

Growing Shiitake

—The Basics

Although shiitake has been cultivated in China and Japan since at least the time of Christ, it is still virtually unknown as a food crop in the West. Most people don't think of forests as being major food growing areas. That's why farmers are cutting so many of them down to make room for cropland. Actually, with forest mushrooms and other woodlot crops, we can have our trees and eat them too!

Shiitake is not yet known to grow wild in the United States. The only way to produce shiitake is to grow it deliberately. It prospers in sixty percent or better shade outdoors (not darkness) where ventilation is good. Running water is needed several times a year but not continuously (the bark should dry out between waterings to avoid destructive surface molds). Shiitake yards should be places one can easily visit daily, not too remote from one's other activities. Indoor production, often used for commercial operations where continuous fruiting is desirable, requires environments which approximate outdoor conditions, with variable temperature, lighting, humidity and ventilation.

Felling

Oak logs are usually used, but many other hardwoods can also produce shiitake. Select young, living, healthy trees in stands needing to be thinned. Avoid damaged bark, sections with bark less than 1/8" thick (too fragile!), logs over 7" diameter (too heavy!), deadfalls, and logs of uncertain age or origin. Ideal width is 4". Cut logs 30" to 48" long. Shiitake will not grow on living trees.

The "perfect" time to fell trees is the fall and winter. This is when the core is dense with stored sugars. Felling in summer produces lots more contamination as well as lowered yield. You should inoculate as soon as possible but not more than 3 weeks from felling. Avoid leaving fresh logs in contact with the ground, or dragging them through the dirt, if possible.

Optimal moisture content for spawning is 35 to 45 percent. This is not bark moisture, which can be affected by spraying or rainfall, but core moisture, which can only be affected by soaking or moisture conservation after cutting.

Strain Selection

There are three basic categories of shiitake spawn: 1) year round fruiting (wide-range); 2) winter to spring (warm); 3) fall, winter, and spring (cold).

The best types for most uses are the year-round, wide-range strains. These produce quickly and easily, so logs turn over more rapidly and less growing area is required. Warm weather types are usually grown for dried mushroom production, and often require two to three summers after inoculation until the first flush. The cold weather types generally fruit two summers after inoculation although there are some varieties which will produce mushrooms the first fall after spring inoculation. Cold weather strains are most likely to produce the highest grade, or "donko" mushrooms.

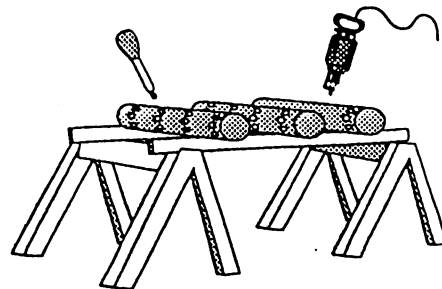
All strains need one full summer before they will produce. Generally, the more spawn you put into a log, the sooner it will produce its first crop when environmental conditions are right.

Inoculation

We supply spawn in three forms, (1) on wooden plugs (dowels), (2) in sawdust, and (3) in grain. Plugs are inoculated by pre-drilling the logs. Sawdust is inoculated by either predrilling and using a special pressure inoculation tool, or by

making a saw-cut and packing it with spawn. Grain spawn is for producing mushrooms on sawdust, chips or other substrates.

Refrigerate spawn if you don't plan to inoculate within 10 days. It's best to keep the spawn at room temperature for a few days before spawning. In a large operation, the person handling the logs (and coming into contact with the bark) should not be the same person who inoculates the spawn. Wash hands frequently to avoid contamination. Do not expose spawn to sunlight or dirt. Spawn will propagate more rapidly with the grain of the wood, so you will need to inoculate across the grain, one close-spaced row every 6 to 10 inches along the surface. We recommend not staggering the holes in a diamond pattern, but instead drilling the circles straight around or at a slight diagonal, which tends to have a growth-compartmentalizing effect, preventing contaminants from progressing along the grain.



