

Indigenous system of white-button mushroom production

for augmenting farm income in northern India

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White button mushroom (Agaricus bisporus) cultivation is mostly advocated as a commercial, indoor crop with proper hygienic conditions. But, the indigenous practised of growing this mushroom by the farmers in northern India, presents an antithetical case for study. Applying the local wisdom for the production of mushroom crop using the locally available resources in a temporary thatched bamboo-house in Haryana and Punjab is an important indigenous agriculture activity as a means of augmenting farm income. Same practice was replicated in Jammu and Kashmir albeit not matching the scale and grandeur reveals locals' skill in raising white-button mushroom as a source of additional income. With optimum productivity and better price for mushrooms in the market, the mushrooms yield more returns than any other field crops or commercial crops per unit area. White button mushroom cultivation during winter in northern India is a potential horticulture activity to double the farmers' income. An attempt is made to document the finer details of this traditional knowledge after an exploratory survey in four states of northern India.

Key words: *Agaricus, bisporus*, Farmer, Income, Indigenous system, Mushroom, Production

MUSHROOM is considered and propagated as complete health food owing to its high nutritive and medicinal values. Mushroom is rich in proteins, dietary fibre, vitamins and minerals. On dry weight basis, different mushrooms contain 26 to 82% carbohydrates and 12 to 35% proteins. Presence of vitamins B and C, unsaturated fatty acids, amino acids and high K:Na ratio makes it ideal for heart patients, pregnant women, children and people suffering from infirmity. Hence, mushrooms are gaining importance in recent times in the wake of increasing health awareness among the people and the nutritional advantage they offer.

The farmers in India have practised and adopted cultivation of different edible mushrooms by their indigenous practices. Paddy-straw mushroom (*Volvariella volvaceae*) in

coastal Odisha, milky mushroom (*Calocybe indica*) in Tamil Nadu, shiitake mushroom (*Lentinula* spp.) in north-eastern states of India and white-button mushroom (*Agaricus bisporus*) in northern India are some examples of such practices. The indigenous system of cultivating white-button mushroom by the farmers in the plains of Haryana and Punjab in temporary thatched houses using bamboo and paddy-straw is of magnanimous scale among all.

In India, white-button mushroom contributes >85% of total mushroom production. Commercial production of this mushroom is cost intensive enterprise, requiring insulated cropping rooms, chilling facility, costly inputs such as chemical fertilizers, chicken manure, wheat bran, oil-seed cakes, labour etc. Farmers in northern India, however,

adopt seasonal cultivation of mushrooms during winter in temporary thatched houses using the locally available resources with them. This low-cost indigenous system has evolved into a commercially profitable venture in recent years. However, commensurate efforts are not made to document and popularize this technique to double farmers' income.

The farmers' acumen in adopting the mushroom cultivation according to different climatic and weather conditions is noteworthy. Documentation of such indigenous knowledge is first step towards protection of tacit indigenous knowledge in the era of globalization and Intellectual Property Rights. Hence, the present study was undertaken to explore, analyse and document indigenous cultivation



Fig. 1. Mushroom huts and compost preparation area



Fig. 2. Number of mushroom sheds/ huts adjacent to one another



Fig. 3. Three-rack arrangement in a shed

practices of white-button mushroom in Haryana, Himachal Pradesh, Punjab, and Jammu and Kashmir.

An exploratory study was undertaken with an objective of observing, analysing and documenting the indigenous method of white-button mushroom cultivation in Haryana, Himachal Pradesh, Jammu and Kashmir, and Punjab. Uncontrolled observations coupled with personal interviews were employed for the present study. In most cases one-to-one interaction with either the owner or the farm manager was followed. In some cases, group interactions with farmer groups were organized. The study area comprised of Sonapat, Panipat and Kurukshetra districts of Haryana; Solan district of Himachal Pradesh; Hoshiarpur district of Punjab; Kathua and Jammu districts of Jammu and Kashmir. Information on season, site selection, cropping room – their structure and design, composting, crop management, post-harvest practices and marketing were recorded. The facts gathered and the data collected in the study were verified during personal visit to the farms. Prior consent of the information providers was taken for documentation.

The observations and information gathered during the study are discussed here.

The seasonal mushroom production practised by the farmers involves mainly three activities; compost preparation to prepare the growing substrate to raise button mushroom, construction of temporary thatched house or rooms for creating micro-climate suitable for white-button mushroom and crop management involving spawning, casing, spraying water, harvesting, etc.

