

SPECIALTY MUSHROOM CULTIVATION



**SPECIALTY
MUSHROOMS**

Cultivation

IN THE NORTHEAST UNITED STATES

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INTRODUCTION

This series of booklets is intended to support any farmer, student, educator, organizer, entrepreneur or homesteader who is interested in taking specialty mushroom cultivation to the community level. This first booklet provides an introduction to mushrooms, mycology, and the specialty mushroom industry. We also discuss the ways mushrooms offer solutions to a wide range of community challenges in both rural and urban locations. Book Two provides a detailed overview of common cultivation methods, and the third book discusses the parameters for fruiting, harvest, and sales. While the overall intention of these guides is to support cultivators to get started or improve a commercial operation, the information and methods offered here also apply to anyone interested in mushroom production at many other scales.

Mushrooms have so much to teach us beyond reusing waste streams and producing high quality food. They are also teachers of the connection all beings share, the importance of community, and the truth that nothing goes to waste. Yes, the specialty mushroom industry is rapidly growing, and there are huge business opportunities in working with fungi. This should not supercede the deeper truths fungi have to teach. Hopefully as this industry expands it can do so with the values of community and connection.

The best teachers for growing and working with fungi are the mushrooms themselves. A lot of learning how to cultivate mushrooms is trying to grow them, watching what happens, and then adjusting accordingly. As with any farming venture, it is key to accept that you will have both successes and failures. Mushroom cultivation is a constant dance of observation and reaction,



of science and art. Hopefully these booklets give you a beat to start that dance, to explore with curiosity who fungi are and how to ally with them in your life. There are several options for profitable mushroom production, as well as multiple entry points along the supply chain. Each method offers a different set of material, infrastructure, capital, and skill requirements. Depending on your personal interests and goals, there are many possibilities for incorporating mushrooms into your life and business. As with any business, starting out by identifying your mission and goals is extremely important. It may turn out you don't want a business at all, but want to work with fungi at a slow, exploratory, non-pressured pace. Or maybe you want to generate 100K in revenue from specialty mushrooms next year, and amazingly both are achievable. Work with fungi patiently and persistently, and you are bound to be successful.



In North America, button, crimini, and portobello (*Agaricus bisporus*) are the most commonly cultivated mushrooms, making up 92% of mushroom production. (USDA-NASS, 2018) All other species of “edible” mushrooms are considered specialty mushrooms. Of the thousands of species in this category, a very small amount are cultivated, but those that are offer strong prospects. Opportunities exist to offer fresh specialty mushrooms to local markets and develop value-added products within the food and medicinal product sectors. The two most common specialty mushrooms are shiitake and oyster but lion’s mane, chestnut, maitake, and cordyceps are increasingly becoming available in the marketplace.

MYCOLOGY 101

Fungi are a kingdom of living organisms that include an estimated 1.5 - 5 million species, though only about 5% have been named. Fungi are classified by three unique factors:

- 1. Their cell walls contain Chitin;**
- 2. Their mode of digestion is absorption;**
- 3. They are heterotrophic** (meaning they cannot produce their own food).

Mushroom-forming fungi are a subset of this kingdom that likely number close to 140,000 species. About 20,000 species have been identified, of those only 200 species have been cultivated, with about 20 reaching large scale cultivation. There is plenty of room for discovery in the fields of taxonomy and cultivation when it comes to mushroom-producing fungi.



All mushrooms are fungi, but not all fungi are mushrooms! The word “mushroom” refers to the fruiting body of certain fungi that can be seen by the naked eye and picked by hand. Mushrooms can grow from many different substrates and occupy many different ecological niches. There are countless different shapes, colors, and morphological characteristics that mushrooms express. Many times mushrooms have a very short lifespan so they can be difficult to study in the field. A mushroom is only one piece of the larger fungal life cycle.



