

GROWING SHIITAKE MUSHROOMS (*Lentinula edodes*) IN THE HIGHLANDS

Shiitake mushrooms are a traditional oriental delicacy. Their cultivation can be traced back to the Chinese Sung Dynasty (960 - 1127AD). In 1904 the Japanese researcher Dr Shozabura Mimura published the first studies of inoculating logs with cultured mycelium.

In Scotland the first investigations into the commercial production of Shiitake began in 1993, under the guidance of Dr William Slee of the University of Gloucester, and there is now a Grower's Association (see back page for contact address) based in the Highlands.

Log preparation

Log preparation includes all the steps needed to convert a standing tree into Shiitake logs.

The process of growing Shiitake mushrooms is slow and labour intensive. Shiitake is a true saprophyte, existing only on dead wood. Hardwood logs (Oak, Beech, Birch and Alder) must be obtained during December to March, their dormant period. The best Shiitake logs come from clean stemmed trees close-grown on fertile sites. The ideal size is 1 metre x 12 - 20cm diameter. Logs larger than this are awkward and too heavy to handle without incurring serious back injuries.

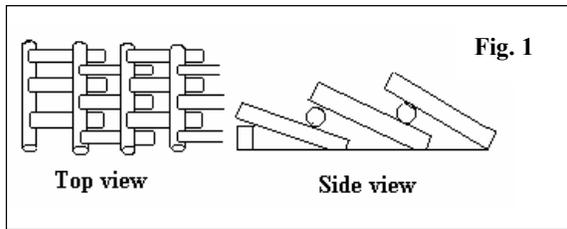
Once cut the logs must lie for at least 7 days, and no more than 8 weeks, before inoculation. However, if they will not be inoculated within 2 to 3 weeks, trees should be left 'in the length' and trimmed with branch stubs left on. Care should be taken to ensure that the bark is not damaged by the saw running up the side of the stem. This minimizes drying and the risk of contamination of cut surfaces by spores of weed fungi. Final cutting to size and trimming is carried out immediately prior to inoculation.

Inoculation

This is done using an ordinary D.I.Y. drill fitted with a specialized Shiitake bit with a depth stop. These bits are designed for 10,000 rpm and have a lead screw and a single cutting edge to reduce binding in green wood. The diameter of the bit is 12mm which matches the sawdust spawn inoculating tool. Holes are drilled along and around the log at regular intervals creating a diamond pattern. The number of holes drilled can be estimated at no less than one row of holes for every 2.5cm of log diameter, with holes spaced every 10cm along the row (Fig.2). Extra holes should be drilled near the ends of the logs and around any side branches and wounds to ensure rapid colonization by Shiitake to prevent 'weed' fungi invading the log. Using a special inoculation tool, sawdust spawn is inserted into each hole. Alternatively, wooden dowels colonized with mushroom mycelium may be tapped into each hole using a hammer. Inoculation holes and wounds in the bark are then sealed over with smoking hot cheese wax to prevent the Shiitake spawn from drying out or being contaminated by 'weed' fungi.

Incubation of logs.

During incubation or spawn run, Shiitake mycelium permeates the log. The goal of incubation is to achieve rapid colonization of the log by Shiitake and minimize contamination by other fungi.



The logs must be stacked outside in an area where there is moist air but with good ventilation and dappled shade. The west coast of Scotland with its damp, mild climate is more favourable for Shiitake production than the drier east coast.

Logs can be stacked in a number of ways (Fig. 1). In exposed, windy sites logs should be stacked at an angle low to the ground and windbreaks should be erected to lessen the drying effects of the wind. The mycelium will take between 18 months - 2 years to grow through the log depending upon spawn type, the size of log and the timber species used.

Fruiting

Shiitake logs are ready to fruit when the spawn has colonized the outer cylinder of available sapwood. The most obvious sign that the logs are nearing the end of the spawn run is the appearance of a chocolate brown and white 'star' pattern forming on the ends of the logs, and 'volunteer' mushrooms growing through the inoculation

holes. Logs can be 'shocked' into producing mushrooms from Spring onwards when the air temperature rises, and remains, above 8°C. Fluctuations in temperature in our changeable climate are detrimental to Shiitake production.

