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Boosting mushroom production through innovative technologies

The mushroom component in a farming system augurs well to impart the diversification as it makes use of agro-residues of the farm and also recycle the spent mushroom compost after harvesting the mushrooms. Mushroom being an indoor crop, its farming is less affected by the vagaries of the climatic conditions. Mushroom can also be fitted either as an agribusiness with environment controlled production unit by the resource rich farmers or as a livelihood activity for small farmers. Many farmers in North Indian states have adopted mushroom cultivation as a regular farming activity during winter. The use of low cost mushroom houses made from bamboo, paddy straw and other cheap raw materials has made huge difference to their income levels. In recent times, the practice of adopting tropical mushrooms like *Pleurotus* sp. and *Calocybe indica* adjusting to the prevailing climate and using the same facilities has helped the farmers in getting round the year returns compared to just three to four months returns earlier. Extending the mushroom cultivation beyond winter has turned the mushroom growing as a year activity than as four months activity of growing white button mushroom alone in the past.

THE technologies and strategies have many potential interventions in mushroom cultivation. Without straying into the debate of doubling the real or nominal income, the strength of each technology/strategy in isolation to increase monetary benefit or saving of time and energy is discussed. However, in unison, all the potential technologies developed in mushroom cultivation adopted can undoubtedly double the mushroom growers' real income.

TECHNOLOGICAL INTERVENTIONS IN MUSHROOM PRODUCTION

Short Method and Total Indoor Composting

The agriculture residues are either composted or pasteurized or autoclaved to prepare suitable medium to grow different mushrooms. The compost prepared by short method or total indoor composting method to grow *Agaricus* mushroom have proven to be superior over long method of composting in terms of productivity, environment safety and resource use efficiency. A difference of 4-6% higher yield coupled with saving on labour, chemicals, etc. translate into huge monetary benefits for farmers. Around 20% reduction in water requirement in composting process through the advanced composting technology envisages the sustainable practice of "more crop per drop".

Zero Energy Poly Tunnel (ZEPT)

The compost prepared in the pasteurization tunnels with air circulation by active pressure though yields better than the long method of composting, the cost involved in machinery and the infrastructure is beyond the reach of resource poor farmers. As an alternative, DMR, solan, has evolved a novel approach where in the high density polyethylene (HDPE) pipes with holes at regular intervals are inserted through the compost pile. It was demonstrated that passive aeration effectively controlled the composting process, shortened the compost period, enhance the substrate quality and *Agaricus* yield as of pile composting. The parallel arrangement (10% perforations) of pipes was found best among different passive aeration treatments for achieving the quality substrate in just 16 days and

ZEPT method of composting with HDPE pipes in the compost pile


Fruiting of shiitake through short duration cultivation technology of shiitake mushroom

enhance the *A. bisporus* yield up to 27.6%. This new intervention also opens the possibility to cultivate *A. bisporus* on a ligno-cellulosic, non-pasteurized, non-conditioned, aerated substrate. The shortened composting period from 30 to 16 days saves considerable amount of energy, labour and cost on infrastructure.

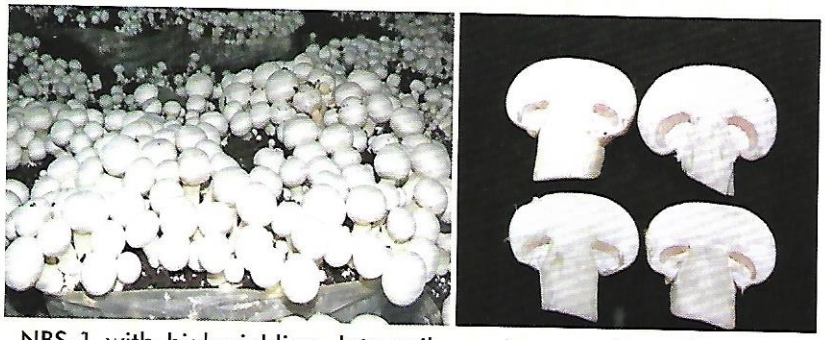
Cultivation Technology of Shiitake Mushroom

Shiitake mushroom (*Lentinula edodes*) - a wood rotting fungus belonging to the class basidiomycetes, produces edible basidiocarps which are highly valued in international market for their unique flavour, taste and enticing aroma. Traditionally, the shiitake mushroom is cultivated on wood logs under natural environmental conditions by inoculating the wood plug spawn on wood logs followed by cold shock treatment by submerging the logs in cold water after a year of mycelia growth and subsequently harvesting the mushrooms during a growth period from three to four years. The duration and inefficiency of this method was the reason for less takers for commercial cultivation of this mushroom in India. However, short duration cultivation on synthetic logs made from saw dust has been developed.

