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Feasibility of Winter Oyster- Milky Mushroom Cropping Sequence for Year-Round Production under Assam Condition

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Abstract**—** *The study was carried out during kharif and rabi season of 2018-19, 2019-20 and 2020-21 at 20 numbers of farmers field having low technology mushroom house at different locations of Assam. Existing farmers practice ie. growing of winter Oyster Mushroom alone from October to February under which farmers can grow two crops per year , was taken as control for comparision of farmer's income with tested practice that is Winter Mushroom followed by Summer Mushroom Cropping sequence . The specific objective of the study was to demonstrate the double cropping of Mushroom Farming viz. Winter Oyster Mushroom followed by Milky Mushroom. The study showed that under the tested double cropping sequence, five crops comprising three crops for Winter Mushroom (September to March)and two crops for Summer Milky Mushroom (April to August)can be grown per year. It was observed that in a 15 feet X 18 feet low technology mushroom house, 400 bags per batch can be accommodate. The winter Oyster and Milky Mushroom cropping system produced the average winter Oyster yield of 2931.6kg per year from 3 batches (400 bags/batch)and an average Milky Mushroom yield of 1240kg from 2batches (five batches in a year)compared to an average yield of 1320kg per year from 2 batches in a year (400 bags per batch) obtained at farmers practice. The percentage yield increase of Winter Oyster – Milky Mushroom cropping sequence (average of three years) over farmers practice was recorded as 216%. The economic analysis showed that growing Milky Mushroom during summer season enhance additional income to the growers who usually grow winter oyster mushroom as single crop for 5 months. Hence growing Winter Oyster Mushroom – Milky Mushroom crop sequence for the year round is a potential income generating enterprise which can be adopted by farmers and unemployment youth of Assam.*

Keywords**— Year round, Milky mushroom, Winter Oyster , cropping sequence, Assam**

I. INTRODUCTION

Mushroom which is considered as "Power House Of Nutrient is rich in proteins, dietary fibre, vitamins and minerals like Cu, Zn and Mg in traces with attractive flavor, rich in medicinal properties like antiviral, antitumor and anti cancer. Mushroom cultivation can directly improve livelihoods through economic, nutritional and medicinal contributions.

In Assam, the agro-climatic conditions as well as locally available raw material make mushroom cultivation an economically viable proposition and hence it can be taken up on a large scale by individual entrepreneur. However, the commercial cultivation of mushroom is very conspicuous. Growers of Assam are mainly engaged in cultivating Oyster Mushroom *(Plurotus spp.)* during the winter month, they are not as much of aware of other summer verities for round the year production. Household cultivations have not been seen due to the lack of awareness and scientific knowledge on summer mushroom for year round production. This creates a problem to sustain the market chain in the summer season.

Milky mushroom (*Calocybe indica*), the third commercially grown mushroom in India, has long shelf life, sustainable yield, delicious taste, unique texture and cholesterol free foods with certain important medicinal properties including their antiviral effect. It is an excellent source of thiamine, riboflavin, nicotinic acid, pyridoxine, biotin and ascorbic acid. The Paddy straw was found to be the best substrate for cultivation of milky mushroom (Maurya et al., 2019).which is locally available in Assam. As during summer, the temperature and relative Humidity of Assam are very much suitable for Milky Mushroom cultivation, the Mushroom growers of Assam can cultivate this crop during summer season along with winter grown Oyster mushroom.

Considering the importance of Mushroom as potential income generating agribusiness (Chang and Miles 1990), it is the need of the hour to make the population aware about the year round Mushroom farming in order to enhance their livelihood both economically and nutritionally. The present study was carried out to find out the feasibility of Winter Oyster –Milky mushroom crop sequence in Assam condition.

II. MATERIALS AND METHODS

The study was carried out at 20 numbers of farmers field having low technology mushroom house at different locations of Kamrup district of Assam during 2018-19, 2019-20 and 2020-21 covering total 10 villages. Farmers were selected on the basis of their interest on Mushroom farming. The required inputs like quality spawn, polypropylene bags along with technical guidance were provided accordingly.

