

# **Technologies Developed by ICAR-Directorate of Mushroom Research for Commercial Use**

*Compiled and edited by*

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**Technologies Developed by  
ICAR-Directorate of Mushroom Research  
Chambaghat, Solan-173 213 (HP)**



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## Foreword

Promotion of integrated farming system approach involving synergic blending of field crops, horticulture, dairy, fisheries, poultry etc. is gaining popularity in the recent times with a view to double the farmers' income by 2022. Mushroom cultivation is one such activity which can be accommodated in any farming system module to generate regular farm income. However, mushroom cultivation in India is largely confining to button mushroom production under controlled conditions and is not viable for small scale growers. The ICAR-DMR has made great efforts to diversify the mushroom cultivation activity by standardizing the cultivation techniques for many exotic mushrooms, which can be adopted by the small scale growers at commercial level. The high yielding strains developed by ICAR-DMR in cultivated mushrooms helps to boost up the benefit cost ratios in existing mushroom production units. Hence, efforts were made to compile the information on whole range of technologies developed by ICAR-DMR to promote their adaptability at commercial scale.



**V P Sharma**  
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## 1. Commercial strains released by ICAR-DMR, Solan

### a. High yielding strains of button mushroom

#### DMR-Button-03-White

- Avg. cap dia.: 43 mm
- Avg. cap length: 9 mm
- Avg. Stem length: 17 mm
- Avg. Fruit body weight: 12 g
- Fruit body colour - white to off white
- Yield : average 20-22 kg/100 kg compost



#### DMR-Button-06-Brown

- Avg. cap dia.: 41.5mm
- Avg. cap length: 9.3mm
- Avg. stem length: 18mm
- Avg. fruit body weight: 10g
- Fruit body colour: Brown
- Yield: average 20-25 kg/100 kg compost



#### DMR-Button-NBS-1

Mushroom Farm	:	Completely environment- controlled unit
Culture characteristics and growth	:	Fine and signing mycelial growth,
Growth rate	:	On compost agar media 2.1 mm/day On Malt extract agar 2.33 mm/day
Time taken for spawn run in pasteurised compost	:	13 days
Time taken for case run	:	7 days
Time taken for first harvest (days post-casing)	:	14 days

## Distinguishing morphological characteristics

- Fruit body shape: Cap dome shaped without any depression
- Avg. cap dia.: 48 mm
- Avg. stem dia.: 15 mm
- Avg. cap length: 9 mm
- Avg. stem length: 18 mm
- Avg. gill size: 2.0 mm
- Avg. fruit body weight: 14 g
- Fruit body colour: Pure white
- Veil opening: compact fruit body, late veil opening



❖ **Agronomic features** (e.g. resistance to over watering /under watering, high CO<sub>2</sub>, low/high temperature etc.)

i. Pasteurized compost

ii. Compost moisture <62%

iii. Spawn rate @ 1% of wet weight of compost

iv. Spawn run conditions

- Temperature – 24-26°C (bed temperature)
- Relative humidity – 90-95% (cropping room)
- CO<sub>2</sub> – >8000ppm (cropping room)
- Light – Not required

v. Casing: 1.5 inch layer of soil + FYM (1 ½ yr old) (1:1)

- Temperature 24-26°C (bed temperature)
- Relative humidity – 90-95% (cropping room)
- CO<sub>2</sub> – >8000 ppm (cropping room)
- Light – Not required
- Light watering on mushroom bed on spawn run



## vi. Fruiting/cropping

- Temperature – 14-16°C (bed temperature)
- Relative humidity – 85-90%
- CO<sub>2</sub> – 800 - 1000ppm
- Air circulation/exchange – three-four air change /day
- Light watering on alternate days specially if required
- Harvest at 4-5 cm size of button without leaving any fruit body part on bed
- Packaging in perforated polythene/polypropylene or paper bags/punnets

viii. Yield : 18-21 kg/100 kg compost

**DMR-Button-NBS-5**

Mushroom Farm	:	Completely environment-controlled unit
Culture characteristics and growth	:	Fine and signing mycelial growth,
Growth rate	:	On compost agar media 1.8 mm/day On Malt extract agar 2.66 mm/day
Time taken for spawn run in pasteurised compost	:	12 days
Time taken for case run	:	6 days
Time taken for first harvest (days post-casing)	:	13-14 days

**Distinguishing morphological characteristics**

- Fruit body shape: Cap dome shaped without any depression
- Avg. cap dia.: 40mm
- Avg. stem dia.: 12mm
- Avg. cap length: 12mm
- Avg. stem length: 18mm
- Avg. gill size: 2.5mm
- Avg. fruit body weight: 13.75g



- Fruit body colour: White to off white depending upon humidity level
- Veil opening: Compact fruit body, late veil opening
- ❖ **Agronomic features** (e.g. resistance to over watering /under watering, high CO<sub>2</sub>, low/high temperature etc.)
  - i. Pasteurized compost
  - ii. Compost moisture <62%
  - iii. Spawn rate @ 1% of wet weight of compost.
  - iv. Spawn run conditions
    - Temperature – 24-26°C (bed temperature)
    - Relative humidity – 90-95% (cropping room)
    - CO<sub>2</sub> – >8000ppm (cropping room)
    - Light – Not required
  - v. Casing: 1.5 inch layer of soil + FYM (1½ yr old) (1:1)
    - Temperature 24-26°C (bed temperature)
    - Relative humidity – 90-95% (cropping room)
    - CO<sub>2</sub> – >8000ppm (cropping room)
    - Light – Not required
    - Light watering on mushroom bed on spawn run
  - vi. Fruiting/cropping
    - Temperature – 14-16°C (bed temperature)
    - Relative humidity – 85-90%
    - CO<sub>2</sub> – 800 - 1000ppm
    - Air circulation/exchange – three-four air change /day
    - Light watering on alternate days specially if required
    - Harvest at 4-5 cm size of button without leaving any fruit body part on bed
    - Packaging in perforated polythene/polypropylene or paper bags/punnets
  - viii. Yield: 20-23 kg/100 kg compost

## b. High yielding strains of paddy straw mushroom

### DMRO-247

#### Fruit body characteristics

- Fruit body shape: Oval
- Fruit body size: Big (5-7 cm long × 4-5 cm wide)
- Fruit body weight: 14-18g
- Fruit body colour: Light brown
- Veil opening: Lesser tendency of veil opening
- K/Na ratio in fruit body: 8.0 to 12.0 on different substrates
- Protein content (dry wt. basis): 32-37% on different substrates
- Fruit body texture: Comparatively hard



#### Spawn run conditions

- Temperature - 30-35°C (bed temperature)
- Relative humidity – 90-95% (cropping room)
- CO<sub>2</sub> – 5000-8000ppm (cropping room)
- Light – Not required
- Air circulation/exchange – once or twice (4-5 min/day)
- Light watering on mushroom bed on completion of spawn run

