CULTIVATING MUSHROOMS on SMALL FAMILY FARMS

María de la Fuente

Commonly Cultivated Edible Fungi

- Button Mushrooms — *Agaricus spp.*
- Oyster Mushrooms — *Pleurotus spp.*
- Shiitake — *Lentinula edodes*
- Reishi or Ling Chi — *Ganoderma lucidum*
- Lion's Mane — *Hericium erinaceus*
- Nameko — *Pholiota nameko*
- Ears — *Auricularia* spp.
- Chicken-of-the-Woods — *Polyporus sulphureus*

More Cultivated Edible Fungi

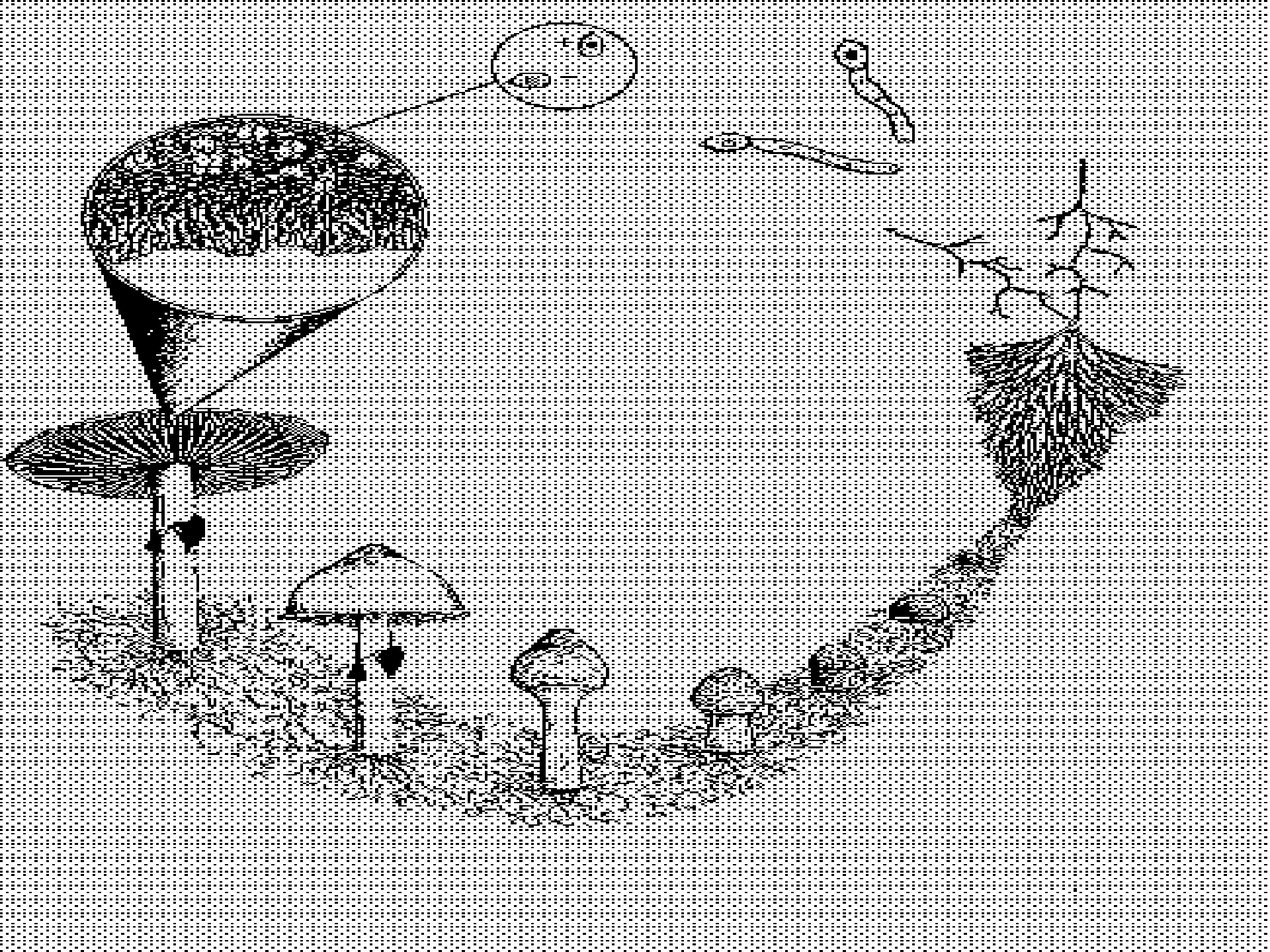
- White jelly — *Tremella* spp.
- Shaggy Mane — *Coprinus comatus*
- Garden Giant — *Stropharia rugoso-annulata*
- Paddy Straw — *Volvariella volvacea*
- Velvet-stemmed or Enokitake — *Flammulina velutipes*
- Maitake or Hen-of-the-Woods — *Grifola frondosa*

