

Indoor Oyster Mushroom farming, a livelihood diversification option for flood affected families

Practical Action: Transforming lives, inspiring change

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Introduction

Oyster mushroom farming is rapidly expanding in Nepal. Increased consciousness of its nutritional value and increased market demand is making mushroom cultivation one of the most sought businesses among the farming communities. Oyster mushroom is grown in substrate that comprises sterilised wheat or paddy straw and does not require much space compared to other crops. It's per unit production and profit extracted is comparatively higher than other crops.

This technical brief details the cultivation of oyster mushrooms from spawning to harvesting. This technical brief also discusses about oyster mushroom cultivation as an adaptive and crop diversification technique in flood plains to minimise risk of flood and drought to livelihood.



Photo 1 Oyster mushroom grown by Practical Action's beneficiary in Bardiya District, Nepal



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Problem/Context

In Nepal, majority of people, almost 80 per cent inhabiting in the river basins are marginal and small land holders. Agriculture is their mainstay and the average land holding size is only 0.24 ha per household. However, they have very limited access to resource and knowledge to cope with adverse situation. Numerous risks to agriculture production such as pest disease outbreak, market shock and extreme events like drought and flood often undermine agricultural production. And any reductions to agricultural production can have significant impacts on their food security, nutrition, income and overall wellbeing. They have to struggle hard to meet their family's basic needs.

Mushroom production has higher income per unit area and does not require much space compared to other field crops. Since mushroom is grown indoors, huts can be constructed on an elevated area or on a raised platform so that the production would not be affected by flood water. Also, farmers would not have to face the risk of failure of regular income source. Whereby it also increases resilience of farmers and eliminates the loss by floods to a great extent.

How to produce oyster mushroom?

Oyster mushrooms are highly tolerant of variations in temperature, humidity, light conditions and Carbon dioxide levels. It can be produced easily by all class of farmers and it does not require high level of skill compared to the production of other varieties of mushrooms. A simple training can suffice to understand necessary steps of oyster mushroom cultivation.

I. Materials required

a. Growth chamber/mushroom house

One of the most important aspects of growing mushrooms indoors is providing right fruiting environment. Unless there is adequate temperature, humidity and air exchange, the mushroom block will dry up and not produce any fruit¹. Growth chamber/mushroom house can be built using modern materials or local resources. But this technical brief is targeted towards marginal farmers who cannot afford modern housing materials. In such cases, a growth chamber can be built using locally available resources like bamboo, wood and straws. This can give growth chamber the similar look as hut. Thatch roof and walls in the house help to maintain room temperature and humidity. For air exchange and light, the house should be sufficiently ventilated. However, during incubation period, mushroom does not require light and air exchange. So, the growth chambers should be constructed in such a way that ventilation can be covered or opened as per requirement.

b. Machinery

For small scale production, straw can be chopped using a knife or a sickle. However, in a large scale or commercial production, it is worth using manually or electrically operated straw cutter machines. Nowadays straw cutting machines (chaff cutter) are readily available in the market. Its cost ranges from £ 75 to 115.

c. Metal drum or steam pasteuriser

Before using as a substrate, chopped straw should be sterilised. The chopped straw can be sterilised using modern steam steriliser or by using metal drum and water.

d. Other materials

- **Wheat/ rice straw:** Wheat or rice straw is used as a growth media to produce mushroom
- **Mushroom spawn:** Substance that has been inoculated with mushroom mycelium
- **Plastic bags:** Plastic bags measuring 20 x 30 cm or 18 x 25 cm are used to grow oyster mushrooms
- **Jute or nylon rope:** To hang substrate packet

II. Step by step guide to grow oyster mushrooms

a. Sterilisation/pasteurisation of straw

Step 1: chopping and hydration

Sterilisation of straw can be done in various ways either by using modern and sophisticated sterilising equipment or by using conventional technology. In this technical brief, we have described the most affordable and user-friendly methods of sterilisation. In this method, straw is first chopped into 1-2 inches size pieces and hydrated. This helps to break the waterproof coating on the straw and enables it to absorb water, providing a better medium for mycelium to grow.

Procedure:

- Chop the straw into 1-2 inches size pieces
- Hydrate the chopped straw with warm water by mixing or agitating with hands. The warm water hydrates the straw faster.
- Spread the chopped straw on a clean carpet and let it dry in shade for 4-8 hours.

Step 2: Sterilisation or pasteurisation

Sterilisation of straw for substrate is the most critical step in mushroom cultivation. Various microorganisms and fungal spores are present in straw. These microorganisms or fungus compete with mushroom for nutrition or produce toxins, which have detrimental effects in growth and development of mushroom. Some microorganisms can even cause diseases. So the straw should be partially sterilised. Partial sterilisation helps destroy unwanted microorganisms and fungus and is also cost effective compared to complete sterilisation.