#### Fruiting/cropping

- Temperature - 28-32°C ((bed temperature)
- Relative humidity – 85-90%
- CO<sub>2</sub> – 600-800ppm
- Light – Fluorescent light 4-5 hours/day
- Air circulation/exchange – three-four times/day (4-5 min/exchange)
- Very light watering on alternate days specially if required
- Harvesting twice, once morning and once after noon
- Harvest at button stage without leaving any fruit body part on bed
- Packaging in perforated polythene/polypropylene or paper bags

## DMRO-484

### Fruit body characteristics

- Fruit body size: Big (5-7 cm long × 3-5 cm wide) oval shape
- Fruit body weight: 14-20g
- Fruit body colour: Whitish or greyish
- Veil opening: Lesser tendency of veil opening
- Fat content: 0.79%, less than brown strain
- Fibres: 6.02%, higher than brown strain
- Potassium/Sodium ratio: 128.03, slightly higher than brown strain
- Protein content (dry wt. basis): 36.88% on composted substrate slightly less than brown strain
- Mineral content: All elements like calcium, sodium, potassium, iron, copper, zinc and magnesium higher (1.06 to 1.50 times) than brown strain
- Vitamin D: 0.58 fold less than brown strain
- Fruit body texture: Comparatively hard



### Spawn run conditions

- Temperature - 30-35°C (bed temperature)
- Relative humidity – 90-95% (cropping room)
- CO<sub>2</sub> – 5000-8000ppm (cropping room)
- Light – Not required
- Air circulation/exchange – once or twice (4-5 min/day)
- Light watering on mushroom bed on completion of spawn run

### Fruiting/cropping

- Temperature - 28-32°C ((bed temperature)
- Relative humidity – 85-90%
- CO<sub>2</sub> – 600-800 ppm
- Light – Fluorescent light 4-5 hours/day
- Air circulation/exchange – three-four times/day (4-5 min/exchange)
- Very light watering on alternate days specially if required
- Harvesting twice, once morning and once after noon
- Packaging in perforated polythene/polypropylene or paper bags

### c. High yielding strains of shiitake mushroom

#### DMR- Shiitake 38

##### Fruit body characteristics

- Fruit body shape: spherical, centre dark brown, outer light brown white scars uniformly distributed throughout the cap
- Fruit body size: Cap dia. 6.5-8.0cm; stipe length 5-6cm
- Fruit body weight: 40-45g
- Fruit body colour: Brown



##### Spawn run conditions

- Temperature – 23-25°C (bag temperature)
- Relative humidity – 75-80% (cropping room)
- CO<sub>2</sub> – 5000-8000 ppm (cropping room)
- Light – 8-10 h daily

##### Fruiting/cropping

- Temperature - 22-24°C (bag temperature)
- Relative humidity – 80-85%
- CO<sub>2</sub> – 600-800ppm
- Light – Fluorescent light 8-10 hours/day
- Air circulation/exchange – Two times/day (5-10 min/exchange)
- Light watering daily is required
- Harvesting once in week
- Packaging in perforated polythene/polypropylene or paper bags

**Yield:** 31-40 kg/100 kg saw dust

## DMR- Shiitake 388

### Fruit body characteristics

- Fruit body shape: spherical, Initially fruit bodies are pale yellow in colour, turns light brown with maturity, ring of white scars on the cap
- Fruit body size: Cap dia. 6-7cm stipe length 5-6cm
- Fruit body weight: 35-39g
- Fruit body colour: Light brown
- Veil opening: opened veil from beginning



### Spawn run conditions

- Temperature – 23-25°C (bag temperature)
- Relative humidity – 75-80% (cropping room)
- CO<sub>2</sub> – 5000-8000 ppm (cropping room)
- Light – 8-10h daily
- Air circulation/exchange- Nil
- No watering during spawn run

### Fruiting/cropping

- Temperature - 22-24°C (bag temperature)
- Relative humidity – 80-85%
- CO<sub>2</sub> – 600-800ppm
- Light – Fluorescent light 8-10 hours/day
- Air circulation/exchange – Two times/day (5-10 min/exchange)
- Light watering daily is required
- Harvesting once in week
- Packaging in perforated polythene/polypropylene or paper bags.

**Yield :** 22.3-43.9kg/100kg substrate

## d. High yielding strains of milky mushroom

### DMR- Milky 334

#### Fruit body characteristics

- Fruit body shape: Cap spherical white, long stipe
- Fruit body size: Cap dia. 7-8 cm, stipe length 11-12cm
- Fruit body weight: 33-38 g
- Fruit body colour: white
- Veil opening: opened veil from beginning



#### Spawn run conditions

- Temperature -25-30°C (bag temperature)
- Relative humidity -80-85% (cropping room)
- CO<sub>2</sub> - 5000-8000ppm (cropping room)
- Light - No light during spawn run
- Air circulation/exchange- Nil
- Light watering during once in 2-3 days

#### Fruiting/cropping

- 3-4 cm thick layer of casing soil (75%) + sand (25%) sterilized in autoclave at 15 psi for one hour or chemically treated with formaldehyde solution (2%)
- Temperature - 28-34°C (bag temperature)
- Relative humidity - 80-90%
- CO<sub>2</sub> - 600-800ppm
- Light - fluorescent light 8-10 hours/day
- Air circulation/exchange -once a day (5-10 min/exchange)
- Watering once or twice in a day
- Harvesting : daily

**Yield:** 74-82 kg/100 kg of wheat dry straw/paddy straw

## e. High yielding strains of *Macrocybe* mushroom

### DMR-*Macrocybe* -01

#### Fruit body characteristics

- Average fruit body weight - 20-40g
- Fruit body colour: white
- The mushroom do not have the off smell



#### Spawn run and fruiting conditions

- Temperature : 25-35°C
- Relative humidity : 70-80%
- Light : 8-10 hours (more than 100 lux),
- CO<sub>2</sub> : < 800ppm

**Yield** : 40-70kg per 100kg of dry substrate

- Mushrooms can be stored up to 10 days in refrigerator and 3-4 days at room temperature (20-26°C)



## **2. Technology for short duration fruiting in shiitake (*Lentinula edodes*) mushroom**

Shiitake is the most important culinary medicinal mushroom which ranks at number two in terms of total mushroom production in the world. Shiitake is a prized mushroom with delicious taste, exotic flavour and aroma. It is used medicinally for diseases involving depressed immune function including cancer, AIDS. Lentinan (a cell-wall constituent extracted from the fruiting bodies of shiitake) is an immunomodulating and nutraceutical agent mainly useful to cure the cancer. Cultivation of shiitake is done on sawdust of selected broad leaved trees enriched with the organic nitrogen source.