Considering the climatic condition two varieties of Mushroom *viz.* Winter Oyster (*Pleurotus* spp.) and Milky Mushroom (*Caelocybe indica*) were tested to find out the feasibility of best cropping sequence for year round production in Assam. The cultivation techniques were adopted as standard techniques given by Directorate of Mushroom Research, Solan, Himachal Pradesh and the standard cultivation techniques (Singh et al.,2011).The experiment was conducted in the standard size of 15 feet X 18 feet low technology mushroom house where 400 bags per batch were accommodated. The spawning of Winter Oyster and Milky Mushroom was done through freshly prepared, 15 days old spawn. A moisture content of about 65% was maintained in the wet substrate prior to spawning. Spawning was done @ 5% by wet weight basis of the ready substrate in polypropylene bags of 60 × 40 cm size with 100 gauge thickness. The spawn bags were tricked by the help of sterilized needle to allow the air flow. After spawning, the bags were shifted in to cropping room and kept in dark place where temperature in between (25-30 0C) and relative humidity (85-90%) were maintained till mycelium colonized the substrates. Cultivation process of Milky mushroom is similar as with Oyster mushroom while only additional process of casing is done.(S. Maheshwari,K Chetan et al 2018)

During *rabi* season, the spawning of bags of the first batch of Winter Oyster were done in the month of September 2018 which were completed its cycle in the month of November. The second spawning of batch were started in November and completed its production period during the month of January followed by 3rd crop cycle of same variety which were finally completed by March2019.To find out the cropping sequence, immediately after harvesting of 3rd batch of winter Oyster, the first batch of summer Milky mushroom spawning bags were hanged in the same unit of all the locations in the month of April which was continued to produce fruiting bodies up to the month of June . Then the 2nd batch of the same variety was spawned which was continued up to the month of August(Table 1). This way, under the tested double cropping sequence, five crops comprising three crops for Winter mushroom (September to March) and two crops for Summer Milky Mushroom (April to August) were grown in a year. Existing farmers' practice, i.e., growing of winter Oyster Mushroom alone from October to February under which farmers can grow two crops per year , was taken as control for comparison of farmer's income with tested practice that is Winter Mushroom followed by summer mushroom Cropping sequence. The similar experiment was conducted in three consecutive years. The temperature and humidity of all the units were recorded with the help of thermo hygrometer. The different parameters of fresh yield, cost of production, total production , net income were determined to evaluate the performance of the varieties. Yield was determined by weighing the fruiting bodies of both fresh and dry mushroom and the total yield was determined by adding the yield of 3flushes of the mushroom.

Biological efficiency: Biological efficiency of mushrooms was calculated by dividing weight of fresh mushroom yield (in Kg) by weight of air dried substrate (in Kg) and multiply by 100

$$\text{Biological efficiency} = \frac{\text{Yield of fresh mushroom in kg}}{\text{Total weight of dry substrate used in kg}} * 100$$

Gross return: The total monetary returns of the economic produce obtained from the varieties gowned included in the system were calculated based on the local market price. The total return was expressed in terms 100bags.

Net Return: This has been calculated by subtracting the cost of cultivation from the gross return.

The average profitably index of each unit was calculated by estimating the benefit cost ratio.(BCR).

