

## **Chapter 1**

### **Introduction**

- 1.1 Agriculture still remains the principal occupation of rural Meghalaya. With just about 15% of the geographical area under cultivation and limited use of modern techniques, low productivity characterizes most of Meghalaya's agriculture. As a result, though about 70% of the population is directly or indirectly engaged in agriculture, the contribution of agricultural production to the state's GDP is low, the population engaged in agriculture is mostly below the poverty line, and the state is still dependent upon imports from other states for major food items such as Rice, Pulses, meat, eggs, food grains, etc.
- 1.2 Rice is the most grown cereal crop accounting for over 80% of the food grain production in the state and more than a third of the cropped area. Other important food crops are maize, a few minor cereals and pulses. Besides these, potato, ginger, turmeric, black pepper, areca nut, bay leaf, betel-vine, short-staple cotton, jute, mesta, mustard and rapeseed etc. are also grown as cash or plantation crops. Rapeseed and mustard are the most important oilseeds accounting for over two-thirds of the oilseed production. The productivity of most of these crops is below the national standards.
- 1.3 The state is known for its horticulture. Climatic conditions in Meghalaya permit cultivation of large variety of horticulture crops i.e. fruits, vegetables, flowers, spices and medicinal plants. The important fruits grown are citrus fruits, pineapples, papayas, bananas, straw berries, Jackfruit, etc. The 'mandarin oranges' grown in Meghalaya are of very high quality. In addition to this, a large variety of vegetables are grown in the state, including cauliflower, cabbage and radish. Areca nut and betel vine plantations can be seen all over the state, especially in the southern slopes bordering Bangladesh. Other plantation crops like tea, coffee and cashew have been introduced lately and are becoming popular. A large variety of spices, flowers and medicinal plants are also grown in the state.
- 1.4 Edible Mushrooms are found in abundance across the forested areas of the State because of the congenial climatic conditions for their growth. However, unguided collection of wild edible mushrooms from forest poses great danger, often resulting in fatal food poisoning. Mushroom is known since ancient times as a food item used by a section of people, collected from wild with empirical method of identification of the edible species. With the advent of scientific cultivation techniques, cultivable edible species can now be produced for safe consumption. These scientific techniques have made it

possible to cultivate edible mushrooms as nutritional food, and on seeing the opportunity to enhance farmers' incomes, the cultivation of mushroom commenced in Meghalaya since 1982.

1.5 The cultivation of Mushroom in Meghalaya started with experimentation in the District and Local Research Station and Laboratories (DLRSL) at Shillong in 1981 - 82. During this period spawn was produced and trials were conducted at the lab and a few farmers' locations. Encouraged by the results, a proposal was submitted to the North Eastern Council (NEC) for establishing a Mushroom Centre in Shillong, which was approved and sanctioned during 1982-83, and named as "The Regional Centre for Training and Cultivation of Mushrooms". The Department of Agriculture, Government of Meghalaya, allocated a plot of land in its existing farm at Upper Shillong and the present premises of the Centre were constructed by the NEC funds. Spawn production has been initiated at the Upper Shillong Centre for supply within the state on demand. The NEC allotted additional funds annually, till the scheme was absorbed as a continuing State Plan scheme of the Government of Meghalaya.

1.6 Training programs were started for farmers, schools, colleges, clubs etc. all over Meghalaya and cultivation of Oyster mushrooms (*Pleurotus sp.*) and button mushrooms (*Agaricus sp.*) was started as demonstrations at the centre in Upper Shillong. Training programmes were also organized for the officers and staff at the Research stations at Jowai and Tura. Given the potential for expanding mushroom to the Garo Hills region, a mushroom centre was also sanctioned and set up at the Research station in Songsangre Tura.

1.7 Mushrooms are also highly amenable for food processing. Mushrooms are used to make soups, pickles; vegetables etc. and they are also used as additives in many food preparations. Mushrooms are considered as a vegetarian delicacy all over the world and their consumption is increasing in India as well. Meghalaya also has distinct demand for these products. Fresh mushrooms have very limited life and hence they need to be consumed within few hours. But processing and canning increase their shelf life to a few months.

#### **1.8 Nutritional Value of Mushrooms:**

1.8.1 For thousands of years, edible fungi have been revered for their immense health benefits and extensively used in folk medicine. Modern medicine also confirms that mushrooms do promote immune function; boost health; lower the risk of cancer; inhibit tumor growth; help balance blood

sugar; ward off viruses, bacteria, and fungi; reduce inflammation; and support the body's detoxification mechanisms. Mushroom diet is good for heart due to its low fat content, higher proportion of unsaturated fatty acids and absence of cholesterol. Minimal sodium with rich potassium in mushroom enhances salt balance and facilitates blood circulation in humans and hence found suitable for high blood pressure patients. The diabetic and obese patients choose mushroom as an ideal food owing to its low calorific value, less starch, and less sugars. The fermentable dietary fibre in mushrooms augments healthy functioning of bowel system as fibre serves as a food for beneficial microbes in human digestion system.