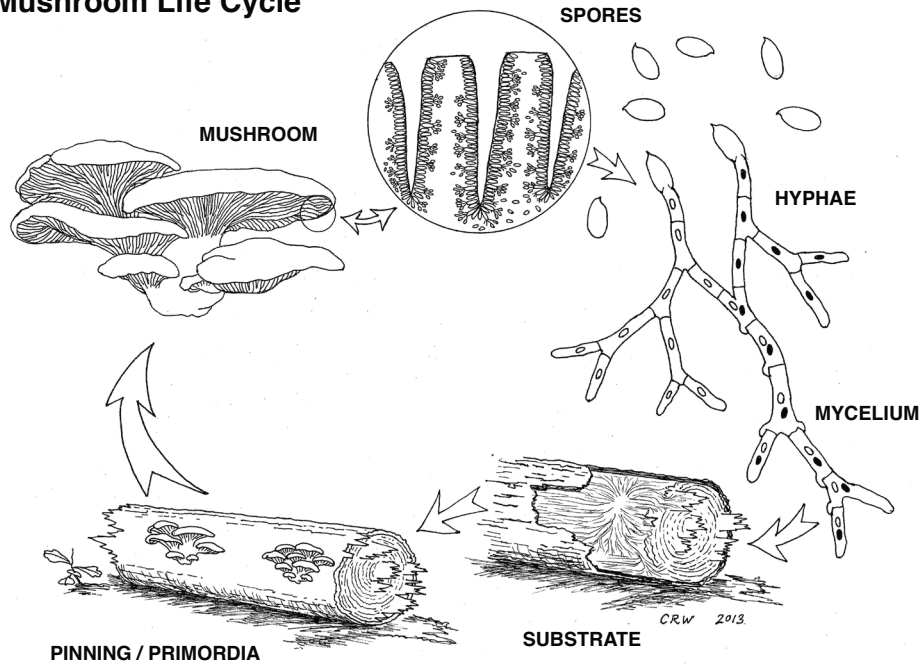
The main body of the organism is known as mycelium, which grows in multiple directions as it seeks food to digest. All fungi digest food in their environment with enzymes that are produced by the mycelium. Mycelium only has one cell wall so it is extremely sensitive to moisture loss. Because of this, to find mycelium in the wild you need to roll over logs or dig into the leaves where moisture content is higher. Mycelium is what cultivators need to grow before fruiting mushrooms. Any good tomato grower knows they need to grow healthy plants to produce beautiful tomatoes. Likewise a mushroom farmer must cultivate healthy mycelium FIRST and then create a favorable environment for mushrooms to fruit.

When the environmental conditions are right, mycelium will form mushrooms. Some fungi are very particular in what they need to switch over from mycelial growth to producing a mushroom. The most commonly cultivated mushrooms do not require much to induce fruiting. The mushroom’s main role in the life cycle is to produce spores. Spores are similar to seeds in that they are the reproductive elements of the organism. They are microscopic packets of genetic material that are distributed by insects, rain, and wind to hopefully find a new food source. Spores are produced by mushrooms in the tens of thousands. In fact, every breath we take on this planet we inhale mushroom spores.

In the wild, the mushroom life cycle rotates between these 3 phases - mushroom, spore, mycelium - in a constant evolution of change and growth. Amazingly, mushroom tissue can revert to mycelial growth for many species of mushrooms. This is extremely useful for the cultivator as exact clones with the same DNA can be taken from mushroom tissue and further expanded. These clones from individual mushrooms are called strains.

THREE ECOLOGICAL ROLES

Mushroom Life Cycle



Mycorrhizal fungi form beneficial partnerships with plants and trees, trading water and nutrients for carbohydrates and sugars. Over 80% of plants have mycorrhizal partners. These fungi not only extend the root zone but they also link together different trees and tree species to exchange information and resources. A small amount of mycorrhizal fungi (Examples: truffles, porcini, chanterelle) produce mushrooms. These mushrooms tend to be high value because they are extremely difficult to cultivate. Mostly they get to market through wild foraging and not cultivation. If you are trying to cultivate mycorrhizal fungi, not only are you growing the fungus but you also need to worry about growing the tree species properly and creating the proper soil biome to successfully produce mushrooms.

Parasites and Pathogens feed off living plants and trees and can range in their impacts; these are the disease fungi often focused on in forestry and agriculture. These fungi are not commonly cultivated but some mushroom producing parasites can also be saprophytic and easily grown like cordyceps and maitake. Others are great specialty mushrooms that are not readily cultivated like chaga and honey mushrooms.

