

Part I Shiitake

Chapter 3

Shiitake Log Cultivation

SHIITAKE LOG CULTIVATION IN NEPAL

Keshari L. Manandhar

Center for Agricultural Technology Bijuwari, Kathmandu, Nepal (pkm@ccsl.com.np)

Background

Wild shiitake is known as “Mrige Chyau” in Nepal and the name means “deer mushroom.” Perhaps the name comes from the look of a deer or its skin. Traditionally, the people of Nepal collect wild mushrooms from the forest during the rainy season for their own consumption as well as for sale. Shiitake accounts for about 5% of the collected wild mushroom crop. The wild edible mushrooms are sold on the street and in the markets of Kathmandu in locally made bamboo baskets that are good for keeping wild mushrooms fresh for a longer period. The price for a small basket full of mushrooms is very low. The people in the city are fond of wild mushrooms, and there are frequent incidences of mushroom poisoning. Poisoning reports are common from the hospitals, with between 100 to 120 cases appearing per year per hospital. The villagers usually recognize the edible mushrooms from the knowledge inherited from their parents or neighbors. Among these wild mushrooms shiitake used to be one of the most common varieties. However, wild shiitake is getting hard to find these days, perhaps due to a lack of wood logs lying on the forest ground. Local people now collect the logs and use them for fuel.

In research involving shiitake cultivation, a Japanese volunteer named Naoaki Watanabe initiated an experiment in the Division of Plant Pathology (NARC) in 1979 and got successful results from *Quercus* logs. Mr. Kanagawa had also grown shiitake on Celtic tree logs with equally good results. However this particular shiitake cultivation technology could not be used by Nepalese farmers due to the general low availability of those trees. As a result, most all shiitake cultivation technology knowledge remained hidden within the Division of Plant Pathology. Recently the situation within the forestry department has changed and the community forestry program has made great progress and been extended to include forest conservation, management, utilization programmes which are in the hand of forest users groups (FUG). As shiitake cultivation needs wood logs, it is appropriate now to integrate shiitake cultivation into the community forestry programmes. The author has particular hopes that such a programme will be started and well developed in the near future.

Preliminary Investigation

An initial feasibility study was carried out before beginning a closer investigation into shiitake cultivation. Local mushroom growers had been growing white button mushrooms and oyster mushrooms for last 20-25 years and this experience was highly beneficial. These farmers have recently requested a new type of mushroom that they might grow for commercially in order to realize a higher income. The community forestry program in Nepal is well organized and has formed FUG for forest conservation, management and utilization. There is now a demand for non-timber forest products and shiitake log cultivation has been found to be one of the best new options.

Anticipating the farmers' need, the Centre for Agricultural Technology (CAT) initiated a research project concerning shiitake log cultivation in the year 2000 under the support of Hill Agriculture Research Program (HARP). This was the first recent investigation of shiitake cultivation in Nepal. Potential mushroom growers are small scale farmers so they can not afford to invest much for mushroom cultivation. There is no big mushroom industry in Nepal, but there are a large number of small scale mushroom farmers. Therefore, it was concluded that shiitake log cultivation was an appropriate method for

these small farmers because shiitake bag cultivation requires a larger initial investment than log cultivation. It was certain that the farmers wouldn't invest much because they were not yet confident of the success in their shiitake cultivation operations. In this regard, it was decided that the most common and fastest growing tree species should be identified. Ideally the trees would be available everywhere and be the cheapest among the wood logs available from different trees species. The identification of locally available fast growing tree species would make it possible to grow shiitake on wood logs in Nepal.

The main objective of this investigation was:

1. To identify the locally available fast growing tree species that were appropriate for shiitake log cultivation
2. To find out the appropriate technology, mountain area locations, and climate for the growth of shiitake



Figure 1. Map of Nepal (location of experiment marked)

This research work was initiated in August 2000 by growing shiitake on wood logs of 18 different tree species. The experiment was carried out at three locations including Chhampy (1,540m) in the Lalitpur district of Kathmandu valley, Devitar (1,300m) in the Kavre district of Kathmandu valley and Lumle (1,600m) in the Pokhara valley located in Western Nepal. These locations are chosen for their cool and humid climate as well as their being the nearest locations to the big markets of Kathmandu and Pokhara. The tree species used at the three locations are shown in Table 1.

