

Mushroom and spawn production: An ideal component for start-ups for unemployed youth

Mushrooms have excellent source of good quality vegetable protein and can produce highest protein in per unit area within short period of time. Mushroom production is considered a highly profitable and environmentally sustainable venture which helps in recycling and management of abundant agricultural wastes which is otherwise burnt in the field by few farmers. Mushrooms have excellent business opportunities which can be opted by any farmers/aspirants/agri-professionals as a start-up with a low investment and minimum space by utilizing vertical spaces. Even after production of the mushroom, spent compost of mushroom can be utilized for making of soilless media for growing of vegetables in polyhouses as well as bioconversion in vermicomposting or may be utilized for growing of organic rich vegetables. Mushroom production technology is highly ideal for women residing in the urban and peri-urban areas for generation of cottage employment which can be helpful in improving their livelihood and nutritional security.

MUSHROOM production technology is getting popularity day by day in the urban and peri-urban area due to increasing demand, superior taste with immuno-boosting properties as well as generation of wealth from the waste and multi-step opportunities for becoming entrepreneurs or setup of new start-ups. Mushroom production technology is highly women friendly due to minimum requirement of the labourers and have ability to produce highest protein in per unit area. It is highly rewarding and fascinating in-house activity for the retired persons, unemployed youth as well as housewives who can grow mushrooms in boxes/bags or any poly-containers in the rooms while attending to several household responsibilities. Mushroom cultivation is carried out indoor in any mud or brick houses/rooms, thatched shed, basement, or garages, etc. and Paddy straw mushroom can be grown inside as well as outside in shady places like fruit orchards of mango or litchi or banana. Among the mushrooms, white button mushroom has maximum share (73%) followed by oyster mushroom (16%), paddy straw mushroom (7%) and milky mushroom (3%) in India. In 2016-2017, Indian Mushroom Industry generated revenue of ₹ 7282.26 lacs by export of 1,054 q of white button mushroom in canned and frozen form. In India, varieties of edible mushroom are grown locally by purchasing of quality mushroom from the seller of mushroom spawn; as per increasing demand of mushroom spawn by the growers, an estimated requirement of spawn is about 8,000-10,000 tonnes/year. Several unemployed youth and aspirants are looking for mushroom production technology as a startups especially in spawn production, button mushroom (*Agaricus bisporus*), oyster mushroom

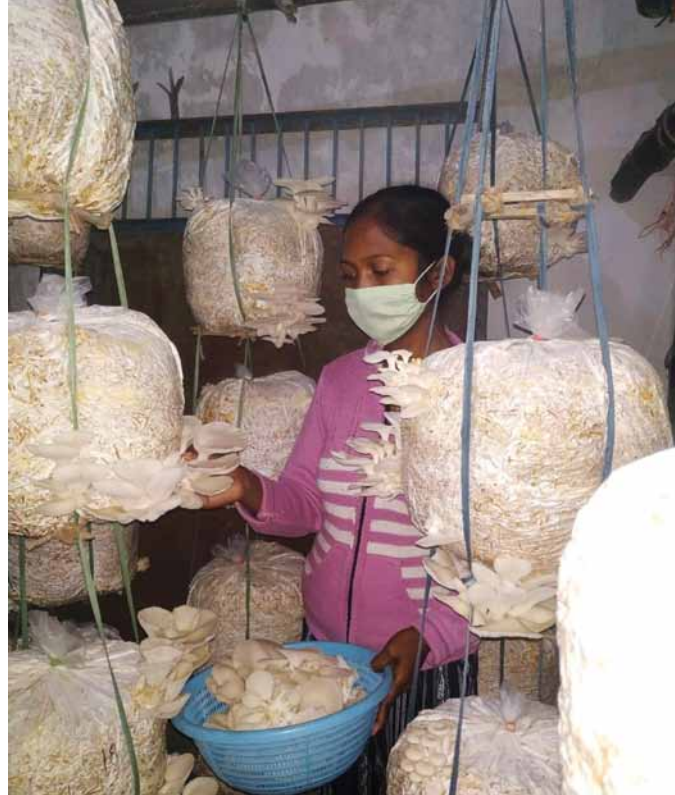
(*Pleurotus* spp.) and medicinal mushrooms like Shiitake (*Lentinus edodes*) and *Cordyceps militaris* of the urban and peri-urban areas due to their marketing.