Saprophytes decompose dead organic matter (logs, woodchips, straw, sawdust, grain hulls, etc.) as a food source. These fungi are the reason we are not buried in dead organic material. The most commonly cultivated mushrooms: agaricus, oyster, shiitake, and lion's mane are saprophytes. These are the easiest mushrooms to grow because you can work with dead material which is easy to manipulate.



Mushrooms are highly nutritious and medicinal food, with twice the protein of most vegetables and rich in all the essential amino acids that humans need in their diet. They offer an excellent protein source with zero saturated fats, along with dietary fiber and minerals. Mushrooms also offer an impressive array of medicinal compounds that offer antiviral, antimicrobial, anti-inflammatory, and immune modulating benefits. (Chang, 2004 and Wasser, 2002)

While mushroom poisoning is actually a very rare occurrence, many people are afraid of this possibility. It's important to learn how to properly identify any mushrooms you are growing to ensure you don't consume a toxic species by mistake. After learning the key morphological characteristics to look at, beginner identification is not hard to master.

VOCABULARY TERMS:

- 1 Fungi:**
Kingdom of organisms including mushrooms, yeasts, and molds that reproduce through spores
- 2 Spore:**
The microscopic reproductive element a mushroom releases
- 3 Mycelium:**
The fungal organism itself, usually white and thready
- 4 Mushroom:**
A fruiting body that can be seen by the naked eye and picked by hand



DEFINING THE SPECIALTY MUSHROOM INDUSTRY

Specialty mushrooms are defined by USDA as any species not belonging to the genus *Agaricus* (i.e. button, crimini, portabella). The most common specialty mushrooms are shiitake (*Lentinula edodes*) and oyster (*Pleurotus ostreatus*), which represent the second and third most produced mushrooms in the United States (USDA-NASS, 2018).

THE PAST

The specialty mushroom industry is still extremely young in the United States. Shiitake mushrooms were the first specialty mushroom commercially cultivated in the United States. They were first grown on hardwood oak logs and sold in supermarkets in the 1980's. Before this time, only one species, *Agaricus bisporus*, was cultivated and sold to the public. One farm that was a leader in introducing specialty mushrooms in the United States was Ostrom Farm located in Washington state. With the help of a Japanese scientist, they began production of oysters on straw, shiitakes on logs, and enoki in bottle culture.



The roots of mushroom production in the US are linked also to the late 60's and early 70's, when the amount of people growing psilocybe mushrooms at home was rapidly expanding. Several books, including *Psilocybin: The Magic Mushroom Grower's Guide*, published in 1975, and 8 years later, *The Mushroom Cultivator* opened the door for many home scale specialty mushroom cultivators. Slowly, supplies like flow hoods, pressure cookers, and the necessary information became available for potential growers of specialty mushrooms.

In the 2000's with the continued growth of the local agriculture movement, small-scale mushroom farms started to pop up around the country. Now in 2019, over 300 small-scale mushroom farms are located around the country, growing anywhere from 20 pounds to thousands of pounds per week.

The cultivation of mushrooms is relatively recent in the agricultural evolution of humans. In Asia, mushrooms were first cultivated in the 12th century. Wu San Kwung is credited as the first shiitake cultivator in the world. Somehow, he found that beating the logs and slashing the bark promoted fruiting of the shiitake mushrooms. Very inefficient methods of cultivation relying on spores colonizing the logs were used until the mid 1940's. At this point folks began to use pure tissue cultures, mycelium on a wooden medium, to inoculate logs. This quickly expanded the shiitake industry in Japan. Around the same time, cultivation on sawdust was reported as a method for testing strains. It wasn't until the 1970's that sawdust block production was used commercially. This means that the method of cultivation MOST specialty mushroom farms in the world use has only been around for about 50 years! No wonder there is so much to learn and improve upon.

THE PRESENT

Demand for specialty mushrooms is rapidly rising as consumers look to purchase more foods that are healthy, nutritious, and medicinal. United States per capita consumption of all mushroom species was only 0.69 lbs. in 1978, but by 1999, averaged 4 lbs. per capita. Based on more recent analysis, annual mushroom consumption is higher in suburban (4.3 lbs. per capita) then metropolitan (3.3 lbs. per capita) areas, and is highest among Asian (6.1 lbs. per capita) and non-Hispanic white (3.0 lbs. per capita) communities. Consumption is also positively correlated with income (Lucier et al., 2003).