Table 1. Tree species used in experiment to choose appropriate shiitake log

Location	Chhampy	Devitar	Lumle
Tree species	<i>Alnus nepalensis</i> *	<i>Faxinus floribanda</i> *	<i>Daphniphyllum himalensis</i>
	<i>Castanopsis indica</i> *	<i>Betula alnoides</i> *	<i>Castanopsis hystrix</i> *
	<i>Prunus serasoides</i>	<i>Alnus nepalensis</i> *	<i>Engelhardtia spicata</i>
	<i>Betula alnoides</i> *	<i>Castanopsis species</i> *	<i>Macaranga pastulata</i> *
	<i>Juglans regia</i>		<i>Alnus nepalensis</i> *
	<i>Schima wallish</i>		<i>Celtis australis</i> *
	<i>Spondia axillaris</i>		<i>Betula alnoides</i> *
	<i>Pinus walachina</i>		<i>Quercus delata</i> *
	<i>Quercus semicarpifolia</i> *		
	<i>Quercus tricoloria</i> *		

* Tree species that was able to produce shiitake

Among the tested tree species, *Alnus*, *Betula* and *Castanopsis* were found to be most common in many parts of the country. *Alnus* grows naturally on river banks, on exposed land in mountainous landslide areas, and on waste land in the agricultural and watershed areas. These trees usually grow in sandy soil and are available from the eastern to western part of the country. *Alnus* is a fast growing tree with soft wood. Farmers usually grow them on their wasteland and in private forests for their own consumption as a timber and fuel wood. A five-year old *Alnus* tree is just the appropriate size to cut down for shiitake cultivation. From such a tree there may be nine to ten pieces of one-meter long log with a diameter between 5-15cm. In general one tree cost NPR¹ 250-300 (USD3.47-4.16). *Alnus* trees are also used for sheltering tea plantations and cardamom farms. CAT has recommended *Alnus*, *Betula* and *Castanopsis* trees be used for shiitake cultivation. The shiitake production data from 3 different tree species and 4 different strains are given in Table 2.

The shiitake strains used for the research work were mostly Japanese strains such as Mori 121, Mori 290 and Meiji. Some wild strains from Nepal were also tested but the fruiting bodies were found to be thin and small in size. Two other strains, one each from Malaysia and Bhutan, were also tested but the Mori strains were determined to be the best and most suitable for the climate of Nepal.

¹ NPR (Nepalese Rupee, USD1 = NPR72.05 in March, 2005)

Table 2. Average yield of 4 strains from logs of three tree species (g)

Shiitake strain	<i>Alnus</i>	<i>Betula</i>	<i>Castanopsis</i>
Mori 121	3,590	2,650	4,620
Mori 290	4,970	1,600	2,360
Mori 465	1,610	1,860	2,360
Meiji 410	1,860	1,360	1,720