- 1.8.2 Mushroom cultivation has the potential to address several nutritional concerns of the society in terms of protein and vitamin deficiencies, and may even provide gainful employment to the rural people engaged in production. Another advantage is that most agricultural residues of the state are either burnt, or wasted and can actually be used as feedstock for Mushroom culture after composting. This will also have an impact on the environment. The socio-economic status of the farming community is improved through additional revenue generated by Mushroom culture by utilizing farm residue and plant biomass. In addition to this, it paves way for diversification of farming, gainful employment and improved life status. The spent substrate after the cultivation of mushroom is more readily digestible and palatable to livestock and it can be exploited as a source of manure, vermi composting and mulch for soil.
- 1.8.3 Compounds restricting tumor activity such as Lentinan is widely used as a leading cancer drug in pharmaceutical industries. Ergothioneine is a specific antioxidant found in *Flammulina velutipes* and *Agaricus bisporus*, which is necessary for healthy eyes, kidney, bone marrow, liver and skin and can slow down the aging process. Antioxidants present in mushroom scavenge the free radicals present in body system and reduce cell maturity. Thus mushrooms act as anti-aging agents. A diverse collection of polysaccharides (beta-glucans) and minerals, isolated from mushroom is responsible for regulation and strengthening the human immune system.
- 1.8.4 General people are less aware about the economic value of mushrooms. Mushroom is a saprophytic organism and hence it utilizes organic and agricultural waste. This reduces the burden of farmers to dispose their farm wastes. Additional income is obtained through quality mushroom production by utilizing these residues. Mushroom cultivation both seasonal and commercial in nature and hence can generate handsome

income to the growers. The employment generation through cultivation and associated allied activities is also immense. The value addition to mushrooms is another economic avenue. The commercial use of spent mushroom substrate for biofuel, biogas production, manures, potting medium, etc. also generate additional revenue to the farmer.

- 1.8.5 The prevalent diet in the State is primarily based on cereals v.i.z. rice maize and millets, which are deficient in proteins. The inclusion of mushroom in the diet will bridge the protein gap and improve the general health of the people. Mushroom is considered to be a health food suitable for all age groups. Mushrooms are rich in protein, dietary fiber, vitamins and minerals. The digestible carbohydrate profile of mushroom includes starches, pentose, hexoses, disaccharides, amino sugars, sugar alcohols and sugar acids. The total carbohydrate content in mushroom varies from 26-82% on dry weight basis in different mushrooms. The crude fibre composition of the mushroom consists of partially digestible polysaccharides and chitin.
- 1.8.6 Mushrooms are gradually becoming a popular cuisine choice in the state due their nutritional status. Mushrooms are rich in minerals and vitamins and very low on fat and sugar. Edible mushrooms contain rich proteins that are composed of threonine and valine but deficient in sulphur containing amino acids (methionine and cysteine). The low lipid level with no cholesterol and higher proportion of polyunsaturated fatty acids makes it that much more attractive. In addition to these, mushroom is also an excellent source of vitamins especially C and B (Folic acid, Thiamine, Riboflavine and Niacin). Minerals viz., potassium, sodium and phosphorous are higher in mushroom fruit bodies besides other essential minerals (Cu, Zn, Mg) in traces but it is deficient in iron and calcium in general. Above all, growth promoting substances viz., enzymes, alkaloids, sterols, antioxidants and other undefined organic complexes are also present in mushrooms.
- 1.8.7 Edible mushrooms commonly have insignificant lipid level with higher proportion of polyunsaturated fatty acids. All these result in low calorific yield from mushroom foods. Mushrooms do not have cholesterol. Instead, they have ergosterol that acts as a precursor for Vitamin D synthesis in human body. Similarly, ergosterol in button mushroom is converted in to vitamin D<sub>2</sub> when exposed to UV radiation or sunlight. The protein content of edible mushrooms is usually high, but varies greatly. The crude protein content of mushrooms varies from 12-35% depending upon the species. The free amino acids composition differs widely but in general they are rich in threonine and valine but deficient in sulphur containing amino

acids (ethionine and cysteine). Nutritive values of different mushroom are given in Table 1.1.

Table 1.1. Nutritive values of different mushrooms (dry weight basis g/100g)

| <b>Mushroom</b>              | <b>Carbohydrate</b> | <b>Fibre</b> | <b>Protein</b> | <b>Fat</b> | <b>Ash</b> | <b>Energy kcal</b> |
|------------------------------|---------------------|--------------|----------------|------------|------------|--------------------|
| <b>Agaricus bisporus</b>     | 46.17               | 20.90        | 33.48          | 3.10       | 5.70       | 499                |
| <b>Pleurotus sajor-caju</b>  | 63.40               | 48.60        | 19.23          | 2.70       | 6.32       | 412                |
| <b>Lentinula edodes</b>      | 47.60               | 28.80        | 32.93          | 3.73       | 5.20       | 387                |
| <b>Pleurotus ostreatus</b>   | 57.60               | 8.70         | 30.40          | 2.20       | 9.80       | 265                |
| <b>Volvariella volvaceae</b> | 54.80               | 5.50         | 37.50          | 2.60       | 1.10       | 305                |
| <b>Calocybe indica</b>       | 64.26               | 3.40         | 17.69          | 4.10       | 7.43       | 391                |
| <b>Flammulina velutipes</b>  | 73.10               | 3.70         | 17.60          | 1.90       | 7.40       | 378                |
| <b>Auricularia auricular</b> | 82.80               | 19.80        | 4.20           | 8.30       | 4.70       | 351                |

Source: Stamets, 2005 (*A.bisporous*, *P. sajor-caju*, *Lentinula edodes*), FAO, 1972 (*Pleurotus ostreatus* , *V. volvaceae*), Doshi and Sharma, 1995 (*Calocybe indica*), Crison and Sand, 1978 (*Flammulina velutipes* and *Auricularia spp*).