Sales have increased with demand. In 2017, production of specialty mushrooms grew by four percent from 2016 levels to 25.4 million pounds with a sales value of \$96.2 million. This averages 0.08 lbs produced per



capita, compared to the national demand average of 4lbs/per. The other 3.92 lbs per capita were provided from the *Agaricus* industry. Slowly, the demand for specialty mushrooms is increasing and clearly there is lots of room for growth. In 2017 there were only 226 growers commercially producing specialty mushrooms in the United States (USDA-NASS, 2018). In a previous USDA-SARE-sponsored national survey of shiitake growers, 89% of respondents indicated that demand consistently exceeded supply in their region (Mudge, 2011). A 2015 Chatham University study interviewed 23 Northeastern buyers who reported needing 7,075 pounds of shiitake (307 lbs. per buyer) annually to fulfill customer demand, but only 2,060 pounds (29% of demand) of locally-produced shiitakes were available for purchase. Seventy percent of these buyers expected demand for forest-grown shiitakes to increase over the next five years (Matthews, 2015).

Economically viable farming enterprises often require large investments in land and equipment. These investments, plus long learning curves on production and marketing, tend to limit who can enter traditional agricultural production of crops and livestock. Specialty mushrooms, in

contrast, are unique among agricultural products as they are of high value, but production can be adapted to a wide range of production environments. Most notable is the low square footage requirements to achieve profitability. For example, our previous field research indicated that one half-acre of woodland can support a 1,000-log shiitake operation. The business would cost \$4,740 to establish and would yield approximately 1,040 pounds of mushrooms or about \$12,480 of gross income, or \$24,960 per acre (Mudge, 2013). Cornell Extension Agency (CEA) mushroom growers reported better profit potential for indoor production as compared to outdoors. They provided estimates of \$1 to \$3 per square foot in net income, representing a potential \$43,560 to \$130,680 income per acre for indoor growing operations.



THE FUTURE

There are many opportunities opening up involving the use of fungi in many different sectors. Specialty mushroom cultivation is a skill that can slowly be crafted and evolved to do many things. Some of the fields that are starting to involve specialty mushrooms and the growth of fungi are:

- **Mushroom supplements**
- **Myco textiles**
- **Fungi as food additives**
- **Mycoremediation**
- **Psychology**

These fields are in their infancy and have a lot of work to be done to evolve into healthy industries or commercially viable processes. The possible impact they could have on our world is huge. The development of people and resources studying and working with mushrooms in all of these different ways will hopefully grow in the coming years. In China, there are over 10 mushroom institutes and hundreds of scientists studying mushroom cultivation. Here in the US, there is really only one academic department at the University of Pennsylvania that studies mushroom cultivation. The extension program at Cornell Small Farms Program is the only institution focused on specialty mushroom research and education. Because of this, the private sector and small scale mushroom farms need to continue leading the way in research and development of these opportunities.



MUSHROOM SUPPLEMENTS

The functional mushroom industry is expanding rapidly with expected sales of \$34.3 billion by 2024, up from 20 billion in 2018. (Mordor Intelligence, 2019) The projected CAGR (compound annual growth rate) has increased over the last year, according to Research and Market reports. In 2018, it was reported that the market is expected to grow at a rate of 6.4%, while in 2019 an expected increase of 8.04% was reported. As consumers become more educated about what is in their mushroom supplements, US mushroom farms will be able to tap into this market more heavily. Consumers will likely want to shift away from foreign-produced supplements as well as away from mycelial-based products. This positions American mushroom farms strongly to begin offering value-added products to this extremely fast-growing functional mushroom market.

MYCOTEXTILES

This is a new field being led by Ecovative located in New York state. They have introduced the concept of using dried and molded mycelium as a textile. Products have been developed to replace packaging material, plastic parts, and even to be used as insulation. Building materials and art installations have all been created using organic matter and mushroom mycelium. Reishi is one great species for making mycotextiles because of the density of the mycelium.

