



Photo by: Keith Weller courtesy of USDA ARS

Mushrooms are the fleshy, spore-bearing fruiting bodies of fungi typically produced above ground on soil or on their food sources. The standard for the name mushroom is the cultivated white button mushroom, *Agaricus bisporus*, hence the word mushroom is most often applied to fungi that have a stem, a cap, and gills on the underside of the cap.

- Taken from Wikipedia, The Free Encyclopedia; www.en.wikipedia.org, search Mushrooms

Introduction

Nearly all production of specialty mushrooms takes place in large, highly-controlled, mechanized facilities including the most popular *Agaricus bisporus* varieties such as white buttons, portabellas and criminis found at most retail grocers. These varieties are usually grown commercially via large-scale production making it difficult for a small-scale grower to compete with these larger producers.

Mushroom production presents an opportunity for a value-added, specialty crop for producers without a large amount of land or space. Other cultivated species becoming popular including shiitake, maitake or hen-of-the-woods, oyster and enoki can be cultivated on a small scale. These types are some of the easier, more common specialty mushrooms available for production.

Mushroom cultivation can also be a way to add value from materials in thinning woodlots and similar wastes. Growing mushrooms can assist in organic farm waste management by producing value-added bedding matter from food processing and agricultural by-products.

Commonly thought to contain little nutritional value, mushrooms are high in fiber, and provide

vitamins like thiamine (B1), riboflavin (B2), niacin (B3), biotin (B7), cobalamins (B12) and ascorbic acid (C), along with minerals, including iron, selenium, potassium and phosphorus. Mushrooms also contain antioxidants.

Market Information

The trend for specialty mushroom sales is the retail market. Particularly fresh market and local specialty, organic or whole, food stores. Successful growers are also finding excellent marketing opportunities with chefs and up-scale restaurants, catering businesses, Community Supported Agriculture (CSA) subscribers, and specialty pizza parlors. Gift catalogs and internet sales are another opportunity for dried and value-added mushroom products like soups and dip mixes.

Shiitake mushroom sales have increased steadily in recent years as restaurants and retail chains make them more available to consumers. This species is becoming a popular gourmet food item and greater demand is expected in the shiitake market.

Oyster mushroom markets are being developed by larger growers as they diversify their operations. Because of the short shelf life of oyster varieties, a local grower that can market directly and deliver a

quality consistent product, can take advantage of what the larger producers have started.

Pennsylvania leads the U.S. as a mushroom producing state. Being the largest cash crop for Pennsylvania, they supply 61 percent of the total production for the nation; 60 percent of which is fresh market. California remains second in the nation's mushroom production at 14 percent. Nearly all states report some type of mushroom production, increasing at about seven percent each year.

Growers reported 2006-2007 *Agaricus* mushrooms sales at 814 million pounds: 697 million pounds fresh market and 117 million pounds processing. Value for all *Agaricus* mushroom sales totaled \$915 million. The total number of U.S. mushroom growers is reported at 279. Specialty mushroom growers totaled 179 producing 13 million pounds. A specialty grower is defined as having at least 200 natural wood logs in production or some commercial indoor growing area and \$200 in sales. Value for all specialty mushrooms totaled \$40.4 million.

The Mushroom Council reports that the average consumer purchases 0.13 pounds per month. Heavy buyers accounted for 0.71 pounds per month and resulted in 42 percent of total sales.

Production Considerations

According to experts, oyster and shiitake mushrooms are the easiest to grow for beginners. Once it is decided which mushroom variety(ies) will be grown it is important to learn and become familiar with fungi life cycles and growth requirements. Each mushroom species prefers and grows well in a particular growing medium, but some grow on a variety of materials. Growing outdoors requires different production methods than indoor production.

The six basic steps to mushroom production include:

- Choose a growing medium
- Pasteurize or sterilize the medium
- Seed the beds with spawn (spawn is like seed that what will produce the mycelium and eventually the mushroom “fruit” for harvest and is taken from mature mushrooms grown on sterile media)
- Maintain optimal growing conditions for mycelium growth and fruiting (temperature, moisture)
- Harvest, package, and sell the mushrooms
- Clean the facility and equipment and start again

Because mushrooms have no chlorophyll, they must get all their nutrients from organic matter in their growing medium. Once the proper growing medium is selected, then it’s pasteurized and

placed in large trays, beds, bags, or logs. Oyster mushrooms will grow well on sawdust, sterile wheat or rice straw, and logs while shiitake are most commonly grown on logs, but can be grown in sawdust as well.

If using logs, hardwoods approximately four to six inches in diameter and about four-feet long can be used. Logs are typically cut during the dormant season. Oaks, sweetgum, cottonwood, beech, birch, willow, or other non-aromatic hardwoods can be utilized. As a rule of thumb, denser woods will produce mushrooms twice as long as softer woods, and smaller logs produce quicker, but for a limited time compared to large logs.