Sterilisation can be done in a 200 litre metal drum and a simple heat source for the drum can either be a gas stove focused on the bottom of the drum or firewood.

Procedure:

- Place 200 litre metal drum above the heating source. Firewood stove can be constructed by digging a hole of 5 to 6 inches depth and 12 inches in diameter and placing stones or bricks on 3 sides in triangular fashion on the outer surface around the hole.
- Place 1 feet tall tripod with iron or steel mesh (size equals to diameter of drum) inside the drum.
- Pour water up to 8 inches from the bottom of drum. Water level should not reach mesh.
- Place hydrated and shade dried straw above the mesh and gently press the straw.
- Cover the drum with transparent white plastic or lid.

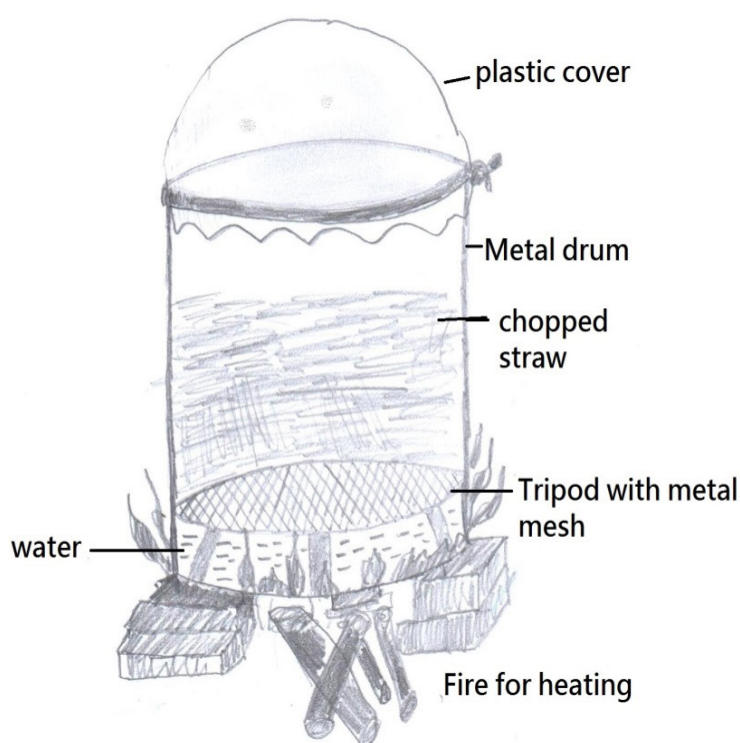


Photo 2 Sterilisation of straw/substrate

To make air tight:

- Tie plastic around the mouth of the drum with rubber ribbon. We can make rubber ribbon by cutting a tyre tube.
- Cover the mouth of the drum with lid and press with weight. Straw will be sterilised when water droplets start dripping from the edge of the lid that can be observed from outside.
- Heat the drum. When water boils, the plastic above the drum starts to inflate. After the plastic cover inflates, reduce the heat and continue heating at lower temperature for 60-90 minutes.
- After 60-90 minutes of heating, remove the sterilised straw from the drum and cool it by spreading it on a carpet in a clean room. Once cool, it is ready for spawning.

b. Spawning

The mycelium of fungi (mushroom seed) which is used to inoculate substrate is known as spawn and the process of inoculating the substrate is called spawning.

- **Selection of variety:** Different varieties of oyster mushrooms are available in the market but selection should be done based on climate, consumers' demand and available variety of spawn. Common varieties of oyster mushrooms grown in Nepal are:
 - *Pleurotus florida*, *Pleurotus ostreatus* and *Pleurotus cornucopiae* (suitable for cool climate/season)
 - *Pleurotus sajor-caj*, *Pleurotus flabellatus* and *Pleurotus sapidus* (suitable for warm climate/season)



Photo 3 Mushroom spawn

- **Selection of spawn:** Good production depends upon the quality of spawn. The spawn should be pure and of high quality. Normally, spawn is developed using special technology in wheat grains. The spawn should be brought from an authorised and trusted place and it should be ensured that the spawn is not contaminated by other undesirable fungal or bacterial species that could negatively impact the quality and yield of the mushroom crop.