III. RESULTS AND DISCUSSION

The data presented in Table 2 and Fig. 1 revealed that , the winter Oyster and Milky Mushroom cropping system produced significant yield over farmers practice. Where the average winter Oyster yield of 2931.6kg per year from 3 batches and an average Milky Mushroom yield of 1240kg (two batches in a year) were obtained compared to an average yield of 1320kg from 2 batches in a year obtained at farmers practice. The total average yield of 4171.6kg from round the year(from 5 batches ,per batch comprises 400 bags) was observed .Hence, it is highly significant as on the farmers practice. Similarly Krishnamoorthy *et al*.,(2000),Mahalakshmi *et al.,* (2019) reported that on seasonal performance of Oyster mushroom the yield performance is poor in the summer season. They have also lowest primodial fruit bodies in the summer season. Uppadhyay *et al*,(2003)and Tripathi *et al*., (2005) also reported that maximum yield of Oyster Mushroom and Milky crop sequence was observed during October to February. Hence by adopting this cropping sequence additional yield could get by farmers by maintaining the spawning time(Table.1).

Data presented in the table 3.revealed the incremental yield (Kg/400bags) of the round the year production of Winter Oyster and Milky Mushroom crop sequence over farmers practice. It was observed that , an average incremental yield of 2851.60 kg (from 5 batches, one batch comprises of 400 bags) was observed in demonstration., Hence, farmers will highly benefited by adopting Winter Oyster-Milky Mushroom crop sequence instead of single crop in a year. Similarly. Uddin *et al*.,(2011) reported that instead of single crop, mushroom variety grown in different season crop sequence showed the benefit of Mushroom growers.

The table .4, Revealed the biological efficiency of crop grown under demonstration and farmers practice. The BE of winter oyster under demonstration was 162.6% ,Milky mushroom was 103.3%,whereas under Farmers practice, BE was 110.0% . It was observed(Fig3,4) that at the time of cultivation of Winter Oyster Mushroom (Sept to March) the Average temperature was ranges from 20-30 ^{0}C and in the case of Minimum temperature the range was 8-21^{0}C . Similarly Relative humidity was 80-90%. During the period of cultivation of Milky Mushroom average maximum temperature of 31-33 was recorded. The present findings was conformity with Tripathi et al.,(2005)who suggested that better growth of Oyster mushroom was found in the temperature range of 20-30 0C with relative humidity of more than 85%.And also during the cultivation time of Milky mushroom, Temperature range of 31-34 0 C was observed which was reported earlier by Sing *et al*.,(2011) .

Data presented In the Table No. 5 anf Fig.2 showed the Gross cost, Gross return and Net return of both demonstration as well as farmers practice. The Net Return of Rs. 4,00,596.00/-was estimated for year round production of 5 batches of crop (3batch of Winter Oyster and 2 batch of Milky Mushroom,one batch comprises 400bags) and for farmers practice net return of Rs 96,283.00 was estimated for growing single crop . But by looking the data of Incremental return of Demonstration over FP Rs. 3,04,313.00/- was calculated.

Table:1.Year wise spawning and harvesting date of Winter Oyster- Milky Mushroom crop sequence

Year	Demonstration										Farmers Practice			
	Winter Oyster						Milky Mushroom				Winter Oyster			
	Spawning of batch1	Last harvest of Batch 1	Spawning Batch2 March	Last harvest of Batch2	Spawning Batch3	Last Harvest of Batch 3	Spawning Date of batch1	Last Harvest of Batch1	Spawning Date of batch1	Last Harvest of Batch2	Spawning Date of batch1	Last harvest of Batch 1	Spawning Date of batch2	Last harvest of Batch 1
2018-19	01-9-18	10.11.18	11.11.18	20.1.19	21.1.19	31.3.19	1-4-19	22-6-19	23.6.19	31.8.19	30.10.18	20.12.18	25.12.18	20.2.19
2019-20	01-9-19	15.11.19	16.11.19	27.1.20	28.1.20	31.3.20	1.4.20	18.6.20	19.6.20	31.8.20	6.11.19	2.01.20	8.01.20	25.2.20
2020-21	01-9-20	11.11.20	12.11.20	25.1.21	26.1.21	31.3.21	1.4.21	13.6.20	14.6.20	31.8.20	2.11.20	3.01.21	5.01.21	28.2.21

Table 2: Yield (Kg/400 bags) of Round the Year production of Winter Oyster and Milky Mushroom and Farmers' Practice

Year	Yield under Demonstration			Yield under Farmers' Practice
	Winter Oyster*	Milky**	Total***	Winter Oyester**
2018-19	3128.00	1216.00	4344.00	1320.00
2019-20	2863.00	1136.00	3999.00	1296.00
2020-21	2804.00	1368.00	4172.00	1344.00
Average	2931.60	1240.00	4171.60	1320.00

* indicate yield from 3 batches

** Indicate yield from two batches

*** Indicate yield from round the year demonstration of 5 batches

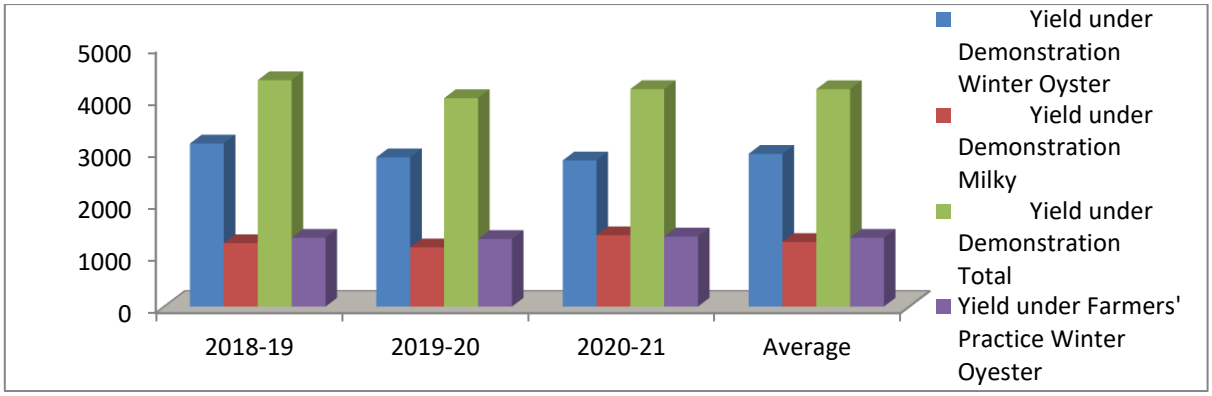


Fig.1: Yield (Kg/400 bags) of Round the Year production of Winter Oyster and Milky Mushroom and Farmers' Practice

Table 3: Incremental Yield (Kg/400 bags) of Round the Year production of Winter Oyster and Milky Mushroom over Farmers' practice

Year	Yield under Demonstration	Yield under farmers' Practice	Incremental Yield of Demonstration over Farmers' practice	Percent increase
2018-19	4344.00	1320.00	3024.00	229.09
2019-20	3999.00	1296.00	2703.00	208.56
2020-21	4172.00	1344.00	2828.00	210.42
Average	4171.60	1320.00	2851.60	216.00

Table.4: Biological efficiency (BE)of Winter Oyster- Milky Mushroom cropping sequence and Farmers' Practice

Biological efficiency(%)		
Demonstration		FP
Winter Oyster	Milky	Winter Oyster
162.6	103.3	110.0

Table. 5: Economics (Rs.)of of Round the Year production of Winter Oyster and Milky Mushroom over Farmers' practice

Particulars	Demonstration			Farmers' Practice
	Winter Oyester*	Milky**	Total***	Winter Oyester**
Average Yield (Kg/ 400 bags)	2931.60	1240.00	4171.60	1320.00
Total Cost	85,386.00	51,810.00	1,37,196.00	62,117.00
Gross Return	3,51,792.00	1,86,000.00	5,37,792.00	1,58,400.00
Net Return	2,66,406.00	1,34,190.00	4,00,596.00	96,283.00
Incremental return of Demonstration over FP			3,04,313.00	
B:C	4.12	3.59	3.91	2.55