Season: Farmers in the study area

take up seasonal mushroom production between October and February extending at times up to March depending upon prevailing weather conditions. It was observed that, generally composting and shed construction begins in October and cropping starts from November. Coinciding with second month of first cropping, they prepare another lot of compost and fill it after disposing compost of first crop. However, in Himachal Pradesh, December is avoided for cropping as the temperature dips very low ($<10^{\circ}\text{C}$). In Jammu, single crop is taken by majority of the farmers from November to January.

Site selection: In Haryana and Punjab, farmers identify site in paddy field after the crop is harvested. After harvesting *kharif* paddy crop, they leave required area uncultivated during *rabi*. Farmers select comparatively plain area in a locality and minor undulations were levelled by farm-labours. Preference was given to vicinity to road and they demarcate required area for compost making and mushroom houses. It was generally observed that, almost equal area was earmarked for composting and mushroom huts (Fig. 1). Composting area includes space for pre-wetting of straw, compost piles, water-storage tanks, casing soil preparation etc. Thatched mushroom huts are laid out lengthwise in north– south direction to protect them from wind disturbances. Usually, farmers change the location of mushroom house from that of previous year.

In Himachal Pradesh, and Jammu and Kashmir, seasonal cultivation of white-button mushroom is almost akin with respect to scale and structure of mushroom houses. The cultivation is mainly taken up in constructed small-mud houses or

even in reinforced concrete buildings. Unlike the Haryana and Punjab model, they have limited decision to make on-site selection, direction of the mushroom houses, as these are permanent buildings.

Structure and design of mushroom houses: In Haryana and Punjab temporary thatched houses are erected using mainly bamboo, paddy-straw and polythene-sheets. Varying numbers of huts are juxtaposed (Fig. 2) in the space available in their field. Only a single hut is delineated for better understanding the structure of these temporary mushroom-houses.

Normally, single hut spreads over 22.52×602 (three racks arrangement (Fig. 3) or 28.52×602 (four-rack arrangement- Fig. 4) area. Poles of either eucalyptus or bamboo of 8 to 102 cm height and 11 to 13 cm dia are used along periphery, which form borders for each hut. In some cases, twin bamboo poles of lesser dia are also used in place of thick single pole. These poles are firmly inserted in soil up to 1.5 cm to 22 cm leaving about 7 cm to 82 cm above ground at a distance of 6 cm to 82 cm intervals. Similar poles but of higher length (12 cm to 142 cm) are inserted lengthwise at the middle of hut which form the lengthwise spire. Hence, a total of 21 to 30 such poles are required to form the frame for entire hut. Series of bamboos (9 to 10 cm dia) on the top are laid parallel from middle line to border line to hold the thatched roof. Usually this series of bamboos on the top are placed at an interval of 11.52 cm apart (122 cm and 162 cm length for 3– and 4– racked huts, respectively). Some farmers strengthen this roof by making net of synthetic ropes intertwined between



Fig. 4. Four-rack arrangement in a shed

bamboos along the length of the roof. This structure supports polythene sheet, which is placed on the roof to protect racks from rains. This is overlaid with paddy-straw or *sarkanda* grass (*Sacharam munja*) all over the roof. All sides of the hut are similarly covered with straw leaving door space.

Each hut comprises of 3 or 4 racks and each rack in turn is divided into 3–4 cm vertical shelves (Figs. 3 and 4). Number of racks and shelves in each hut depends on strength and thickness of the bamboo used or spacing between each of the racks, shelves or sub-shelves. Racks are laid leaving 2 to 2.52 cm space for recess from the border of shed and also between each rack. For erecting each rack, bamboos of medium dia (9–10 cm) are cut into equal length of 7.5 to 82 cm. Such poles are vertically inserted in parallel lines keeping width of the rack constant (mostly 3.52 cm). These poles are firmly inserted 1 to 1.52 cm in the soil leaving about 62 cm above the ground at an interval of 3 to 3.52 cm along the length of entire hut. Two such parallel lines of bamboo are used to create shelves and between two vertical shelves 1 to 1.252 cm distance is maintained. However, first shelf is usually positioned at a height of about 1.52 cm from the ground level. These shelves are strengthened by tying 2 to 3 lines of thinner (1.5 to 3 cm dia) long bamboo sticks lengthwise at a distance of 9 to 122 cm. Such sticks are usually available in 6 to 7.5 cm length in the market. Some portion of weak tapering end of these bamboo sticks are overlapped with thicker end of the adjacent pole. Compost holding trays are created over the shelves by spreading polythene sheets. Such sheets are usually punched at regular intervals



