39.65	47.70
Net Block	153.14	142.86	133.39	124.67	116.62
Net Working Capital					
Net Current Assets	33.17	75.65	124.83	180.88	244.00
Total	**186.32**	**218.51**	**258.22**	**305.55**	**360.63**

Name of the Firm/Promoter:

Annexure-XIII

Projected Cash Flow Statement

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5
Cash From Operating Activities					
Profit Before Tax	46.60	56.79	64.31	71.93	79.68
Add:					
Depreciation	11.18	10.28	9.47	8.72	8.04
Interest on Term Loan	10.82	8.12	5.41	2.71	0.00
Cash before working capital Change	68.60	75.19	79.19	83.36	87.72
Change in Working Capital	0.00	0.00	0.00	0.00	0.00
Tax	0.00	0.00	0.00	0.00	0.00
Cash from Operating Activities	**68.60**	**75.19**	**79.19**	**83.36**	**87.72**
Cash From Investing Activities					
Purchase of Fixed Assets	164.32	0.00	0.00	0.00	0.00
Cash generated from investing activities	**-164.32**	**0.00**	**0.00**	**0.00**	**0.00**
Cash From Financing Activities					
Promoter's Contribution	41.32	0.00	0.00	0.00	0.00
Capital Expenditure Loan	123.00	0.00	0.00	0.00	0.00
Repayment of Term Loan	24.60	24.60	24.60	24.60	24.60
Interest on Loan	10.82	8.12	5.41	2.71	0.00
Cash generated from Finance Activities	**128.90**	**-32.72**	**-30.01**	**-27.31**	**-24.60**
Opening Balance	0.00	33.17	75.65	124.83	180.88
Cash generated during the year	33.17	42.47	49.18	56.06	63.12
Closing Balance (Cash & Bank Balance)	**33.17**	**75.65**	**124.83**	**180.88**	**244.00**

Annexure-XIV

Debt Equity Analysis

Particulars	Year 1	Year 2	Year 3	Year 4	Year 5
Debt Funds					
Term Loan	98.40	73.80	49.20	24.60	0.00
Debt Fund	**98.40**	**73.80**	**49.20**	**24.60**	**0.00**
Equity Fund					
Owner Funds	87.92	144.71	209.02	280.95	360.63
Debt Equity Ratio	**1.12**	**0.51**	**0.24**	**0.09**	**0.00**
Avg. D/E Ratio	**0.39**				
Net Current Asset	33.17	75.65	124.83	180.88	244.00
Net Current Liability	35.42	32.72	30.01	27.31	24.60
Current Ratio	**0.94**	**2.31**	**4.16**	**6.62**	**9.92**

Name of the Firm/Promoter:

CONCLUSION

Mushroom cultivation has tremendous potential in the country due to vast availability of raw materials and cheap labour. Mushrooms have been kept under a major thrust area by the govt. There is a vast potential of export of this commodity to Europe, America and middle East countries. Production figures envisaged in the project (Promoter: ---) are based on 100% capacity utilization, which can easily be achieved in a year's time if the farm is managed properly and there is a constant supply of raw materials. Yield realization are based on the cultivation of advanced hybrids by providing exact environment conditions to derive optimum potential of the strain. These projections can very well be achieved, however DMR, Solan (HP) in no way guarantees for the above production and profit since it will not be directly involved in the execution of the project and in the production phases. Much would depend upon the skill and management of the entrepreneur for the success of the project. At the moment most of the projects of similar capacity or more are running successfully and earning handsome profits.

(Shwet Kamal)
Principal Scientist
ICAR-Directorate of Mushroom Research
Chambaghat, Solan (H.P.) – 173213.

(V.P. Sharma)
Director
ICAR-Directorate of Mushroom Research,
Chambaghat, Solan (H.P.) – 173213.

Dated: