

# **MUSHROOM CULTIVATION**

**A profitable Enterprise**

# Mushrooms – the only vegetable source of Vit. D



**Exposing mushrooms to UV light for one hour increased Vit. D content by 100 times**

# Steps to be understand

**1.  
Mushroom  
Science**

**2.  
Mushroom  
Biotechnolo  
gy**

**3.  
Mushroom  
Mycorestora  
tion**

# 1. MUSHROOM SCIENCE

## Production of mushrooms for food

A. Mushroom Biology



B. Compost Technology



C. Environmental  
Technology



# 2. MUSHROOM BIOTECHNOLOGY

## Mushroom derivatives for health

A. Mushroom Biology



B. Fermentation  
Technology



C. Bioprocess Parameters



# 3. MUSHROOM MYCORESTORATION

## Beneficial Environmental effects

A. Mushroom Biology



B. Mushroom Ecology



C. Bioremediation  
Technology



# CULTIVATION

## Steps of cultivation



```
graph LR; A[Spawn] --> B[Compost]; B --> C[Cropping]; C --> D[Processing]; D --> E[Marketing]
```

Spawn

Compost

Cropping

Processing

Marketing

# Conditions To be Monitor: Production Stage

- **Spawn Run**

conditions during mycelial colonization of the substrate

- **Pinhead Initiation**

conditions for fructification to occur

- **Cropping**

conditions needed to sustain the cyclic production of mushrooms or flushing



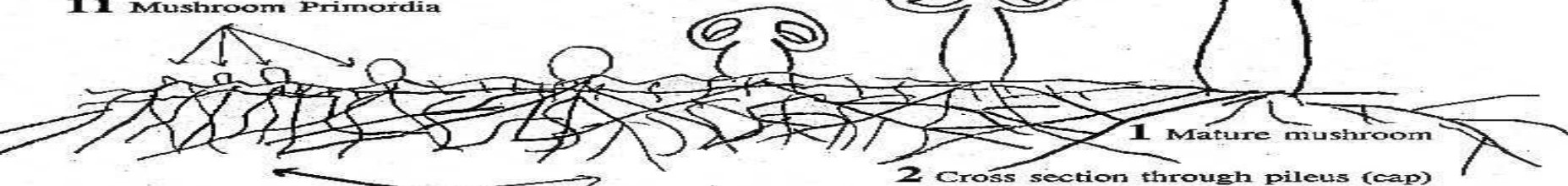
# Conditions to Monitor: Culture Parameters

- **Relative Humidity**
- **Air Temperature**
- **Duration of Stage**
- **CO<sub>2</sub>**
- **Fresh Air Exchanges**
- **Light**
- **Intervals**
- **Watering**

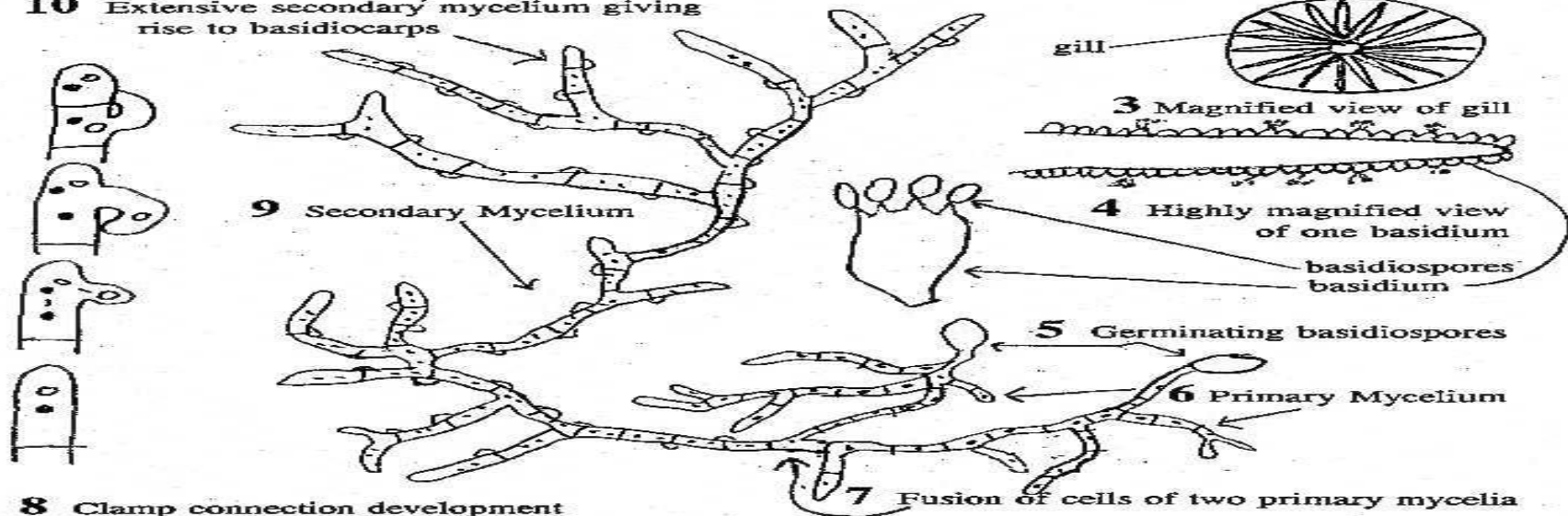
## Basidiomycete Life Cycle

This handout illustrates the generalized features of a typical basidiomycete mushroom life cycle. Certain aspects of this life cycle may vary among genera and species, but the basic features hold true for most mushrooms. Explanations of the numbered diagrams follow on the second page.