MYCOREMEDIATION

This is a process of using mycelium to remediate toxins on this planet. As our waste issues grow in both quantity and quality, developing a variety of solutions is important. Mycoremediation is slowly becoming one of those solutions. Fungi can be allies in breaking down plastics, petrochemicals, pesticides, and organic matter. With the growth of small scale mushroom farms around the country, the amount of mycelial biomass available to any one location is expanding rapidly. Learning to apply this “waste” mycelium in a remediation setting would allow local solutions to toxic problems. It should be noted that goals for mycoremediation should not be mixed with production of edible or medicinal products, though the spawn production sector can address all these opportunities at once.

MENTAL HEALTH AND HEALING

We could talk all day about psilocybe mushrooms, but for now a couple of paragraphs will do. Johns Hopkins University is leading the charge in taking “magic mushrooms” out of the medieval dungeons they were placed in during the 1960’s to reveal the opportunities for working with these mushrooms. One study they looked at was improving depression and anxiety in terminally ill cancer patients. After a single session with



psilocybin mushrooms, eighty percent of participants reported a significant reduction in depression and anxiety six months later.

Psilocybin mushrooms are also being explored for their ability to help decrease addiction, cope with PTSD, reduce anxiety and depression, and connect with god. In November of 2018, there was even a study conducted that looked at the scheduling of this mushroom, which is currently a Schedule 1 drug. A Schedule 1 drug is classified as having “no currently accepted medical use and a high potential for abuse” (DEA, 2019) Confirming what many have known all along, based on the 8 factors of controlled substances, the scientists recommended it be switched to a Schedule 4 drug, similar to prescription sleeping aids. Shout out to Oakland, CA and Denver, CO, the first cities to decriminalize psilocybin in 2019.

Along with all of these new opportunities, specialty mushroom consumption continues to increase in the United States and will keep growing in the American diet. The specialty mushroom industry seems to be heading for more growth and expansion. More mushrooms will be cultivated and consumed, while the applications and areas of use will expand.



3 SECTORS OF THE SPECIALTY MUSHROOM INDUSTRY

When thinking about growing mushrooms it is important to know that most businesses do not do the entire process of cultivation in-house. Depending on the mission and goals of a cultivator, the involvement in each of these processes may change. There are three different sectors of the commercial mushroom industry:

1. **Spawn production**
2. **Block production**
3. **Fruiting and sales**

Each of these three sectors can require completely different infrastructure, skill levels, and contacts to operate successfully. As the small-scale specialty mushroom industry grows, there continues to be more specialization and focus for individual businesses. Some examples:

Example 1: A farmer has a 300-person CSA and wants to offer their customers mushrooms. They need 60 pounds of mushrooms per week. Rather than put a lot of time and resources right away into producing spawn and fruiting blocks, they can simply buy ready-to-fruit blocks. This allows the farmer to expand upon an existing market and develop their skills in fruiting mushrooms and managing sales. This method is also very easy to scale. If the farmer wanted to start selling 10 pounds each to four of their restaurant customers, they could easily increase the amount of blocks they are purchasing.

Example 2: A college grad wants to focus on e-commerce and mycoremediation. Fresh mushrooms do not ship well and are a by-product, not the focus of mycoremediation. Rather than trying to start a mushroom production farm, they focus on growing and offering spawn. Instead of investing in infrastructure to sell mushrooms, all of their time, energy, and resources go into producing spawn to be sold online and used in mycoremediation projects around the country.

Example 3: Two entrepreneurs see the potential for the expanding mushroom industry and strategically place 20 block-production facilities around the country to reduce shipping costs so every farm can economically grow specialty mushrooms outside or in an unused barn. They don't have the channels to sell fresh mushrooms, so they focus on producing blocks for farmers to fruit mushrooms from.



Choose your own Adventure

Breaking specialty mushroom cultivation into these three categories can be extremely helpful for anyone starting their own farm or anyone interested in supplementing an existing business with mushrooms. The size of the farm, combined with your mission and goals, will dictate which aspects are done on the farm. As a grower becomes more established and increases the size of their production, it might make sense to shift more to on-farm production. This is a great way to design opportunities of growth into the business without needing to find new customers.