* indicate cost/ return from 3 batches

** Indicate cost / return from two batches

*** Indicate cost / return from round the year demonstration of 5 batches

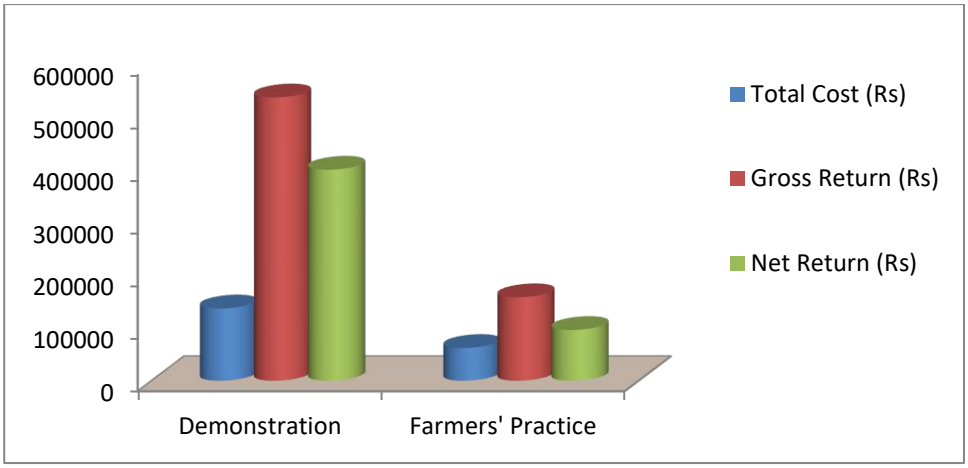
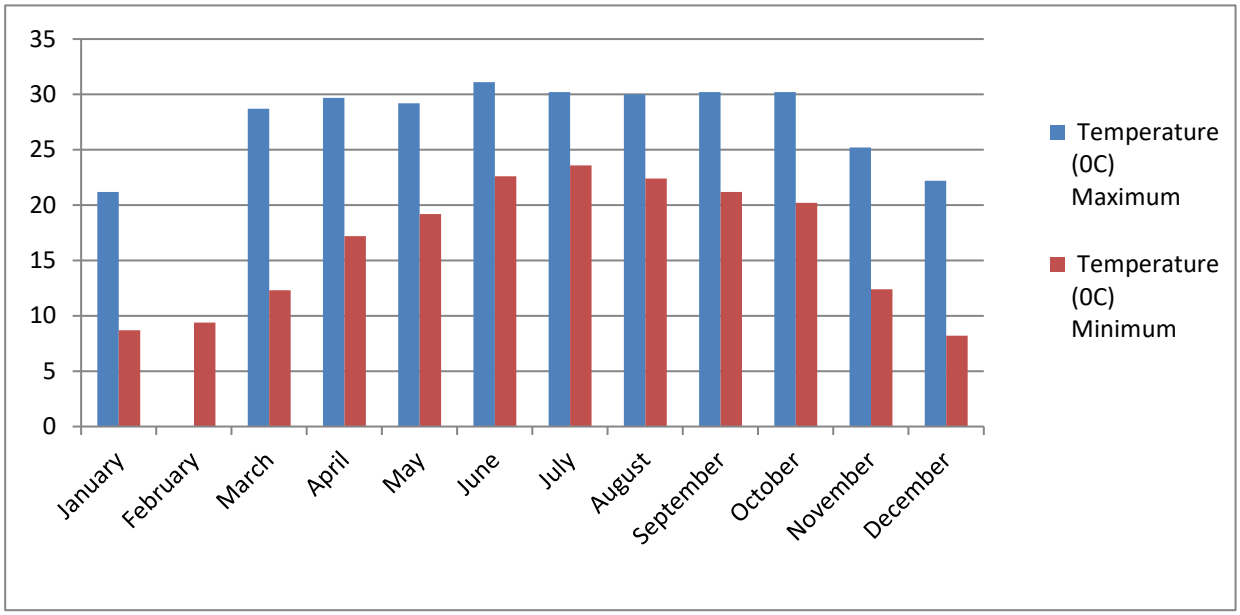