Limited Cultivation Edible Fungi

« Morel	*Morchella esculenta*
« Black Morel	*Morchella angusticeps*
« Summer White Truffle	*Tuber aestivum*
« White Italian Truffle	*Tuber magnatum*
« Black Perigord Truffle	*Tuber melanosporum*
« Chanterelles	*Cantharellus* spp.
« Maize Mushroom	*Ustilago maydis*

Commonly Cultivated *Agaricus* Mushrooms

- *Agaricus augustus* — Prince Button Mushroom
- *Agaricus bisporus "portobello"* — Italian *Agaricus* or Portobello
- *Agaricus bitorquis* — Warm-Weather Button
- *Agaricus bisporus* (=*A. brunnescens*) — White Button Mushroom

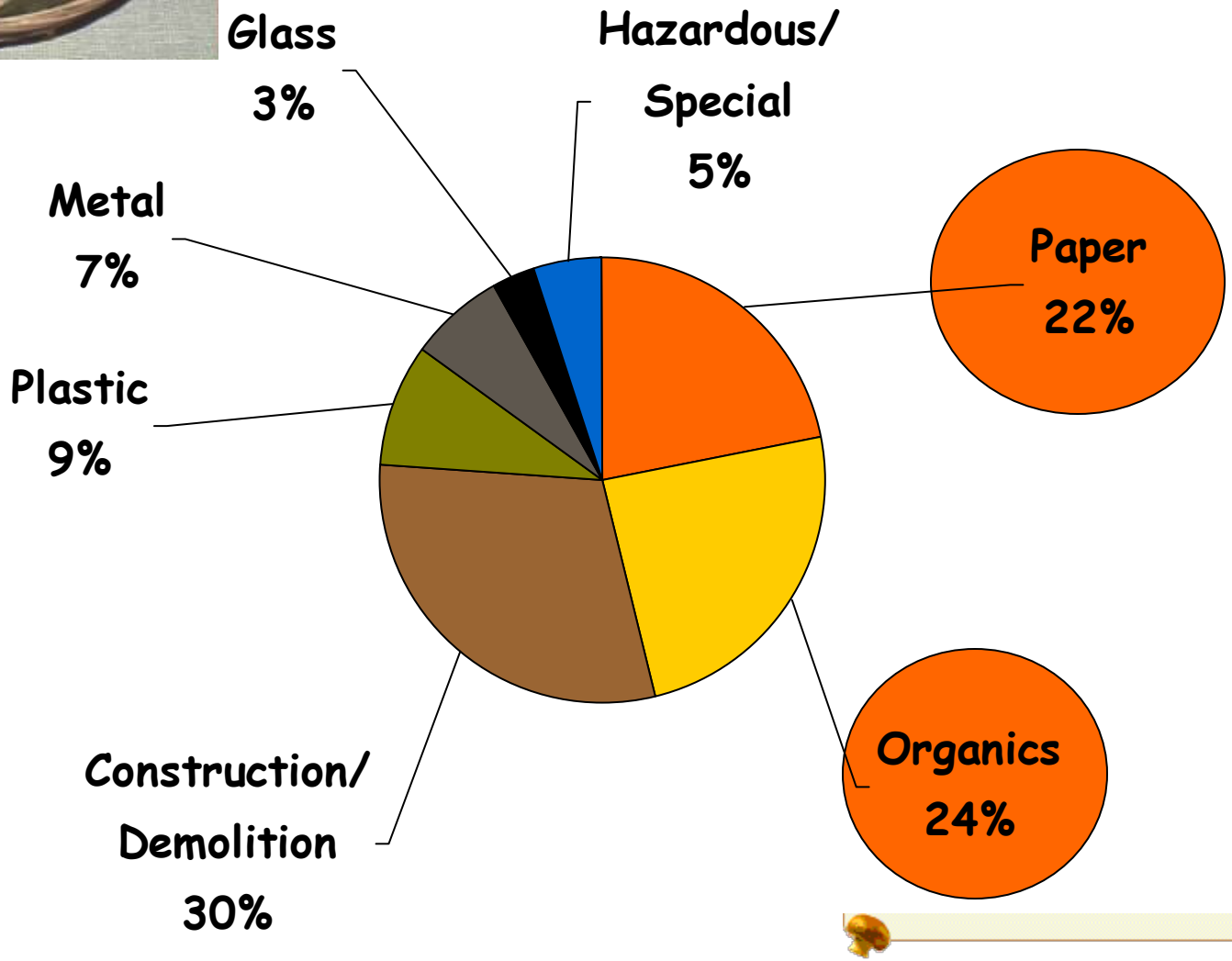


Recycling Waste Materials

- Worldwide interest in growing specialty mushrooms for their food (nutritional) and medicinal value.
- Assembly Bill 939 of the Integrated Waste Management Act required a 25% diversion of the state's waste from landfills by 1995, and a 50% diversion by 2000. The city of San Jose through its program "Agriculture in Partnership" found new approaches for the management of the city recollections and have an impact on local agriculture.
- Organic food and fiber are gaining popularity in both the United States and abroad. It is a $ 1 billion industry that spans from the farmer's market to major manufacturers of foods.

Waste and Recycling

Waste Characterization Study Composition of Materials going to Landfill



City Curb Side Collection

Municipal Composting Facility

Schematic Process

Culture Parameters or Conditions to Monitor

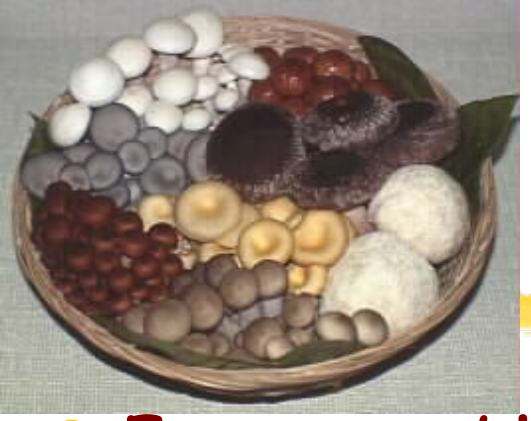
