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Short Note

Scenario of commercial mushroom production in Nagaland

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Mushroom, a health food and also called 'white vegetables' or 'boneless vegetarian meat', has been identified as priority item in government's programmes in North East India. It contains 20-35% protein (dry weight basis) and protein is of superior quality (Kakon*et al*., 2012). There are many types of mushrooms produced and marketed worldwide. The total world mushroom production in 2019 was reported as 43 million tonne. Five genera accounted for 86% of the world production with *Lentinula edodes* contributing 26%, *Auricularia* spp. 21%, *Pleurotus* spp21%, *Agaricus bisporus* 11% and *Flammulina* 7% (Singh *et al*., 2020). In India, mushroom production at present is about 0.24 million tonne (Sharma *et al*., 2021), and white button mushroom has the maximum share of 73% in total production of mushroom followed by 16% of oyster (Sharma *et al*., 2017).

In North Eastern region of India (including Nagaland), oyster (*Pleurotus* spp.) mushroom has the maximum share in mushroom production and consumption (Rajesha, 2018). Mushrooms are known by different names in the local dialects of the North Eastern states like 'Tit' (Meghalaya) 'Kathphula' (Assam and Tripura), 'Cheaoe' (Sikkim), 'Chenggum' (Manipur), 'Pa' (Mizoram), 'Konger' (Ao dialect, Nagaland) and 'Indeo' (Galo dialect, Arunachal Pradesh) (Borah *et al*., 2019). North East India has high biodiversity in mushroom flora (Verma *et al*., 1995). Nagaland is home to over 140 wild mushrooms including over 50 popular wild edible mushroom species (Ao *et al*., 2020). In study on the mushroom diversity in various districts of the state, 37 species were identified as edible and 21 species had medicinal properties (Ao *et al*., 2016).

In the state of Nagaland,mushrooms have been a delicacy since time immemorial (Ao *et al*., 2016) and there is practice of collection of seasonal wild edible mushroom, drying in the sun and storing these mushrooms for future use but the cultivation is limited. Hence, North-East India provides an economic opportunity to develop the mushroom cultivation enterprise in the region.The substrate required for mushroom cultivation is in plenty and its recycling via growing mushrooms can help in enhancing income and imparting higher level of sustainability in rural areas. Some of the mushrooms suitable for cultivation are discussed here.

Oyster Mushroom: In Nagaland, even though prevailing weather condition is favourable for many mushrooms, the commercial cultivation is restricted to oyster mushroom cultivation because of its simple cultivation technology, low investment, availability of paddy straw as a raw material and easy availability of spawn for mushroom cultivation. The Oyster (*Pleurotus* spp.) mushroom is suitable for both temperate and sub-tropical regions of both hill and plain area of Nagaland. For temperate region *Pleurotus ostreatus, P. florida*(winter strain) and *P. fossulatus*(Kabul *dhingri*), *P. eryngii*(King oyster) are ideal. For subtropical regions (20-30°C) the most popular ones are *P. sajor-caju, P. florida, P. flabellatus* and *P. eous*. In Nagaland *P. florida* and

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Table 1. Ideal time for commercial mushroom cultivation in different districts of Nagaland

S. No.	Species	Area	Months	Suitable Districts
1.	Oyster	Hills	March to Oct	Kiphire, Kohima, Longleng, Mokokchung, Mon, Phek, Tuensang, Wokha, Zunheboto, Noklak
		Plains	Oct to March	Dimapur, Peren
2.	Shiitake	Hills	Throughout the year	Kiphire, Kohima, Longleng, Mokokchung, Mon, Phek, Tuensang, Wokha, Zunheboto, Noklak
3.	Milky	Plains	March to Oct	Dimapur, Peren, Wokha
4.	Paddy straw	Plains	March to Oct	Dimapur, Peren, Wokha

P.sajor-caju are most popular. The ideal growing season in hills is during March to October and in plains during October to March for higher production (Table 1). Rajesha *et al*. (2018) reported the biological efficiency of 50% i.e. 50 kg fresh oyster mushroom per 100 kg of dry substrate of paddy straw in Nagaland.

