OYSTER MUSHROOMS PRODUCTION STEPS
ILLUSTRATIVE GUIDE FOR FARMERS
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OYSTER MUSHROOMS
PRODUCTION STEPS

ILLUSTRATIVE GUIDE FOR FARMERS

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and
Ole S. Pedersen
INTRODUCTION

Around the world edible wild mushrooms are regarded as a delicacy and can be found in and outside forests, either picked for home consumption or sold at local markets. They are used in various dishes and contain important vitamins, minerals and proteins and many species are believed to cure ailments.

Wild mushrooms, however, can also bring illnesses and even death to people, who are unaware of the many look-alike poisonous species. Thus, for many people the cultivated mushrooms are a good alternative to the wild mushrooms.

The most common and easily cultivated mushrooms in Lao PDR are:

- Oyster mushrooms (*Pleurotus spp.*)
- Straw mushroom (*Volvariella volvacea*)
- Wood ear mushrooms (*Auricularia spp.*)

Other edible species of mushrooms require more attention and knowledge, thus these mushroom are not yet cultivated in Lao PDR. These include:

- King oyster mushroom (*Pleurotus eryngii*)
- Shiitake (*Lentinula erodes*)
- Namekho (*Pholiaota nameko*)
- Enoki mushroom (*Flammulina velutipes*)
All of the above-mentioned mushrooms grow naturally on dead wood or decaying plant materials and therefore possible to cultivate. One famous medicinal mushroom is reishi or ling-zhi (Ganoderma sp), common in Laos and cultivated in huge quantities in China.

Another important group of wild edible mushrooms are those living in soils connected with roots of trees. These cannot be cultivated.

It is recommended that a newcomer in mushroom cultivation starts with easy-to-grow and easy-to-sell mushrooms such as the oyster mushrooms.

This illustrated farmer guide is prepared with the purpose to provide basic knowledge and techniques required for oyster mushroom cultivation and largely based on experiences from working with five farmer groups in Phonexay District of Luang Prabang Province.

Extension workers and already skilled oyster mushroom growers can help inexperienced farmers to cultivate oyster mushrooms.
The oyster mushroom has a whitish grey color in all parts. The cap is waxy, 5–25 cm wide with an in-rolled and often splitting margin. With age the cap becomes increasingly funnel shaped. The flesh is also white and firm. The gills descend about half way down the stem. The stem is rather short and firm. In nature it grows on several living or newly dead trees.
Oyster Mushroom Production Steps

1. Planning
2. Order sawdust & mix with lime
3. Order spawn and other material
4. Final mix of growing material
5. Sterilize bags
6. Inoculate with spawn
7. Incubate bags
8. Making growing house
9. Move bags to growing house
10. Harvesting
11. After harvest care
One oyster mushroom production circle takes 3 - 4 months and it is important to get a good overview of all the production details, not least time and costs evolved.

**Timing, helping hands and visit to growers**
Oyster mushroom can be cultivated year round. Take into consideration weather and other work and make sure you have enough people to help, particularly when filling bags, sterilization and inoculation. Visit a producer in your province to get more information.

**Costs, market and profit**
Get a good overview of costs involved and consider how much oyster mushroom can be sold at local markets and to what price. Then calculate profit. *(see example on page 41-42)*

**Growing materials**
Check availability of sawdust as well as various minerals needed to mix with sawdust and for the bags. Look for where to buy before you start. *(see proposed procurement list on page 39-40 and steps 2-5)*

**Equipment**
Basis equipment, such as sterilization oil drums, water cans, shovels, and weights are available in most villages as well material for making simple growing houses. In addition you need plastic sheets, ring necks, caps, cotton, alcohol lamp, etc. as well as the mushroom spawn should be quality. *(see page 39-40 and steps 2-5)*
Get sawdust from local sawmills. Start with small amounts such as 500-600 kg for 1,000 bags.

**Options for sawdust**

Good sawdust is soft wood from eucalyptus, rubber and mango trees but sawdust from other soft wood trees can also be used. If using sawdust from teak tree, then mix with 10% from other soft wood trees.
Mixing sawdust and lime

1. Make sure that the lime (Calcium carbonate) is homogenous by filtering it to fine powder through a net.

2. The mixing of sawdust and the powdered lime should be done on a cement floor or on thick plastic sheets (avoid bare soil).

After mixed with lime, add water - until water can drip when pressing hard in your hand.

3. Let the sawdust-lime mix rest at least one month on cement or thick plastic – and cover with a plastic sheet to maintain moisture.
**STEP 3**  Order spawn material

Check price and quality of spawn materials from more than one producer. Calculate number of bottles needed.