The short duration cultivation technology is follows as

- Wet saw dust thoroughly with water for 16-18 hours
- Add 20% wheat bran, 1% calcium carbonate and 0.5% gypsum
- Mix the substrate thoroughly
- Fill 1.5-2 kg of wet substrate in heat resistant poly propylene bags
- Sterilize the bags in an autoclave at 22 p.s.i pressure for 90-120 min
- Inoculate grain spawn of strain no DMRO-388 @ 3% (wet wt basis, top spawning) under aseptic conditions
- Incubate bags at 4 hr/20 hr light / dark cycles at 23-25°C.
- Spawn run will be completed in 36-40 days including bump formation and browning.
- Peel of the pp bags and immerse the synthetic logs in cold water (6-8°C) for 10-15 minutes to promote primordial formation
- Transfer the logs to a cropping room and place them in racks
- Maintain uniform temperature of 20-22°C and a RH of 85-90%
- Provide light for 10-12 hours daily
- After 2-3 days of the cold water treatment, small primordia will develop
- Primordia will be fully grown in next 3-4 days
- Harvest mushrooms before unveiling the margin of the cap
- 600-800g of fresh mushrooms can be harvested from 1 kg of dry substrate
- Mushrooms can be consumed fresh or sun dried



**a. Substrate preparation and filling in pp bags**



**b. Sterilization of the substrate in autoclave**



**c. Inoculation with grain spawn in sterilized substrate**



**d. Incubation**



**e. Cold shock treatment**



**f. Fruit bodies of shiitake**

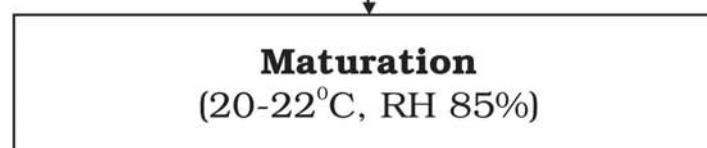
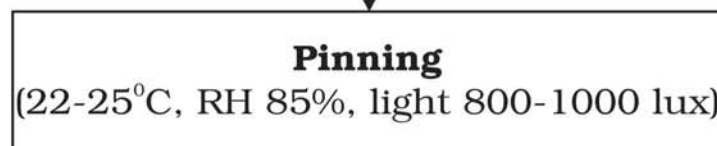
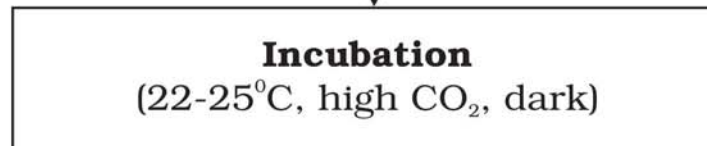
## Flow chart of short duration cultivation of shiitake mushroom

### Substrate

### Wetting - 65%



### Spawn



### **3. Production technology of kabul dhingri (*Pleurotus eryngii*)**

*Pleurotus eryngii* is an edible oyster mushroom species which is very popular and has tremendous scope for export in both fresh and dried forms to various European and South East Asian countries. It is better known as Kabul Dhingri due to its natural occurrence in high altitude regions of North West Himalayas. Its natural growth and collection has hampered due to ecological disturbances. Earlier, people have attempted to cultivate *Pleurotus eryngii* during summer but very less yields were obtained. The cultivation technology developed ICAR-DMR, Solan on cereal straw / saw dust based substrate made its production much easier.

The cultivation technology developed by ICAR-DMR is as follows

- For cultivation of *Pleurotus eryngii* saw dust / wheat straw/ paddy straw supplement with organic nitrogen materials are used as substrate
- Substrate is wetted thoroughly in water for 16-18 hours
- After wetting 20% wheat bran is added in the substrate and mixed thoroughly
- Two kg of wet substrate is filled in each polypropylene bag (8X16")
- The bags are plugged with non-absorbent cotton by inserting polypropylene ring at the mouth of bags
- The filled bags are sterilized in an autoclave for 90-120 min at 22 p.s.i pressure
- After sterilization, the bags are cooled down to room temperature and then inoculated with grain spawn @ 10-15% on wet weight basis
- Inoculated bags are incubated at 22-25°C
- Spawn run will be completed in 15-20 days
- After the completion of spawn run PP bags will be removed and the blocks will be placed in the cropping room.
- The temperature and relative humidity of the cropping should be maintained at 10-15°C and 80-85% respectively
- Light (800-1000 lux) is provided for five hours daily for optimum development of the fruiting bodies
- Pin heads start developing after 5-7 days after removing the bags
- Matured fruit bodies are harvested 3-4 days after pinning
- 300-400g of mushrooms can be harvested per kg of substrate
- Harvested crop can be marketed fresh or can be dried



**a. Preparation of substrate**



**b. Filling of substrates in pp bags**



**c. Sterilization of substrate**



**d. Addition of grain spawn**



**e. Incubation**

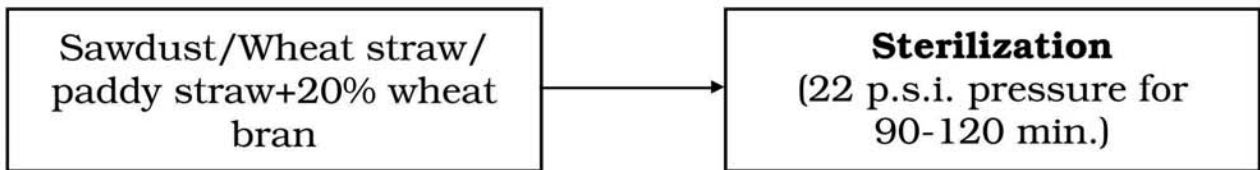


**f. Fruit bodies of king oyster mushroom produced on saw dust**

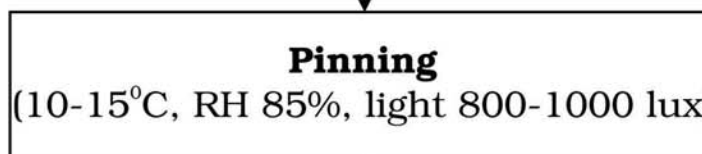
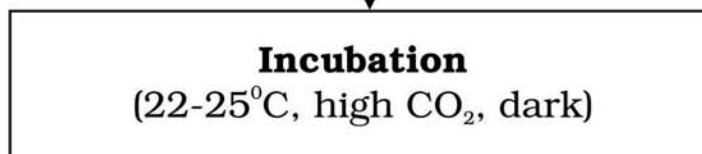
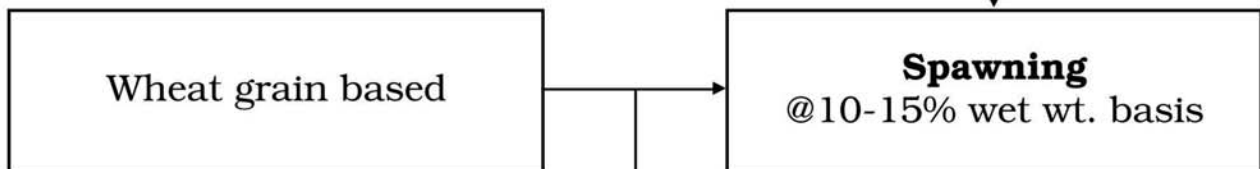
## Flow chart of kabul dhingri production

### Substrate

### Wetting - 65%



### Spawn



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#### **4. Production technology of wood ear mushroom (*Auricularia polytricha*)**

With no caps or stems, the wood ear mushroom, which is sometimes called cloud ear, tree ear or black fungus, is most commonly sold dried and is popular in Asian cooking. *Auricularia polytricha* is commercially cultivated in the South East Asian countries. This mushroom ranks fourth among all the cultivated edible mushroom. This mushroom is believed to cure sore throat, anemia, certain digestive disorders especially piles on regular consumption. In India this mushroom is collected and consumed in North-Eastern States.

The cultivation technology developed by ICAR-DMR is as follows.

- Soak the fresh wheat straw of good quality for 16-18 hours in water
- Drain out the excess water and add 5% wheat bran (w/w) in soaked wheat straw
- Fill 2kg substrate in each polypropylene bag and sterilize at 22 p.s.i pressure for 60-90 min
- On cooling, add spawn @ 4-5% wet weight basis
- Incubate the spawned bags at 25-30°C
- Spawn run will be completed in 20-25 days
- On completion of spawn run give cross cut to give slits and hang the bags for fruiting at 25-26°C
- Maintain high relative humidity of 85-90% by spraying water once or twice on the bags
- Give diffused light and aeration for 1-2 hrs daily
- Fruit bodies will emerge after 10-12 days after giving the cross cuts and will mature for harvesting in the next 4-5 days
- Harvest mature fruit bodies which can be consumed fresh or can be dried
- 1000-1100 g of fresh mushrooms are produced per kg of dry substrate



**a. Wetting of straw**



**b. Filling of straw in pp bags**



**c. Spawn run stage**



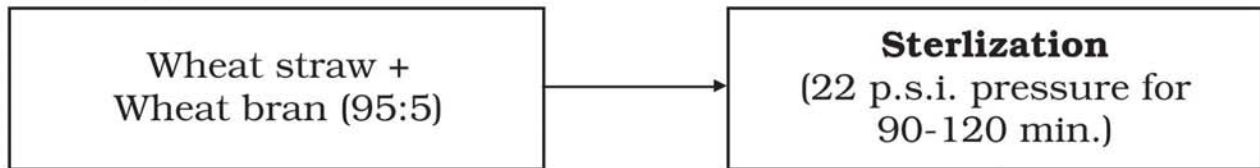
**d. Wood ear mushroom cultivation in bag**



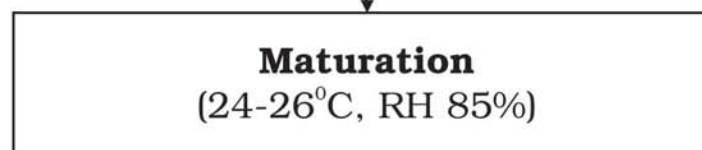
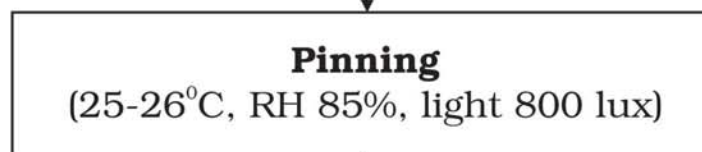
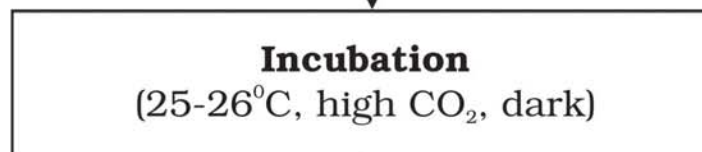
## Flow chart of wood ear mushroom production

### Substrate

### Wetting - 65%



### Spawn



## **5. Production technology of winter mushroom (*Flammulina velutipes*)**

*Flammulina velutipes* (winter mushroom; Enokitake) is a delicious edible mushroom that can be found naturally on dead elm trees. It is being cultivated all over the world especially in China, Siberia, Asia Minor, Europe, Africa, North America, Australia, Taiwan and Japan in a commercial scale. This mushroom is particularly known for its preventive as well as curative properties for liver diseases and gastroenteric ulcers.

The cultivation technology developed by ICAR-DMR, Solan is as follows.

- Soak the saw dust in fresh water for 16-18 hours.
- Drain out the excess water after wetting and add 5% wheat bran in the wetted saw dust
- Fill two kg substrate in each polypropylene bags
- Plug the bags with non-absorbent cotton by inserting ring at the mouth of the bag
- Sterilize the filled bags in an autoclave at 22 p.s.i pressure for 90-120 min
- Inoculate cooled bags with wheat grain based spawn @ 4% dry weight basis
- Incubate the spawned bags at temperature between 23 - 25°C for mycelial growth
- After spawn run, keep the bags in the dark at a temperature of 10-14°C and maintain the RH at 80- 85%
- Primordia will form in 10-12 days after reducing the temperature
- Fruit bodies will mature at 3-5°C
- Harvest fruit bodies when the stipe lengths reaches to 14-18 cm
- Harvested fruit bodies can be consumed fresh or can be sun dried
- 400-500g fresh mushrooms are produced per kg dry substrate



**a. Preparation of substrate**



**b. Filling of substrates in pp bags**



**c. Sterilization of substrate**



**d. Addition of grain spawn**



**e. Incubation**

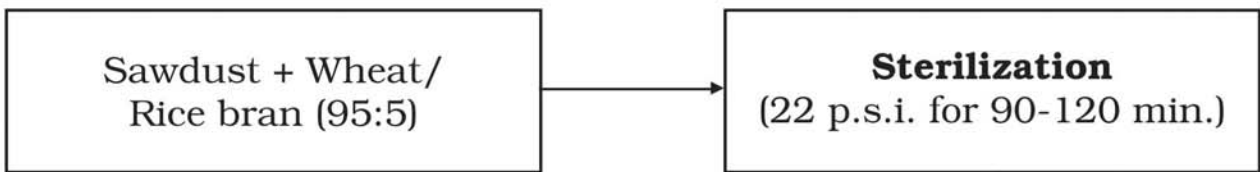


**f. Slender long fruit bodies of winter mushrooms**

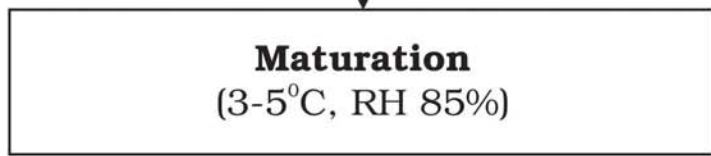
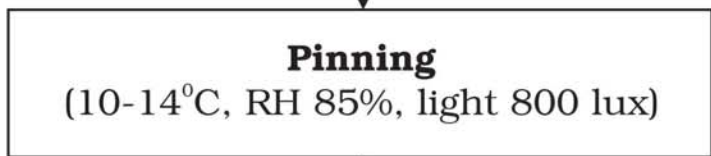
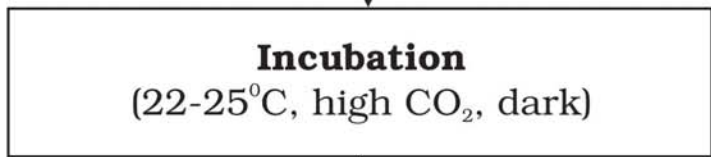
## Flow chart of winter mushroom production