The fruiting stage is stimulated by soaking the logs in a tank containing very cold water for 2 - 4 days. The greater the difference between the air and water temperatures, the greater the 'shock' to the log. It is this shock that activates the fungus to start producing mushrooms. After 2-4 days the water is drained out of the tank and the logs may **either** be left for a further 2-4 days until 'pinning' (the emergence of embryonic mushrooms) occurs, **or**, the logs may be moved straight into a building - ideally a polytunnel with some shading. If the logs have been left to 'pin' in the tank care must be taken whilst moving them into the building to prevent the miniscule pins from being damaged.

After 7-10 days mushrooms should start to grow on the logs. During this period the air temperature should be kept at 60 - 80 f. and relative humidity around 85%. Mushrooms are ready for picking when the cap is 75% open. Beware of pest damage at this stage, namely slugs, and take appropriate action. Fruiting should last for about 10 days and then the logs are taken outside to 'rest' in a dappled shady area for 8 weeks. Fully inoculated logs should fruit 3 times per year for 5 years.

With proper husbandry, yields on a per log basis are from 100-150gms per log per fruiting.

Numerous varieties of spawn are now available from a Scottish producer. The varieties named 'WR46', 'WR85' (WR = Wide Ranging strain) and 'West Wind' are proving to do well in the Highlands.

Points to consider

The following factors must be taken into consideration before embarking upon Shiitake mushroom production:

- Site
- Availability of good quality hardwood logs, mushroom spawn and equipment.
- Availability of labour.
- Availability of machinery to move logs around site.
- Availability of water.
- Marketing the produce

Site

You will require a site to stack the inoculated logs during the spawn run where they can be left undisturbed for 18 months - 2 years. The size of the site will depend on the number of logs inoculated and should be under dappled shade, sheltered from the wind but with some

movement. The use of windbreaks may be necessary in excessively windy parts.

An irrigation system should be readily available to water the logs during dry weather. If Shiitake logs are allowed to dry out this will seriously compromise their ability to produce mushrooms.

air

Easy access to and from the site is another important factor. Whether you use a wheelbarrow, a tractor and trailer, or a quad and trailer (preferably the latter) to move your logs around the site, easy access to the stacking area proximity to the soaking tanks and the fruiting area (i.e. polytunnel) is desirable.

Availability of suitable logs, mushroom spawn and equipment.

Hardwood logs (oak, beech or birch) must be obtained during December to March, their dormant period. Only live, healthy trees that are relatively straight and contain a high percentage of sapwood should be selected. Trees with numerous decayed branch stubs, discoloured wood and other signs of internal decay should be avoided. Moss, lichens or other organic matter on the bark should be removed prior to inoculation. Logs that have damaged bark either from felling or from the saw chain should be discarded. These wounds will only allow weed fungi access to colonise the log.

These logs can be obtained from one of the following:

- your own woodland. You may require a felling license and you should contact the Forestry Commission to clarify your situation.
- a local estate - contact the head forester
- firewood merchants who advertise in local newspapers.

It is advisable to instruct your supplier to handle the logs carefully to avoid damage to the bark and to keep them free from mud. Soil contains mycelium and spores of many weed fungi which could infect the logs. To get good quality Shiitake logs delivered to your site, you should be prepared to pay a higher price than the usual 'firewood price' to reflect the extra care involved. Mushroom spawn and equipment are readily available from a Scottish supplier (Ann Miller's Speciality Mushrooms) or from U.S. suppliers via the internet (*details of which are given at the end*).

Availability of Labour

All aspects of Shiitake production are labour intensive.

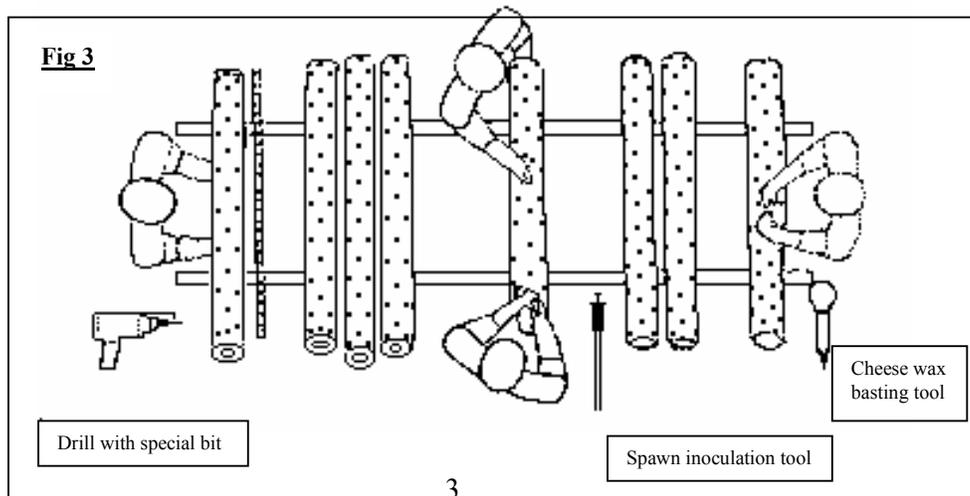
- A Shiitake log weighs from 20lbs to 60lbs, so it is recommended that your labour force is young, strong and healthy!
- A well-trained, competent team of four should be able to inoculate 200 logs per day (fig 3) - one to drill, two to fill and one to wax.
- Two persons would be adequate for 'shocking' and fruiting the logs.

Availability of machinery

Good quality machinery, kept in working order is definitely a necessity in Shiitake mushroom production. Depending upon the number of logs you decide to inoculate you will require one of the following: a wheelbarrow, an all terrain vehicle, a tractor and trailer or a fork lift. Your machinery should be readily available and in working order whenever you require it. You should aim for the minimum effort in moving logs between the various stages and try to use a sequential approach when laying out your site.

Availability of water

The difference between obtaining a good Shiitake crop or a poor one depends on maintaining a favourable moisture content in the logs. A readily available source of water is an absolute necessity for irrigation during the 'Spawn run', for 'shocking' the logs and when the logs are 'resting'. Periodic rainfall may provide enough moisture during the 'spawn run' and when the logs are 'resting' for west coast growers, although this moisture can easily be lost if the site is very windy. However, for growers in drier parts of the Highlands, especially those situated in the east, an irrigation system is required. This can simply be a series of garden sprinklers to mimic rainfall.



Marketing

The grower should research potential customers long before any mushrooms are picked. The chefs of local top class hotels and gourmet restaurants should be contacted directly to determine if and when mushrooms are likely to be needed and what quantity is required. Shiitake mushrooms will keep fresh for four days after picking and for up to two weeks if refrigerated. Chefs will typically buy a few pounds of Shiitake per week throughout the season, but demand may fluctuate due to various factors. In order to sell your Shiitake you must be prepared to:

- give lots of trial samples to lots of chefs.
- telephone your customers, weekly, for their order at a time when they are not busy.
- grade your Shiitake, selecting only top quality mushrooms, and pack in standardized mushroom containers.
- deliver your Shiitake regularly.
- be flexible regarding payment - fit in with the customer's accounting system - each one is different.
- try other outlets e.g. farmers' markets.



As well as fresh mushrooms there is also a market for dried Shiitake. Shiitake dry very well in domestic food driers and this is a good method of using your second quality mushrooms. The main outlets for dried mushrooms are delicatessens or 'health' food shops, but their extended shelf life may also be attractive to customers at a market. This method also extends the season for selling the Shiitake.

Finally, the 'Pet Log' market - inoculated and fully colonized logs are proving to be popular with gardeners. Sold at the point of fruiting, they make attractive and unusual gifts. 'Pet Logs' can be successfully marketed through classified sections of gardening magazines, on the internet, and at farmers markets.

Contacts for further information Highland Shiitake Growers Association

- Kate Thompson, 01381 620692

Spawn suppliers

Anne Millers Specialty Mushrooms,
Inverurie, Aberdeenshire
01467 671315

American Shiitake folk

Field & Forest Products, Wisconsin
www.ffp@mari.net

Scottish Forestry Grant Scheme & Felling licenses

Forestry Commission, Woodlands, Fodderty Way,
Dingwall, Ross-shire. IV15 9XB

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