FOR EXAMPLE: A grower has purchased ready-to-fruit blocks for the first two years of production, going from selling 50 pounds per week to 200 pounds per week. They have been working 20 hours per week with one employee and now are ready to put more time and resources into production. The blocks they have been buying in have cost about \$7 each. They can produce them in house for \$3.50 per block.

Current annual expense for blocks: \$72,800

Annual expenses for producing in-house: \$36,400

Making this change could increase profit by \$36,400 per year! This would not require finding new customers, but rather investing in infrastructure and employees. In a single year the \$36,000 saved from no longer buying in blocks could cover the expenses associated with creating a space and on-boarding employees to produce blocks in-house. As a result, the long term profitability of the business would be improved. When the grower was producing 50 pounds per week, the cost differential between buying-in blocks versus producing in-house was only \$9,100 per year, which may not have been worth the extra stress, labor, and investment to produce the blocks.

Building relationships within the industry is extremely useful for weathering the storms of mushroom production. Every farm experiences loss and contamination. It is great when there are other businesses that help create resiliency within the industry. By networking and building relationships with farms at different levels, a grower becomes more resilient. If they lose spawn or blocks to contamination or are short on fresh mushrooms they can work with their neighbor to fulfill their orders. Likewise, if a grower over-produces, they can work with neighboring farms to offer their surplus. By collaborating, the movement of specialty mushrooms becomes stronger.





SPAWN PRODUCTION

1. Spawn Production

Spawn is mycelium that is used to inoculate a new substrate. It is produced on high-nutrient materials like agar and grain. The production of spawn is the most specialized and finicky aspect of specialty mushroom production. It can come in many different forms: agar, grain, sawdust or plug. It is very important when growing mushrooms that spawn does not contain other microorganisms. If the spawn has trace amount of mold or bacteria, those contaminants will expand exponentially into the bulk substrate. If a 10 pound bag of spawn that is contaminated is used, now there will be 300 pounds of contaminated substrate! Not only are all of those materials and time wasted (especially if you don't learn from the mistake), but all the material needs to be thrown out in the compost.

The materials used in spawn production can easily be infected by microorganisms that are all around us like molds, yeasts, and bacteria. Because of this, very particular infrastructure and methods are needed in spawn production. It is an advanced part of mushroom production and needs constant focus and attention. For small-scale and beginning growers, it can make more sense to purchase spawn from another company. This frees up time for other aspects of cultivation or to do something other than farm!

LET'S TAKE A LOOK AT THE ECONOMICS:

- 10 lb of grain spawn = \$20
- Shipping 10 lb bag of spawn = \$10
- Total cost per 10 lb of spawn= \$30
- 10 lb of spawn can inoculate 150-300 pounds of substrate.
- 150-300 pounds of substrate = 30-60 lbs of mushrooms

SPAWN COSTS ARE .50 TO \$1 PER POUND OF MUSHROOM

If producing 100 pounds of mushrooms, \$50 - \$100 would be spent on spawn while grossing around \$1000 in sales. Could 10 pounds of spawn be produced for less than \$100 per week? Probably not. But 50 pounds of spawn could be produced for less than \$500 per week. It is all a matter of scale, and what the grower wants to spend their time on. If you want to purchase spawn rather than produce it, some good companies to look at are:

Fungi Ally - Massachusetts

North Spore - Maine

Lambert Spawn - Pennsylvania

KSS Sales - Pennsylvania

Mushroom Mountain - South Carolina

Amycel - Texas

Amycel - California

Field and Forest - Wisconsin

Northwest Mycological Consultants - Oregon

For an updated list visit (cornellmushrooms.org)

Ready to Fruit Blocks



2. Block Production

After producing spawn, the next step in mushroom cultivation is to produce the bulk substrate or fruiting substrate or simply blocks. This is the material the mushrooms are going to fruit from. There are several factors that play into producing high quality blocks:

- 1. Finding low cost sources for substrates;**
- 2. Providing the proper nutritional recipe for the mushrooms to grow;**
- 3. Treating, inoculating, and incubating the blocks properly until they are ready to fruit.**

When broken down into individual tasks, there are over 60 steps that go into producing blocks, starting from sourcing and storing materials all the way to initiating fruit body formation. The most common substrates used in block production are straw, sawdust, soybean hulls, and wheat bran. Buying

these in bulk helps to reduce cost, but storage then becomes a necessity. Developing a formula optimized for maximum fruiting and mycelial run can be a challenge when starting out. Formulas will be explored in more depth in the second booklet. The process of mixing, inoculating, and incubating blocks can be time and equipment intensive. Many farms do not have the time, space, or resources to begin producing blocks from the start.