Mushrooms comprise about 80-90% of water, and 8-10% of fiber. In addition to these, mushroom is an excellent source of vitamins especially C and B (Folic acid, Thiamine, Riboflavin and Niacin). Minerals like potassium, sodium and phosphorus are higher in fruit bodies of the mushroom. It also contains other essential minerals (Cu, Zn, Mg) in traces but deficient in iron and calcium.

## **Chapter 2** **Meghalaya Mushroom Mission**

2.1 The three major mushroom producing countries as per *FAO* data are China, USA, and Netherlands that account for more than 60% of the world production while the share of China itself is 46%. China produces almost half of the world's mushrooms. India ranks 14<sup>th</sup> in the world with a production of 48,000 MT and about 60 – 70% of the mushrooms produced are exported. In India Punjab leads in mushroom production followed by Uttarakhand and Haryana. Meghalaya produces 27 tons per year.

2.2 The highest per capita consumption of mushroom is in Netherlands (11.62 kg) followed by Ireland (6.10 kg) and Belgium (4.46 kg). However, as per Indian estimates per capita consumption in India is about 90 g, which very less compared to other countries including. The European Union and USA are the biggest markets and Poland and China are the biggest competitors, for mushrooms from India.

2.3 With a view to expand the cultivation of Mushroom in the state due to its high value and low volume characteristic, availability of a growing local market and its potential for export, the Government of Meghalaya envisages the implementation of the Meghalaya Mushroom Mission with an aim to scale up mushroom production in a mission mode to exploit the full potential of the sector and bring about economic prosperity and livelihood security to the farming community of the State. The Mission strives to augment farmers income by providing an alternate source of livelihood and an activity that can be taken up during the lean season when temperatures are suitable for mushroom cultivation.

### **2.4 Objectives of the Mission:**

2.4.1 To scale up mushroom production in the state through a cluster approach

- 2.4.2 To diversify the dietary patterns of the state so nutrition and health of the citizens is improved.
- 2.4.3 To focus on the value addition of mushroom and mushroom products for improved economic gain, once sufficient volumes are generated.
- 2.4.4 To create adequate infrastructure and upgrade the existing Production Centres for provision of various services to the farmers.
- 2.4.5 To build the skill base and the capacities of potential farmers through capacity building programme.

2.5 The Mission will focus mainly on the production of Oyster Mushroom, Button Mushroom and Shiitake Mushroom. Taking into consideration the capacity to produce spawn, the target to be achieved under the Mission will increase the production from the present 27 MT to 5000 MT within 5 years. It is envisaged that more than 1000 farmers and entrepreneurs would be covered through the Mission across the state in a cluster approach.

2.6 Considering the wide range of activities to be taken up under the Mission, it is further broken down into the following Mini Missions to focus on specific components of the Mission.

- 2.6.1 Mini Mission I: Promotion and expansion of Mushroom Cultivation throughout the State through a cluster approach and Farmer Producers Organizations.
- 2.6.2 Mini Mission II: Spawn production and critical infrastructure development.
- 2.6.3 Mini Mission III: Capacity Building, and Entrepreneurship Development.
- 2.6.4 Mini Mission IV: Marketing, Value Addition and Processing

2.7 The Mission will be implemented over a period of 5 years and will include within it concurrent evaluation and mid-term corrections wherever needed. The programme will be flexible to accommodate mid-course corrections. A comprehensive report will be prepared every year after a systematic end of the year evaluation and necessary changes will be incorporated in the Mission document in the form of executive instructions. [11]  
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### **CHAPTER 3**

#### **Mini Missions**

##### **Mini Mission I: Promotion And Expansion Of Mushroom Cultivation**

3.1 This Mini-Mission will encourage the farmers to take up mushroom cultivation as an alternate income generating activity as well as an activity that is integrated into the farm business, to enhance farm income. The initial intervention to support farmers will be taken up in the already existing villages and clusters as listed in Annexure I and II. Button Mushroom will be taken up in 8 clusters with 800 farmers where the climate is congenial to its growth. Oyster Mushroom will be taken up in 16 clusters with 100 farmers per cluster. SMEs will be promoted with start up funding whereby 100 youth will be assisted to take up the venture.

3.2 Every farmer reached out to under the Mini Mission –I will produce button mushroom and oyster mushroom, as the case may be. A cluster approach would be adopted to promote and expand the production of mushroom whereby the District Horticulture Officers would identify clusters of villages with congenial climatic conditions for better coordination and collective marketing. Awareness programmes will be conducted in identified villages and selection of potential farmers will be done. The farmers taking up mushroom cultivation in these clusters would be encouraged to organize themselves into Farmer Producer Groups (FPG) that will gradually be upgraded to Famer Producers Organization (FPO) to enable them to source various schemes and services through SFAC and other organizations including financial institutions to further promote the activity. Formation of Mushroom Farmers Association will also be catalyzed.

