

Shiitake and Oyster Mushrooms

Introduction

Nearly all U.S. commercial production of *Agaricus* mushrooms takes place in large, highly mechanized facilities where every aspect of the environment is carefully controlled. This includes the common button mushroom, portabellas and criminis. Small producers generally cannot compete with these large producers. The cultivation of the highly desirable morel (*Morchella* spp.) has been patented by some large companies and while kits are available, they are not reliable. Chanterelles (*Cantharellus* spp.) cannot be reliably produced artificially either.

There are, however, other mushroom species that can be cultivated on a small scale. Shiitake (*Lentinula edodes*) and oyster (*Pleurotus* spp.) mushrooms are the easiest and most common specialty mushrooms that are produced commercially.

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



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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 benefits, 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 shiitake and/or oyster 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.

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. The fungus 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. 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 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. After soaking, the logs are loosely stacked for production under a clear plastic cover. The normal season for shiitake production in Kentucky is



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from March to October or November. A building or greenhouse with humidity and temperature controls is necessary for winter production.

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, artificial log production 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 production.

OYSTER mushrooms can be grown on hardwood logs like shiitake, with 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.

Oyster mushrooms can also 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 can 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 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 returns estimates (2003) 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 \$300 and harvest costs are \$242. Total variable costs are approximately \$541 with total fixed costs running \$297 for a total cost of \$838. Profits with no hired labor (a family run business) can come to \$2,893. Hired labor, at a cost of \$480, can reduce these profits to \$2,413.

More Information

- Kentucky Shiitake Production Workbook (University of Kentucky, 2001-2004) *sections*:
 - 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
<http://www.ca.uky.edu/agc/pubs/for/for89/for89.pdf>

- The following sections of the Kentucky Shiitake Production Workbook are *in press*:
...Log Selection and Preparation, FOR-79
...Incubation and Stacking, FOR-83
...Pest Control, FOR-84
...Processing and Storage, FOR-86

• Cultivation of Oyster Mushrooms (Pennsylvania State University, 2003)
<http://pubs.cas.psu.edu/freepubs/pdfs/UL207.pdf>

• Farming Exotic Mushrooms in the Forest (USDA National Agroforestry Center, 2000)
<http://www.unl.edu/nac/afnotes/ff-2>

• Income Opportunities in Special Forest Production: Mushrooms (USDA, 1993)

<http://www.fpl.fs.fed.us/documnts/usda/agib666/aib66611.pdf>

• Mushroom Cultivation and Marketing: Horticulture Production Guide (ATTRA, 2004)

<http://www.attra.org/attra-pub/mushroom.html>

BOOKS IN PRINT:

• *Growing Gourmet and Medicinal Mushrooms*. Paul Stamets. 3rd ed. 2000. Ten Speed Press: Berkeley. 574 pp.

• *Growing Shiitake Mushrooms in a Continental Climate*. M.E. Kozak and J. Krawczyk. 1993. Field & Forest Products: Peshtigo, WI. 112 pp.