MISSISSIPPI STATE UNIVERSITY EXTENSION

Outdoor Shiitake Mushroom Production on Hardwood Logs in Mississippi

Shiitake (shee-tah-key) mushroom, *Lentinula edodes*, is a popular specialty mushroom grown, marketed, and eaten around the world. It is from Japan. Mushroom foragers will not find shiitake mushrooms growing wild in the United States. The shiitake has an umbrella-shaped cap that is tannish brown on top with whitish, cream-colored underside gills. Shiitake mushrooms have culinary and medicinal properties. They are high in protein, nicely aromatic, and chewy, making them the perfect meat substitute in vegetarian dishes. The medicinal benefits include promoting heart health and supporting the immune system with anti-tumor, anti-viral, and anti-fungal properties.

The mushroom cap is the edible part. It begins as a fungal spore that germinates and spreads threadlike filament hyphae (roots) throughout a suitable substrate (hardwood) until saturation. It produces a reproductive mushroom structure (cap) on the surface when environmental conditions are right. Most mushroom fungi obtain energy and nutrients by decomposing plant material. Shiitake mushrooms feed on the cellulose and lignin in specific wood. They are cultivated outdoors on hardwood logs (known as bolts) or on hardwood sawdust blocks in environmentally controlled growth chambers. This publication covers outdoor shiitake production on logs using spawn-inoculated sawdust or wooden dowel plugs.

Basic Terms in Shiitake Mushroom Production

- **Bolt** – A hardwood log inoculated with mushroom spawn.
- **Forcing/Shocking** – Tricking the mushroom mycelium into thinking it needs to produce a fruit (mushroom cap). Generally accomplished by a temperature change (i.e., soaking a hardwood bolt overnight or for 12–24 hours in chilly water). Forcing can occur naturally when the temperature drops in the fall.
- **Fruiting** – The production of a mushroom or the reproductive part of a fungus.
- **Hyphae/Mycelium** – The fine, white, threadlike network of filament that makes up the vegetative part of a fungus.
- **Pinning/Flush** – When the mushrooms emerge from the bolt after the mycelium has colonized or saturated the wood.
- **Spawn** – Fungal mycelium cultured on grain and sawdust under sterile conditions and used to inoculate hardwood logs.
- **Spawn Run** – An incubation period lasting 6–18 months. The time it takes a fungus to grow throughout a log, and initiate growth of the first flush of mushrooms.
- **Substrate** – Wood-based fiber (log or sawdust) that is high in carbon, the main food source for fungal mycelium.

Basic Steps to Grow Shiitake Mushrooms on Logs

Cultivating shiitake mushrooms is simple if you have the right tools (Table 1; Figure 1). It begins by taking harvested, cut-to-length logs and drilling rows of holes 6 inches apart along the length of the log. The rows of drilled holes are offset and spaced 2 inches apart, covering the entire log and creating a staggered diamond pattern or a spiral (Figure 2). A 4-inch by 3-foot-long log typically has 40-plus holes made with an extremely high-speed drill (3,600 rpm) or an adapted angle grinder (10,000 rpm). The hole depth varies depending on whether you use dowel plugs or sawdust spawn. Dowel spawn requires a hole with a diameter of five-sixteenths of an inch (8.5 mm) drilled to a depth of 1–1½ inches. Sawdust spawn requires a wider drill bit (12–12.5 mm) drilled to 1 inch deep. Screw tip bits with collar depth stops work best. Fill the drill holes immediately with spawn to prevent desiccation or contamination. Hammer the dowel plugs flat into the holes.

Table 1. Mushroom inoculation provisions and price tags.

Supplies	Cost **
Fresh-cut hardwood logs (4–6 inches in diameter and 24–36 inches long)	FREE–$4 each
Drill or angle grinder with adapter	$80–$144
Drill bit with collar depth stop (12 mm sawdust or 8.5 mm plug)	$16.50
Inoculation tool (sawdust) or hammer (dowels)	$42 or $3
Shiitake spawn strain (5-pound sawdust block/1,000 wooden dowels)	$26/$46
Food-grade cheese wax	$4.50 per pound
Wax daubers or brushes	$1.60 per 4-pack
Aluminum tags	$2.75 per 25 tags
Staple gun (light/heavy duty) with 8–10 mm staples	$15
Electric kettle cooker (350–400°F)	$40

** Field & Forest Products and Wal-Mart prices, 2025. The initial average cost for supplies is $250–$360, without hardwood logs.

Figure 1. Tools used for inoculating logs with mushroom spawn.