<table>
<thead>
<tr>
<th>For 1,000 mushroom bags</th>
<th>For 5,000 mushroom bags</th>
<th>For 10,000 mushroom bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spawn bottles: 40</td>
<td>Spawn bottles: 200</td>
<td>Spawn bottles: 400</td>
</tr>
</tbody>
</table>
STEP 4

Final mixing and filling & closing plastic bags

A) Make sure you have all material and equipment.

<table>
<thead>
<tr>
<th>Material</th>
<th>For 1,000 mushroom bags</th>
<th>For 5,000 mushroom bags</th>
<th>For 5,000 mushroom bags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broken rice</td>
<td>25 - 30 kg</td>
<td>125 - 150 kg</td>
<td>250 - 300 kg</td>
</tr>
<tr>
<td>Rice bran</td>
<td>50 - 60 kg</td>
<td>250 - 300 kg</td>
<td>500 - 600 kg</td>
</tr>
<tr>
<td>Magnesium sulfate</td>
<td>3 - 5 kg</td>
<td>15 - 25 kg</td>
<td>30 - 50 kg</td>
</tr>
<tr>
<td>Pumice</td>
<td>5 kg</td>
<td>25 kg</td>
<td>50 kg</td>
</tr>
<tr>
<td>Plastic bags (7” x 12.5”)</td>
<td>5 kg</td>
<td>25 kg</td>
<td>50 kg</td>
</tr>
<tr>
<td>Plastic necks</td>
<td>1 bag</td>
<td>5 bags</td>
<td>10 bags</td>
</tr>
<tr>
<td>Cotton</td>
<td>1 kg</td>
<td>5 kg</td>
<td>10 kgs</td>
</tr>
<tr>
<td>Rubber bands</td>
<td>1 bag</td>
<td>5 bags</td>
<td>10 bags</td>
</tr>
<tr>
<td>Plastic sheet</td>
<td>1 roll</td>
<td>5 rolls</td>
<td>10 rolls</td>
</tr>
<tr>
<td>Oil drum</td>
<td>2</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
MATERIALS

- Rice Bran
- Broken rice
- Sawdust mix
- Plastic bags
Oyster Mushrooms Production steps - Illustrative guide for farmers

- Pumice
- Calcium sulfate
- Magnesium sulfate
- Rubber bands
- Shovels
- Plastic neck and caps, cotton
B) Final mixing of growing material

Mix broken rice, rice bran, calcium sulfate, and magnesium sulfate, pumice with the sawdust-lime mix.

Make sure the mixing is taking place on cement floor or on thick plastic.

C) Adding water

Add water to keep moisture until you can make a cake by pressing hard with your hand without water dripping out (equal’s 60 - 65% water).
D) Filling and packing the bags

Fill plastic bags to the top with the final mix (substrate) using small shovels.

Then press by hand using a firm hand.

Another option is to compress the bags with a machine.
E) Closing the bag

(i) Put cotton in the plastic cap

(ii) Put top of bag through the neck

(iii) Fold the plastic backwards
(iv) Close with rubber band

(v) Close with plastic cap
STEP 5  Sterilization of substrate bags

It is very important to completely sterilize substrate bags – and if not done as described below, you will have a poor harvest or no harvest at all.

A) Placing oil-drums

Ensure steady place for drums and make sure you have enough firewood for 5-6 non-stop boiling.
B) Add frame, sisal bags and water
Prepare a 40 cm high frame on which the bags will stand on.

Soak the sisal bags/sheets in water and line with two layers and

Add until nearly covering the frame.
C) Fill the oil drum

Make sure the oil-drum is firmly packed with bags.

Each oil drum contains 100-110 bags

D) Close the oil drum

Fold sisal bags to the top, cover with two layers of plastic sheets and close tightly with rubber strings.
E) Sterilizing the bags

Boil the water for at least 5 hours and the steamed water will ensure sufficient heat to sterilize the substrate bags.

Important to keep the water boiling all the time – you will see some steam coming out.
STEP 6  Inoculation of bags

After 5-6 hours of sterilization – let the bags cool down for 20 min before taking out the cover plastic and let it cool for another 4 hours.

A) Transfer to inoculation area

Any transport method can be used, but be sure the bags are kept very clean and don’t let them touch the soil.
B) Make sure inoculation room is clean

Inoculation room must be kept very clean and the inoculation should be done indoor – without much air circulation. Place the bags orderly in rows.
C) Make inoculation materials ready

Get the spawn materials from a supplier. The spawns are coated on sorghum seeds.