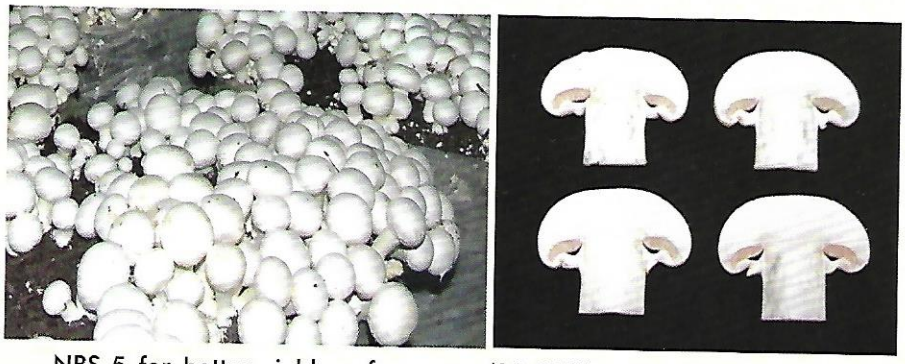
In this intensive cultivation technology, saw dust obtained from the broad leaved trees (*Quercus* sp., *Castanopsis* sp., *Populus* sp. and *Salix* sp. etc.) as the basal ingredient is supplemented with starchy substances like cereal bran, as a source of nitrogen. Calcium carbonate and calcium sulfate (gypsum) are mixed to balance the pH of the substrate. Then the ingredients are mixed in a mixer and moistened to hold 60-65% moisture. Now this substrate is filled in polypropylene bags (1.5 -2.0 kg) and

Mushroom Hybrids

Two new hybrids, NBS-1 and NBS-5, of *Agaricus bisporus* which have shown promising results in research trials as at well as farmers' units on commercial scale. Both hybrids besides possessing browning resistance, give higher yield compared to other varieties and hybrids.



NBS-1 with high-yielding, late veil opening, non-browning strain suitable for canning



NBS-5 for better yield performance (23-25%), good morphological quality, late veil opening, non-browning strain

NBS-1 and NBS-5 give 25 and 23% yield, respectively, at Tirupati Balaji Mushroom at Baramati, Pune, while it is 22 and 23%, respectively, at Weikfield mushrooms, Pune. The yield levels of NBS-5 is at par with strains imported (A-15 and S-465) at Flex Foods, Dehradun.

Cultivation technology of *Macrocybe gigantea* standardized on wheat straw

sterilized at 121°C and 15 psi. After allowing autoclaved substrate to cool to the room temperature, it is seeded with grain spawn @ 3% on dry weight basis under aseptic conditions. The bags after spawning are shaken to evenly distribute the spawn. Inoculated bags are kept for incubation at 25°C with 4 hours of light per day. Optimum mycelial growth will take place in around 18-22 days. Fully colonized blocks are then taken out by slicing and peeling off the poly cover and kept for 4 weeks in the conducive environment for browning of the exterior surface. Temperature of about 18-20^{0}C and 2,000-3,000 ppm CO_2 and high relative humidity (above 85%) are considered ideal environment for this stage. As the browning approaches completion, pin heads starts to form 1-2 mm beneath the surface. Primordia development is stimulated by soaking the blocks in ice cold water for 15-20 minutes. Similar soaking is required for subsequent flushes also. Mushrooms are ready for harvesting after 7-9 days after cold water treatment.

The new short duration technology under ideal conditions can give the fruit bodies within 55-60 days which is much lower than the natural log cultivation. With this technology, the farmers can take two crops in place of earlier one crop. Further, shiitake offers an advantage of synchronizing its production to the market demand by altering the date of cold shock treatment. This will help farmers to overcome the situation of distress sale and in achieving higher financial returns due to matching the production during better demand.

Improving Yield and Quality in Mushrooms

The average yields of mushrooms including the *Agaricus* sp. in India are below par compared to yields in western countries. This calls for focusing on strategies to enhance the productivity of mushrooms. The crop management practices and good mushroom cultivation practices like maintaining humidity, hygiene, homogeneity, farm records etc. will be highly rewarding. However, the crop improvement to develop strains for better productivity potential and quality traits will give farmers additional income.