### 11 Mushroom Primordia



### 10 Extensive secondary mycelium giving rise to basidiocarps



# Commonly Cultivated Edible Mushrooms

- ▣ **Button Mushrooms - *Agaricus* spp.**
- ▣ **Oyster Mushrooms - *Pleurotus* spp.**
- ▣ **Shiitake - *Lentinula edodes***
- ▣ **Paddy Straw - *Volvariella volvacea***
- ▣ **Milky Mushroom - *Macrocybe* spp.**
- ▣ **Reishi or Ling Chi - *Ganoderma lucidum***

# More Cultivated Edible Mushrooms

- ▣ **White Jelly - Tremella**
- ▣ **Inky caps - Coprinus comatus**
- ▣ **Winter Mushroom - Flammulina velutipes**
- ▣ **Nameko - Pholiota nameko**
- ▣ **Ears - Auricularia spp.**
- ▣ **Chicken-of-the-Woods - Polyporus sulphureus**

# Limited Cultivated Edible Mushrooms

- ▣ **Morel - *Morchella esculenta***
- ▣ **White Truffle - Tuber**
- ▣ **Maize Mushroom - *Ustilago maydis***

# Button Mushroom: *Agaricus* spp. (16-18°C)



# Button Mushroom cultivation

**The cultivation may be of two types:**

**a. Outdoor**

**b. Indoor activities, however, the steps involve:**

- ▣ Compost preparation**
- ▣ Spawn-run**
- ▣ Casing**
- ▣ Cropping and harvest**

# Compost Preparation

**Compost is a selective decomposed substrate for growing white button mushroom**

- ▣ **Paddy straw**
- ▣ **Wheat straw**
- ▣ **Corn straw and cobs**
- ▣ **Sugarcane straw**



# Spawn-run

1. Double layer spawning
2. Top layer spawning
3. Through spawning
4. Shake up spawnin
5. Spot spawning
  - Temperature:  $23 \pm 1^\circ\text{C}$
  - RH: 95%
  - CO<sub>2</sub> concentration: 1.0-1.5% and keeping the bags under above conditions for 12-14 days
  - Completion of spawn run (change of dark brown compost into light brown colour)

# Casing

- To promote sporophore production in button mushroom, a relatively biological inert material is added as surface layer to the fully colonized compost
  - This casing layer is usually 3.8 to 5.0 cm deep and usually applied after approximately 2 weeks of spawning
  - This casing layer must have a neutral or alkaline pH
- A number of mixtures could be used as casing soil
1. Soil: peat mixture in 2 : 1 or 3 : 1 ratio
  2. Soil and sand mixture in 2 : 1 ratio
  3. Well-rotten cow dung mixed with light soil in 3 : 1 ratio

# Quality of casing material

- ▣ 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  $\mu$  moh)

# Cropping and harvest



**Mushroom crop in polythene bags**



**Mushroom crop in aluminum trays**



**Mushroom crop baskets**



**Mushroom crop in plastic trays**

# Oyster Mushroom: *Pleurotus* sp. (20-30+°C)



# Commonly Cultivated Oyster Mushrooms

- ▣ ***Pleurotus citrinopileatus* - Golden Oyster**
- ▣ ***Pleurotus columbinus* - Blue Oyster**
- ▣ ***Pleurotus flabellatus* - Strawberry Oyster**
- ▣ ***Pleurotus ostreatus* - Pearl Oyster, Hiratake**
- ▣ ***Pleurotus florida* - Florida Oyster**
- ▣ ***Pleurotus pulmonarius* - Phoenix Oyster**
- ▣ ***Pleurotus sajor-caju* - Tropical Phoenix Oyster**



# Pleurotus spp.

## Spawn Run Parameters

- ▣ **Relative Humidity: 90-100%.**
- ▣ **Substrate Temp: Fastest growth 25 - 28°C.**  
Thermal death occurs above 40°C / 48 hr.
- ▣ **Duration: 10-14 days for colonization.**
- ▣ **CO<sub>2</sub>: 20,000 ppm or 20% by volume**  
Growth is stimulated up to 28,000 ppm.
- ▣ **Fresh Air Exchanges: None (0/hr).**
- ▣ **Light: Incubation in total darkness.**

# Pleurotus spp. Pinhead Initiation Parameters

- ▣ **Relative Humidity: 95%.**
- ▣ **Air Temp: 12-15°C**
- ▣ **Duration: 7-14 days.**
- ▣ **CO<sub>2</sub>: less than 600 ppm.**
- ▣ **Fresh Air Exchanges: 4/hr.**
- ▣ **Light: Phototropic**, exposure of 2,000 lux/hr for 12 hr/day. Grow lux type fluorescent lighting recommended, Diffuse natural light is sufficient.
- ▣ **Watering: Regular misting once to twice daily**  
until fruit bodies are 30-40% harvest size.