3.3 A coordinator will be nominated in each District at the level of Assistant Director (Horticulture) and will undertake the implementation of the Mushroom Mission. Major thrust will be given to villages that are already performing well in mushroom cultivation such as the Rapleng Cluster that

includes the villages of Laitdiengsai, Laitkyrhong, Pingwait, Kharang, and Syniasya. This cluster will be recognized as the Mushroom Hub under the Mission.

3.4 While the major focus is on production of Button and Oyster Mushroom, a major impetus will also be given to the production of Shiitake Mushroom. A total number of 25 entrepreneurs will be identified and trained in production of Shiitake mushroom. Further, the Khadar Shnong Area people, being one of the most neglected areas of the State, have in depth knowledge of the substrate for growing Shiitake mushroom and due consideration to promote Shiitake in these zones will be taken up.

### **Mini Mission II**

#### **Spawn Production, Bulk Pasteurisation And Critical Infrastructure**

3.5 Successful mushroom production depends upon proper maintenance of pure culture and spawn capable of providing higher yield of quality mushrooms. Maintenance of vigour and genetic characteristics of a pure strain in form of culture is the main objective of strain preservation. The isolation, purification and maintenance of mushroom cultures require technical expertise and aseptic laboratory facilities. Therefore, most of the small mushroom growers rely entirely on commercial spawn producers, governmental or non-governmental organizations that play a vital role in supplying reliable spawn of the desired mushroom strain or variety.

3.6 At present there are 4 spawn production units in the State that include (1) Mushroom Development Centre with a production of 7.2 tons of spawn per year, (2) ICAR with a production, as per demand, of about 2.7 tons per year, (3) CPGS Barapani producing spawn as per requirement and (4) Research Station at Tura. This needs to be enhanced and another 3 spawn production units are proposed to be added under the Mission. Capacities of these units will also be expanded in order to ensure a substantial increase in the production of spawn. The spawn production shall remain in the Government domain and each of the units for spawn production will cost Rs. 50 lakhs per

unit that include Lab set up, equipment etc. Indicative equipment required in the spawn labs are at Annexure IV. Besides this, the Lab at the MDC will also be upgraded with additional infrastructure and equipment. Strict quality control will have to be maintained in the Labs to ensure good quality spawn free from contamination. Proper selection of varieties and strains will be done and cultures will be maintained in aseptic conditions.

3.7 The MDC will also take up trial projects for specialty mushrooms like Lion's Mane etc. Further research in local mushroom would also be undertaken in the labs. Research on alternate substrates will be undertaken to ensure adequate availability of substrates for all types of cultivated mushroom.

3.8 Bulk Pasteurization Units for production of compost using the short method shall be set up at the clusters and operated by entrepreneurs/associations/farmers groups/FPOs/CFC to ensure availability of quality compost for button mushroom. The assistance for Bulk Pasteurization Units will be 75:25 financing where 75% funding will be from the govt. and 25% will be own contribution. An intensive training programme on bulk pasteurization and short method of compost preparation for button mushroom will be organized for compost producers prior to commencement of the composting units.

3.9 Other critical infrastructure will be developed depending on the requirement during the course of implementation of the Mission.

### **Mini Mission III**

#### **Capacity Building, Training And Entrepreneurship Development**

3.10 Capacity Building will be the major intervention to ensure the success of this Mission. The process of training and capacity building will be organized through the Mission duration for multiple stakeholders v.i.z. mushroom growers, potential entrepreneurs, farmer producer groups/organizations, cooperative societies etc.

3.10.1 The following aspects will be covered:

- (a) Awareness programmes on potential of Mushroom cultivation
- (b) Composting techniques
- (c) Methods of culturing various types of mushroom
- (d) Cost cutting techniques in various mushroom production processes

3.11 Training on actual cultivation through a hand-holding approach will be taken up in the clusters. The MDC will assess the training needs and will provide training on new developments in mushroom cultivation from time to time. The Centre shall also identify training programmes on specific aspects of mushroom culture. It will also prepare a budget for each training programme with expenditure to be incurred under the Mission.

3.5 Entrepreneurship Development Programmes (EDP) will also be taken up for mushroom growers who take up mushroom production and processing. Exposure visits to successful Mushroom farms in the country will also be organized for Mushroom farmers and entrepreneurs.

#### **Mini Mission IV:**

#### **Marketing, Value Addition And Processing**

3.7 Mushrooms are very popular in most developed countries and they are becoming popular in developing countries as well. As the market for mushrooms is growing rapidly in India, due to aroma, nutritional values, subtle flavour and special taste diverse food preparations like soups, vegetables, pickles etc. are being increasingly made. They are also used for garnishing, to prepare many varieties of gravy and for stuffing several food preparations. Star hotels, exclusive restaurants, certain caterers are the bulk consumers and a firm tie up for regular supply with some of them is advisable. The product can be sold even through the departmental stores, super markets etc. Since fresh mushrooms have very limited shelf life, processing and canning will need to be taken up under the Mission once the volumes increase, to enhance the shelf life. Convergence will be worked out with the Directorate of Food Processing to identify various methods of processing of mushroom and disseminate the technologies to the clusters and

entrepreneurs. The technologies include drying, ready to eat recipes, soup powders, etc.