Wooden-plug spawn (easiest method)

1. **Drill.** Use a 5/16" (8.5 mm) drill bit. Beginning two or three inches from the end of the log, drill close-spaced rows (2-4" between holes), 1 1/2" deep. Move down the log, drilling rows every 6 to 8 inches until you get 2 or 3 inches from the other end.
2. **Hammer.** Tap wooden plugs flush with a hammer, leaving air space below.
3. **Wax.** Apply hot melted wax to seal in moisture and protect spawn.

Sawdust spawn (commercial technique)

1. **Drill.** Use a 3/8" to 5/8" drill bit (7/16 is best), to drill rows of holes on 2 to 4-inch centers, 3/4" deep, 6" apart.
2. **Fill.** Pack spawn firmly to rim of hole. No air space is necessary.
3. **Wax.** Seal with hot wax. If you don't have a glass basting tool, use a butter knife, spoon, small piece of sponge, or a tongue depressor to apply the wax.

Spawn Run

After inoculating, the spawn run will take 4 to 10 months before the log is completely colonized by the fungus. Freshly inoculated logs should be temporarily stacked in square criss-cross tight piles (crib stack) in the shade and covered with burlap or shade cloth for about 2 months. Uncover the logs after rainfall and allow the bark to dry, to prevent growth of unwelcome fungi.

Cold temperatures cannot hurt the spawn, although growth will diminish when temperatures are below 43°F. Spawn can die above 100°F, so it is important to always protect your logs from overheating.

After 2 months, restack in a loose crib stack, 4-6 in a layer, or lean the logs with one end on bare ground in deep shade, racked so there is air space around each log. Air circulation is especially important for the logs closest to the ground. The slant angle can be determined by the sunlight, with the objective being to keep as little of the log exposed to direct sun as possible (unless air temperature is always below 43°F and some solar warming is desirable). If mold begins to appear, the logs are too damp. Restack every 2-4 months but don't reverse ends. The spawn run is nearly complete when fuzzy white blotches appear at log ends or mushrooms appear after a rainfall. If the fungus is any other color, you have contamination and the log should be removed from the laying yard. To

reduce the chances of contamination by wild fungi of incompletely colonized logs, we suggest rotating spawn yards each year, moving logs to the "permanent" laying yard after shiitake mushrooms appear.

Dormant periods

Leave stacks exposed all winter. You may want to greenhouse some of your logs for winter production. If your outdoor yards aren't sheltered from the drying effect of sun or wind, you may want to reduce exposure by using polyvinyl or evergreen shade areas, lowering log stack angle, or covering stacks with burlap or shade cloth. Some growers lay gravel in stack areas to minimize contamination from soil or forest microorganisms. Snow cover will not hurt the logs.

Fruiting

You need to provide room for the mushroom to grow out from the log and give yourself access for harvesting. Some people get satisfying yields without ever moving a log. To get optimum, more or less continuous, production, you can "cycle" about 1/7 of your producing logs each week as follows:

1. Soak the logs for 6-36 hours, depending on temperatures. Stand them in a 55-gallon can or stand or lay and weight them in a tub or stock tank; otherwise use a sprinkler system. If air is warm and water is cool, the soak can be 6-12 hrs. If air is cool and water is cool, longer soaking is recommended. If bubbles no longer appear on the surface of the logs, they are totally saturated and should be removed.

2. You might want to "thump" them into position for fruiting. Some Asian growers use mechanical vibrators or electric shock. Authors differ on this but we recommend "cold shock" (very cold water) as the most effective way to force fruiting.

3. "Pinning" occurs as the primordia form and push through the bark. Careful management during pinning can result in higher yields. Optimal conditions maintain the logs between 55 and 65% moisture at 55 to 65°F until small bumps form under the bark.

4. Wait at least 30 days after a harvest before soaking again. This "rest period" is essential to allow the mycelia to store more nutrients.