Wash your hands. Use only clean equipment.
Shake spawn bottle against semi-soft materials to loosening the sorghum seeds.
Clean spawn bottles with 70% alcohol.
Then, bring bottles to inoculation room.
Do not open the bottles.

D) Clean hands and put fill lamp with alcohol

Fill lamp with 90% alcohol and clean again your hands with soap and 70% alcohol before inoculation.
E) Start inoculation (maximum two most qualified persons)

Inoculation must be done with extreme caution in order to ensure high yields and disease free substrate bags.

Open the spawn bottle very close to the flame and heat around the opening (2-3 seconds).

At the same time another person open the sterialized substrate bag and add 10-20 sorghum seeds or fill to the top. Then shake the mushroom bag. Act quickly and close bottle with the cap.
STEP 7 Resting the bags (incubation)

Keep inoculated bags upright inside a room to let the mushroom mycelium grow for 25-30 days.

The room should be closed, but allow some ventilation.

Check if any bags develop abnormal mycelium (such as black, green, brown, orange or red spots). Remove these to a secure place and burn.
The growing house can be made by locally available material and sized for planned harvests of 4-5 circles.

1,000 bags: 2m x 3m (6 sq m)
2,000 bags: 3m x 4m (12 sq m)
3,000 bags: 4m x 5m (20 sq m)
4,000 bags: 5m x 6m (30 sq m)
5,000 bags: 6m x 7m (42 sq m)
House should be kept semi-dark with some ventilation at the top of the roof.

Floor should have a layer of sand to keep the house clean.
STEP 9  Move bags to growing house and opening the bags

A) Move to growing house

After finished incubation, move the spawn bags to the growing house.

B) Opening the bags

The mycelium has now spread well within the spawn bag and it is time to open the bags by removing the caps. Take off the rubber bands, plastic neck and the cotton.

After 2-3 days add water to increase humidity and better growth of the mushrooms.
C) Spraying with clean water

Watering has the purpose of keeping high humidity in the growing house. Water the bags 2 times daily. Pour water from the top, so the water can run downwards but not into the bags.

A water tube can also be used – but then spray the water finely by e. g. holding the finger at the end of the tube. Humidity should not be lower than 80%.
A) Harvesting

Mushrooms fruiting bodies will appear a few days after the bags have been opened.

Harvest the mushrooms gently. If too small the income will be less (lower weight) and if too old they are less tasty and you will get lower price.

Harvesting continues for 3-4 months.
B) Daily care

Apart from watering, check also if mushrooms and bags are healthy.

If getting diseases (see page 34), immediately remove the bags to a secure place such as in closed big plastic bags or as compost at least 200 m away from the growing house. If temperature is higher than 35°C, spray at least 3 times a day.

If you feel comfortable, it means the mushrooms are also well.
C) Problems of contamination of other small fungi

Daily, check the bags to see if there are any spots or if part of the bag becomes un-normal.

Green fungi will appear, if the bags were not well sterilized or contaminated during inoculation by e.g. dirty hands and tools. Green bags should immediately be carried outside and burned.

The best way to prevent pests and diseases is to carefully follow instructions; keep tools and growing house clean and do not allow too many people in the growing house.
D) Problems of rodents and other animals

During the incubation rodents and other animals will like to eat the sorghum seeds and will spread diseases. Also during harvest the rodents will eat the fruiting bodies. Protect by keep floor clean and use traps.
STEP 11  After harvest care

A) Sterilize growing house

After harvest wash the growing house with water and add lime to disinfect and wait at least one month before use.

Clean plastic necks and caps with soap and sundry.
STEP 12  Recording and market development

A) Record harvest date and amount

Use a book to record all harvests, problems, etc. It will help you to see if you have done well and improve for next season. Average harvest of 0.2 kg per one kg bag is regarded as very good.

