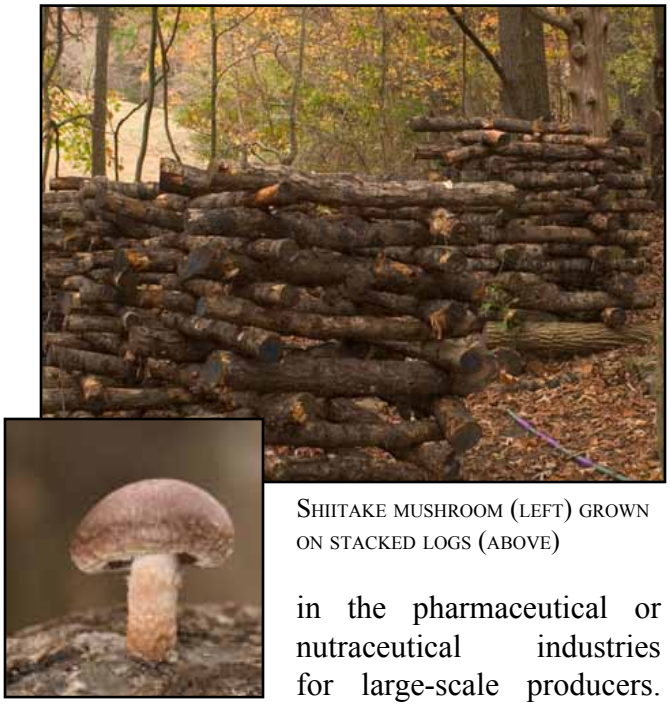
UK COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY — COLLEGE OF AGRICULTURE

Shiitake and Oyster Mushrooms



SHIITAKE MUSHROOM (LEFT) GROWN ON STACKED LOGS (ABOVE)

Introduction

Shiitake (*Lentinula edodes*) and oyster (*Pleurotus* spp.) mushrooms are specialty mushrooms that are well-suited for small-scale production in Kentucky. Unlike *Agaricus* types (common button mushroom, portabellas, and criminis), which require large, highly mechanized facilities with environmental controls, shiitake and oyster mushrooms can be log-cultivated outdoors. While growers with access to a woodlot will have a clear advantage in terms of production site and log supply, these mushrooms can also be cultivated in other heavily shaded locations.

Marketing

The market for log-grown specialty mushrooms continues to develop in Kentucky. Fine restaurants (particularly those specializing in Continental, French, or Asian cuisine), along with organic or whole food markets, are currently the main market outlets.

Additional options for marketing Kentucky log-grown fresh shiitake and oyster mushrooms include locally owned supermarkets (in contrast to national chains) and pizza parlors. Dried mushrooms can be sold at local outlets, as well as by mail order or on the Internet. Value-added products, such as soups or dip mixes, are an additional possibility. Shiitake is known for its medicinal as well as its culinary value, so there may be possible markets in the pharmaceutical or nutraceutical industries for large-scale producers. Growers will need to provide a consistent year-round supply of quality mushrooms to compete in these larger markets.

Growers producing sawdust-grown mushrooms under controlled environmental conditions can provide a year-round supply, giving them a marketing advantage. However, log-grown mushrooms are considered superior in flavor and have a longer shelf life when compared to those grown on artificial media. Additionally, log-grown mushrooms may contain higher percentages of the medicinally active ingredient(s) present in these species. Whether the quality factors are sufficient to outweigh the efficiency factors in the marketplace is uncertain.

Crop Diversification & Biofuel Research Education Center

Market Outlook

Specialty mushrooms, which are relatively new to the U.S.,

are becoming very popular as a gourmet food item. Their increasing presence (especially shiitake mushrooms) in national food market chains indicates they are becoming mainstream. Sales of shiitake mushrooms have increased steadily over the past 15 years. As consumer awareness increases through taste tests and other effective marketing strategies, an even greater demand is expected.

Production Considerations

Production methods

SHIITAKE MUSHROOMS are cultivated on small-diameter (3 to 8 inches) hardwood logs that have been cut from decay-free, live trees with intact bark. Trees are most commonly inoculated in late winter/early spring (February/March) as soon as possible after felling. Logs can also be inoculated successfully at the time of leaf drop in the autumn when the food-rich sap is returning to the roots for the winter (October/November). However, the rising sap in the late winter/early spring has a higher sugar content and will encourage a more rapid growth of the fungus.