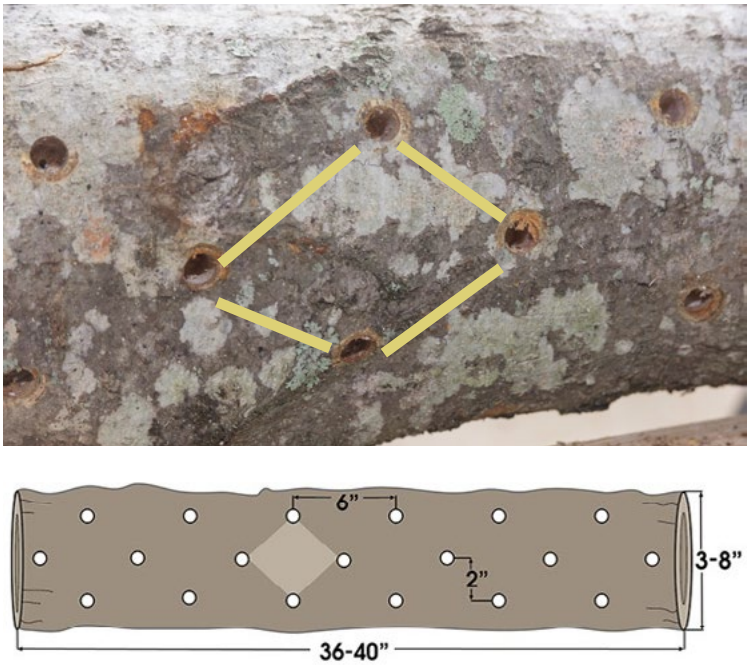

Figure 2. Inoculation drill holes are spaced every 6 inches along the length of the log and rows are spaced 2 inches apart. Holes are offset in a diamond or spiral pattern.

Safety Tips: Always use safety glasses and ear plugs while operating drill equipment. Secure longer hair back and button up loose clothing, especially during drilling. Gloves and apron are additional optional apparel (Figure 3).

Figure 3. Protective safety gear.

The sawdust spawn requires a special spring-loaded, thumb- or palm-pressure, plunger-type inoculation tool. Seal each inoculated hole with a coat of hot cheese wax using a cotton dauber, brush, or sponge. This prevents bacteria, fungal competitors, and moisture loss from the spawn inoculation site. There is no need to wax the cut end of the bolts. The last thing is labeling each bolt with the inoculation date and spawn strain using a metal tag (Figure 4).

Figure 4. Aluminum tag for documenting log inoculation information (i.e., mushroom strain, date, wood variety).

After inoculation, stack bolts off the ground near a water source in 60 percent or more shade for 9–18 months (Figure 5). Proper moisture content is critical for spawn incubation. It is important for the log bark to dry between waterings, but **the log itself should never dry out**. To keep bolts at 35 percent or more moisture content, soak them at least once a month, especially during Mississippi's hot, dry summer months (July, August, and September). To increase moisture content, use an overhead sprinkler or immerse bolts in a livestock watering trough for 12 hours every month. Do not leave an inoculated bolt in the water for longer than 24 hours as this risks drowning the mycelium.

Figure 5. Bolts are stacked on a pallet with the aluminum tag visible for 9-plus months in the shade near a water source.

Shiitake Strain Selection

Shiitake spawn strains differ in cap size, texture, spawn-run speed/length, response to chilly water forcing, tendency to fruit at different temperatures, and mushroom storage characteristics. Some strains prefer growing indoors rather than outdoors.

Mushroom spawn strains are classified by fruiting time.

- **Cold-weather strains**: Have the longest spawn run (colonization period) time and fruit in the early spring and late fall. Fruiting temperature range is 40–70°F.
- **Warm-weather strains**: Have a 9- to 12-month spawn run time. Fruiting occurs in the summer and early fall months. Fruiting temperature range is 5–85°F.
- **Wide-range strains**: Have a quick spawn run time (6–9 months), and fruit sooner than other strains. Also, they are not as fussy about the fruiting temperature range of 55–75°F.

For outside hardwood log production in Mississippi, select warm-weather or wide-range strains. The biggest contributing factor to good versus poor mushroom production is keeping the moist, inoculated log off the ground and under shade.

Spawn Type

Shiitake spawn is sold in 2-, 5-, or 10-pound sawdust blocks or 250-, 500-, or 1,000-count wooden dowel plugs. They are packaged in a thick, plastic grow bag with a small mesh filter that allows for gas exchange (Figure 6a). Moist, brownish sawdust blocks and plugs will have white mycelium running through them (Figure 6b). The bottom of the blocks may have a thicker, felt layer with brown patches that appear fuzzy with free brownish liquid in the bag. This is good and normal. Upon receiving, refrigerate (40°F) the spawn immediately. **Do not freeze.** It will last for months if left in its

plastic grow bag. Prior to inoculation, let spawn bags reach room temperature.