B) Labels

In some cases you might add labels, so consumers can see where the mushrooms have been produced.
C) Signboards

If your village is producing a lot and you are close to a main road, it might be a good idea to set-up a signboard.
# ECONOMY

## 1,000 bags

### Fixed Costs

<table>
<thead>
<tr>
<th>No</th>
<th>Fixed Production Costs</th>
<th>Unit</th>
<th>Qty</th>
<th>Unit cost</th>
<th>Total</th>
<th>Time used</th>
<th>Cost/ growing circle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sterilization oil drums</td>
<td>Unit</td>
<td>2</td>
<td>250,000</td>
<td>500,000</td>
<td>20</td>
<td>25,000</td>
</tr>
<tr>
<td>2</td>
<td>Rack inside oil drum</td>
<td>Pc</td>
<td>2</td>
<td>30,000</td>
<td>60,000</td>
<td>12</td>
<td>5,000</td>
</tr>
<tr>
<td>3</td>
<td>Neck (plastic ring)</td>
<td>Bag</td>
<td>1</td>
<td>120,000</td>
<td>120,000</td>
<td>6</td>
<td>20,000</td>
</tr>
<tr>
<td>4</td>
<td>Cover cap</td>
<td>Bag</td>
<td>1</td>
<td>120,000</td>
<td>120,000</td>
<td>6</td>
<td>20,000</td>
</tr>
<tr>
<td>5</td>
<td>Watering Can</td>
<td>Can</td>
<td>1</td>
<td>45,000</td>
<td>45,000</td>
<td>9</td>
<td>5,000</td>
</tr>
<tr>
<td>6</td>
<td>Weight / 30 kg</td>
<td>Unit</td>
<td>1</td>
<td>200,000</td>
<td>200,000</td>
<td>50</td>
<td>4,000</td>
</tr>
<tr>
<td>7</td>
<td>Alcohol Lamp</td>
<td>Unit</td>
<td>1</td>
<td>70,000</td>
<td>70,000</td>
<td>10</td>
<td>7,000</td>
</tr>
<tr>
<td>8</td>
<td>Sisal bag</td>
<td>Bag</td>
<td>4</td>
<td>15,000</td>
<td>60,000</td>
<td>6</td>
<td>10,000</td>
</tr>
<tr>
<td>9</td>
<td>Bottle Sprayer</td>
<td>Pc</td>
<td>1</td>
<td>50,000</td>
<td>50,000</td>
<td>5</td>
<td>10,000</td>
</tr>
<tr>
<td>10</td>
<td>Thermometer</td>
<td>Pc</td>
<td>1</td>
<td>35,000</td>
<td>35,000</td>
<td>15</td>
<td>3,000</td>
</tr>
<tr>
<td>11</td>
<td>Big Plastic basket</td>
<td>Unit</td>
<td>1</td>
<td>75,000</td>
<td>75,000</td>
<td>10</td>
<td>7,500</td>
</tr>
<tr>
<td>12</td>
<td>Spade</td>
<td>Unit</td>
<td>2</td>
<td>56,000</td>
<td>112,000</td>
<td>16</td>
<td>14,000</td>
</tr>
</tbody>
</table>

Sub-total fixed production costs and costs per growing circle

|                | 1,975,500 | 130,500 |
## Running Costs

<table>
<thead>
<tr>
<th>No.</th>
<th>Item Description</th>
<th>Unit</th>
<th>No</th>
<th>Price/unit</th>
<th>Total (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mushroom spawn (from lab)</td>
<td>Bottle</td>
<td>40</td>
<td>5,000</td>
<td>200,000</td>
</tr>
<tr>
<td>2</td>
<td>Saw dust (incl. transport)</td>
<td>Kg</td>
<td>500</td>
<td>500</td>
<td>250,000</td>
</tr>
<tr>
<td>3</td>
<td>Rice bran</td>
<td>Kg</td>
<td>60</td>
<td>3,500</td>
<td>210,000</td>
</tr>
<tr>
<td>4</td>
<td>Broken rice</td>
<td>Kg</td>
<td>30</td>
<td>4,500</td>
<td>135,000</td>
</tr>
<tr>
<td>5</td>
<td>MgSO4 (Magnesium sulfate)</td>
<td>Kg</td>
<td>5</td>
<td>10,000</td>
<td>50,000</td>
</tr>
<tr>
<td>6</td>
<td>CaSO4 (Calcium sulfate)</td>
<td>Kg</td>
<td>5</td>
<td>10,000</td>
<td>50,000</td>
</tr>
<tr>
<td>7</td>
<td>Phoumai</td>
<td>Kg</td>
<td>5</td>
<td>10,000</td>
<td>50,000</td>
</tr>
<tr>
<td>8</td>
<td>CaCO3 (Calcium carbonate)</td>
<td>Kg</td>
<td>5</td>
<td>3,000</td>
<td>15,000</td>
</tr>
<tr>
<td>9</td>
<td>Plastic bag</td>
<td>Kg</td>
<td>5</td>
<td>30,000</td>
<td>150,000</td>
</tr>
<tr>
<td>10</td>
<td>Plastic sheet (cover tank)</td>
<td>Roll</td>
<td>1</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>11</td>
<td>Cotton cover</td>
<td>Kg</td>
<td>2</td>
<td>45,000</td>
<td>90,000</td>
</tr>
<tr>
<td>12</td>
<td>Rubber ring</td>
<td>Bag</td>
<td>1</td>
<td>35,000</td>
<td>35,000</td>
</tr>
<tr>
<td>13</td>
<td>Alcohol 90</td>
<td>Liter</td>
<td>1</td>
<td>45,000</td>
<td>45,000</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal running costs (III)</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,345,000</strong></td>
</tr>
<tr>
<td>1</td>
<td>Growing house (per season)</td>
<td>house</td>
<td>1</td>
<td>500,000</td>
<td>500,000</td>
</tr>
<tr>
<td></td>
<td><strong>Total Fixed and running costs I + II + III</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1,845,000</strong></td>
</tr>
</tbody>
</table>
The economy of oyster mushroom cultivation depends on harvest (kg) and price as shown in below example for 1,000 bags