Similarly, the high yielding strains with high biological efficiency (BE) in *Pleurotus ostreatus* (DMRP-356 with 155 % BE; DMRP-339 with 105% BE), *P. sajor-caju* (DMRP-337 with 117% BE), *Volvariella volvacea* hybrids (OE-210-77+OE-274-111 and OE-210-77+OE-274-18) have been developed. These hybrids have shown improved yield potential consistently under

Mr Jose Prakash with members of the Koonpura association

Processed products of mushrooms

research trials (DMR Annual Report 2015-16).

Cultivation Trials of Mushroom Varieties

Continuous efforts to cultivate/domesticate many wild mushrooms are underway at Solan. Much progress has been achieved in standardizing the technologies by using different agro-residues to cultivate different mushrooms such as *Flammulina velutipes, Hericium coralloides, Lentinus sajor caju, Lentinus squarrosulus, Macroletpiota procera, Pleurotus eryngii* (King Oyster mushroom), *Volvariella bombycina, Macrocybe gigantea,* etc.

The cultivation technology of *Macrocybe gigantea* has been standardized. The on-farm research trial of M*acrocybe gigantea* has been taken at farmers' fields in Haryana. This new tropical edible mushroom is rich in protein, vitamin D, potassium, iron and zinc. This mushroom resembles white button mushroom and milky mushroom which makes its marketing easy. Further, pungency associated with milky mushroom is not found in this mushroom and its suitability for tropical climate can be promoted as USP of this mushroom among the growers.

To grow this mushroom, the substrate (wheat straw/ paddy straw) is pasteurized by hot water treatment for six hours. After the spawning, the room temperature is maintained at 25-35°C for good cropping. This mushroom can also be promoted to be grown after winter when the climate is no more suitable for white button mushroom. Adoption of such mushrooms as a diversifying activity opens new ways to double the farmers' income.

Doubling Processing and Value-addition

The processing and value-addition has not received the commensurate attention it merits in mushrooms. Mushroom being a perishable crop leaves the farmers with very less bargaining power. Farmers are losing lot of income on this account. Hence, the value addition and processing must be key component in mushroom farming. Large growers must be equipped to process the mushrooms left after selling fresh mushrooms. Unsold mushrooms if not processed either for drying, canning or for preparing value added products will go as wastage. The processing not only avoids this loss but generates additional revenue after value-addition. The Directorate of Mushroom Research, Solan, has developed many processed products such as pickle, *murabba, samosa,* etc. and mushroom fortified products like biscuits and noodles which are becoming popular among the consumers. Many entrepreneurs have achieved commercial success in mushroom value addition enterprises by their innovative models and recipes of mushrooms. Mr Jose Prakash of Tiruvantapuram in Kerala and Ms Manorama Devi of Samastipur in Bihar and Mr Thiru. A.R. Mohamed Khan of Villupuram district in Tamil Nadu are making good progress in value-addition and processing of mushrooms.

Small scale mushroom units often find it difficult to sustain the production on profitable basis. This is mainly on account of efforts and resource required to market less than 6-8 kgs of fresh mushrooms. Mr Jose Prakash in Tiruvanantapuram has found a way to address this problem through his association- 'Koonpura'. He has promoted cooperative farming and marketing of fresh mushrooms in his region. He also supplies required quantity of spawn to growers while collecting fresh mushrooms. He has promoted variety of processed products of mushrooms in his region. Both fresh and dry mushrooms are processed in "Koonpura". Variety of Indianised mushroom fortified eatables like, mushroom *cutlets, samosa, tikki,* burger, pickle, *pappad*, dry soup powder, dry mushroom *chutney*, mushroom *murukku*, mushroom chips, etc. are made by him. Some of his processed products of mushrooms are shown above. Besides solving the marketing problems, his innovation has led to augmentation of demand for mushrooms because of his efforts in popularizing his products. Case analysis of Mr Jose Prakash emphasizes the need for strategy to make the small scale mushroom production as profitable avocation. Many localities in the country support one or the other edible mushroom variety in natural climate. This will open up the avenues for resource poor small and marginal farmers in amplifying their income generation by more than two times.

For further interaction, please write to:
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