Some growers use clear poly covers reaching to the ground to control moisture loss for several days after soaking. You may also use poly to keep rain off the logs during the rest period, or during the harvest period (wet shiitake doesn't keep as well). Special felt blankets are often used on the West Coast, where excessive drying is a serious problem.

Harvesting

Harvest shiitake after the veil breaks while the caps still have curled edges and are less than 4 inches in diameter. During cool weather, the mushrooms may be left on the logs for many days. When it's warm, however, you should harvest early and often, to minimize bug damage and discoloration from spore discharge. Bugs that get under the caps can be removed by soaking.

Fresh shiitake will keep for 2-3 weeks in the refrigerator, but should be marketed within 4 to 5 days from picking. Store in cloth or paper bags, or in perforated cardboard boxes (not plastic). Surplus shiitake may be dried for later use, or cooked and frozen.

It is possible to fruit shiitake at any time of year. Therefore the production can be scheduled to coincide with labor availability and to keep a constant supply in the market. Continuous production encourages consistently high prices. Left to nature, a log will fruit for as many years as its

diameter in inches. Forced fruiting speeds crop production but also shortens the productive life, since each log has a fixed available quantity of nutrients, which, once exhausted, are gone.

Calculating Production Rates

A one person farm (less than 5000 logs) can produce 45-65 pounds per day (at 0.25 to 0.33 lb/flush/log). A two person farm (5,000-10,000 logs) can produce about 110 pounds per day. A four person farm (20,000-30,000 logs) can produce about 220 pounds per day. Labor is needed for soaking the logs, harvesting the mushrooms, packaging them, and then selling them. A small farm with perhaps a father and his son and hired help in season, inoculating 4,000 logs/yr will generate \$20,000 to \$30,000 pre-tax annual income or about \$10 per hour of labor.

To produce 110 pounds per day it is necessary to have space for a permanent laying yard, a temporary laying yard of about 400 square yards, tanks for soaking the logs, and one or more indoor fruiting areas for the winter.

It is possible to cycle 35 to 40 batches per year through a greenhouse, barn, or modified poultry house to produce continuously. Indoor space requirements average one square foot per log. The amount of light needed is about the level required for reading. Air flow and humidity should also be controlled. We recommend carefully reading one or more of the books referenced below, starting small, and slowly growing into the business before making a large investment.

Returns for Raising Shiitake Mushrooms on One Cord of Wood

All figures are approximate. No cost is assigned to logs or to labor. Logs per cord: 300 (4" diameter, 42" long). Inoculation holes per log: 25. Mushroom drying ratio: 7 pounds fresh produces 1 pound dry.

Inoculation Costs	Cord	Log
Using plug spawn:		
1000 dowels/bag, 10 bags @ \$35	\$350	\$1.16
(easier & faster, fewer contaminated logs)		
Using sawdust spawn		
15 bags spawn @ \$19	\$285	\$.95
(Less expensive, produces mushrooms sooner)		
Expected returns over four years - at wholesale prices		
All sold fresh: 2.25 pounds/log		
x 300 logs x \$4/pound	\$2700	\$9.00
All sold dried: 325 lbs/log		
x 300 logs x \$13/pound	\$1267	\$4.22
70% sold fresh, 30% sold dried:	\$2270	\$7.57

From 1988 to 1991, some 230 U.S. shiitake growers increased production from 3.7 to 4.1 million pounds and earned from \$22 to 22.4 million/year in gross sales, about \$4.17 per pound. Local wholesale rates vary from \$3 to \$9 per pound.

For more information about growing shiitake, we recommend you read: *Growing Shiitake Mushrooms in a Continental Climate* by Kozak and Krawczyk (\$12); *Year-round Shiitake Cultivation in the North* by Kozak and Krawczyk (\$10); *Growing Shiitake Commercially* by Bob Harris (\$13.50) and *Shiitake Growers Handbook* by Paul Przybylowicz and John Donoghue (\$25.00), which are available from



© 1993 **Mushroom people**
P.O. Box 220 Summertown TN 38483-0220
Phone or Fax (615)964-2200
Shiitake spawn and supplies since 1976