

## Theme General Management

### A Review in Mushroom Cultivation and Marketing

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**Abstract:** The market for mushrooms continues to grow due to interest in their culinary, nutritional, and health benefits. They also show potential for use in waste management. However, as fungi, mushrooms have life cycles very different from those of green plants. The choice of species to raise depends both on the growth media available and on market considerations. Oyster mushrooms, which grow on many substrates, are easiest for a beginner. Shiitake mushrooms already have earned considerable consumer demand. Only two mycorrhizal mushrooms, morels and truffles, have been commercially cultivated. Mushroom cultivation offers benefits to market gardens when it is integrated into the existing production system. A careful analysis of potential markets must be the first step in deciding whether to raise mushrooms to sell. Many information resources are available for further research.

**Key words:** *Agaricus biosporus*, *Shittake*, wood logs, marketing.

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## **Introduction**

Small-scale mushroom production represents an opportunity for farmers interested in an additional enterprise and is a specialty option for farmers without much land. This publication is designed for market gardeners who want to incorporate mushrooms into their systems and for those farmers who want to use mushroom cultivation as a way to extract value from woodlot thinnings and other “waste” materials. Mushroom production can play an important role in managing farm organic wastes when agricultural and food processing by-products are used as growing media for edible fungi. The spent substrate can then be composted and applied directly back to the soil. This publication includes resources for entrepreneurs who wish to do further research.

Many people are intrigued by mushrooms’ nutritional and medicinal properties, in addition to their culinary appeal. Mushrooms contain many essential amino acids; white button mushrooms, for example, contain more protein than kidney beans. Shiitake mushrooms are less nutritious, but are still a good source of protein.(Royse and Schisler, 1980). As a group, mushrooms also contain some unsaturated fatty acids, provide several of the B vitamins, and vitamin D. Some even contain significant vitamin C, as well as the minerals potassium, phosphorus, calcium, and magnesium (Park, 2001). Mushroom production is labor- and management-intensive. Specialty mushrooms are not a “get rich quick” enterprise. On the contrary, it takes a considerable amount of knowledge, research, planning, and capital investment to set up a production system.

Mushroom production is completely different from growing green plants. Mushrooms do not contain chlorophyll and therefore depend on other plant

material (the “substrate”) for their food. The part of the organism that we see and call a mushroom is really just the fruiting body. Unseen is the mycelium—tiny threads that grow throughout the substrate and collect nutrients by breaking down the organic material. This is the main body of the mushroom. Generally, each mushroom species prefers a particular growing medium, although some species can grow on a wide range of materials.

If you are considering mushroom production, become thoroughly familiar with the life cycles of fungi. A very general description is included below. A plant pathology textbook is a good resource for learning more about these complex life cycles. Growing mushrooms outdoors as a part of a market garden involves little effort after you have inoculated the logs or other substrate with the mushroom spawn. Your duties are mainly to maintain humidity and monitor for fruiting. When mushrooms appear, you add them to your other garden products and sell them.

Most available markets, however, require more mushrooms than occasional fruiting provides. Indoor production can fill the gaps when outside fruiting lags. The entire operation can also be conducted inside. However, indoor mushroom production demands a much higher level of knowledge, continuous monitoring, and timely manipulation of environmental conditions. These are the steps in mushroom production—a cycle that takes about 15 weeks (time varies by species) from start to finish.

1. Choosing a growing medium
2. Pasteurizing or sterilizing the medium

3. Seeding the beds with spawn (material from mature mushrooms grown on sterile media)
4. Maintaining optimal temperature, moisture, and other conditions for mycelium growth and the conditions that favor fruiting (This is the most challenging step.)
5. Harvesting, packaging, and selling the mushrooms . Cleaning the facility and beginning again (Cooner, 2001).
6. The substrate on which the mushrooms will fruit must be sterilized or pasteurized in order to destroy any fungal and/or bacterial competitors.