Fig. 5. Making compost holding troughs with polythene sheets and plastic threads

to drain excess water from the compost. Margins of these polythene sheets are kept raised by tying plastic threads, making trough (Fig. 5) to hold compost for 10 to 15 cm. Compost is evenly spread over these trays for growing mushroom. Though, most farmers make three shelves in a rack, making four shelves is also observed. Some farmers spread the compost on ground surface also thus making an extra tier for cultivation. Generally 16 to 18 tonne of compost is accommodated in one such shed which can yield 2 to 2.5 tonne of fresh button mushrooms depending on the compost quality, spawn quality and management practices.

Farmers use an innovative implement designed by themselves to make pits for inserting poles. The implement (Fig. 6) works as an auger in making deep hole without loosening the nearby soil. The pit becomes just sufficient to insert a pole and hold it tightly. This gives strength to hut and prevents the shed either from collapsing or from leaning due to wind disturbances.

In Himachal Pradesh, and Jammu and Kashmir, the growing houses vary from temporary to semi-permanent to permanent structures. Some farmers use concrete rooms with cemented floor and roof (Fig. 7). Most commonly observed mushroom growing rooms are simple from-plastered brick walls raised from 12 to 162 cm height and covered with either tin or asbestos sheets. Covering such sheets with locally available (*Sarkhanda*) grass as an insulating material is an important indigenous practice. This helps in moderating the temperature of growing rooms especially during the beginning of season when outside temperature is very high. Some poor farmers erect small huts using locally



Fig. 6. Indigenous equipment to make holes in the land for shed construction

available wooden poles and straw. Even the very resource poor farmers in the region were seen making the mushroom sheds using the decrepit materials available with them. Some families also convert their living rooms into cropping rooms (Fig. 7) for taking up mushroom cultivation during the season.

Shelves for compost filling are all the more interesting in Jammu and Kashmir. Rich and the poor alike hoard used and discarded fruit crates till the season; nail or glue the strips wherever necessary and use these crates as containers of compost material (Fig. 8). These assemblages and their arrangements in cropping room over one another in several lines create an awe-inspiring innovative practice. After filling compost in wooden crates ($122 \times 182 \times 92 \text{ cm}^3$) farmers place them in horizontal and vertical rows leaving the space in between for labour movement. It was also observed that many farmers spread the compost over racks constructed usually in 3 to 4 tiers. During survey, it was observed that farmers cultivated mushrooms in sheds or rooms of varying dimensions from 200–1,000 sq ft and more than 1,000 sq ft by very few farmers. Generally rooms of such a dimension were filled with 200–650 crates or polythene bags containing 2 to 6 tonne of compost.

Compost preparation: Mushroom growers across the region give due care to compost making due to its significant role in mushroom production and productivity. Farmers in Jammu and Kashmir start making compost between late September and early October to synchronise harvesting of mushrooms with good prices during November. However,



Fig. 7. Cropping in *pucca* houses



Fig. 8. Arrangement of fruit and vegetable cartons as compost containers



Fig. 9. Full grown fruiting bodies of white button mushroom

growers in Haryana and Punjab generally start their first lot of composting in October. It was observed that, farmers across north India followed different proportion of raw materials to prepare compost for seasonal cultivation of white-button mushroom. However, most commonly used combination of raw materials is listed in Table 1.

Table 1. Raw materials commonly used by farmers in Haryana and Punjab for compost making.

Ingredients	Quantity
Wheat straw	40 q
Chicken manure	20–24 q
Urea	40–50 kg
Ammonium sulphate	40–50 kg
Gypsum	6–7 q
Lindane	1 kg
Furadon	2 kg

Most farmers in northern India prepare the selective compost by following long method of compost preparation. This method of composting takes 28 to 30 days over which the mixed materials are watered and frequently turned and made into fresh piles 7 to 8 times so that the compost becomes uniformly pasteurised, homogeneous and free from ammonia (NH_3). Small-and marginal-mushroom growers in Himachal Pradesh do not prepare compost on their own but purchase from private commercial mushroom production units or from state department of horticulture.

