Standard Operating Procedure (SOP)
Button Mushroom Cultivation in Mountains of Indian Himalayan Region

NMHS Project: Innovative Technologies for Climate Change Mitigation and Biodiversity Conservation with alternate livelihood opportunities for mountain communities in North Western Himachal Himalayas

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The environmental conditions in the Himalayan region are suitable for button mushroom cultivation for almost 7-8 months. Its cultivation in plain areas is restricted to winter months only. During summers in plain areas mushroom cultivation needs heavy investments to maintain the temperature and moisture, through controlled conditions and production cost goes very high which is not economically viable in small scale growing. Growers in hill areas have better prospects to market their produce in the plain areas during summers. The cost of production under natural conditions in hills is quite low.

Step 1: Compost preparation

Himalayan Research Group (HRG) Shimla in HP took an initiative to popularize the button mushroom cultivation technology in Himachal Pradesh. HRG established a small scale industrial unit of 35 MT/batch capacity for the supply of spawned button mushroom compost preparation with short method at village Dhangiara in Tehsil Chachiot of District Mandi, H.P. in 2002. Establishment of compost and spawn facility to provide the quality raw material to the farmers facilitated the button mushroom activity in remote and difficult areas of six districts of H.P. Button mushroom is a temperate mushroom needs low temperature for its cultivation and has better market acceptance than any other mushrooms in the region. Button mushroom compost is a selective substrate prepared through short method of composting involving outdoor phase-I and indoor Phase-II pasteurization composting stages. Compost is made mainly with agriculture residues and poultry waste. Among agriculture waste wheat straw, cotton seed cake, wheat bran are the major ingredient. Gypsum powder is used to balance the pH and moisture of the compost in combination of small quantity of urea to balance nitrogen carbon ratio. Wheat straw wetting is followed by addition of chicken manure. Both the ingredients are mixed well through manual turning. In next turning, cotton seed cake and wheat bran are added. In third turning urea is added. All turning are in alternate days with one day rest. After addition of urea complete composting material is stacked long stack of 5' wide 5' high. After one day rest turning is given to make a similar stack with inner material of stack comes to the outer side of the stack with addition of gypsum powder. Similar three more turnings are given with alternate days. After completing turning cycle outstood phase-I of composting is completed and compost is shifted to insulated pasteurization tunnel with porous floor and air ducting having temperature display system outside for observation.

After filling 75% of the tunnel air is circulated in the compost with high speed blowers fitted at the bottom to maintain the level of oxygen and temperature level. Temperature is maintained around 52-53 ^{o}C for next 36 hours. If it tends to increase cooled fresh air is introduced. On the third day of filling the tunnel temperature is raised to 58 ^{o}C to pasteurize the compost for 8 hours. After pasteurization fresh air is in introduce to decrease the 1 ^{o}C temperature/hour of the compost and is finally maintained at 48-50 ^{o}C for next 150-160 hours with continuous flow of fresh air to develop selective fungal flora to support mushroom colonistation and development. After 10 days of indoor phase-II composting compost in tunnel is cooled to 20 ^{o}C for spawning

Button Mushroom Compost Preparation

Step 2: Spawn preparation

Mushroom seed commonly known as "spawn" is prepared through the process of tissue culture or spore culture. The main substrate required for spawn preparation is wheat grain alongwith small quantities of chalk powder and gypsum. For e.g. 10 Kg of wheat grains are boiled in 15 liters of water for 5-10 minutes till grains look transparent but shall not break and allowed soaking in hot water without heating for few minutes more to retain the moisture content by grains. Decant off water of grains and allow them to cool, till surface dry. Add 2% calcium sulphate (gypsum) and 0.5% calcium carbonate (chalk powder) by weight of dry grains. The calcium sulphate prevents the sticking of grains and calcium carbonate is necessary to adjust the pH. The grains can be filled into polypropylene bags of 500g or one kg capacity. Bags are plugged with non-absorbent cotton and sterilized in an autoclave at 15lbs for 1hr. After cooling the bottles are inoculated with a bit of mycelium of *Agaricus bisporus* and incubated for 18-20 days at 25^{0}C to colonize the grains fully.

Button Mushroom Spawn Preparation

Step 3: Spawning and packing

Spawn is thoroughly mixed with compost @ 2% by weight of compost. Spawning is done under sterilised conditions. Proper hygiene needs to be maintained in and around the spawning room to avoid contamination in cropping rooms as well. Workers should wear different/clean set of clothing and wash their hands with disinfectant or soap before spawning. Cultivation can either be done in poly-bags, trays or in shelves. Compost in poly-bags of 10kg capacity is easy to handle and transfer from one place to another with less contamination chances. Spawned compost bags are kept either on floor or in shelves for spawn run under room temperature varies between 22-24^{o}C. Colour change of compost from dark brown to light brown with white spawn spread is an indication of mycelium colonization, which usually takes 12-17 days. During spawn run less ventilation is required.