Business opportunities/model in mushroom

Setup of mushroom spawn production unit as a profitable venture: Mushroom spawn production is a profitable agribusiness model/venture and can be started with minimum investment in short period of time. In India, the demand of high-quality mushroom spawn is increasing day-by-day due to gradually increasing popularity as a cottage or naturally ventilated production and in controlled conditions production units. A setup of successful venture of mushroom spawn production unit requires hands on training (3-5 days) and roughly ₹ 4-6 lakhs for purchase of basic microbiological equipment's likewise Autoclave, laminar flow/biosafety, hot air oven and air conditioner and two room set of infrastructure. Mushroom spawn can be produced in three simple steps, 1. Preparation of mushroom spawn substrates by soaking, washing, boiling of the grain's substrates, 2. Sterilization of the prepared substrates in poly propylene bags with the help of autoclaves at 121°C (16 lbs) for one hour, 3. Inoculation and incubation of the sterilized substrates first inoculated with mother spawn (button/oyster/milky or shiitake) which can be prepared by the tissue culture on malt extract agar medium or potato dextrose agar medium of the mushroom and these tissue culture mycelium are used for growing of mother spawn on sterilized grains in bottles and this mother spawn is further used in multiplication/production of commercial spawn. One bottle of mother spawn (300 g) is sufficient

to multiply in 25-30 polypropylene bags (wt. 500 g/bag) and after inoculation, inoculated bags are incubated at ambient temperature or $24\pm 2^{\circ}\text{C}$. Mission of Integrated Development of Horticulture (MIDH), Government of India is providing 40% subsidy of the total cost of ₹ 15 lakhs for the set-up mushroom spawn production unit. Moreover, ICAR-Indian Institute of Vegetable Research, Varanasi regularly organizes training for capacity building of trainees, aspirants and incubates of the region to set-up mushroom spawn production unit. Several spawn units have been established at our incubates as a capacity of technological partner to supply quality mushroom spawn to the growers of urban and peri-urban areas in the city namely, 1. Mrs Anupama Singh, Tikari, Varanasi, UP, running her 'Anupama mushroom spawn production unit' and her annual production of spawn is around 25 q and a total sale of ₹ 2-2.5 lakhs by spawn. 2. Mrs Sheela, Husainabad, Jaunpur, UP running her 'Om Mushroom Spawn Production Unit, and supplying oyster, milky and button mushroom to the growers and her annual production of spawn is around 15-20 q and a total sale of ₹ 1.5-2.0 lakhs by spawn.

Set of *Pleurotus* (oyster) mushroom production unit: A profitable cottage business: In India, *Pleurotus* is gaining popularity day by day due to ease of growth, doubling income in short period of time and required minimum investment and it can grow in thatched or mud or brick house. Among the *Pleurotus*, species very much popular among the growers are *P. sajor-caju*, *P. florida*, *P. sapidus*, *P. eryngii*, *P. columbinus*, *P. cornucopiae*, *P. flabellatus*, *P. oestriatus*, *P. citrinopileatus*. *Pleurotus* can grow on various agricultural waste materials like wheat or paddy straw, dried banana leaves, legume substrates, groundnut shells, dried weeds, wooden logs, corncobs, dried water hyacinth, sugarcane bagasse, cotton waste and sawdust. Most of the species of *Pleurotus* grows in a temperature range of 20° to 30°C (optimum temperature $24\pm 2^{\circ}\text{C}$) and can grow organically by substrate sterilization by boiling or steaming as well as by chemical sterilization. In chemical sterilization, substrate is soaked in Carbendazim @7-10 g/100 L and Formaldehyde (37% @100 ml/ 100 L of water) for 16-18 hr. Sterilized substrates, after surface drying, are filled in bag prepared by spawning @2-2.5% of the wet substrate in PP bags, and then making holes (0.25-0.5 cm at 10-15 cm distance) all over the surface of the bag for free diffusion of gases and heat generated inside. Relative humidity in growing room should range between 85-90% during spawn-run and production. An average biological efficiency (fresh weight of mushrooms harvested divided by dry substrate weight $\times 100$) can range between 70-80% or more depending on the substrate. To harvest the mushrooms, they are gripped by the stalk and gently twisted. The oyster mushrooms remain fresh for 3 to 6 days in a refrigerator/cool place. In oyster mushroom production, ABI unit of ICAR-IIVR, Varanasi developed several success stories and several trainees and incubates engaged in oyster mushroom production and are getting excellent production in Oyster. Among some successful entrepreneurs/incubates, most of the entrepreneurs are from the peri-urban area due to huge availability of the agricultural wastes from the rural areas and high demand