- Relative Humidity:
- Air T:
- Duration of Stage:
- CO_2:
- Fresh Air Exchanges:
- Light:
- Intervals:
- Watering:

Culture Parameters at Every Production Stage

- **Spawn Run Parameters** or conditions during mycelial colonization of the substrate.
- **Pinhead Initiation Parameters** or conditions for fructification to occur.
- **Cropping Parameters** or conditions needed to sustain the cyclic production of mushrooms or flushing.

Insulation Material

- External walls and ceiling insulated with insulation boards, Tuff-R Blackore ®, an insulating sheathing made by Celofex ®, consistent of semi-rigid carbon black-filled polyisocyanurate-foam with aluminum foil faces on both sides of about ¾ inch thickness.
  This gives an insulation coefficient of R=7.5.
- Wooden floors twice treated with waterproof varnish.



Plastic Shelves

- Easy assembly 18" depth, 36" long by 18" wide plastic shelves, made into 4, 5 or 6 tiers (58", 72", or 86") height according to slopped ceiling (6'10" to 10' height), were distributed to accommodate maximum capacity and permit air flow and laborer movement in the shed.
- Shelf system is economic heavy-duty made of high-impact plastic resin, for indoor and outdoor use, that will not rust, stain, peel or bend, and that with equally distributed weight can hold up to 750 pounds per 5 assembled shelves.
- The shelves are vented, thus preventing mold and mildew development, and feet raise shelf off floor, allowing dripping of water excess, airflow and cleaning undersurface.