Fig. 2: Economics(Rs.) of of Round the Year production of Winter Oyster and Milky Mushroom over Farmers' practice



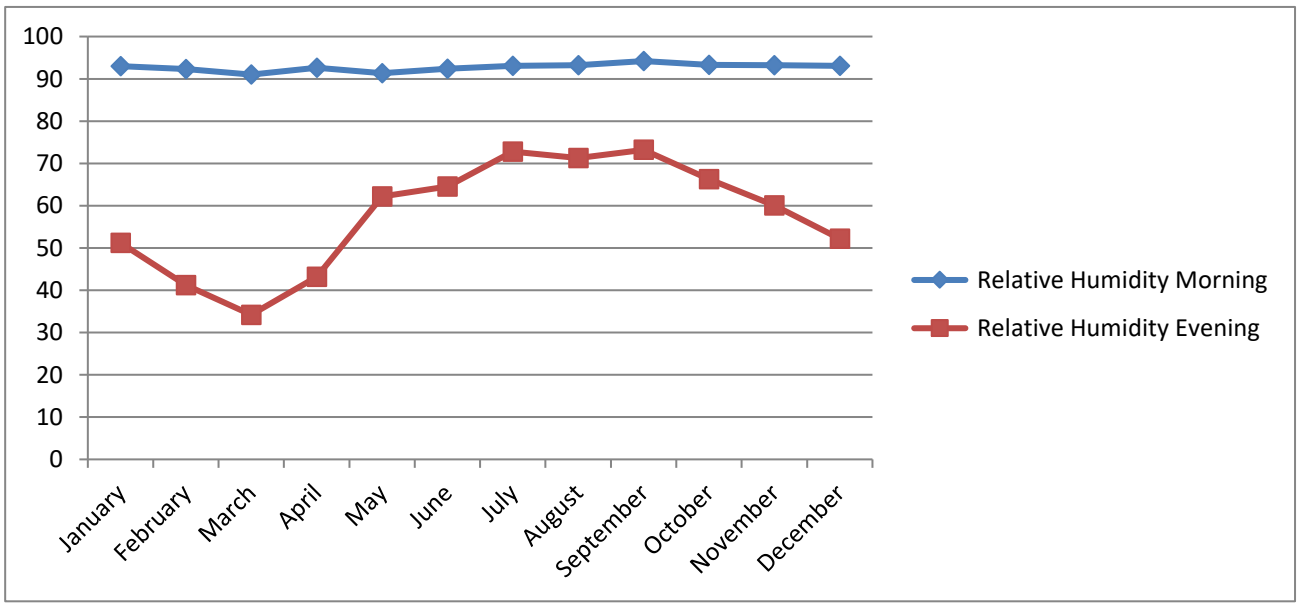


Fig.3&4: Meteorological Parameters during experimental period

Plate 1: Photograph under Experiment

IV. CONCLUSION

Hence in a 15 feet X 18 feet mushroom house, the winter Oyster and Milky Mushroom cropping system produced the average winter Oyster yield of 2931.6kg per year from 3 batches (400 bags/batch)and an average Milky Mushroom yield of 1240kg from 2batches (five batches in a year)compared to an average yield of 1320kg per year from 2 batches in a year (400 bags per batch) obtained at farmers practice. The percentage yield increase of Winter Oyster – Milky Mushroom cropping sequence (average of three years) over farmers practice was recorded as 216%. The economic analysis showed that growing Milky Mushroom during summer season enhance additional income to the growers who usually grow winter oyster mushroom as single crop . Hence growing Winter Oyster Mushroom – Milky Mushroom crop sequence for the year round is a potential income generating enterprise which can be adopted by farmers and unemployment youth of Assam.

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