Figure 6a. Spawn inoculated plugs and a sawdust block in grow bags.

Figure 6b. Loose inoculated plugs and sawdust.

Obtaining Hardwood Logs (Bolts)

Shiitake mushroom production is a terrific way to reduce wood waste and potentially generate income, but it is labor-intensive. Mississippians have access to unmarketable hardwood logs left from timber harvests, limb-pruning debris from tree care professionals, and small-woodlot improvement activities.

The best tree species for growing shiitake mushrooms are red or white oak (*Quercus*), sweetgum (*Liquidambar*), hophornbeam or ironwood (*Ostrya*), hornbeam (*Carpinus*), beech (*Fagus*), and persimmon (*Diospyros*). Cut logs from living trees in late fall to early spring when leaves are shed and wood contains the highest amounts of stored carbohydrates. The high carbohydrate and sugar content in tree sap encourages rapid fungal mycelial growth. In Mississippi, this is from November to March, at least a couple of weeks before bud-swell. For ease in handling, the perfect size logs are 4–6 inches in diameter and 3 feet long (Figure 7).

Figure 7. Stack of freshly cut hardwood logs.

Purchase logs in good condition with intact bark, without rot and scarring. Smaller-sized logs are undesirable because they tend to dry out quicker and produce fewer mushroom flushes. Larger logs require more spawn inoculations (more drill holes), take longer to produce mushrooms, and have an increased chance of contamination by other undesirable fungi. Larger logs are also heavier and more difficult to move around the cultivation site.

The general recommendation is to inoculate logs within three weeks of felling to take advantage of their high moisture content. Do not store cut logs in direct sunlight. The internal moisture content needs to stay above 35 percent for decent mycelial growth. If you notice your bolts are dry and lightweight, soak them for 12 hours.

Shiitake Cultivation Site/ Bolt Laying Yard

The perfect bolt storage location would face northeast, have access to water/electricity (solar), and be protected from sunlight and drying winds. Tree canopy shade levels (evergreen versus deciduous) may not be enough to achieve the desired 60–100 percent shade. Have a mesh 80-percent shade cloth on site for extra shade during long summer months. The produced mushrooms' condition can tell you if there is adequate shade at the production location. Under too much shade, mushrooms produce longer stems and smaller caps. A 1- to 2-inch stem is ideal. Conversely, if mushrooms receive too much sunlight and wind, the caps will be smaller, cracked, and leathery.

Side note: To shiitake mushroom connoisseurs, a cracked cap is desirable because it is meatier, with a more intense flavor due to stressful growing conditions (Figure 8).

Figure 8. Moisture-stressed, cracked mushroom cap.

A clean source of chilly water is a necessity for maintaining the minimum 35-percent bolt moisture level and for forced fruiting. Please note that chlorinated public water may harm fungal mycelium; if used, let the public water sit in the soaking tank for 24 hours beforehand.

Forcing Bolts to Produce Mushrooms

Make sure that the spawn strain used responds to forcing. Referencing *Field & Forest Products*, the wide-range and warm-weather shiitake strains will respond to forcing. Only force logs that are fully colonized. If the bolts have given you mushrooms sometime earlier in the season, they are ready for forcing.

Forcing is tricking the fungal mycelium into fruiting before its natural fruiting time (late summer or early fall). Immerse bolts in water 20 degrees colder than the average air temperature for 12–24 hours (Figure 9).

Figure 9. Stacked inoculated hardwood bolts and an animal water tank used to force bolts into mushroom production.

Once white mycelial growth is visible at the end of the bolts (spawn run), one year from the time of inoculation, they can be forced to fruit (produce a mushroom cap) by immersing them in chilly water overnight. A flush of mushrooms usually appears 10 days after forcing. Let the bolts rest for 8 weeks or more to rejuvenate between forcing events. Bolts will simply stop responding to forcing as the outside temperature gets close to the soak water temperature.

Fruiting, Harvesting, Storing, and Marketing

Bolts will fruit naturally after heavy rainfall or with major temperature changes. Whether from forcing or natural weather change, once pinning (mushroom formation) has begun, a shiitake mushroom will reach maturity in 3 to 7 days. Stack fruiting and harvesting stage bolts so that the mushrooms are visible and easy to pick. Leaning bolts vertically against a supporting fence or beam decreases slug damage to caps (Figure 10). It is not the size of the mushroom that determines when to harvest. The gills should be visible, and the mushroom's outer edge slightly curled under. A flattened-out edge means the mushroom is slightly overripe but still edible.