Crop management: Farmers mostly depend on purchased spawn as it is seasonal agriculture activity for them. Generally 0.5% seed rate (5 g of spawn/kg of compost) on wet compost weight basis is adopted among the growers. In Haryana and Punjab, prepared compost is mixed with mushroom spawn and spread

over the racks for about 4 to 62 cm height and allowed for the fungal mycelia to spread (spawn run) for about 7–12 days. After the spawn run a layer of casing soil of about 12–2 cm is spread over compost uniformly. Mushroom pin-heads start appearing 8 to 12 days after spreading the casing soil. Such pinheads develop into full-grown mushroom fruiting (Fig. 9) bodies after 3 to 4 days.

High temperature in Jammu and Kashmir during October does not augur well for good spawn run. Hence, they adopt several indigenous practices to keep temperature of compost bags and trays down to the desired level. Covering of roof sheets with either dry grass or a shade net is most commonly observed. They also spread newspaper sheets all over compost and sprinkle water over them and also spray water on floor and walls at regular intervals during daytime. However, problem in high altitude area of Himachal Pradesh is to counter problems associated with low temperature, especially during peak winter. Hence, farmers here use electric room heaters, high wattage light bulbs and water-boilers to raise temperature and maintain desired relative humidity in mushroom houses.

Casing soil to cover the compost after spawn run is prepared in their compost yard. Some farmers in Haryana use only garden soil while others mix garden soil with well rotten farmyard manure in equal proportions. In case of non-availability of farmyard manure farmers mix burnt rice husk with garden soil. Soil or mixture of soil and decomposed farmyard manure is thoroughly wetted and excess water is then allowed to drain (Fig. 10). This

process is repeated 4 to 5 times. Then drenching with 0.1% formalin and covering it with polythene sheet for two days disinfect the casing soil.

Water storage: Technique of storing water is another indigenous knowledge in the area. They dig a pond in the vicinity of mushroom sheds and cover the whole pond with polythene to prevent percolation or draining of stored-water. Water is supplied to this pond either from canal or by pumping. This water is used for composting activity, casing soil preparation and spraying to compost beds during cropping.

Post-harvest operations and marketing: Matured fresh fruiting bodies are harvested usually in evening hours. Soiled stipes of mushroom are cut with knife and washed with fresh water. Some farmers wash with potassium metabisulphite solution to make them appear attractive to consumers. Harvested mushrooms are transported in bulk to nearby big vegetable markets. Transportation is done usually in the night (at cooler temperature) to retain freshness of the mushrooms. Retailers in the market do packaging into small polythene packets. All mushroom growing areas supply mushrooms to nearby urban areas like Delhi, Sonapat, Panipat, Chandigarh, Amritsar, Hoshiarpur, Jammu, Shimla etc.

ECONOMICS

The construction of each temporary bamboo shed costs between ₹ 80,000 and 1,00,000. Equal amount is spent on raw materials, wages, packaging, marketing and transportation costs and other miscellaneous expenditure.



Fig. 10. Preparation of casing soil to cover the compost after spawn-run

In one season farmers grow two crops thus harvesting around 4 to 5 tonne of fresh mushrooms per shed. The average selling price of fresh mushrooms varies between ₹ 75 and 100 in the wholesale market. With the lowest productivity and lowest market prices, farmers can get a minimum of ₹ 300,000 which is ₹ 1 lakh more than his actual investment per shed. With better productivity and better market prices the farmers can get ₹ 500,000 which is 2.5 times more than his total investment. In an area of about 4,000 sq. feet such high returns in 110 to 120 days is unthinkable in any other field crop or commercial crop. Hence, in all the agro-ecological regions, wherever the climate supports, different mushroom varieties must be promoted among the farmers as an important strategy to double their farm income.

With increasing interest in scientific advancement and use of high-end technology, the farmers' traditional knowledge and innovations are plausibly not getting its due attention. Moreover, the role of indigenous knowledge among rural community in their own advancement cannot be over emphasized. A pure indigenous practice amalgamating with modern hi-tech scientific interventions is resulting in a metamorphosed form of both. A time may come when the indigenous practice is completely overwhelmed by modern practices as per the needs of the people. This may result in loss of an indigenous

practice and subsequently enormous intrinsic advantages of it. Hence, the need to document and validate the farmers' indigenous practices is being felt more than ever in the past.