### Substrate

### Wetting - 65%



### Spawn



## 6. Production technology of milky mushroom (*Calocybe indica*)

Milky white mushrooms are highly suitable for commercial production in humid tropical and subtropical regions of the world. Milky white mushroom extracts are known to have anti-hyperglycemic effect and anti-lipid peroxidation effect. *Calocybe indica* can be grown on wide range of substrates like paddy straw, wheat straw, sugarcane bagasse, etc.

The cultivation technology developed by ICAR-DMR is as follows

- Wet paddy/wheat straw in water for 10-12 hours
- Make pile of the wet straw
- Give turning to the pile after 2 days
- Add 1 % calcium carbonate on dry weight basis
- After thoroughly mixing of calcium carbonate make pile of the substrate
- Pasteurize the substrate at 60°C for 4 hours
- Fill 5 kg wet substrate in each polythene bags
- Layer spawning is done @ 4-5% on wet weight basis
- Incubate bags at 28-32°C under dark conditions
- Spawn run will be completed in 15-20 days
- After complete spawn run case the bags
- Use sterilized casing material prepared by mixing garden soil 75% + sand 25% of pH 7.8-7.9
- Maintain temperature 30-35°C and R.H. 80-90% for cropping
- Maintain high relative humidity (85-90%) by spraying water once or twice on the bags and in the room
- After casing, primordia will be formed in 6-8 days
- Provide light 600-1000 lux for 4-6 hours daily
- Harvest mushrooms when the stipe length reaches of 7-8cm by twisting
- Harvested fruit bodies can be consumed fresh or store the clean mushrooms by wrapping in film for 7-10 days at room temperature



**a. Wetting of straw**



**b. Making a pile**



**c. Pasteurization of substrate**



**d. Spawing**



**e. Tying the bags**



**f. Incubation**



**g. Casing**



**h. Initiation of pinning in casing material**



**i. Matured fruit bodies of milky mushroom**

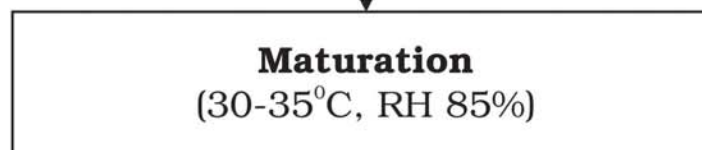
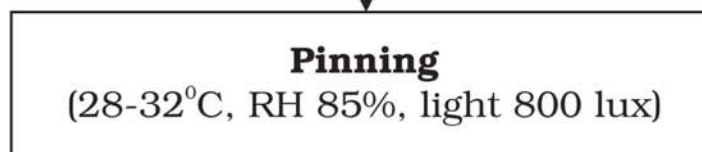
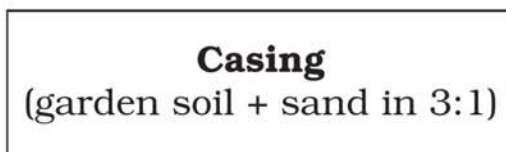
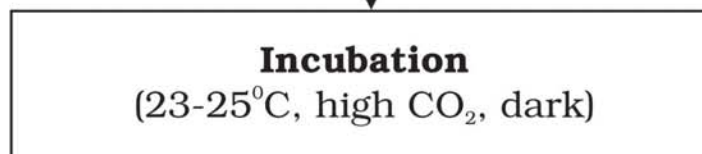
## Flow chart of milky mushroom production

### Substrate

### Wetting - 65%



### Spawn



## **7. Production technology of black poplar mushroom (*Agrocybe aegerita*)**

*Agrocybe aegerita* is one of the tastiest mushrooms grown in the temperate climates mostly on poplar and willow wood and develop the fruit bodies in nature from spring to autumn. The fruit bodies have unique flavour, good nutritive and medicinal values. This mushroom is known to have an antitumour lectin. It is an important source for many bioactive secondary metabolites such as indole derivatives with free radical scavenging activity, cylindan with anticancer activity, and also agrocybenine with antifungal activity. Under artificial conditions it can be cultivated on wheat straw or saw dust.

The cultivation technology developed by ICAR-DMR is as follows

- Soak good quality wheat straw overnight for 16-18 hours and later remove the straw and drain out excess water
- Mix 4-5 % wheat or rice bran on wet weight basis
- Fill 2 kg substrate in each polypropylene bag
- Sterilize the filled bags at 22 p.s.i pressure for 90-120 min
- After cooling, spawn the substrate @ 4% on wet weight basis aseptically
- Incubate at 25 -28°C for completion of spawn run
- Spawn run will be completed in 20-25 days
- Cross cut or give slits and hang the bags for fruiting at 25°C with 85-90% RH
- Spray water daily on bags and in the room
- Small primordia will appear after 5-8 days after opening the bags which become ready to harvest in the next four days.
- Fresh mushrooms can be consumed or sun dried
- Fruit bodies can be stored in the refrigerator for 7-10 days
- 500-600g of mushrooms can be harvested from 1 kg of dry substrate