of oyster mushroom in the city, viz. 1. Mr. Surya Kant Maurya, Shevapuri, Varanasi, is running his oyster mushroom production unit and his daily production has already reached up to 20 kg/day and selling their fresh produce @₹120/kg and also selling dried oyster mushroom @₹700/kg and his annual income is around ₹ 1.50 lakhs, 2. Mr. Manoj Kumar Shulka, Aurai, Bhadohi also engaged in oyster mushroom cultivation and his daily oyster mushroom production is around 10-12 kg/day and dealing dried oyster mushroom @₹750-800/kg and his annual income is around ₹2.0 lakhs. Moreover, a women group of Bhavanipur, Varanasi also engaged in oyster mushroom production and are getting very good business in their village by the increasing demand of fresh and dried oyster mushroom.

Seasonal and controlled condition button mushroom: In India, seasonal button mushrooms are very much popular among the growers and consumers but have very limited window for production especially during winter months (November-February) in the north-west plains of India and for 7-8 months on the hills, while production of controlled environment-cropping rooms are getting popularity day-by-day for round year production. White button mushroom requires $20-22^{\circ}\text{C}$ for vegetative growth (spawn run) and $12-18^{\circ}\text{C}$ for reproductive growth with relative humidity of 80-90% and proper ventilation. In modern cultivation technology, controlled conditioned room, button mushroom cultivation has two major components, i.e. composting (preparation of substrate/compost), and crop management (raising of mushroom crop). Composting is the method in which microbes act upon the substrate (organic and inorganic), resulting in changed physical and chemical property of the substrate on which mycelium of mushroom can grow and compost is prepared by aerobic decomposition process and then after needed pasteurization of compost in pasteurization tunnel or bunker. Compost is generally pasteurized to destroy undesirable micro- and macro-organisms. In pasteurization tunnels the temperature in compost is



maintained at 45°C for 4-5 days. The heat treatment reduces the amount of mesophilic microorganism in the substrate. Thermophilic microfauna, although able to survive the heating process, will be deactivated when the temperature drops to cultivation values (22-24°C) by cooling. The compost is pasteurized not sterilized since the presence of certain microorganism in compost is essential. The mixing of compost and spawn can be done @ 0.75-1% spawn per quintal compost and spawned compost is filled in polythene bags or trays. The spawned bags should be kept in the crop room for spawn run. Spawn run is the spread of mycelium of the mushroom throughout the compost within 12-15 days and during spawn run, temperature and relative humidity should range between 20-24°C and 85-95%, respectively. When mycelium covers entire surface of compost within 12-15 days then casing by mixing of 2 years old FYM (Farmyard manure) and 2 years old spent mushroom compost in 1:1 ratio or by cocopeat should be done. Then casing materials are sterilized by formaldehyde (4%) for the treatment of casing mixture. Then this mixture is covered with polythene sheet for 48 hr. Pin head initiation takes place after 10-12 days of casing and the fruiting bodies of the mushroom can be harvested for around 32-40 days after spawning. The crops should be harvested before the gills open. From 100 kg compost prepared by long method of composting 18-20 kg of button mushroom can be obtained. Similarly, 24-26 kg button mushroom can be obtained from pasteurized compost in controlled condition. In seasonal and controlled condition, button mushroom cultivation, several success stories have developed who are running their controlled condition button mushroom production unit. Among some successful entrepreneurs, most of