Shiitake mushroom: The selling of dried wild edible shiitake mushroom is common in Nagaland. Nowadays, the cultivation of shiitake in Nagaland is picking up due to its local demand as well as organic shiitake are in high demand from many cosmetic industries situated in other parts of India.In Nagaland,four species of Shiitake *viz*., *Lentinula edodes*, *L. squarrosulus*, *L. sajor-caju*, *L. tigrinus* have been identified (Ao *et al*., 2020). Among the North-eastern states, Nagaland is most appropriate state for shiitake cultivation because forest in Nagaland is dominated by hard wood forest especially oak, chestnut and alder woods which are the best woods for Shiitake mushrooms.Cultivation on wood logs is more popular in Nagaland due to availability of tree branches for cultivation. Presently the training on mushroom cultivation through wood log has been given to different farmers in Nagaland. The Konger Agritech, Dimapur is one of the private organization that trained about 500 farmers and supplied the 15,00,000 Shiitake dowel spawns for the enhancement of shiitake mushroom production in Nagaland.

Paddy straw mushroom: It is an edible and commercially cultivated mushroom in India. The temperature required for the growth of Paddy straw mushroom is 30°-38° C. In Nagaland, cultivation of this mushroom is restricted only to the plain area.The substrate for this mushroom is paddy straw. The commercial cultivation of this mushroom in Nagaland started only after 2019. Now the cultivation of this mushroom is picking up in the districts of Dimapur and Peren due to availability of spawn and suitable weather condition for cultivation (Table 1).

Milky mushroom: The milky mushroom requires temperature range of 30-35°C. The suitable weather condition is prevailing only in limited area. Therefore, the cultivation of this mushroom in Nagaland is very sporadic and this mushroom has been cultivated by one or two farmers for the purpose of testing the suitability of mushroom cultivation (Table 1).

Spawn availability for mushroom cultivation in Nagaland

In Nagaland, ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema provides the commercial spawn and mother spawn of oyster and Shiitake mushroom. In addition, the state government (Department of Horticulture), Private organization and some of the well trained spawn and mushroom growing farmers also supply the commercial spawn. Due to intervention by the ICAR, Nagaland Centre, the mushroom production increased by many fold due to spawn production training, awareness and supply to the needy person.

Success story of mushroom cultivation in Nagaland:

Success story 1: Oyster mushroom production in aspirational district of Nagaland

Under TSP project by ICAR Research Complex for NEH Region, Nagaland Centre Medziphema, five interested beneficiaries were selected for the mushroom farming in the Thanamir village and imparted training. Mr. Tangit is one of these beneficiaries and is well educated youth and residing in the Thanamir village of Kiphire district of Nagaland and he has started the cultivation of oyster mushroom. He is also in-charge of Nagaland Baptist Church Council (NBCC) at Thanamir village.

Under TSP project, ICAR Nagaland Centre supplied the mushroom packets and other necessary inputs such as sprayers, boiling drum, polythene bags. Initially he started the cultivation of mushroom by using spawn supplied by ICAR in the village by using paddy straw as well as banana waste. He harvested 37 kg of mushroom using 50 packets of spawn (200 g each). Now he has become one of the successful mushroom growers in the Thanamir village and role model for the rest. He has become one of the master trainers and is guiding the farmers about the mushroom cultivation in other villages as well.

Mr. Tangit, mushroom entreprenuer

Success story 2: Dr. Sosang Longkumer: An Entrepreneur of mushroom cultivation in Nagaland

Intrigued by the great prospect, a young and well educated Naga youth Dr.Sosang Longkumer started the venture of mushroom spawn production and is one of the successful mushroom entrepreneur in Nagaland. He is a37-year-old man, a resident of Dimapur, Nagaland, who dedicated himself to start the mushroom production in Nagaland. Now, he is a social entrepreneur and CEO of ALON MPCS Limited (Society) in Nagaland. Dr. Sosang grew up by watching his father, Rev Dr.Nuklu Longkumer doing mushrooms cultivation as a time pass activity in their village (Changtongya, Mokokchung district, Nagaland) while serving as a pastor. He realized that mushrooms cultivation can be done by anyone and taken up as a full time activity. Mushroom cultivation is best suited in Northeast hilly states due to its appropriate climatic condition and profitable venture due to its huge demand and consumption gap. By understanding the scope and opportunities of mushroom cultivation in Nagaland, he initially consulted ICAR Nagaland Centre, Medziphema for acquaintance with the mushroom cultivation.