**a. Preparation of substrate**



**b. Filling of substrates in pp bags**



**c. Sterilization of substrate**



**d. Addition of grain spawn**



**e. Incubation**

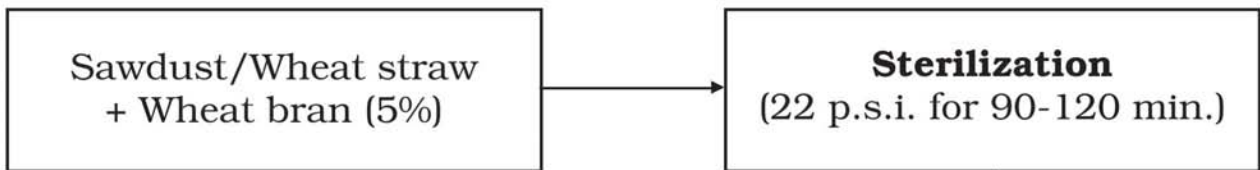


**f. Matured fruit bodies of black poplar mushroom**

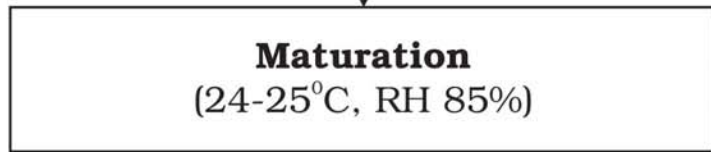
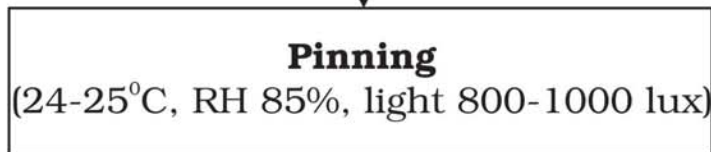
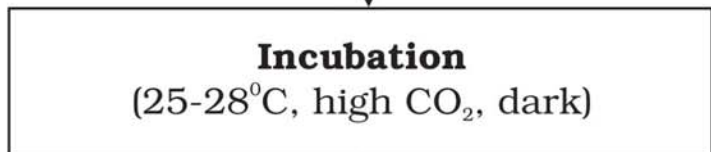
## Flow chart of *Agrocybe* production

### Substrate

### Wetting - 65%



### Spawn



## 8. Indoor cultivation of paddy straw mushroom (*Volvariella* spp.)

Paddy straw mushroom (*Volvariella volvacea*) also known as Chinese mushroom, ranks sixth among the cultivated mushrooms of the world. This mushroom has several advantages like requirement of the tropical or sub-tropical climate, fast growth rate, easy cultivation technology and good acceptability at consumers' level. In India this mushroom is cultivated in the states of Odhisa, Andhra Pradesh, Tamil Nadu, Kerala and West Bengal. The unique flavor and textural characteristics of the fruit bodies distinguish this mushroom from other edible mushrooms. The straw mushroom is known to be rich in minerals such as potassium, sodium and phosphorus. Potassium constitutes the major fraction of major elements followed by sodium and calcium. This mushroom can be cultivated on paddy straw and cotton ginning mill waste as substrate.

- Take paddy straw and add cotton ginning mill waste in 1:1 (w/w) ratio
- Add 5% chicken manure
- Wet thoroughly with water added with 1.5% lime
- Make pile of the mixed substrate
- Give turning after three days
- Re-stack and repeat the process for next three days
- Pasteurize substrate at 60-62°C for 3-4 hours and then condition at 45-50°C for 2-3 days for complete elimination of ammonia
- Add spawn @1.5% on wet weight basis
- Cover the beds with plastic sheet
- Spawn run will be completed in 4-5 days at 32-35°C
- Remove plastic sheets from spawned substrate
- Maintain room temperature at 28-32°C, RH-80-85%
- Give intermittent fresh air circulation and fluorescent light for 4-5 hours/day
- Harvest first flush after 9-10 days of spawning
- Harvest at button stage and consume in fresh form



**a. Wetting of straw**



**b. Making pile**



**c. Filling the substrate in racks**



**d. Covering the substrate**



**e. Initiation of pinning**



**f. Mature fruit bodies ready for harvesting**

## Flow chart of paddy straw mushroom production

### Substrate

#### Wetting - 65%

Paddy straw+ Cotton ginning  
mill waste (1:1 w/w)  
+ 5% chicken manure

**Pasteurization**  
60-62°C for 3-4 hrs

### Spawn

Paddy straw based

**Spawning**  
@1.5% on wet wt. basis

**Incubation**  
(32-35°C, high CO<sub>2</sub>, dark)

**Pinning**  
(28-32°C, RH 85%, light 600 lux)

**Maturation**  
(28-32°C, RH 85%)

## **9. Production technology of pink oyster mushroom (*Pleurotus djamor*)**

Pink oyster mushroom (*Pleurotus djamor* var. *roseus*) has its name due to the intense pink color of its cap. It grows in dense cluster and is able to flourish on a wide variety of base materials such as wheat straw, paddy straw, sugarcane baggase etc. This species is so aggressive as to colonize unpasteurized bulk substrates before competitors can flourish.

The cultivation technology is as follows

- Soak the good quality wheat straw /paddy straw overnight
- Add one per cent lime and make pile
- Give turning on third day and re make the pile
- Keep the pile as such for two days
- Pasteurize the substrate at 60°C for 4 hours
- Add spawn @ 3% on wet wt basis
- Fill 5 kg substrate per bag
- Incubate bags at 22-25°C under dark conditions
- Spawn run will be completed in 8-10 days
- Make holes of one inch dia. all over the surface of the bags
- Spray water twice in the rooms
- Provide light (600-1000 lux) for 3-4 hours daily
- The Pinning will start within 10-12 days
- Harvest mature fruit bodies
- Mushroom can be consumed fresh or sun dried
- 600-700g of fresh mushrooms can be produced from one kg of dry substrate



**a. Wetting of straw**



**b. Making a pile**



**c. Pasteurization of substrate**



**d. Spawning**



**e. Tying the bags**



**f. Incubation**



**g. matured fruit bodies of pink oyster mushroom**

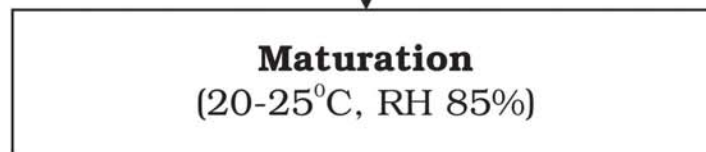
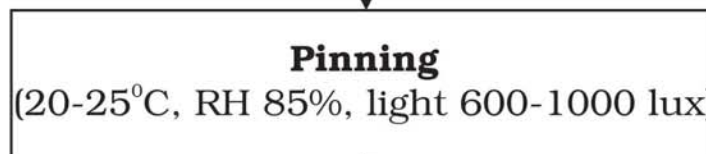
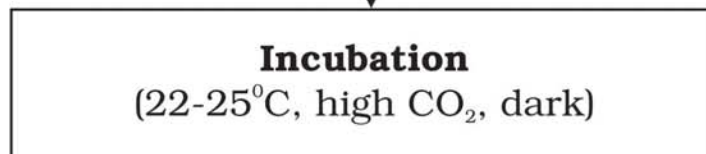
## Flow chart of pink oyster mushroom production

### Substrate

### Wetting - 65%



### Spawn





## 10. Production technology of monkey head mushroom (*Hericium erinaceus*)

*Hericium erinaceus* is an important mushroom with edible values and medicinal properties. This mushroom is declared in the red list of endangered species in various European countries. Both the mycelium and the fruiting bodies contain many bioactive compounds with drug efficacy. Recent evidence demonstrates that it is helpful to cure Alzheimer's disease and many types of cancer. Furthermore, emerging pieces of evidence have shown that different active molecules in *H. erinaceus* have different functions on different organs. Monkey head mushroom is a choice edible when young and the texture of the cooked mushroom is often compared to seafood. This mushroom can be grown on saw dust, sugar cane bagasse, cotton seed hulls or chopped paddy straw as substrate.