Button Mushroom Spawning

Step 4: Casing soil

When the compost is completely colonised with mycelium it is ready for the casing, which means covering the colonised compost with a layer of pasteurized soil known as casing soil. This is an important aspect in which the vegetative phase changes to reproductive phase. Different types of casing materials are in use as casing but HRG has developed a method of making compost from vermicompost. In the initial years further improvement has been done with the addition of coco peat. Moist leached vermicompost is mixed with moist coco peat with 2-3 turning on concrete floor. pH of the casing soil is adjusted with Chalk Powder (CaCO3) to >7. This casing mixture is pasteurized in insulated tunnel at 58-60 ^{0}C with steam from boiler for 8-10 hours. Cooled casing soil is provided in air tight sealed black plastic bags to the growers with spawned compost.

The best material of casing soil used by the author is the vermicompost prepared with cattle dung and organic material. The use of vermicompost as casing soil has been practiced for the first time. The casing soil is steam sterilized at 58^{o}C for six hours in casing chamber. Steam sterilization is preferred over chemical sterilization. The pH of the casing soil should be around 7.5 – 8.0, which could be adjusted by adding chalk powder before its application.

Button Mushroom Casing Preparation

Step 5: Cultivation by farmers

Small farmers need not to understand composting, spawn making since this being highly technical and specialized process done by experts. At the same time construction of the new rooms for cultivation is not need as in hill areas people usually have extra rooms in their houses. Even empty cowsheds can also be used for seasonal cropping. In that case farmers can keep mushroom compost bags in their houses/cowsheds, which would be easy for them to handle and look after the rest of the activities. The temperature requirement for vegetative growth/mycelial is 22-250C while during fruiting period it should be between 16-200C.

Compost Stacking in Cultivation Room

- **Casing**

After complete spawn colonization the compost bags are opened and folded to outside. 2.5-3.0 cm thick layer of casing soil is spread over the leveled compost surface and sprayed with 0.2% Bavistin solution. Surface is kept wet by sprinkling water and humidity is maintained 70-80%. Temperature conditions remain the same, till the casing soil layer is also impregnated with mushroom mycelium.

Harvesting of Button Mushroom

- **Crop Management:**

Case run is seen on the sides of bag and by slightly digging the casing layer in the centre. If it is impregnated with white mycelium this means case run is complete. At this stage temperature should be lower down to 16-200C. Windows and doors should be opened to introduce fresh air, which lowers the temperature, and initiate pinning (initial stage of fruiting bodies). Within next 7-8 days mushroom crop will be ready to harvest.

Harvesting of Button Mushroom

- **Harvesting and Grading**

Mushrooms are harvested at button stage when cap is closed with 3-4 cm in diameter. Mushroom is held between fore finger and thumb and slightly pressed against soil and twisted gently to take it out and collected in the basket to protect it from damage. After harvesting, the lower part of the stem is removed. Crop is washed, graded, and packed in 200g packet or depending upon the requirement of the consumers.

- **Marketing**

Market varies from place to place. Popularisation of new product into the market is very important. People should make aware of nutritive value of mushrooms and as a delicacy. After bringing mushroom crop into market, assessment of its consumption in the market on daily basis is very important to restrict the number of growers. As the shelf life of mushrooms is very short in comparison to other vegetable crop so marketing need extra caution. The crop can be marketed in the nearby towns and district Headquarters. Initially it took time to establish the market and make shopkeepers and consumers aware of mushrooms. The cycle of mushroom growing can be set in such a way that the mushroom supply should be regular in the market and there should not be glut into the market. When production increases the area of marketing needs to be increased. Though this increases the cost of transportation but day to day spoilage can be saved. It is not always possible that fresh mushrooms are consumed in the market daily. In that case mushrooms should be preserved in different forms or in blanched form. After processing the mushrooms can be stored for longer time period for consumption. This will not spoil the crop and growers will not face any economic loss.