Note : The yield was estimated from 8 logs for a year

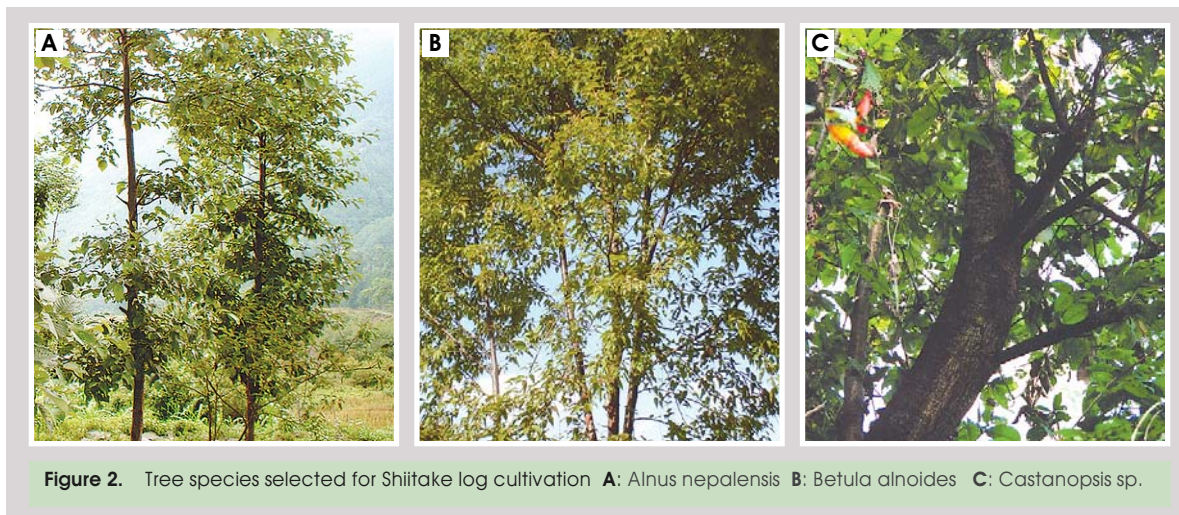


Figure 2. Tree species selected for Shiitake log cultivation **A:** *Alnus nepalensis* **B:** *Betula alnoides* **C:** *Castanopsis* sp.

Further research has continued to investigate the timing of wood log cutting and the appropriate periods for wood log drying under different seasons and situations. It will also be necessary to know whether log inoculation can be done all year round or not and the various cost benefit ratios are still to be worked out.

Production Process

The wood logs are cut down in December when the average temperature is 19-22 °C and humidity 70-80% (Fig. 3A). The logs are piled up in a heap and dried under shed for a period of one month. The ideal size of the wood logs is one meter long and 10-15cm in diameter. These wood logs are cut carefully so as not to damage the bark and also handled carefully during the operation.

In January when the average temperature is 19-22 °C and humidity 70-80%, these logs are inoculated using shiitake sawdust spawn. The holes are drilled at a distance of 15-20cm and the size of the holes is 1.5cm in diameter and 2cm deep (Fig. 3B). The inoculation is done by hand and sealed with paraffin wax (Figs. 3C and D).





Figure 3. Tree felling and inoculation **A:** Cutting the tree logs by axe **B:** Drilling the wood logs to make the holes **C:** Spawning the logs with hand **D:** Waxing the inoculated holes with molten wax

These inoculated logs are piled and sprinkled with water 2-3 times a week and stored for a month (Figs 4A, B and C). Then the logs are turned upside down and stacked again. The same process is repeated every month and the wood log stacking is done in the same way throughout the spawn run period. Some farmers piled the logs in a crib stack and watered them every 4-5 days.



Figure 4. Incubation and fruiting induction **A:** Wood logs stacked inside a plastic bamboo shed-Chhampy **B:** Wood logs stacked in shed - Kakani **C:** Sprinkling water on logs **D:** Water tank (small pond) for dipping logs in water