The cultivation technology is as follows

- Wet the substrate thoroughly
- Add 5% wheat bran
- Fill 2 kg substrate in polypropylene bags
- Plug the bags with non-absorbent cotton by inserting a ring on the mouth of the bag
- Sterilize the substrate at 22 p.s.i for 90-120 min
- Add spawn @ 3% on wet wt basis
- Incubate bags at 23-25°C for 20-25 days
- The optimum temperature for fructification is between 20-25°C
- Fruiting will start after 7-10 days of bag opening
- Harvest the matured fruit bodies
- Mushroom can be consumed fresh or sun dried

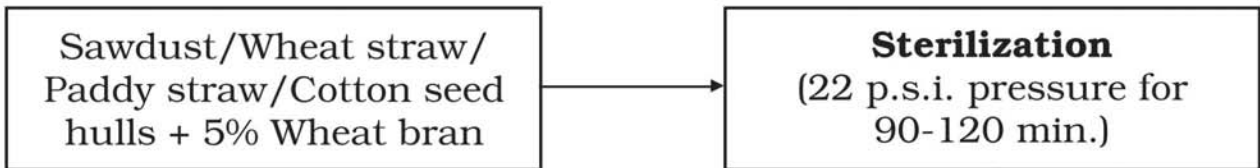


Matured fruit bodies of *H. Erinaceus* grown on wheat straw based substrate

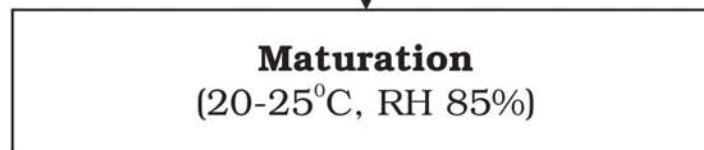
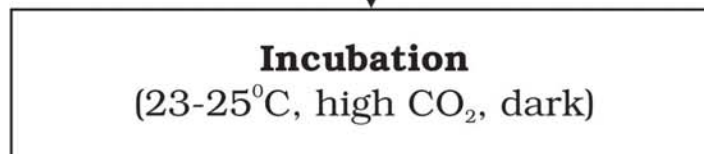
## Flow chart of monkey head mushroom production

### Substrate

#### Wetting - 65%



### Spawn



## 11. Indoor composting technique for white button mushroom

Button mushroom is cultivated on a selective substrate known as compost. Earlier the compost was prepared by long method of composting. However, due to some environmental issues another method known as indoor composting is evolved. The following protocol enables the production of environment friendly white button mushroom compost within in 12 days time against 20 to 28 days normally taken in short and long method of composting, respectively.

- Procedure for production of such compost was perfected using aerated phase-I bunkers keeping intermittent temperature range. Such method produces significantly more compost per unit weight of the ingredients taken compared to present day technologies being used by the seasonal and environment control units
- Yields obtained were also higher compared to other techniques. Further, such technique improved the consistency of the compost quality

-4 day	:	Mixing and wetting of ingredients is done out door
-3 day	:	Turning, trampling by Bobcat, through mixing of ingredients and addition of water
-2 day	:	High aerobic heap of substrate is made
0 day	:	Filling in phase -I bunker (Blower fan switched on @ 5 min/h)
+3 day	:	Emptying the bunker, turning and mixing of composting mixture and refilling 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 and compost is ready for spawning

## 12. Zero Energy Polytunnel Technique for compost making of button mushroom

The compost prepared in the pasteurization tunnels with air circulation by active pressure though yields better than the long method of composting, the cost involved in machinery and the infrastructure is beyond the reach of resource poor farmers. As an alternative, ICAR-DMR has evolved a novel approach where in the high density polyethylene (HDPE) pipes with holes at regular intervals are inserted through the compost pile.

- It was demonstrated that passive aeration effectively controlled the composting process, shortened the compost period, enhance the substrate quality and *Agaricus* yield as of pile composting.
- The parallel arrangement (10% perforations) of pipes was found best among different passive aeration treatments for achieving the quality substrate in just 16 day and enhance the *A. bisporus* yield up to 27.6%.
- This new intervention also opens the possibility to cultivate *A. bisporus* on a lingo-cellulosic, non-pasteurized, non-conditioned, aerated substrate.
- The shortened composting period from 30 days to 16 days saves considerable amount of energy, labor and cost on infrastructure.



Button mushroom compost preparation by using ZEPT technique

### **13. Post composting supplementation in *Agaricus bisporus* compost**

- Supplements used in the mushroom cultivation can be of both animal and plant origin which may be carbohydrate rich, protein rich or oil rich substances
- Use cotton seed meal, cotton seed cake, soybean meal, defatted soybean cake as supplements. First coarsely grind the supplements
- Sterilize the supplements with 0.5% formaldehyde and add in the compost at the time of spawning @ 1% fresh wt of the compost (One kg of supplement would require around 1.0 ml of commercial formalin dissolved in 700 ml water)
- Solution is properly mixed with supplement and dough is made
- Put dough in some container and seal the container for 48 hrs
- Increase in yield due to supplementation with cottonseed meal or soybean meal is over-whelming (15-20% increase) both on compost prepared by long method and short method

## 14. Management of mushroom flies

- Sticky trap is used for monitoring and management of mushroom flies
- The trap consists of a 15 W yellow bulb and a polythene sheet of any size coated with mustard oil hanged on the wall
- Flies show photo-tactic behaviour in the morning and evening hours and all the flies will stick to the polythene sheet
- This sticky trap became highly popular among the mushroom growers and is widely adopted in almost all the mushroom growing states of India
- In addition to the trap, spraying of deltamethrin, malathion or dichlorvos as adulticides on walls and floor once or twice was found very effective in control of flies



**a. Sciariid fly**



**b. Sciariid larva**



**c. Infected mushroom fruit bodies**



**d. Phorid fly**



**e. Phorid larva**



**f. Infected mushroom fruit bodies**

## 15. Integrated management of wet bubble disease

Wet bubble produces two main symptoms, one if young pin heads are infected they develop monstrous shapes which often do not resemble mushrooms. When infection take place before the differentiation of stipe and pileus the sclerodermoid form resulted, whereas, infection after differentiation resulted in the production of thickened stipe with deformation of the gills.