In the present work, an attempt was made to document indigenous practices associated with seasonal cultivation of white-button mushroom from site selection to production, marketing and its economics. This cultivation method highlights farmers' innovation and proved to be a success story in commercial terms. Farmers' decision-making process about technology adoption covers several steps and each step is based on practical economic consideration. By preferring mushroom production in place of *rabi* crops on fertile fields, farmers of Haryana and Punjab take a measured risk. However, our interaction with farmers revealed that climatic conditions in north Indian plains during winter supports good mushroom production without costly environment manipulation required for their cultivation. Erection of temporary structures during winter also ensures availability of land for growing field crops during rest of the year. Materials used for the structures such as bamboos are often reused. Hence, ideally, the profit from the mushroom production is higher in subsequent years as the cost of the sheds is not incurred.

Similarly, use of fruit and vegetable crates for mushroom production in Jammu and Kashmir is testimony to farmers' innovation to

reduce cost of production and increase profitability. Such practices if adopted by several farmers can double their farm income and also the consumers demand for mushrooms is also met. Foothills of Himachal Pradesh, and Jammu and Kashmir face cooler winter and increasing the temperature through electrical appliances become necessary. Farmers grow seasonal mushrooms here as they are assured of higher income arising out of higher prices due to increased demand for mushrooms. This underlines the fact that returns accrued exceeds electricity cost resulting in more profit to them. This paradox of abundant supply with increased price for mushrooms during winter is due to increased consumption in the hotels and marriage ceremonies coinciding with its seasonal cultivation.

Notwithstanding its favourable weather and being one of the earliest states to begin mushroom cultivation, Himachal Pradesh has been lukewarm in picking up seasonal mushroom production. The successful method and scale of seasonal mushroom cultivation in adjoining states of Haryana and Punjab is yet to be emulated in Himachal Pradesh. Though, we find few small farmers taking up mushroom cultivation in their courtyards during winter, its non-adoptability by many is not fully comprehended. One of the possible reason is increasing cost of raw materials and their transportation from plain to hills.

Farmers of Haryana and Punjab shift the site of mushroom production from the previous years to reduce the incidence of soil-borne diseases. This indigenous measure by many farmers is praise worthy as widespread occurrence of wet bubble, green mould, brown plaster mould etc results in heavy loss of income to farmers. Few of the farmers also used yellow sticky traps to counter the menace of small mushroom flies in the growing rooms. This cost effective and efficient practice results in significant reduction of flies in the mushroom sheds.

The compost, on which

mushrooms are grown, is a selective medium for the growth of white-button mushroom mycelium. Production and quality of mushrooms is decided by compost quality. Compost is prepared by two different methods, the short method and the long method. Short method composting takes less time but is cost intensive on account of machinery and pasteurization tunnels. Hence, farmers adopt long method of composting to reduce the investment. By lab analysis the best compost for white-button mushroom will have 68–72% moisture and pH of 7.2–7.8. Apart from their indigenous methods to ensure qualities of good compost are mentioned earlier. Many progressive farmers use pH paper to analyse compost pH and few even get the compost analysed in research laboratories of Directorate of Mushroom Research, (Solan), IARI (New Delhi) and HAIC (Murthal, Haryana).

Seasonal mushroom cultivation during winter brings copious supply of fresh button mushrooms in vegetable markets of north India during winter. Special mushroom *mandis* are organized by farmer

groups and vegetable vendors in several cities. Farmers continue to get good prices for mushroom throughout the season. However, on several occasions sharp decline in mushroom prices is also seen. In such cases some farmers decide to sell the produce to nearby canning units or to pickling units. This will at least save their cost of transportation to vegetable markets.

SUMMARY

Innovation and adoption of various technologies by seasonal mushroom growers of four north Indian states resulted in considerable economic profit to them. It also provided job opportunity for huge number of labourers. These labourers from adjoining states usually migrate during mushroom growing season to Haryana and Punjab to cater the need. In that way, the core labour group refresh their skill of mushroom growing year-after-year, thereby becoming more experienced and the employers get dependable persons to take care of whole activity. The labourers usually work under a leader on contractual basis and relationship between employers and labourers

becomes enduring. This ensures smooth running of whole process. Economic returns claimed by farmers are huge, many growers with 60 to 80 huts or above claim to have crossed 1 crore turn over in a season. Hence we may opine that the seasonal mushroom growing activity by north Indian farmers reached a level akin to small-scale industry and efforts are needed to replicate this success in other parts of the country with similar climatic conditions and resources. Interpolation of many such indigenous practices have inherent potential to bring desirable changes in the lives of rural folk. Detailed economic and social impact analysis of such activity needs further investigation and interventions by scientists to further refine the location specific technologies.

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