the entrepreneurs run their units in the peri-urban area due to easily availability of the agricultural waste at a reasonable price from the rural areas and high demand of button mushroom in the city. Among the successful entrepreneurs, Mr. Shubham Modi, Ranchi, Jharkhand, a successful entrepreneur is running two controlled condition button mushroom production units and one unit has total capacity of production of button mushroom 1,200-1,500 kg/day and his second unit capacity is around 400-500 kg/day as well as he also engaged in selling of readymade button mushroom compost to the aspirants and growers of the city and his total annual turnover is around >₹1.0 crores. Like Shubham Modi, several other button mushroom producers also engaged in controlled condition, Mr. Dilip Kumar Pandey, Mataldei, Varanasi is running his controlled condition unit of button mushroom production and is selling readymade button mushroom compost. His total annual income is around ₹25 lakhs per year.

Seasonal cultivation of Indian mushroom (Tropical mushroom) or Milky mushroom: *Calocybe indica* is an edible white summer mushroom also known as milky mushroom. It can be easily grown in the temperature range of 25-35°C. It has moderate protein content and has a good biological efficiency (80-100%) under optimum conditions. Its sporophores have long shelf life. The major advantage is that it can be best fitted in relay cropping when no other mushroom can be grown at higher temperature. *Calocybe indica* has a very good scope for further cultivation and it can replace the other tropical mushrooms like *Pleurotus* sp. and *Volvariella* sp. In milky mushroom cultivation, several success stories have developed. Among the successful entrepreneurs, Mr. Ajay Kumar Pandit, is a progressive mushroom entrepreneur who engaged in milky mushroom as well as in oyster mushroom and generated more than ₹1.5-2.0 lakhs annually.



Pinning of *Calocybe*

Seasonal cultivation of paddy-straw/para mushroom: *Volvariella volvacea*, the paddy straw mushroom, or straw mushroom is the most popular mushroom in Southeast



Matured fruiting bodies of milky mushroom

Asia. *V. diplasia* is white while *V. volvacea* is blackish. *V. bombycine* differs from the cultivated *V. volvacea* in terms of habitat as well as colour. Cultivation of this mushroom started in China almost three hundred years ago. Several species of *Volvariella* have been grown for food. *V. bombycina* and *V. diplasia*, have been cultivated in India. *Volvariella volvacea* thrives in a temperature range of 28 to 38°C and relative humidity of 75-85%. In a modified method of cultivation, bundled substrates (rice straw, banana leaves or water hyacinth), prepared in the same way as those used for beds, are soaked in water, drained, then packed (layered) in the wooden frames. Spawn is mixed in with each layer as the frame is packed or filled. The spawned substrate in the boxes may be placed in a specially built incubation room with a high temperature (35 to 38°C) and high relative humidity (at least 75%), or it may be covered with plastic sheets and placed under shade outdoors. For spawning, the air temperature is cooled to 35°C and the bed temperature to about 28 to 32°C. The amount of spawn to be used is calculated at 1.5% of wet weight basis.