Things that need to be considered while selecting spawn:

- Should be well covered with white thread like mycelium.
 - Should not be covered with cotton like fluffy mycelium.
 - Attention should be paid to the date of inoculation, as degradation due to mold, bacteria and waste products happens quickly.
 - Spawn bearing spots with unusual colour (pink, blue, yellow) should be avoided.
- **Preparation for growing room:** The growing room should be clean with ample light and without any direct sunlight. It should be well ventilated to enable fresh air flow. If the growing room has mud floor, then it should be carpeted with plastic sheet or covered with sand. The growing room should be disinfected by spraying 1:20 (5%) solution of bleach along the walls and corners before keeping mushroom bags. Ideal temperature for optimum growth of mushroom is 10 to 25°C for winter species and 10 to 30°C for summer species. If the temperature is above 30°C, jute bags soaked with treated water can be hung along the wall of the room. This will help reduce room temperature and retain moisture to some extent.

If the growing room has racks for placing mushroom bags, then it should also be disinfected before placing the mushroom bags. In case the mushroom bags are to be hung, the hanging rope should be disinfected before hanging the mushroom bags.

- **Bagging and culturing the spawnⁱⁱ:** Plastic bags measuring 20 x 30 cm, or 18 x 25 cm are used as mushroom beds.

Procedure:

- Pierce a hole of 0.5 to 1 cm diameter, 10 cm apart in a plastic bag with the help of a paper punching machine.
- Open the bag and put a handful of straw inside it.
- Press the straw down tightly, to make a 3-5 cm thick layer at the bottom of the bag.
- Spread one spoonful of spawn around the edges of this layer (but don't put any in the middle). This makes the first straw-spawn layer.
- Continue to add 3-4 additional layers in the same way until you have nearly filled the bag.
- Put a final layer of straw on top, so the top of this final layer is 5-7 cm below the mouth of the bag.



Photo 4 Mushroom farmers inoculating spawn and bagging

Put a clean piece of cotton in the bag to close the hole in the bag. This makes a ventilation hole, and filters out harmful microorganisms. Then close the mouth of the bag with a rubber band. Tie the bags to each other with nylon rope (3-5 bags per rope) and hang them in the growing room. Or place each mushroom bag on wooden or bamboo racks. The mouth of each bag should be pointing upwards. The bags should not touch each other but should be kept a few centimeters apart.

c. Crop management

Mushroom itself is a mold and can be infected easily by other harmful molds. So, mushroom farmers should be aware of important management practice for successful mushroom production.

- **Incubation:** After inoculation, the bags should be incubated for certain time to allow mycelium to develop well and cover the whole bag. Ventilation should be covered or closed to make incubation room dark and cool. Ideal temperature for incubation is 20 to 25 °C. Mycelium takes more time to develop if temperature falls below 10°C. Similarly, if the temperature goes above 30 °C, mycelium develops well but there will be chances of contamination by wild mushroom spores.

As mycelium spreads and covers whole bag, aroma emits from the bags that attract rats. So rat entrances should be blocked. The bags should be monitored regularly to examine any signs of discolouration from competitor molds (e.g. blue, green or gray patches). If you observe green or coloured molds growing, get rid of the mold as soon as possible. If it is just a small patch, scoop it off, or you can try adding a little salt or baking soda to the area which should kill it off and still allow the mushroom to grow. Or spray with diluted hydrogen peroxide (1:10 peroxide to water). But if the mold spreads over, you will need to dump the whole bag in the compost.



Photo 5 Incubation of spawned bag- hanging or placing in a rack.

- **Fruiting :** The spawn spreading time is different for each species of mushroom and depends on size of the bag, amount of spawn, and the temperature, and can take about three weeks' time. Once the mycelium covers the whole bags (looks whitish), the mushroom bags should be moved to the growth chamber or remove ventilation cover from the incubation room, so that light and fresh air can pass through and helps in proper growth of mushroom. If aeration is poor and Carbon dioxide is high then stem of mushroom will develop long and mushroom caps will look like trumpets. To allow mushroom grow profusely, remove plastic by cutting it with the help of a sharp knife. After 3-4 days, small round white bulb called primordium appears which later develops into mushroom. To induce primordium, light is very essential. So if the room is darker you will need to provide florescent light. Light also determines quality of mushroom produced. In poor light conditions, mushroom will develop with long stem, small cap and dull colour.

During the time of active growth, humidity of growth chamber or growing room should be maintained at 70 to 80 per cent. To maintain the humidity, water should be sprayed through a nozzle in form of mist 3-4 times a day. Water used for spraying should be clean, unchlorinated and neutral in PH. If iron content in water is higher, mushroom growth will be delayed and production will be poor.