- 3.8 Packaging and branding to promote marketing of mushroom and mushroom by-products will be one of the major considerations. The assistance of the Meghalaya Institute of Entrepreneurship will be sought in the matter. Aggressive advertising and trade promotion through buyers and sellers meet will be taken up.
- 3.9 Organizing awareness camps mushroom fairs mobilization camps in 16 clusters for 5 years will be attempted in the 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> year of the Mission.

## Chapter 4 Funding and Financial Outlay

### Funding:

The funds for the Mission will be sourced from a number of funding agencies v.i.z. Mission for Integrated Development of Horticulture (MIDH) Government of India, the State Government and through Externally Aided Projects like Meghalaya Livelihood and Access to Market Project (Megh-LAMP) and the German Development Bank KfW.

### Financial Outlay

| SUMMARY OF COSTINGS FOR MUSHROOM MISSION |   |  |          |             |                |
|--|---|--|----------|-------------|----------------|
| Sl no                                    | ITEM  | PARTICULARS  | QUANTITY | UNIT COST   | Total cost (₹) |
| 1  | Mushroom cluster formation                  | Formation of Button Mushroom collection, aggregation, grading Units CFC & FPOs               | 8        | 20,00,000   | 1,60,00,000    |
|  |   | Promotion of Oyster Mushroom collection, aggregation, Grading and packaging Units CFC & FPOs | 8        | 20,00,000   | 1,60,00,000    |
|  |   | Promotion of Mushroom cultivation in new clusters areas                                      | LS       | 2,00,00,000 | 2,00,00,000    |
| 2  | Expansion and improvement of MDC            | Lab expansion and equipment  | LS       | 75,00,000   | 75,00,000      |
| 3  | Establishment of Spawn production Centres   | Establishment of 3 additional spawn production labs  | 3        | 50,00,000   | 1,20,00,000    |
| 4  | Seed Capital for Button Mushroom            | Growing units and equipment  | 800      | 50,000      | 4,00,00,000    |
| 5  | Seed Capital for Oyster Mushroom            | Growing Units  | 1600     | 50,000      | 8,00,00,000    |
| 6  | Start-up funding for Shiitake Mushroom SMEs | Growing units and equipment  | 25       | 2,50,000    | 62,50,000      |

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|    |                        |  |        |           |                     |
|----|------------------------|--|--------|-----------|---------------------|
| 7  | Training               | Hands on Training at MDC and regional spawn production Centres for entrepreneurs & Progressive Farmers | 1000   | 12,555    | 25,11,000           |
| 8  | Cluster level training | Hands on cluster level training  | 2000   | 50,000    | 10,00,00,000        |
| 9  | IEC Material           | Z-Cards, Manuals, Brochures, leaflets etc  | 200000 | 12.5      | 25,00,000           |
| 10 | Awareness / Fairs      | Organizing awareness camps / mushroom fairs / mobilization camps in 16 clusters for 5 years            | 80     | 4,00,000  | 3,20,00,000         |
| 11 | Festivals              | State mushroom festivals for 5 years   | 5      | 23,86,000 | 1,19,30,000         |
| 12 | Exposure               | Training cum Exposure visits   | 200    | 7,00,000  | 14,00,00,000        |
| 13 | Marketing              | Packaging & Branding, advertising, marketing / trade promotion / buyer seller meets, etc               | LS     |           | 1,00,00,000         |
|    |                        |  |        | SUB TOTAL | 49,66,91,000        |
| 14 | Cluster Monitoring     | Cluster visits, support etc.   | LS     | 2000000   | 20,00,000           |
|    |                        |  |        |           | <b>50,06,91,000</b> |

## Annexure I

## Button Mushrooms Clusters

| Sl. No      | District                        | Block                         | Village      |
|-------------|---------------------------------|-------------------------------|--------------|
| 1           | East Khasi Hills District       | Mawkynrew                     | Latdiengsai  |
|             |                                 |                               | Laitkyrhong  |
|             |                                 |                               | Kharang      |
|             |                                 |                               | Pingwait     |
|             |                                 |                               | Syniasya     |
|             |                                 | Mawryngkneng                  | Mawryngkneng |
|             |                                 |                               | Puriang      |
|             |                                 | Mylliem                       | Mawklot      |
|             |                                 |                               | Nongumlong   |
|             |                                 |                               | Lawsotun     |
|             |                                 |                               | Lumshyiap    |
|             |                                 | Khadar Shnong Laitkhroh Block | Swer         |
|             |                                 |                               | Mawrah       |
|             |                                 |                               | Mawjrong     |
|             |                                 |                               | Mawkdoh      |
|             |                                 |                               | Laitkhroh    |
|             |                                 |                               | Laitlyngkot  |
|             |                                 |                               | Nongkynrih   |
|             |                                 |                               | Umtyngar     |
|             |                                 |                               | 12 Mer       |
| Laitsohpiah |                                 |                               |              |
| Umdiengpoh  |                                 |                               |              |
| Mawbeh      |                                 |                               |              |
| Jathang     |                                 |                               |              |
| 2           | West Khasi Hills District       | Mawthadraishan                | Shohphria    |
|             |                                 |                               | Nongshillong |
|             |                                 | Mairang                       | Mawphanniaw  |
|             |                                 |                               | Tengri       |
|             |                                 | Nongstoin                     | Mawduh       |
|             |                                 |                               | Nonglwai     |
|             |                                 |                               |              |
| 3           | South West Khasi Hills District | Mawkyrwat                     | Rangmaw      |
|             |                                 |                               | Lawblei      |
|             |                                 |                               | Jakrem       |