Many mushroom suppliers sell several kinds of spawn, and the beginning mushroom farmer should take advantage of this selection in early trials to determine which species grow best on available materials. Eventually, learning to produce spawn might reduce your cost of production Evaluate this possibility only after you have mastered the later stages of cultivation.

While the mycelium is growing—and until it fully occupies the substrate—the mushroom farmer typically manipulates the growing environment to favor mycelial growth. The atmospheric conditions are then changed to initiate “pinheads,” and then to complete fruiting. For example, in oyster mushroom production under closely controlled conditions, the grower lowers the temperature and the CO<sub>2</sub> in the grow room to initiate fruiting. Each species has specific requirements for its stages of development. When you can cut the time between harvests, annual production increases. Short cycles are what large-scale commercial producers aim for, constantly looking for ways to increase efficiency. This is the competition you face if you plan to sell your product on the wholesale market.

## **Mushrooms on the Farm and in the Garden**

Fungi cycle nutrients that nourish new life in the soil. Recognizing this essential function, inventive gardeners integrate mushrooms into farm, garden, and permaculture systems. Mushrooms can also be grown in lawns, polytunnels, vegetable gardens, and woodlands.(Edwards, 2000) Plug-inoculated blocks buried among plantings work well for oyster and *Stropharia rugoso-annulata* mushrooms. Beauséjour suggests using a misting sprinkler for mushrooms in gardens. (Beauséjour, 1999).

Grower and author Ken Litchfield notes that mulching, a standard gardening practice, not only regulates soil temperature and humidity but also nourishes fungi. He also suggests surrounding raised beds with partially buried logs to create mushroom habitats. Inside the beds, vegetables, flowers, and shrubs offer the requisite shade and humidity for mushroom cultivation. In weedy areas, Litchfield suggests putting down organic material and covering it with wet cardboard and wood chips, an ideal substrate for fungi.(Litchfield, 2002)

## **Choosing a Mushroom Species**

A mushroom cultivation kit (check with suppliers listed below) is a handy way to begin to understand the fungal life cycle. Once you successfully use the kit, you can begin to learn the steps that precede that final fruiting stage of the mushroom life cycle. Purchase spawn that will grow on materials you have available. Then design and test a system that duplicates the conditions favorable to all stages of growth. You can use this experience to learn how to create sterile cultures and spawn for the species you are growing.

Choose the species to grow by thinking about:

1. What waste materials are readily available to use as a growth medium?
2. What kind of facility or environment is available?
3. How much will the necessary equipment cost?
4. What level of skill is required to manage the life cycle of the fungus?
5. What is market demand for this species?

According to these criteria, oyster (*Pleurotus* species) and shiitake (*Lentinus edodes*) mushrooms are probably best for most novices, although the maitake (*Grifola frondosa*) is also a possibility. The former two are relatively easy to grow, and there is already a market for them, largely because commercial producers of white button (*Agaricus bisporus*) mushrooms have been diversifying into specialty mushrooms. If you intend to grow mushrooms commercially, shiitake or oyster mushrooms are your best choices. These two species are more thoroughly covered in the following sections.

### **Oyster mushrooms**

Oyster mushrooms (*Pleurotus* species) are a good choice for beginning mushroom cultivators because they are easier to grow than many of the other species, and they can be grown on a small scale with a moderate initial investment. Although commonly grown on sterile straw from wheat or rice, they will also grow on a wide variety of high-cellulose waste materials. Some of these materials do not require sterilization, only pasteurization, which is less expensive. Another advantage of growing oyster mushrooms is that a high percentage of the substrate converts to fruiting bodies, increasing the potential profitability. Oyster mushroom cultivation has one significant drawback: some people are allergic to the spores. In



these cases, air-cleaning equipment or respirators are necessary in order to safely work in the production facility.

The consumer market for oyster mushrooms is being developed by the larger mushroom companies as they diversify their operations. However, because of the short shelf life of many oyster mushroom varieties, this species may offer a special advantage to the local grower who markets directly and can consistently deliver a fresh, high-quality product.