The growing medium or logs are then inoculated. This is the act of introducing the spawn into or on the growing substrate. Logs are inoculated by drilling holes, placing spawn into the holes, and then sealing them with hot wax or plastic foam plugs. This should be done in late winter or early spring (February-March).

Growing can take place outdoors for a natural process or in specially constructed houses, where the farmers can regulate the crucial aspects of heat and humidity for optimal growth. Most growth outdoors takes place from March-October. Inoculated logs should be stacked and placed in a moist, shady area and monitored for moisture levels.

Once logs become filled with the root structure of the mushroom, a network of lacy white filaments

called mycelium (anywhere from 6-18 months), forced fruiting can be managed. This occurs by soaking logs in water for 24 hours and then stacked and covered with clear plastic.

Eventually, tiny white protrusions form on the mycelium and push up through. Farmers call this pinning. The pins continue to grow, becoming the mushroom caps, which are actually the fruit of the plant, just as a tomato is the fruit of a tomato plant.

The harvested mushrooms are set in carts, refrigerated and then packaged and shipped quickly to supermarkets, food processors and restaurants.

As with any plant or animal production system pests and diseases can be an issue. Diseases in shiitake and oyster production include *Trichoderma*, *Hypoxylon*, and *Polyporus versicolor*. These are fungi that can invade logs and decay the wood. *Trichoderma* is a serious competitor for shiitake and logs exhibiting signs must be removed and destroyed. Other log nuisances include termites, bark beetles, and springtails. They cause log damage, but can be controlled by good log management. Other outdoor pests and animals such a birds, deer, squirrels can damage the crop if you are using an outdoor natural production method.



Economics

The University of Kentucky estimated returns on a small-scale shiitake production system of 500 logs inoculated over four years. After six to 18 months of incubation, logs were forced to fruit three times per year. Variable pre-harvest and harvest costs were estimated at \$542 and fixed costs at \$297 for a total cost of \$838. A family run business with no outside hired labor can lead to a yearly profit of \$2,893. It is noted that net revenues in the first two years were negative and profits were not realized until year three.

Raising mushrooms in sterilized indoor environments and growing mediums requires more input and labor management. While this results in a faster fruiting cycle and higher level of returns it also requires greater capital investments and skill. A building must be easy to clean and sanitary procedures should be followed closely to avoid contamination. As an example of initial start-up costs for indoor production, CropKing, Inc. sells complete growing systems, including equipment,

structural components, and technical support, that can range from \$34,500 to over \$100,000 depending on the size.

Growers should receive at least \$2.50 per pound for shiitake or oyster mushrooms. That is, approximately, the price being received for low-quality imports into the Cleveland market. However, this could be higher or lower depending on where you are located and the demand in that area. Reports from CropKing indicate that they have received wholesale prices at \$4-5.00 per pound using their indoor system. Other growers have reported sales at \$6-7.00 per pound selling directly to retail markets and restaurants.

Current market prices at the Pittsburgh, PA produce terminal indicate that PA oyster mushrooms are selling at \$3.30-3.60 per pound, while PA shiitake are selling at \$4.80-5.50 per pound. At the Chicago, IL terminal, oyster mushrooms are currently \$3-3.20 per pound, and shiitake are bringing \$4.20 per pound. Source: USDA Agricultural Marketing Service

The production capacity of an indoor system like CropKing is based of having six, 60-day production cycles per year. Mushroom bags should yield at least eight pounds per bag. Given that the largest indoor unit holds 1,920 mushroom bags, this equals 15,360 pounds of mushrooms for a total annual production of 92,160 pounds (six cycles/year). Assuming market price for oyster mushrooms is \$3-3.60 and shiitake \$4.20-5.50 per pound this results in gross annual receipts of more than \$276,000 and \$387,000 respectively.

References and More Information

References for this paper:

- USDA Ag Marketing Service

- www.ams.usda.gov/fv/mncs/termveg.htm
- University of Kentucky Extension New Crop Opportunities Center
www.uky.edu/Ag/NewCrops/intro.html#alternative
- CropKing Inc.
www.cropking.com
- Ohio Line
www.ohioline.osu.edu
- USDA National Ag Statistics Service
www.nass.usda.gov
- Agricultural Marketing Resource Center
www.agmrc.org
- North American Mushroom Basics
www.americanmushrooms.com
- Pennsylvania State Extension – Six Steps to Mushroom Farming
<http://mushroomspawn.cas.psu.edu/mushroom.shtml>
- National Sustainable Agriculture Information Service
<http://www.attra.ncat.org/attra-pub/PDF/mushroom.pdf>
- Wikipedia, The Free Encyclopedia
<http://en.wikipedia.org/wiki/mushroom>

Other References:

- Ohio Mushroom Society
www.ohiomushroom.org/oms/
- University of Missouri Center of Agroforestry
www.centerforagroforestry.org
- Louisiana State university Ag Center
www.lsuagcenter.com (search mushroom)

Center for Innovative Food Technology

5555 Airport Hwy. Suite 100,

Toledo, OH 43615

www.cift.eisc.org

P: 419.534.3710

F: 419.531.8412