**Annexure II****Oyster Mushrooms Clusters**

| <b>Sl. No</b>     | <b>District</b>                    | <b>Block</b> | <b>Village</b>   |
|-------------------|------------------------------------|--------------|------------------|
| 1                 | East Khasi Hills District          | Mawkynrew    | Latdiengsai      |
|                   |                                    |              | Laitkyrhong      |
|                   |                                    |              | Kharang          |
|                   |                                    |              | Pingwait         |
|                   |                                    |              | Syniasya         |
|                   |                                    | Mawryngkneng | Mawryngkneng     |
|                   |                                    |              | Puriang          |
|                   |                                    | Mylliem      | Mawklot          |
|                   |                                    |              | Nongumlong       |
|                   |                                    |              | Lawsotun         |
|                   |                                    |              | Lumshyiap        |
|                   |                                    | 2            | Ri-Bhoi District |
| Thadnongiaiw      |                                    |              |                  |
| Umdohthli         |                                    |              |                  |
| Khweng            |                                    |              |                  |
| Nongrim Nongladaw |                                    |              |                  |
| Nongpoh           |                                    |              |                  |
| Umsning           |                                    |              |                  |
| Labansaro         |                                    |              |                  |
| Lumsohpetbneng    |                                    |              |                  |
| Shyntorbulia      |                                    |              |                  |
| Syad Rit          |                                    |              |                  |
| Umiarong          |                                    |              |                  |
| Mawpun            |                                    |              |                  |
| Lumnongrim        |                                    |              |                  |
| Kyrdemkulai       |                                    |              |                  |
| Tiehwieh          |                                    |              |                  |
| Umling            | Sajer                              |              |                  |
|                   | Umbuda                             |              |                  |
|                   | Shakoikuna                         |              |                  |
|                   | Nongpoh Area, mawtnum, saiden etc. |              |                  |
| Jirang            | Centre Village                     |              |                  |
|                   | Umlakro                            |              |                  |
|                   | Umsohanpan                         |              |                  |
| 3                 | West Jaintia Hills                 | Laskien      | Priang           |

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|                |                                 |                   |                |
|----------------|---------------------------------|-------------------|----------------|
|                |                                 |                   | Saphai         |
|                |                                 |                   | Lummuriap      |
|                |                                 |                   | Nongkynrih     |
|                |                                 |                   | Laskien        |
|                |                                 |                   | Mawtyrshiah    |
|                |                                 | Amlarem           | Jaralood       |
|                |                                 |                   | Pdengkesh      |
|                |                                 |                   | Moosakhia      |
| 4              | West Khasi Hills District       | Mawthadraishan    | Shohphria      |
|                |                                 |                   | Nongshillong   |
|                |                                 | Mairang           | Mawphanniaw    |
|                |                                 |                   | Tengri         |
|                |                                 | Nongstoin         | Mawduh         |
|                |                                 |                   | Nonglwai       |
| 5              | South West Khasi Hills District | Mawkyrwat         | Rangmaw        |
|                |                                 |                   | Lawblei        |
|                |                                 |                   | Jakrem         |
| 6              | East Jaintia Hills              | Saipung           | Saipung        |
|                |                                 |                   | Tuidam         |
|                |                                 |                   | Saibual        |
|                |                                 |                   | Thuruk         |
|                |                                 | Wapung            | Lad wah wapung |
| 7              | West Garo Hills                 | Rongram           | Sampalgre      |
|                |                                 |                   | Deran gittim   |
|                |                                 |                   | Rongka         |
|                |                                 |                   | Chiring        |
|                |                                 |                   | Araimile       |
|                |                                 |                   | Walbakgre      |
|                |                                 |                   | Matchikol      |
|                |                                 |                   | Edenbari       |
|                |                                 |                   | Rongkhon       |
|                |                                 |                   | Upper Rongkhon |
|                |                                 | Memonggre Rongram |                |
| Upper Babupara |                                 |                   |                |
|                | Samanda                         | Samanda           |                |