Shiitake mushrooms are grown on logs, either inside or outside. Inside, they can also be grown on compressed sawdust logs or in bottles or bags.

### **Log Production**

Hardwood logs approximately 4” to 6” in diameter and of an easily handled length (commonly four feet) are cut during a tree’s dormant season. Oaks, sweetgum, cottonwood, beech, birch, willow, and other non-aromatic hardwoods are appropriate species. The denser woods produce for up to twice as long as the softer ones. Smaller diameter logs produce more quickly than larger ones, but for a shorter time.

Handle the logs carefully to avoid soil contact and damage to the bark. This will help prevent contamination by competing fungi. Inoculate the logs with spawn from a strain suitable to your production system. After inoculation, the spawn develops a thread-like network—the mycelium—growing throughout the log. During this time, you must protect the logs from dehydration by the sun and wind. Spray or mist the logs to maintain the humidity necessary to keep the mycelium alive and growing. When the mycelium has fully occupied the logs and the temperature and humidity are right for fruiting, the mycelium will initiate tiny

“pinheads” at the surface of the log. The pinheads grow into mushrooms in the next couple of days.

### **Growing Shiitakes on Sawdust**

Today, most shiitakes and many other mushroom species are raised on a sterilized sawdust substrate. Although this method allows a much faster fruiting cycle and a high level of return (110% or more of initial dry weight), it also demands a greater capital investment and more skillful management than log production. In order to achieve fruiting as quickly as possible, you need a building in which you can control the temperature and moisture. The building must be easy to keep clean, and sanitary procedures must be strictly followed to avoid contamination.

The chamber and the steam processor to pasteurize or sterilize the sawdust can represent a significant initial investment. For example, Crop King sells a small mushroom production system, including an inoculation table and bagging station, for about \$5,000. The company’s complete growing system—including equipment, structural components, and technical support—can come to more than \$41,000. Recovering these costs is a challenge for a beginner—especially at current mushroom prices. However, innovative producers have used concrete mixers to blend supplemental ingredients and made pasteurized substrate in barrels. Fungi Perfecti sells pressure sterilizers for \$200 to \$1,000, but warns that they are not designed for commercial production.

Using hydrogen peroxide instead of conventional pasteurization is a relatively recent innovation.

### **Shiitake Prices**





The price for shiitake mushrooms fluctuates throughout the season. Prices are highest in the winter when supply is low, and lowest in summer when production peaks. Except in very mild climates, the only logs that fruit in winter are those maintained indoors. Using strains selected to fruit at cooler temperatures can lengthen the harvest season and allow producers to capture the higher prices.

### **Mushroom Species with Limited Commercial Production**

Some species of mushrooms are not yet commercially cultivated. Many of these are mycorrhizal types; that is, they grow only in conjunction with the roots of a higher plant. Matsutakes and chanterelles are typical examples of such mushrooms.

#### **Morels**

Commercial production of morels on anything but a small-scale, seasonal basis is currently not a practical option. Morels are being grown year-round, using a patented process, at only one production facility in North America (in Alabama). It is, however, possible to establish a morel patch by using a morel starter kit. If you are successful, these mushrooms will fruit in the spring at the same time as wild morels. Morel prices are, understandably, at their lowest during this natural fruiting season. Adding them to a farmers' market stand would certainly attract more-loving customers. You can also dry the product for year-round sales if you can grow commercial quantities in your patch.

#### **Truffles**

Growers generally begin truffle production by dipping tree seedlings in a mycorrhizal slurry before planting. After several years, under favorable growing conditions for both the tree and the fungus, truffles form underground fruiting bod-

ies that roughly resemble potatoes. These range from the size of a pea to that of a fist and give off a distinctive odor. Since these “mushrooms” don’t completely emerge from the ground, they have traditionally been sniffed out by pigs or trained dogs. The requirements for growing the black Perigord truffle, *Tuber melanosporum Vitt.*, include choosing an appropriate host plant (usually oak or hazelnut), inoculating its roots with the spawn, and planting it.