Example:
Yield: 1,000 bags = 150 - 200 kg
Price: Per kg: 15,000 - 20,000 kip

Total income:
If total harvest 150 kg (100 x 15,000-20,000 kip):
2,250,000 kip - 3,000,000 kip

If total harvest 200 kg (200 x 15,000-20,000 kip):
3,000,000 kip - 4,000,000 kip

Profit (income – costs):
If harvest 150kg:
2,250,000 kip (income) – 1,975,500 kip (costs) = 274,500 kip (profit)
3,000,000 kip (income) – 1,975,500 kip (costs) = 1,024,500 kip (profit)

If harvest 200kg:
2,250,000 kip (income) – 1,975,500 kip (costs) = 1,024,500 kip (profit)
4,000,000 kip (income) – 1,975,500 kip (costs) = 2,024,500 kip (profit)
### A. 1,000 bags

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Price (kip/kg)</th>
<th>Income (kip)</th>
<th>Costs (kio)</th>
<th>Profit (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 kg</td>
<td>15,000</td>
<td>2,250,000</td>
<td>1,975,500</td>
<td>274,500</td>
</tr>
<tr>
<td>150 kg</td>
<td>20,000</td>
<td>3,000,000</td>
<td>1,975,500</td>
<td>1,024,500</td>
</tr>
<tr>
<td>200 kg</td>
<td>15,000</td>
<td>3,000,000</td>
<td>1,975,500</td>
<td>1,024,500</td>
</tr>
<tr>
<td>200 kg</td>
<td>20,000</td>
<td>4,000,000</td>
<td>1,975,500</td>
<td>2,024,500</td>
</tr>
</tbody>
</table>

### B. 5,000 bags

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Price (kip/kg)</th>
<th>Income (kip)</th>
<th>Costs (kio)</th>
<th>Profit (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>750 kg</td>
<td>15,000</td>
<td>11,250,000</td>
<td>9,877,500</td>
<td>1,372,500</td>
</tr>
<tr>
<td>750 kg</td>
<td>20,000</td>
<td>15,000,000</td>
<td>9,877,500</td>
<td>5,122,500</td>
</tr>
<tr>
<td>1,000 kg</td>
<td>15,000</td>
<td>15,000,000</td>
<td>9,877,500</td>
<td>5,122,500</td>
</tr>
<tr>
<td>1,000 kg</td>
<td>20,000</td>
<td>20,000,000</td>
<td>9,877,500</td>
<td>10,122,500</td>
</tr>
</tbody>
</table>

### C. 10,000 bags

<table>
<thead>
<tr>
<th>Harvest</th>
<th>Price (kip/kg)</th>
<th>Income (kip)</th>
<th>Costs (kio)</th>
<th>Profit (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500 kg</td>
<td>15,000</td>
<td>22,500,000</td>
<td>19,755,000</td>
<td>2,745,000</td>
</tr>
<tr>
<td>1,500 kg</td>
<td>20,000</td>
<td>30,000,000</td>
<td>19,755,000</td>
<td>10,245,000</td>
</tr>
<tr>
<td>2,000 kg</td>
<td>15,000</td>
<td>30,000,000</td>
<td>19,755,000</td>
<td>10,245,000</td>
</tr>
<tr>
<td>2,000 kg</td>
<td>20,000</td>
<td>40,000,000</td>
<td>19,755,000</td>
<td>20,245,000</td>
</tr>
</tbody>
</table>
Additional information:

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