Figure 10. Stack forced or pinning bolts vertically for easy mushroom cap harvesting. Mature mushrooms come in all sizes. Harvest mushrooms at 75 percent maturity. Shiitake mushrooms placed gill side down will leave a white spore print.

Harvest mushrooms by cutting them off where the stem meets the log surface, when they are 75 percent open. Do not rip or damage the harvest site on the bolt. Remove the non-edible woody stem from the cap. You can discard it or steep the stems in water for flavor. Refrigerate caps in a cardboard container or a paper bag for up to 14 days. Each 3-foot-long bolt can produce 3 pounds of mushrooms over a 4-year period. This is for a 1-year-old, inoculated log bolt that fruits twice annually (¼–½ pound per flush). The second and third years are the most productive.

Growing mushrooms is easier than selling them. You must be able to grow and sell a product to succeed financially in a business. To predict yields, you need a preplanned log rotation schedule. Value-added production is a clever way to increase demand. Mushroom caps can be dried, frozen, ground into a powder, made into liquid extracts, or used as a tea. Seven pounds of fresh shiitake yields 1 pound of dried mushrooms. The average wholesale price of U.S.-grown shiitake mushrooms was $7.90 per pound in 2022–2024.

Sawdust Spawn Inoculation

Drill (12–12.5 mm bit) hole to 1 inch deep. Pack spawn into inoculation tool and transfer to log drill hole. Seal with wax.

Plug Spawn Inoculation

Drill 5/16-inch (8.5 mm) hole to a depth of 1–1½ inches. Set dowel plug and hammer flush with log. Seal with wax.

Figure 11. Demonstration of sawdust spawn inoculation and plug spawn inoculation.

References and Additional Resources

Anderson, S., & Marcouiller, D. (1990). *Growing shiitake mushrooms* (OSU Extension Facts No. 5029). Oklahoma State University Extension Service. https://www.mushroomcompany.com/resources/shiitake/okstate.pdf

Bruhn, J., & Hall, M. (2022). *Growing shiitake mushrooms in an agroforestry practice.* University of Missouri Center for Agroforestry. https://extension.missouri.edu/publications/af1010

Kaiser, C., & Ernst, M. (2019). *Shiitake and oyster mushrooms* (CCD CP 82). Center for Crop Diversification, University of Kentucky, College of Agriculture, Food and Environment. https://ccd.uky.edu/sites/default/files/2024-11/ccd-cp-082_shiitake-and-oyster-mushrooms.pdf

Hill, D. B., & Szymanski, M. (2010). *Kentucky shiitake production workbook: Inoculation FOR 81*. University of Kentucky Cooperative Extension Service. https://publications.mgcafe.uky.edu/sites/publications.ca.uky.edu/files/for81.pdf

Lyon, E., Amante, M., Londo, A., Toland, K., & Bratkovich, S. M. (2022a). *Shiitake mushroom production: Steps to cultivation and considerations for production* [Fact sheet]. Ohioline. https://ohioline.osu.edu/factsheet/f-0039

Lyon, E., Amante, M., Londo, A., Toland, K., & Bratkovich, S. M. (2022b). *Shiitake mushroom production: Fruiting, harvesting, and storage* [Fact sheet]. Ohioline. https://ohioline.osu.edu/factsheet/f-0042

Lyon, E., Amante, M., Londo, A., & Toland, K. (2022c). *Shiitake mushroom production: Inoculating logs with spawn* [Fact sheet]. Ohioline. https://ohioline.osu.edu/factsheet/f-0040

Mudge, K., Matthews, A., Waterman, B., Hilshey, B., Siergk, S., Laskovski, N., Rockcastle, J., Rockcastle, S., & Gabriel, S. (2013). *Best management practices for log based shiitake cultivation in the northeastern United States*. Northeast Sustainable Agriculture Research & Education. https://projects.sare.org/wp-content/uploads/977907shiitake-bmp-3-11-final-for-print-hires.pdf

Tridge. (2025). *Price for fresh shiitake mushroom in United States*. dir.tridge.com/prices/fresh-shiitake-mushroom/US

The information given here is for educational purposes only. References to commercial products, trade names, or suppliers are made with the understanding that no endorsement is implied and that no discrimination against other products or suppliers is intended.

Publication 4150 (POD-01-26)

By **Donna H. Beliech**, Area Extension Agent IV, Rankin County. Photos by Donna H. Beliech and Kevin Hudson.

MISSISSIPPI STATE UNIVERSITY EXTENSION

Produced by Agricultural Communications.

Extension Service of Mississippi State University, cooperating with U.S. Department of Agriculture. Published in furtherance of Acts of Congress, May 8 and June 30, 1914. ANGUS L. CATCHOT JR., Director