**Annexure - III****Shiitake Mushrooms Clusters**

| <b>Sl. No.</b> | <b>Blocks</b>          | <b>Villages</b> |   |
|----------------|------------------------|-----------------|---|
| 1              | Khadar Shnong Laitkroh | Khrang          | These are all in Khadar Shnong Laitkroh Block that have in depth knowledge of the substrate on which Shiitake Mushroom thrives. They can be included in the promotion of Shiitake Mushroom Cultivation. |
|                |                        | Kongthong       |   |
|                |                        | Mawsohmad       |   |
|                |                        | Myiong          |   |
|                |                        | Mawmang         |   |
|                |                        | Mawthawtieng    |   |
|                |                        | Pdei            |   |
|                |                        | Kshaid          |   |
|                |                        | Tyniar          |   |
|                |                        | Sder            |   |
|                |                        | Jarain          |   |
|                |                        | Wahsohra        |   |
|                |                        | Diengsong       |   |
|                |                        | Nongtraw        |   |
|                |                        | Nohshut         |   |
|                |                        | Mawtuli         |   |
|                |                        | Dewlieh         |   |
|                |                        | Phong           |   |
|                |                        | Thangtim        |   |
|                |                        | Puhbsien        |   |
|                |                        | Mawtongreng     |   |
|                |                        | Nongbah         |   |
|                |                        | Mawshuit        |   |
|                |                        | Lyngsteng       |   |
|                |                        | Pdang           |   |
|                |                        | Sohkynduh       |   |
|                |                        | Laitmawsiang    |   |
|                |                        | Rymmai          |   |
| Mawshken       |                        |                 |   |
| Thangkyrta     |                        |                 |   |
| Mawrah         |                        |                 |   |
| Rangtmah       |                        |                 |   |
| Dewiong        |                        |                 |   |

**Annexure IV****List of equipment for Spawn Production Units**

| <b>Sl No</b> | <b>Equipment</b>                   |
|--------------|------------------------------------|
| <b>1</b>     | Constant temperature BOD incubator |
| <b>2</b>     | Vertical deep freezer              |
| <b>3</b>     | UV visible spectrophotometer       |
| <b>4</b>     | Compound microscope                |
| <b>5</b>     | Laminar flow chamber               |
| <b>6</b>     | Sensitive weighing balance         |
| <b>7</b>     | Horizontal and Vertical Autoclave  |
| <b>8</b>     | Hot air oven                       |
| <b>9</b>     | pH meter                           |
| <b>10</b>    | SS Steam Kettles                   |
| <b>11</b>    | Steam Boiler                       |
| <b>12</b>    | BOD incubators                     |
| <b>13</b>    | Air curtain, air showers           |
| <b>14</b>    | Refrigerator                       |

**Annexure - V**

**Oyster mushroom (*Pleurotus* sp.)**



Oyster Mushroom is a basidiomycete and belongs to the Genus 'Pleurotus'. The fruit of this mushroom are shell, fan or spatula shaped and the colour varies from shades of white, cream, grey, yellow, pink or light brown depending upon the species. The oyster mushroom is one of the most

suitable fungal organism for producing protein rich food that uses agrowastes as the substrate.

The popular methods of substrate preparation are steam pasteurization and hot water treatment. After substrate treatment freshly prepared 20-30 days old grain spawn spread in layers on the substrate wrapped in a perforated polythene bag. The polythene bag is wrapped tighly and is removed once the mycelial growth appears. One bottle of spawn of 300 g is sufficient for 10-12 kg of wet substrate or 2.8 to 3 kg of dry substrate weight.

The spawned bags or blocks are kept either be kept on a raised platform or shelves or hung in incubation/cropping room for mycelial growth. During mycelial growth stage the bags are to be kept air tight and there is no need to maintain high relative humidity. Once the mycelium has fully colonized the substrate and forms a thick mycelial mat it is ready for fruiting and the bags can be removed.

Once the fruiting starts mushrooms can be harvested by judging the size and shape of the fruiting body. Mushrooms should always be harvested before spraying water. The edge of the cap is thick and cap margin is enrolled in young mushroom while the cap of mature mushroom become flat and inward curling starts. Fresh mushrooms should be packed in perforated polythene bags for marketing. Oyster mushrooms can be store upto 3 to 4 months after drying.

Oyster mushrooms are 100% vegetarian and the nutritive value of oyster mushroom is as good as other edible mushrooms like white button mushroom, shiitake, or paddy straw mushroom. They are rich in vitamin - C and B complex. Protein content varies between 1.6 to 2.5%. It has most of the mineral salts required by the human body.

## Annexure - VI

**Button Mushroom (*Agaricus sp.*)**

Button Mushroom (*Agaricus sp.*) is the most popular mushroom variety grown and consumed the world over. Cultivation of button mushrooms started as early as the sixteenth century and commercial cultivation was initiated in Europe around 17<sup>th</sup> Century. Its production was limited to the winter season, but with technology development, the mushroom is produced almost throughout the year in small, medium and large farms. In most farms *Agaricus bisporus* is grown in most farms across the country.



The vegetative mycelium is composed of many inter-woven septate hyphae. The reproductive phase is initiated by the formation of small knob like swellings at different points of interwoven mycelial strands. These swellings increase in size and break through the surface of the substratum as small balls constituting the button stage. A matured basidiocarp (fruit body) is whitish in colour and consists of thick short stipe with an annulus. The stipe supports the pileus, which appears as a hat like expansion. On the underside of the pileus, a number of radiating gills or lamella are present which are pink when young but purple-brown when mature.

White button mushroom requires 20-28<sup>o</sup> C for vegetative growth and 12-18<sup>o</sup> C for reproductive growth. Besides that it requires relative humidity of 80-90% and enough ventilation during cropping.