Dr. Sosang established the mushroom lab for oyster and shiitake mushrooms under externally funded project for supplying the spawn to Naga farmers and introduced the exotic shiitake mushroom in Nagaland for cultivation. Now, he produces the spawn requirement for the entire Nagaland and other parts of North East. He trains the farmers about the mushroom cultivation and supplies the spawn to the interested farmers. The mushroom production in Nagaland increased many fold and created a sustainable market for the farmers and thus making mushroom production as one of the profitable business venture for Naga farmers. The dedicated efforts and contribution made Dr. Sosang "Mushroom Man of Nagaland".

Economics of oyster mushroom productionin Nagaland

The economics of oyster mushroom cultivation for small and marginal farmers suitable for Nagaland condition has been assessed (Table 2). The low cost cropping house made by locally available bamboo and thatched material with the size of 6m x 3m size for the capacity of 250 bags per crop has been evaluated.The three crops have been considered for utilizing the ideal duration in a season. Under low cost cultivation of the mushroom, an amount of total Rs. 45,000 will be obtained as a gross income and Rs. 24,455 as a net return (Table 2). By following this, the mushroom farmers may get benefit cost ratio of 2.19:1 per season.

Table 2. Economics of oyster mushroom cultivation in Nagaland for 4 crops in a season (250 beds/crop)

(A)	Non-recurring expenditure	Amount (Rs.)
1.	Cost of Low cost mushroom cropping room (thatched roof) of 6m x 3m size (Capacity of 250 beds)	25,000
2.	Chaff cutter	15,000
3.	Aluminium pan (120 litres)	3,000
4.	Knapsack sprayer (1no.)	2000
	Sub total	**45,000**
(B)	**Recurring expenditures (Cost of raw materials)**	
1.	Paddy straw 1 ton (1000kg)	7,000
2.	Spawn 150 packets (200g) @Rs. 25	3,750
3.	Polythene bags (5 kg) (26/18)	1,000
4.	Labour 15 man days @ 300	4,500
5.	Fire wood	2,000
6.	**Chemicals** (Bavistin @ 7g for treating 10 kg straw)	400
7.	Miscellaneous	1000
	Sub Total	**19,650**
8.	(a) Building depreciation 10% + interest 10%	5,000
	(b) Building cost for one crop	1695
	Total expenditure for one crop (Rs. 18,850 + Rs. 1695)	**20545**
(C)	**Income**	
1.	Gross Income (Sale of 375 kg of mushroom @ 100/kg)	**45000**
2.	**Net income for one crop**	**24455**
	Net income (4 crops in a season)	**97820**
3.	**B:C ratio**	**2.19:1**

In addition to above expenditure, many ways of cost reduction strategies are available for the farmers in Nagaland. In case of recurring expenditure, the use of own field paddy straw and involvement of own family member as a labour can reduce the total cost of cultivation. By doing this, an amount of Rs. 11500.00 (the cost of paddy straw is Rs. 7000.00 and labour charge Rs. 4500.00) may be reduced from the total expenditure. In this situation the cost of cultivation will be reduced andapparent B:C ratio of 4.97:1 will be achieved by the small and marginal farmers in Nagaland. Generally, in Nagaland, farmers will be busy in the activities of farm land cultivation during Kharif season. During this time, farmers have been engaged in the cultivation of rice, maize and other horticultural crops. After the harvest of rice and maize, farm activities are reduced and farmers are free and can undertake mushroom cultivation. It is hoped that the vocation of mushroom farming will become an important cottage activity in the integrated rural development programme.

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