OYSTER MUSHROOMS

Shiitake is introduced into holes drilled in the logs by inserting commercially produced spawn (either as loose sawdust, dowels, or plugs). The inoculation sites are then sealed with hot wax to sterilize them and to retain moisture in the logs at those sites. Inoculated logs are stacked and incubated for 6 to 18 months in a moist, shady location. The moisture level of the logs must be closely monitored, and irrigation may be necessary if drought conditions develop. Once white mycelial growth from the spawn is visible at the ends of the logs, growers will know that the spawn has fully occupied the entire log. The logs can then be forced to fruit on a schedule by immersing them in water overnight or for 24 hours. It is recommended that producers wait a year from the time of inoculation before placing the logs on a production schedule. After soaking, the logs are loosely stacked for production under a clear plastic cover. A building or greenhouse with humidity and temperature controls is necessary for winter production. The normal season for shiitake production in Kentucky is from March to October or November.

Shiitake can also be grown on artificial logs or blocks under controlled environmental conditions. Artificial logs are composed largely of sawdust with supplements (such as millet, rice bran or wheat bran) added to this substrate. Artificial logs have the advantages of controlled productivity and efficiency over natural logs, and can be used for year-round production. However, in comparison with natural logs, production of shiitake on artificial logs is highly capital- and labor-intensive. As such, artificial log production may not be appropriate for producers just starting out in a shiitake venture. It is recommended that new producers start small and get a sense of what is involved in shiitake production on natural logs (as well as a sense of what their proposed market will bear) before moving on to artificial log shiitake production.

OYSTER MUSHROOMS can similarly be grown on hardwood logs using spawn introduced into holes drilled in logs. Alternately, the grower can cut an inch-thick layer from the end of a log, cover the cut end with spawn, and then nail the slice back onto the log. Inoculated logs are then placed in black polyethylene bags of vermiculite or sand drenched in water. The bags are stored in a cool place for 4 to 5 weeks before mushrooms appear.

In addition to log culture, oyster mushrooms can be grown on a variety of artificial substrates, such as composted straw, chopped wheat straw with cottonseed hulls, and sawdust. After the

substrate is pasteurized or sterilized, it is cooled and spawn is added. The mixture is placed in sealed plastic bags, bottles, trays, or beds in a controlled environment. Timing to production is similar to that of logs.

Pest management

Potential disease threats include *Trichoderma*, *Hypoxylon,* and *Polyporus versicolor*. These fungi can invade the logs, resulting in wood decay. Logs exhibiting *Trichoderma*, the most serious competitor for shiitake, must be removed from the log area and destroyed. Termites, bark beetles and springtails may also cause damage to the logs, but can be controlled fairly simply by good log management. Direct damage to the mushroom caps can occur as a result of feeding by slugs, snails, birds, squirrels, and deer if the logs are left unprotected. University of Kentucky recommended management practices eliminate many of these difficulties.

Harvest and storage

Mushrooms are harvested by either cutting or twisting them off at the base of the stem. They should be refrigerated immediately in corrugated cardboard containers or paper bags to retain quality and freshness. Packing boxes for fresh mushrooms should be vented to allow for air circulation. Shiitake have a longer shelf-life under refrigeration (12 to 14 days) than the more fragile oyster mushroom (5 to 7 days). Both species can be dried (air-dried or in a dehumidifier) and stored in sealed containers. Drying increases their shelf-life by at least 6 months.

Labor requirements

Log production of shiitake mushrooms requires labor for cutting trees, hauling logs to the inoculation/incubation site, drilling and inoculating logs (5 minutes per log or approximately 8 hours per 100 logs), moving logs into and out of soak tanks, harvesting (30 to 60 minutes per 100 logs per harvest), packing and transporting to markets. Pre-harvest labor for a 500-log operation is estimated at 42 hours, with harvest labor at approximately 18 hours.