Semi-Controlled Conditions

- Temperature of substrate: pocket thermometers (metal 1-inch dial and 5-inch stem)
- Air temperature and relative humidity: battery operated LCD digital thermometer/hygrometer (Thermo-Hygro ®), which also shows temperature maximums and minimums.
- Relative Humidity: time-set semi-automated misting system (Raindial – Irritrol Systems ® Model RD 600 Ext).
- PVC pipes: along the production areas on the ceiling, with Turbo-Flo ® Misters, extremely low flow (1/2 gph) and very small droplet size.

Oyster Mushroom Production

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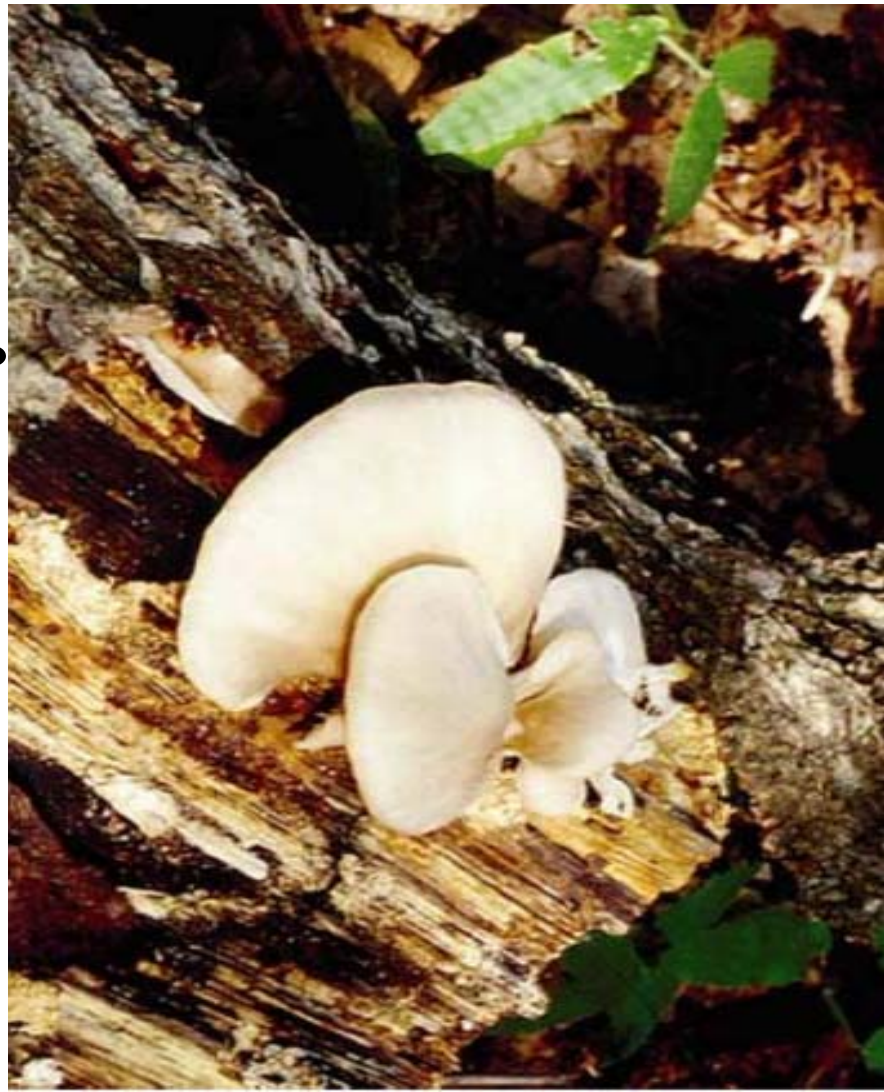
Pleurotus spp.



Natural

Habitat

Biology

- ***Pleurotus spp.*** efficiently utilizes its substrate. Its ability to fruit on a single component substrate, to permeate the straw rapidly while tolerating high carbon dioxide levels and to produce abundant crops within a short time period, makes it ideal for small scale cultivation.