Button Mushroom Retail in Vegetable Shop

Step 7: Business model

Work throughout the last three years has while working with NMHS medium grant project demonstrated that button mushroom cultivation is one of the best activities to generate cash returns in shortest possible time for forest dependent communities. HRG Shimla business model involves both supply of raw material (Seeded compost with casing soil) and facilitation of marketing of farmers mushrooms at nearby larger urban markets. While HRG helps farmers to prepare farmers mushroom house at no cost with locally available material. HRG demonstrate to local households and carpenters to create the wooden shelves to stack the ready to cultivate compost bag keeping in veiw the space and capacity of the individual farmers. This work was mainly accomplished by the household members or their relative having carpentry tools and skills. HRG provide spawned compost quality compost and pasteurized casing soil to the growers on cost at their door step. At the same time HRG team provide demo for button mushroom cultivation prior to supply of compost. On regular basis team guide the growers for day to day cultivation operations. Grading packaging with material for marketing also sourced at the time of supply of compost. All growers at one location were organized in groups and each group will harvest the mushrooms at the mutually agreed time for packaging. Packaged mushroom of each group were collected at one central collection point and transported in one vehicle to the pre-decided market location in nearby urban centre. Each group keep account of the material dispatched to the market and money from market is collected on weekly basis or monthly basis keeping in view the convenience of the person at central collection and forwarding centre. As the mushroom house structure and growing process becomes more standardized, the daily yield of mushrooms stabilizes. Farmers see mushroom room as 'Money Room.' Return is good with no capital and energy cost in natural farming of button mushroom in suitable seasons of March – May and July-September. This season in Indian Himalayan Mountains coincides with tourist influx and reduced supply of mushrooms from the plains and farmers get premium price of Rs. 130-150/Kg. Most of the time, a cost-effective way of adding value to these mushrooms is considered the key opportunity for future development but for small household level seasonal mushroom growing sale Value addition as canning and pickle making requires capital cost, certification (FSSAI) and changes market structure and small farmers fail to cope with these procedures. There is growing demand for mushrooms in Indian Himalayan Region as tourism has increased many folds. This demand is currently met by imports from nearby state of Punjab and Haryana, but could shift to local farmers if production was made cheaper and more efficient with technical support to farmers in Himalayan region.

Step 8: Economics of mushroom cultivation for farmers

The mushroom cultivation is an economically viable activity. If grower is not able to invest much initially then he can start with 2000 Kg compost in which bags are adjusted on the floor without making any shelves in the household or cowshed room. One ton compost costs 19000/- + transportation (Rs. 25/-bag of 10 Kg, Total for 200 bag Rs. 5000/-) and produce average 400kg of mushroom of Rs. 50,000/- @ Rs.125/kg (prevailing market price on wholesale). Expenses for packaging and marketing for 200 Kg mushroom cost on average Rs. 5000/- . The net benefit of Rs. 21,000/-which is 72 % in three month crop cycle and is quite profitable venture for the farmers. Farmers can start cultivation in multiple rooms with a gap of 15-20 days to increase to production and returns once they are familiar with the technology and business requirements.

Button mushroom cultivation provide economic and employment opportunities to transporters and retailers as well. The spent compost of mushroom is very good manure for agriculture fields and is converted to vermicompost after mixing with dung. This helps in increasing the agriculture production and soil fertility. This save time of rural women for collection of forest biomass for making of Farm Yard Manure (FYM) and saved time used in mushroom cultivation operations by household members require no additional cost in the process.

Step 9: End to end support

A crucial factor for the overall success of this button mushroom technology implementation is the integrated approach to design, business strategy, and the implementation process. The goal was to combine existing and new practices and infrastructure to establish a complete system of support from purchase decision to farmer training to technical support, and finally, connecting growers to markets. The introduction of button mushroom cultivation in a village with organization and orientation of the farmers groups (specially of women) to reduce cultivation cost, risk and collective training. Each farmers group was trained in the process of growing mushrooms by a local expert. This help in passing knowledge and creating interest in the community. These trainings are open to all mushroom farmers and others in the village to discuss any difficulties they've been having or new practices they want to adopt. This is a more efficient and sustainable means of trouble-shooting than interacting individually with farmers. Assured market linkage shared with farmers group prior to cultivation planning reduces risk to the farmer, because they know they will have a buyer at a reasonable price for their product. Since the mushrooms have to make it to markets within 3-4 hours after harvesting central collection facility needs to have strict programmed schedule for final packing and forwarding predefined with the growers group to avoid any spoilage. Linkages and support of line department like Agriculture for cryo-storage could increase convenience and profit for farmers.

Step 9: Discussion

The introduction of mushroom production as a means of supplemental income in a village in rural Himalayan household has shown great promise. Development of this venture has resulted in the clear insights about the technology, business, and venture creation in low resource settings over the years. Mountain rural economy is undergoing rapid increases in population density, land is becoming scarce and mushroom growing in less fertile areas will greatly contribute to improving livelihoods and eradicating poverty in rural areas. Mushroom growing has become a good business as it can be integrated easily into both men's and women's daily activities. Mushroom growing was a new venture in the area and has enabled women, men and youth to engage in gainful employment by establishing household growing rooms. There is vast potential for the cultivation of mushrooms because the government agencies provide technical training and raw materials and cheap household labour are readily available, and it requires minimal space in living houses with least damage due to climate vagaries and wild animal menace. At the same time by product of cultivation as spent compost will increase agriculture production as manure and reduce extraction of forest biomass for FYM preparation with conservation of biodiversity and forest habitat.