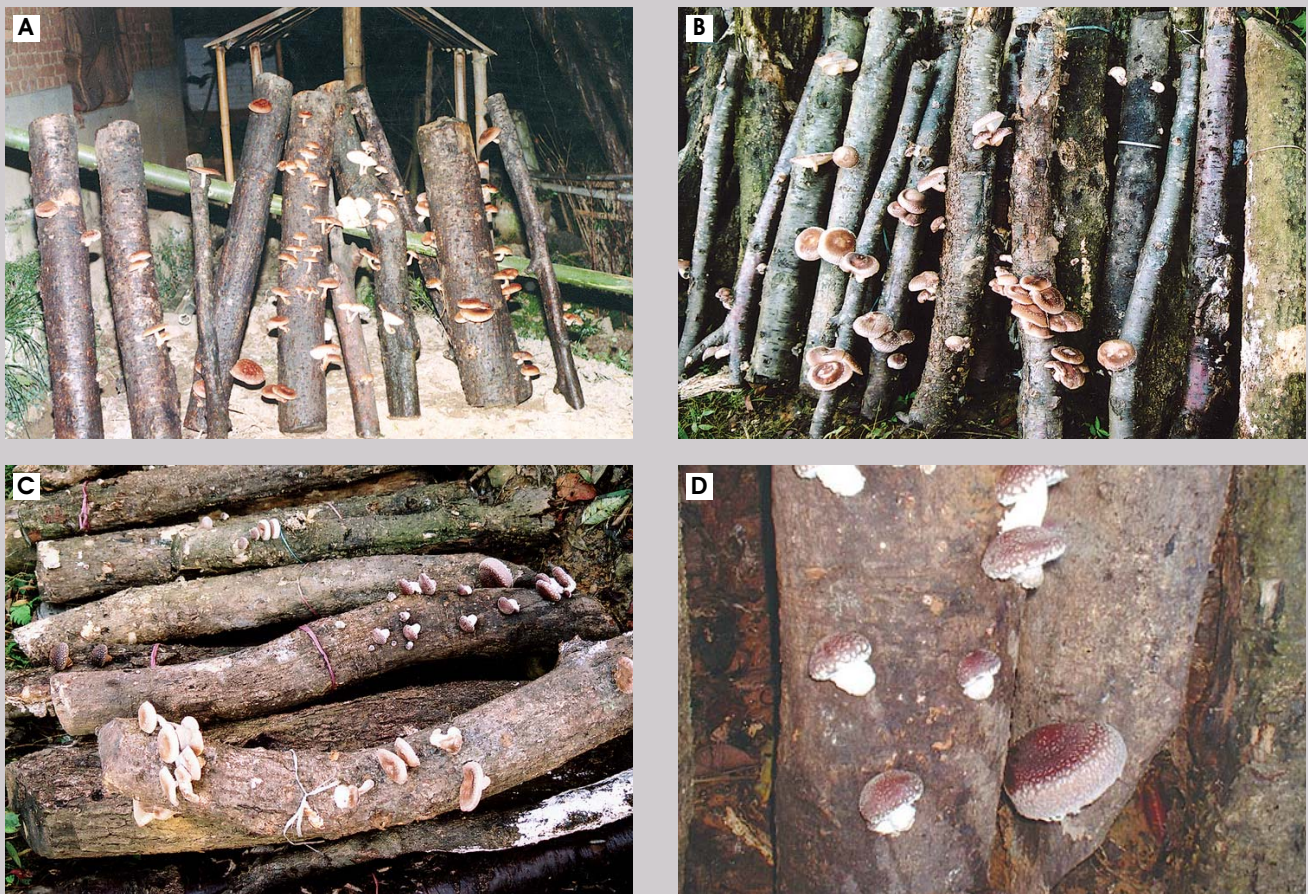


Figure 5. Fruiting **A:** Shiitake from *Alnus nepalensis* **B:** Shiitake on *Betula alnoides* **C:** Shiitake on *Castanopsis* **D:** Small caps on *Castanopsis*

Eight months after inoculation, logs would be ready for fruiting. To check if the logs are ready for induction, growers split them open to view the mycelial growth. In September when the average temperature is 24-26°C and humidity 80-90%, the logs are dipped in water in a small pond or a metallic container for a period of 24-48 hours for induction (Fig. 4D). After dipping, the logs are arranged in a row on the bamboo stand at a distance of 4-6 cm. Watering is done every day so as to keep the logs moist. A week after fruiting induction the young fruiting bodies start to appear on some logs. Shiitake can be harvested from October to December. The production slows in January and starts to up again from February through May. The production of shiitake usually stops in summer due to hot weather. Shiitake is harvested for three years in all the tree species. In tests *Castanopsis* logs produced larger harvest than the other two species, but the exact yields have still to be estimated, and this work continues.