Pleurotus spp. Production Systems

Pleurotus spp. Spawn Run Parameters

(Substrate Colonization)

- **Relative Humidity**: 90-100%.
- **Substrate T**: Fastest growth 78-84°F. Thermal death occurs above 104°F /48 hr.
- **Duration**: 10-14 days for colonization.
- **CO_2**: 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 T**: 55-60°F
- **Duration**: 7-14 days. **CO_2**: less than 600 ppm.
- **Fresh Air Exchanges**: 4/hr.
- **Light**: Phototropic, most responsive to an 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.

Primordia or Pinheads

Fruiting Clusters

Pleurotus spp. Cropping Parameters

- **Relative Humidity**: 85-92%. **Air T**: 60-64°F
- **Duration**: 5-7 weeks. **CO_2**: less than 600 ppm.
- **Fresh Air Exchanges**: 4-6/hr.
- **Light**: Same as for pinhead initiation.
- **Harvest Stage**: Directly before incurved margins elevates to plane.
- **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, which means that for every 100 g of fresh weight of mushrooms, we get only 52.36 g of dry matter after dehydration, loosing 47.64 g of water.
- **Nutritional Content**: Crude Protein has been reported at 30.4% of dry weight.
- **Yield Potential**: Average commercial yield are 1 kilogram fresh weight of mushrooms per kilogram of dry weight of straw substrate.
- **Biological Efficiency**: 100% or more.

Shiitake Production

£

Lentinula (Lentinus) edodes

Natural

Habitat

Biology

- ***Lentinula (Lentinus) edodes.*** A wood decomposer, typically saprophytic growing on dead tissue of deciduous trees mainly Fagaceae (oak, chestnut, shiia *(Pasania)* and beech), and fruiting in the fall, early winter and spring.

Shiitake Production Systems

Shiitake Spawn Run Parameters

(Substrate Colonization)

- **Relative Humidity**: 60-75% for logs; 90% for sawdust blocks.
- **Substrate T**: Fastest growth 77°F. Below 41°F and above 95°F mycelial growth halts.
- **Duration**: 6-12 months for logs; 30-60 days for sawdust blocks.
- **CO_2**: None established. **pH**: 5-6
- **Fresh Air Exchanges**: None (0/hr).
- **Light**: None required.

Shiitake Pinhead Initiation Parameters

- **Initiation:** Submerge logs and blocks in cold water for 24-72 hr.
- **Relative Humidity**: 95%. **Air T**: 59-68°F
- **Duration**: 7-14 days after soaking.
- **CO_2**: None
- **Fresh Air Exchanges**: 2 - 4/hr.
- **Light**: Ambiental natural light or optimally 10 lux in the 370-420 nanometer range.

Primordia or Pinheads

Shiitake Cropping Parameters

- **Relative Humidity**: 85-90%. **Air T**: 59-68°F
- **CO_2**: less than 1000 ppm.
- **Fresh Air Exchanges**: 2-4/hr (cooling).
- **Duration**: 3-5 years on oak logs; 2-3 years on alder.
- **Light**: Same as for pinhead initiation.
- **Harvest Stage**: Directly before incurved margins straightens and the cap expands to plane.
- **Flush Intervals**: Outdoor fall and spring; indoor up to 4 flushes depending on soaking schedule.

Shiitake @ Harvest

- **Moisture Content**: 85% water.
- **Nutritional Content**: Crude Protein 10-17.5% and 55 mg niacin/100 g of dry weight.
- **Yield Potential**: Average commercial yield are 2-3 lb fresh weight of mushrooms per log.
- **Biological Efficiency**: 50-145%.


NORTHWEST
SHIITAKE
MUSHROOMS

Biological Efficiency

- Biological Efficiency is the ability of converting dry matter into fresh weight, expressed as percentage.
- To produce one pound of beef, a cow needs 15 lb of dry matter = 6.7%
- To produce one pound of chicken, a chicken needs 5 lb of dry matter = 20%
- To produce 1 lb of mushrooms, substrate needs 1 lb or less of dry matter $\geq$ 100%

Examples of Biological Efficiency

- Oyster Mushrooms = 100 - 200%
- White Button Mushrooms = 70 -100%
- Shiitake = 50 - 145%
- Maitake = 5 - 35%

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