**Symptoms of wet bubble disease caused by *Mycogone perniciosa***

The integrated approach for management of wet bubble in button mushroom cultivation is as follows

- Always do composting on cemented floor
- Maintain proper moisture in compost and proper pasteurization i.e. 59°C for 6 hours with ample aeration
- Proper pasteurization of casing at 65°C with 65% moisture
- Treat empty room with 2% formalin
- Maintain proper hygiene and sanitation in and around mushroom house
- Use foot dips
- Harvesting should be done from new rooms to older rooms

- Use light trap for monitoring and controlling mushroom flies
- Cook out either by chemical means or by using steam)
- Drench with 2% formalin before disposing off the bags or maintain 70°C temperature inside rooms for 8-10 hours
- Dispose off spent mushroom substrate in pits away from mushroom farm and cover it with layer of soil
- Ensure the cleanness of machinery and all equipment for spawning and compost filling
- Ensure the cleanliness of growing rooms (Floor, walls, shelves, cloths, racks and other equipment and tools must be thoroughly cleaned and treated with disinfectants)
- When the work is done, the machinery, equipment and rooms must be cleaned and washed
- Disinfect the machinery, equipments and the corridor following the route of transportation, the nets, cloths and other inventory with 2% formalin solution before starting work
- Maintain the time needed for the contact action of the disinfectant and the processed surface (not less than 20 minutes), then thoroughly ventilate the growing rooms
- During compost filling and spawning, the personnel doing this work isn't allowed to enter a clean corridor or the warehouse, or contact personnel engaged in harvesting mushrooms
- The components for the preparation of the casing soil must be stored special places, not allowing them to be mixed
- Keep the room clean where the casing soil is stored along with the area adjacent to it
- Transport the casing mixture and its components to the growing rooms only in thoroughly washed and cleaned transportation
- After the application of casing layer, immediately remove the remains of the casing mixture from the working corridor and the growing room, then clean the floor, machinery and equipment
- During the process, there should not be any work that doesn't have to do with the application of casing layer going on in the working corridor; the passageway must be closed
- Alternatively, a spray of 0.8% formalin on to casing surface, immediately after casing, can be effective. However, this concentration is injurious if used at a later stage during crop development

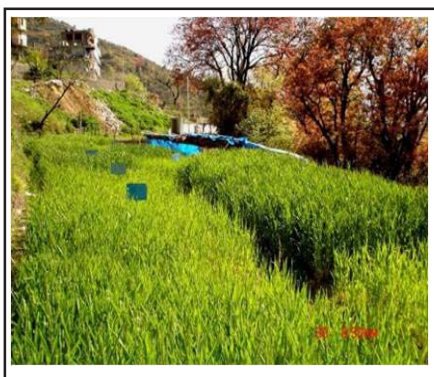


## **16. Techniques for enhancement of quality and shelf-life in harvested button mushroom**

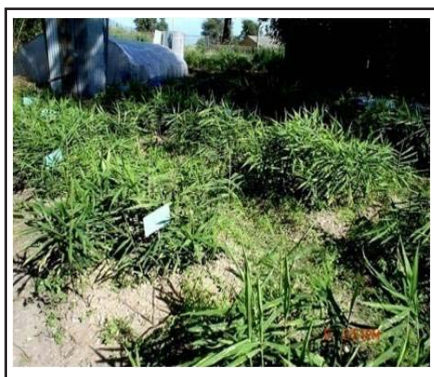
- Spray 0.2% solution of  $\text{CaCl}_2$  on mushroom beds starting from pinhead initiation stage up to completion.
- Wash mushrooms with solution of 0.02% KMS+100ppm EDTA. It helps in maintaining superior quality of the stored mushroom.
- Pack the mushrooms in 100 gauge thick polypropylene bags which helps in retaining the quality for a much longer period than packaging in ordinary polythene bags.

## 17. Recycling of spent mushroom substrate (SMS)

- SMS does not fall in the category of hazardous substances as it does not contain heavy metals.
- Fresh SMS contains 1.9:0.4:2.4% (NPK), while 8-16 months old contains 1.9:0.6:1.0 (NPK).
- SMS obtained from various sources vary in its physical and chemical properties.
- Treatments like rapid salt leaching and re-composting by aerobic or anaerobic methods for one to two years make SMS more suitable for growing flowers, vegetables, fruit, saplings, ornamental shrubs and other horticulture plants of economic importance.
- The use of anaerobically recomposted spent mushroom substrate as casing material gave superior button mushroom yield with better diseases management.
- SMS of paddy straw, oyster and button mushrooms can be used as feeding material for vermi-composting.



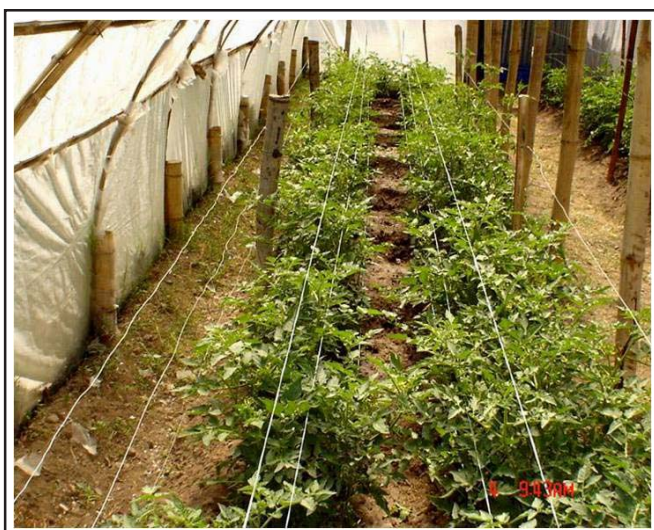
a. Wheat



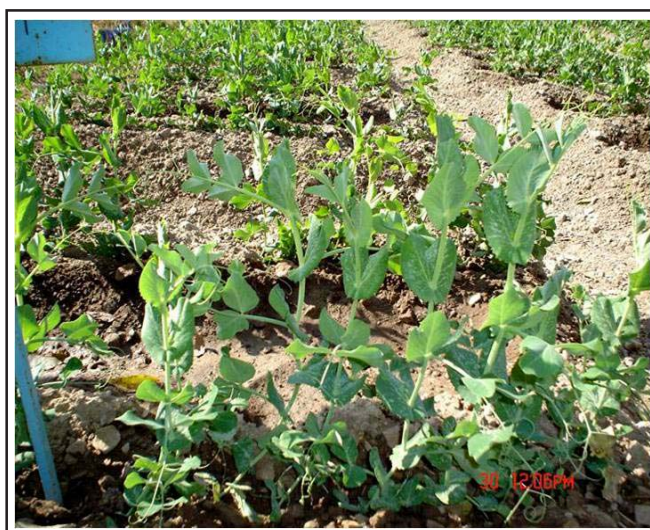
b. Ginger



c. Capsicum



d. Tomato



e. Pea

**Raising of different field and horticultural crops in soils amended with SMS of *A.bisporus***