Farmers have adopted the described process and some of them have succeeded. Logs of *Alnus*, *Betula* and *Castanopsis* trees were recommended in the area near a forest, where cool and humid conditions prevail in the seasons mentioned above.

Spawn Supply and Shiitake Marketing

At present CAT is the only shiitake spawn supplier and it is using sawdust from *Alnus* trees to prepare the spawn. Spawn is packaged in polypropylene bags using pure cultures of shiitake strains. The promotion of shiitake cultivation was initiated by CAT in 2002. To date about 25 farmers have started to inoculate wood logs. Some farmers have already produced shiitake and others have crops still in the spawn run stage.

CAT has collected all the shiitake produced by the farmers around Kathmandu and has itself sold this crop. The clients have been mostly



Figure 6. Shiitake in plastic packets for sale

Japanese, American, European and other foreigners staying in Nepal. There have been some Nepalese consumers but the cost of shiitake in the market is too high for most Nepalese. There is a special market for organic vegetables in Hotel Summitt on Sundays and Wednesdays. Shiitake are often sold in this market. In addition, attempts have been made to sell shiitake in local department stores that cater to Nepalese consumers but the mushrooms are not yet popular for these customers. The price for 1kg of fresh shiitake is NPR500 (USD6.94), which is too costly for an average Nepalese family. For the time being the domestic shiitake market is limited, so neighboring countries with bigger shiitake markets can act as the target markets until the domestic Nepalese market develops more fully.

Case Studies

Though experience is minimal, some successful cases in the early stages are provided here. Productivity varies widely according to individual farmers. Some farmers produce two or three times more than others.

A farmer named Ramu Raut has cultivated shiitake on *Alnus* logs since 2002. He has used wood logs of various diameters, from 5 to 20cm, he has not sprayed enough water on the logs, and the local environment is not quite ideal for mushroom cultivation. His costs and income from shiitake growing are as follows. This farmer is expected to harvest for one more year, so the accumulated volume of production will increase.

A farmer named Sher Bahadur has cultivated shiitake on *Alnus* wood logs since 2003. He has started only 40 logs, so his costs have been low. He received NPR500/kg at the market for his harvested shiitake. He harvested 12kg of shiitake in 2003 and 22kg in 2004. He is still having good harvest and 10kg is expected in 2005. Totally, he is expected to harvest 44kg from 40 logs and earn NPR20,000 (USD277.59) for 3 years. Therefore, the yearly net profit is NPR6,000 (USD83.28) from shiitake growing, an additional income source.

Table 3. Cost for shiitake log cultivation of Ramu Raut

Items	Unit cost in NPR	Cost in NPR
7 trees (70 logs)	300 / tree	2,100
Labor		600
Spawn	30 / bottle	500
Total cost		3,200 (USD44.41)

Table 4. Yield and income from shiitake production of Ramu Raut

Year	Volume of production (kg)	price per kg in NPR	Income inNPR
2002	6	500	3,000
2003	5.5	500	2,750
2004	3.5	500	1,750
Total production	15	500	7,500 (USD104.09)

Table 5. Cost for shiitake log cultivation of Sher Bahadur

Items	Unit cost in NPR	Cost in NPR
4 trees (40 logs)	300 / tree	1,200
Labor		500
Spawn	30 / bottle	300
Total cost		2,000 (USD27.76)

Table 6. Yield and income from shiitake production of Sher Bahadur

Year	Volume of production(kg)	price per kg in NPR	Income inNPR
2003	12	500	6,000
2004	22	500	9,000
2005	10 (expected)	500	5,000
Total production	44	500	20,000 (USD277.59)



Figure 7. Training on shiitake given to farmers

Shiitake farmers in Nepal have learned that shiitake cultivation requires cool and humid climatic conditions near forests and that their productivity depends on proper care and watering. One notable production aspect that needs to be improved is maintaining an appropriate moisture in the logs. Farmers in Nepal feel that they are just starting to understand the cultivation requirements of shiitake. While it cannot be said at present that shiitake growing is more profitable than growing other mushrooms in Nepal, this new product will surely attract new consumers as well as farmers.