# Pleurotus spp.

## Cropping Parameters

- ▣ **Relative Humidity: 85-92%.**
- ▣ **Air Temp: 15-17°C**
- ▣ **Duration: 5-7 weeks.**
- ▣ **CO<sub>2</sub>: less than 600 ppm.**
- ▣ **Fresh Air Exchanges: 4-6/hr.**
- ▣ **Light: Same as for pinhead initiation.**
- ▣ **Harvest Stage: Directly before incurved margins**
- ▣ **Flush Intervals: ~10 days.**
- ▣ **Watering: Regular misting to prevent caps from cracking and to keep resting pinheads viable**

# Pleurotus spp. @ Harvest

- ▣ **Moisture Content: 91% water,**

For every 100 g of fresh weight of mushrooms, we get only 52.36 g of dry matter after dehydration, losing 47.64 g of water.

- ▣ **Nutritional Content: Crude Protein**

30.4% of dry weight.

- ▣ **Yield Potential: Average commercial yield are**

1 kilogram fresh weight of mushrooms per kilogram of dry weight of substrate.

- ▣ **Biological Efficiency: 100% or more.**

# Grower to choose the component

Spawn Unit	Compost Unit	Cropping	Technical competence	Risk
			High	High
			High	Med
			Med	Med
			High	Low
			Med	Med
			Low	High

# Milky Mushroom: *Macrocybe* sp. (18-20°C)





# Paddy straw mushroom: *Volvvariella volvacea* (30-38°C)



# Shiitake Mushroom: *Lentinula* (*Lentinus*) *edodes* (18-22°C)





# Winter mushroom: *Flammulina* Sp. (10-14°C)



# Reishi or Ling Chi: *Ganoderma* sp. (20-22°C)





# Commercializing Technologies

- ▣ **Button mushroom:** In view of the fast rate of growth
- ▣ **Oyster mushroom:** Cultivation of oyster mushroom in the tropical and sub-tropical regions has tremendous potential
- ▣ **Paddy straw mushroom:** Potential of this mushroom remains under exploited despite abundant availability
- ▣ **Milky Mushroom:** Cultivation under controlled environment

# Mushroom Marketing

- ▣ Door to door
- ▣ Farmer to big stores, hotels
- ▣ Farmer to local market
- ▣ Distributer to farmer



# Value added products

- ▣ Mushroom pickle
- ▣ Mushroom nuggets
- ▣ Mushroom cookies
- ▣ Mushroom soup powder
- ▣ Mushroom ketchup
- ▣ Mushroom candy
- ▣ Mushroom papad
- ▣ Mushroom powder .....

# Advantages of Mushroom Production

- 1. Bioconversion exercise reduces environmental pollution**
- 2. Generating employment for rural women and youths**
- 3. High quality proteins, minerals and vitamins**
- 4. Source of foreign exchange**
- 5. Short return agricultural business**

# Mushroom production in India

(in tons)

Button	Oyster	Milky	Paddy straw	Total

# Challenges

- ▣ **Conserving Biodiversity** - need to collect and conserve this biodiversity
- ▣ **Characterizing Biodiversity** - industrially and medicinally important compounds
- ▣ **Understanding Biodiversity** - pattern of life cycle and sexuality for domestication
- ▣ **Exploiting Biodiversity** - developing superior strains

# Research Areas

- ▣ **Propagating Quality Planting Material (Spawn)** - Development of spawn standards, commercial production and availability in all parts
- ▣ **Utilizing Spent Mushroom Substrate** - Need for innovative utilization methods for a zero waste industry
- ▣ **Integrated Pest Management** -Bio-sensors for detecting pathogenic microbes, hygiene standards and bio-control agents

# Research Areas

- ▣ **Postharvest Technology-** Mushroom flavors, Designer mushrooms for health basket and novel compounds
- ▣ **Transfer of Technology with Information Technology** -Models for awareness generation to promote consumption and to enhance production



# Future prospects

**Future depends on positive interactions among “researchers, extension workers, farmers, industry and policy makers”**

**Need for synchronized approach in**

- ▣ **Systematically generating the awareness about mushroom consumption**
- ▣ **Proper technologies for mushroom cultivation**
- ▣ **Development of marketing chains for supply of fresh mushrooms**
- ▣ **Production of indigenous mushroom products**