The white button mushroom is sold as fresh mushroom or is canned and made into soups, sauces and other food products. Protein in mushrooms have 60-70 % digestibility and contains all the essential amino acids. It has medicinal properties also.

The Button Mushroom strains mainly cultivated in India are S-11, TM-79 and Horst H<sub>3</sub>. Scientists of the Horticulture Research Station, Tamil Nadu Agriculture University released the strains Ooty 1 and Ooty (BM) 2 in 2002 for commercial cultivation.

The whole process of button mushroom production can be divided into the following 6 steps:

- (i) Spawn production
- (ii) Compost preparation
- (iii) Spawning
- (iv) Spawn running
- (v) Casing
- (vi) Fruiting

Spawn is produced under sterile conditions from fruiting culture / stocks of selected strains of mushrooms in laboratories. It is essential to use good quality spawn to ensure good flavour, texture, size, high yield and longer shelf life.

The substrate on which button mushroom grows is mainly prepared from a mixture of plant wastes like cereal straw/ sugarcane bagasse etc., combined with salts, supplements and water. 220 g of dry substrate is required to produce 1 kg of mushroom. The compost should contain nitrogen, phosphate and potassium in the ratio of 33:10:25.

The short method of composting is recommended for better yields of button mushroom. During the first phase of compost preparation, paddy straw is placed in layers and sufficient water is added to the stack along with fertilizers, wheat bran, molasses etc. The stack is turned and again watered on the second



day. On the fourth day the stack is again turned for the second time by adding gypsum and watered. The third and final turning is given on the twelfth day when the colour of the compost changes into dark brown and it starts emitting a strong smell of ammonia.

The second phase is the pasteurization phase where the compost prepared needs to be pasteurized in order to kill undesirable microbes and competitors and to convert ammonia into microbial protein. The process of pasteurization is carried out inside a steaming room where the air temperature of 60° C is maintained for 4 hours. The compost finally obtained should be granular in structure with 70% moisture content and pH 7.5. It should have a dark brown colour, sweet un-obnoxious smell and free from ammonia, insects and nematodes. After the process is complete, the substrate is cooled down to 25°C.

Spawning is done in a number of ways like spot spawning, surface spawning and layer spawning.

The compost beds after complete spawn run should be covered with a 3-4 cm thick layer of casing soil to induce fruiting. The casing soil should be pasteurized, treated and or sterilized 15 days before casing is done.

Under favourable environmental conditions the fruit body initials which appear in the form of pin heads start growing and gradually develop into button stage. The first crop appears in about 3 weeks after casing and is harvested at the button stage when caps measure about 2.5 to 4 cm.

## Annexure - VII

### Shiitake Mushroom (*Lentinula edodes*)



Shiitake (*Lentinula edodes*) grow in nature on dead wood of hard wood trees. It is the a very popular culinary and medicinal mushroom ranking at number two in terms of total mushroom production in the world. Shiitake has a delicious taste and a good texture. It is also used medicinally to treat various kinds

of diseases like cancer etc. Lentinan that is extracted from the mushroom is an immune-modulating agent for people of all age groups.

The mycelium of Shiitake mushroom is saprophytic and wood rotting in characteristic and mainly grow in dried wooden by absorbing nutrients from the cambium.

The commercial cultivation can be carried out on sawdust of broad leave trees mainly tuni, mango, safeda, oak, maple and poplar or on logs of 8 – 18 cm dia obtained from 15 to 20 years old trees having thick bark. The felling of logs is done from autumn to early spring as during this period the trees have higher levels of carbohydrate and other organic substrate.

The most suitable time for inoculation is when the logs have moisture content of 40 – 45%. The shiitake mycelium grows between 5 to 30°C but the most optimum temperature is 20-26°C. Low temperatures of 14-20°C are favored during spawning so that there is minimum growth of mould competitors. Small holes of 1 cm<sup>2</sup> and 1.5 to 2 cm deep are drilled into the logs for inoculation. The holes are made at a distance of 20-30 cm vertically and 6 cm between each row. The holes between two rows, are alternate in position. Saw dust spawn is filled in the holes or wood plug spawn is inserted by cutting out similar size pieces.

The saw dust spawn should be kept soft and not tightly pressed. The holes are then sealed with paraffin wax.

Inoculated logs are kept in a flat pile in an open place where the physical conditions are most favorable for the mycelial growth. there should be minimum light exposure during the mycelial growth stage and the pile is be covered with either straw or gunny bags to prevent excessive loss moisture from the logs. The vegetative growth in the logs will be completed within 8-12 months depending upon the culture strain and the type of wood used.

For fruit body induction shiitake requires, temperature shock (temperature drop), high humidity and enough light. The logs for fruiting are either sprayed with cold water or immersed in a tank of cold water. If the logs are immersed in cold water, then during summer they should be kept for 24 hours in cold water at a temperature of 15-18°C while during winter they should be kept for 2-3 days at 10-15°C.

The logs are then leaned against the supports and the cropping area is kept moist to maintain high relative humidity of 80-90% and temperature of 15 – 20°C. Mushrooms are harvested up to 3 times and after a rest for 30-40 days they can be n watered to get more mushrooms. This can be repeated up to 3-4 times per year and these logs will produce crop up to 4-6 years.