### **Pest Management**

Integrated pest management (IPM) is a least-toxic approach for managing any pest. IPM views pests as a natural part of the farm environment. The integrated management of a pest is accomplished by altering the environment to the disadvantage of that pest. In order to accomplish this, you have to be able to identify what pests are active, how many there are, and how many it takes to hurt your profits. If you know the life cycle of each problem organism, you can take measures to make it hard or impossible for it to complete its life cycle. You may be able to encourage natural enemies that will keep the population below the economically damaging threshold.

Here are some examples of non-chemical methods used to control typical pests in the production of white button mushrooms. Mushroom flies, a common pest among many cultivated mushrooms, are attracted to the smell of decaying vegetation such as mushroom substrates. Screening the mushroom house ventilation system will keep adult flies out. Double doors and positive atmospheric pressure within the structure also prevent flies from entering. Since adult fungus flies are drawn to standing pools of water on benches, walks, or floors, places where water can collect should be eliminated. Biocontrol is another option for

several mushroom pests, the sciarid fly among them. A predatory nematode attacks this fly in its larval form. Therefore, this nematode can be added to the composting substrate to prevent infestation.

### **Marketing Mushrooms**

Marketing is the most important consideration of all. If you can't sell your mushrooms at a price that ensures a reasonable profit margin, you don't want to invest in this enterprise. Spend some time—and even some money—educating yourself about marketing your potential product.

### **Market Research**

The goals of market assessment are to project the sales volume and gross income of a new enterprise, to analyze its potential profitability and cash flow, and to gather information about potential buyers and competitors (to help develop a market strategy).

Many specialty mushrooms can be cultivated, but the market, though growing, is still limited. If you are thinking about starting a commercial mushroom enterprise, begin at the end: to whom will you sell them? You cannot make money in any business if you don't have buyers for your product. Learn who buys mushrooms, what kinds they want, and where they shop. You must thoroughly investigate the demand for each mushroom species or product— as well as the available marketing outlets— before committing large amounts of capital to the enterprise.

Check the local situation on your own. Some common methods for conducting initial research include observation of buyers, surveys of stores, personal interviews with growers, and test marketing (once you have an experimental product). Another function of market research is to evaluate the competition. This

will help you determine what market already exists and identify any niches you could fill. To find out more about your competitors, use their products. Talk to them. You may be surprised how much information they will share.

### **Market Channels**

Explore as many marketing strategies as appeal to you. Below are some possibilities.

Market the fresh or dried product directly to your customers (at farmers' markets, to gourmet chefs, over the Internet, through mail-order offerings). Add value to the mushroom by creating processed products (mushroom sauces, dried entrée mixes, teas, extracts) .Wholesale as fresh produce (on contract or by the batch)

### **Financial Analysis**

As a part of your market research, you need to do a financial analysis of the potential enterprise. Develop an enterprise budget with as much detail as you can provide. As with many farm enterprises, mushroom production is often only marginally profitable when labor and management costs are taken into consideration. An example of an enterprise budget for shiitake

If you are adding mushroom production to an integrated farming system, financial analysis is more difficult. Making a clear profit might not be as important as making use of off-season labor or the small logs from woodlot thinning to create a saleable product from what otherwise would have been waste.

### **Conclusion**

Commercial cultivation of mushrooms is not for everyone. It requires someone who is familiar with fungi life cycles and willing to commit time and money to research, designing a system, and developing a business. The mushroom cultivator

must be able to carry out operations on time, be attentive to details, and be vigilant about pest invasions. In most cases, marketing requires excellent public relations skills.

Nevertheless, there is potential for an innovator who can use an existing facility, obtain a low-cost substrate, and produce a reliable supply of a high quality product. As part of a whole-farm system, mushrooms can augment productivity at any scale. Producing a nutritious food at a profit, while using materials that would otherwise be considered “waste,” constitutes a valuable service in the self-sustaining community we might envision for the future. It is a challenge some will find worth taking.

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