Economic Considerations

The major start-up costs for specialty mushroom production include a refrigeration unit, high speed drill, hardwood logs, spawn, and wax. Costs can vary considerably depending on raw materials, equipment used, equipment already available, ability of the producer to build equipment, efficiency and costs of labor, and the production methods used. For example, growers who own their own woodlot can utilize the low quality logs that are cut during timber stand improvement, a cost advantage over producers who must purchase their logs.

University of Kentucky cost and return estimates updated for 2010 are based on the small-scale production of shiitake using approximately 500 logs inoculated over a four-year period. After 6 to 18 months of incubation, the logs are forced to fruit three times a year. Net revenues in the first two years are negative and it is not until the third year that a positive annual return to land, labor and management is realized. In this scenario, pre-harvest costs are $320 and harvest costs are $285. Total variable costs are approximately $600 with total fixed costs running $315, for a total cost of more than $900. Profits with no hired labor (a family run business) can fall in the $2,300 range. Hired labor, at a cost of $540, can reduce these profits to $1,700 range.

Selected Resources

Books in print

- *Growing Gourmet and Medicinal Mushrooms.* Paul Stamets. 3rd ed. 2000. Ten Speed Press: Berkley. 574 pp.
- *Growing Shiitake Mushrooms in a Continental Climate*. M.E. Kozak and J. Krawczyk. 2nd ed. 1993. Field and Forest Products: Peshtigo, WI. 112 pp.

On the Web

- Forest Farming, FOR-115 (University of Kentucky, 2009) http://www.ca.uky.edu/agc/pubs/for/for115/for115.pdf

- Kentucky Shiitake Production Workbook (University of Kentucky)
  - Shiitake Production on Logs: Step-by-Step in Pictures, FOR-77 (2001) http://www.ca.uky.edu/agc/pubs/for/for77/for77.pdf
  - Introduction to Shiitake : The "Forest" Mushroom, FOR-78 (2003) http://www.ca.uky.edu/agc/pubs/for/for78/for78.htm
  - Spawn Selection, FOR-80 (2002) http://www.ca.uky.edu/agc/pubs/for/for80/for80.htm
  - Inoculation, FOR-81 (2004) http://www.ca.uky.edu/agc/pubs/for/for81/for81.pdf
  - Monitoring Moisture Content of Logs, FOR-82 (2002) http://www.ca.uky.edu/agc/pubs/for/for82/for82.htm
  - Harvesting FOR-85 (2002) http://www.ca.uky.edu/agc/pubs/for/for85/for85.htm
  - Potential Profits from a Small Scale Shiitake Enterprise, FOR-88 (2003) http://www.ca.uky.edu/agc/pubs/for/for88/for88.pdf
  - Resources for Shiitake Growers, FOR-89 (2007) http://www.ca.uky.edu/agc/pubs/for/for89/for89.pdf
- Cultivation of Oyster Mushrooms (Pennsylvania State University, 2003) http://pubs.cas.psu.edu/freepubs/pdfs/UL207.pdf
- Cultivation of Shiitake on Natural and Synthetic Logs (Pennsylvania State University, 2001) http://pubs.cas.psu.edu/FreePubs/pdfs/ul203.pdf
- Growing Shiitake Mushrooms in an Agroforestry Practice (University of Missouri, 2008) http://extension.missouri.edu/explorepdf/agguides/agroforestry/af1010.pdf
- Mushroom Cultivation and Marketing (ATTRA, 2004) http://www.attra.org/attra-pub/mushroom.html
- Shiitake Mushrooms Enterprise (Maryland Cooperative Extension, 2003) http://www.naturalresources.umd.edu/Publications/Rural%20Enterprise%20Series/RES_11Shiitake.pdf
- Shiitake Mushrooms Production and Marketing (Virginia Tech and University of Maryland Extension, 2009) http://www.naturalresources.umd.edu/Publications/html/shiitake.html
- Shiitake Mushroom Production on Logs (Alabama Cooperative Extension, 2007) http://www.aces.edu/pubs/docs/U/UNP-0025/

Shiitake photos by Matt Barton, UK Ag Communications; **December 2010**
Oyster mushroom photo by Joseph O'Brien, US Forest Service, www.forestryimages.org
Reviewed by Deborah Hill, Extension Specialist (Issued 2004, Revised 2007, Revised 2010)

For additional information, contact your local County Extension agent