- **Harvesting:** The mushrooms will grow every day over the next 5-7 days. The ideal stage for harvesting oyster mushrooms is when the caps are still slightly convex, like folding down. When the caps begin to flatten and uplift, they are approaching maturity. Harvest by cutting or twisting them off the substrate as close to the base as possible. They grow in shelf like clusters, so you will need to harvest the whole cluster at the same time or the remaining tissue can lead to contamination as it decays. All aborted clusters must be pulled out as well.



Photo 6 Harvesting of mushroom

Things to be considered in mushroom farming

- Too much Carbon dioxide and poor light condition increases the chances of elongated stem and trumpet cap in mushroom. The stems elongate as they search for oxygen and light.
- Too low or too high humidity causes cracking, dryness and sliminess. So, water less if they are slimy or more if they are cracked.
- It is normal to find mushrooms fruiting but drying when small. Mushrooms will start growing on many little clusters and choose one or two to focus energy on growing. If all the clusters are drying up, mist more often and for longer and make sure you have a humidity tent.

Conclusion

With the increase consciousness of the nutritional value and market demand, oyster mushroom farming is gaining popularity among the farming communities. Cultivation technology of oyster mushroom is very simple and does not require larger space and costly infrastructures or facilities. It can be easily grown in a normal bedroom size house/hut constructed using low cost local resources like bamboo and straw. Unlike field crops, there is also a limited chance of damage by natural disaster like flood and drought. However, while constructing mushroom growing house in flood prone areas, elevated areas or upland should be selected and plinth level should be increased up to the safe level.

Case-study

Community mushroom farming beefs up disaster resilience efforts

Every year during monsoon, dozens of households in Nuklipur, a small village of Kailali District in the far west Nepal gets displaced by flash floods. The village lies adjacent to big rivers making the entire villagers vulnerable to flood. Four years ago, the communities in the village formed a Community Disaster Management Committee (CDMC) as a proactive measure to decrease the devastating impact of such floods. Besides helping villagers to set up the committee and providing them with material support like ropes and life jackets, Practical Action's Nepal Flood Resilience Project (NFRP) also suggested to raise money for a disaster relief fund through mushroom farming.

The project supported the villagers with mushroom seeds, plastic packets and technical inputs to do the farming along with farming training. The idea worked better than expected. After four years, the villagers are selling mushrooms worth above NPR 80,000 (£ 525) and they hope to raise similar amount in the second harvest. The farm that started with an earnest desire to raise funds for disaster relief missions not only succeeded in its objective but also managed to benefit the locals in lots of other ways. Apart from helping to raise funds for disaster relief missions, income derived from mushroom farming has also become an unlikely bank for poor villagers.

All CDMC members are now eligible for collateral free loan with a minimal interest rate. So whenever there is a need of a small loan to buy fertilisers for crops, pay tuition fees for the farmers' children or during other emergencies, the farmers can approach the loan facility. This has become a huge relief for villagers who were used to the loans with usurious interest rates as high as 60 per cent. According to CDMC members, around NPR 80,000 (£ 525) is being used for loans. Since the loan is given only to CDMC members and the amount is minimal, the committee has not experienced any problem in the loan practice so far. The CDMC has already generated around NPR 10,000 through the interest they garner from loan (£ 65).

Nuklipur is rapidly making impressive reputation in mushroom cultivation. The successful experiment of community mushroom farming has encouraged many other villagers to replicate the model. More and more CDMCs of other flood prone areas are reaching out to Practical Action's local partner with their proposal of starting mushroom farming.



Photo 7 Farmers growing and selling oyster mushroom in Nuklipur

Cost of solution

Oyster mushroom can be grown successfully by constructing low cost growing room using local resources like bamboo, mud, jute rope, plastic sheets and reed/straw. However, growing room should be constructed in an elevated area so that flood does not affect growing room.

Table 1 Cost to construct growing room to accommodate 100 bags of mushroom with room size 10x15 square feet

S.N.	Materials	Quantity	Unit cost (NPR)	Total cost (NPR)
1.	Bamboo	20 piece	75	1,500
2.	Straw/Reed grass	100 bundle	25	2,500
3.	Rope (Jute/Plastic)	1 bundle	300	300
4.	Nail	1.5 Kg	400	400
5.	Labour	2 person for 3 days	400x2x3	2,400
6.	Plastic sheet	5 Kg	200	1,000
7.	Broiler/metal drum	1	1,000	1,000
Total fixed cost				9,100
Cost of production of 100 bags of mushroom (Recurrent cost)				
8.	Rice straw	1/4 tractor	1,000	1,000
9.	Seed (spawn)	50 packet	140	7,000
10.	Plastic bag	100	2	200
11.	labour	2 person for 2days	300 x 2 x 2	1,200
Total recurrent cost				9,400
(Initial investment needed) Grand total				18,500

*1 GBP equals to 152 NPR

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