Seasonal and controlled cultivation of Shiitake mushroom: Shiitake (*Lentinula edodes*) is the most

important culinary medicinal mushroom which ranks at number two in terms of total mushroom production in the world only next to button mushroom. Shiitake is a prized mushroom with a delicious taste and texture. It is used medicinally for diseases involving depressed immune function including cancer, AIDS, environmental allergies, *Candida* infections and frequent flu and colds. Shiitake is also beneficial for soothing bronchial inflammation and regulating urine incontinence as well as for reducing chronic high cholesterol. *Lentinan* (a cell-wall constituent extracted from the fruiting bodies of shiitake) is an immunomodulating agent which may be useful both as a general rejuvenative for older persons, as well as prophylactically to protect healthy, physically active young people from overwork and exhaustion. The commercial cultivation can be carried out on sawdust of broad leave trees mainly tiny branches of mango, safeda, oak, maple and poplar using saw dust (80 kg), wheat bran (19 kg) and calcium carbonate (1 kg). Water should be adjusted to 60-65% and pH to be adjusted to 5.5-6.0 using gypsum. Saw dust is soaked for 16-18 hours and wheat bran for three hours. All the ingredients are thoroughly mixed. Filling and sterilization of bags: Bags should be filled (1.5 to 2 kg) immediately after mixing all the ingredients. Otherwise, fermentation and contamination may start. Polypropylene (heat resistant) bags are used for filling. The bags are first loosely filled and later pressed to get cylindrical shape. After filling the bag PVC or iron ring is inserted at the mouth of the bag and plugged with non-absorbent cotton. Sterilization is carried out in an autoclave at 22 psi for 1½-2 hr. Spawning is carried out by removing the cotton plugs. Grain spawn is introduced @3% (dry wt. basis) under aseptic conditions. After inoculation bags are placed in cropping rooms where these are incubated in a 4 h/20 h light/dark cycles at 22-26°C. Spawn run may take 60-80 days or more depending upon the strain and environmental conditions. During the period it goes through mycelial growth, mycelial coat, mycelial bump, pigmentation/browning, and coat hardening phase. A thick mycelial sheet coat will develop on the surface of the substrate. This will be formed after 6-8 weeks of inoculation/spawning in natural condition and in controlled condition 3-4 weeks are needed. Bumps



Fruiting of paddy straw mushroom (Vv-7)



Fruiting of paddy straw mushroom (Vv-5)



are clumps of mycelium, commonly formed on the surface of most strains after 8-9 weeks while in controlled condition 7-8 weeks are required. These bumps can turn into mushroom primordia at a later stage but most of them abort. Fluctuating low temperatures and high CO₂ promotes bump formation. Induction of fruiting bodies needs suitable temperature, high RH, good ventilation, and cold water/shock treatment. Sometimes cold-water (4-6°C) treatment is also needed for 10-20 min for initiation of primordia. The fruit bodies further develop and become ready to harvest in next 7-10 days. The mushroom stalk should be broken from the substrate and should not be torn. Harvesting always be done at an early stage to meet out the parameters of the international market. Normally biological efficiency of the shiitake mushrooms is nearly 25-30% in natural condition and 30-35% in controlled conditions on the wet weight of the substrate.

Marketing and value addition of mushrooms

Mushrooms have enormous potential in value addition and preparation of value-added products which solves the problem of short shelf-life and help postharvest losses of mushrooms. From mushrooms, various value-added products can be prepared and help run the cottage industries successfully like Mushroom soup, dried powder, pickles, nuggets, biscuits, papad, kheer mix, cake,

namkeen, preserves, mushroom enriched protein and nutrient supplements, etc. Several success stories have already developed by value addition, 1. Mr. Sanjeev Kumar Mathur, Jamshedpur, Jharkhand, is a successful entrepreneur around mushrooms production, marketing, and value addition. He has launched a brand in the name of 'Churchill' and preparing various mushroom related value-added products like pickles (with and without garlic), namkeens, noodles, biscuits, and dried mushroom and mushroom powder etc. in the market after getting the registration of FSSAI and his annual turnover is around ₹2.5 lakhs by selling of value-added products only. Another person Mr. Santosh Kumar, Bokaro, Jharkhand, also working in production, marketing and value addition is dealing in marketing of fresh button and oyster mushroom, dried oyster mushroom and mushroom powder and his annual income is around ₹2-2.2 lakhs per year.

For further interaction, please write to:

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**Flowers always make people better, happier, and more helpful;
they are sunshine, food and medicine for the soul.**

– Luther Burbank