There are typically two sizes of ready-to-fruit blocks that can be purchased: 5 lb and 10 lb. On average, 5 pound blocks fruit one pound of mushrooms per block, and 10 pound blocks fruit about two pounds per block. Oyster mushrooms can greatly outperform this metric, but when doing projections, these are achievable numbers to use. Typically the blocks cost between \$4.50-\$7.50, depending on the size, plus shipping. When buying blocks in, it is extremely helpful to work with someone who can deliver directly or offer easy pick-up to decrease shipping costs. Shipping costs can also be limited by buying a whole month's supply of blocks at a time and storing them in a cooler. Blocks are initiated once or twice a week as needed. After about three weeks in the cooler, they typically start to fruit in the bag, decreasing overall yield.

Some growers do a combination of buying and producing their own blocks. Long incubation species like shiitake can use a lot of space. Purchasing shiitake blocks while producing oysters can be a good introduction to in-house block production. Other times, specialty species for a particular event or CSA can be bought in for an on-time production run.

One downside to purchasing blocks is that it does require some cash flow. There is typically an 8-12 week window between buying the blocks and being paid for the mushrooms. This means that if you are growing 50 pounds per week at \$7 per block and you are receiving a 1 lb yield per block, there will be around \$2,800-\$4,200 tied up in cash flow.



Fruiting and sales

3. Fruiting and Sales

The easiest aspect of mushroom cultivation to dive into is fruiting and sales. This entails creating a favorable environment for mushrooms to fruit, and then growing, harvesting, storing, and selling the mushrooms. Exclusively doing this step is still a lot of work! Especially when starting out, it can be really helpful to focus on dialing in the conditions to fruit the mushrooms. By observing and working with the mushrooms in the fruiting room, a grower learns how the mushrooms respond to different environmental factors. The grower will learn how to schedule and predict fruitings as well as manage the boom and bust that can happen in mushroom production. This stage is also key in developing a brand and customer base. Many specialty mushroom farms choose to be organic and focus on a higher-end clientele. Having a nice logo and good packaging can really help to create a known brand.

Creating a business focused exclusively on this aspect of specialty mushroom production greatly reduces the infrastructure needed to get started. All that is needed is a walk-in cooler and fruiting room that can be in a basement, barn, or even outside for 3-season growing.. For some farms, this would mean just setting aside some space in the woods and starting to grow. A grow room and walk-in cooler can easily be built for between \$1000-\$5000, depending on your budget.

BUSINESSES TO BUY READY-TO-FRUIT BLOCKS FROM

KSS Sales - Pennsylvania

Cap N Stem Mushrooms - Maine

Mycoterra - Massachusetts

Earth Angel Mushrooms - Missouri

Columbia Mushroom - Oregon

Michigan Mushroom - Michigan

Far West Fungi - California

Bluff City Fungi - Tennessee

Contact the Commercial Mushroom Growers Network on Facebook for other farms.

In this area there is also the opportunity to focus on and produce value-added products like mushroom body products, extracts, soups, teas, and dried mushrooms. These products are becoming more popular in e-commerce, farmers markets, and stores around the United States. Teaming up with a mushroom farm to produce these or focusing on fruiting and value added production is a great market to explore. There are few farms doing it, lots of growth in the market, and grant monies available to assist in developing and promoting value added products.

VOCABULARY TERMS:

- 1 Spawn:** Mycelium used to inoculate a substrate
- 2 Inoculate:** Bringing spawn into contact with a food source
- 3 Substrate:** The food source
- 4 Colonize/Spawn Run:** The period of time from inoculation to fruiting, when the fungi is growing through the substrate
- 5 Strain:** A particular expression of DNA within a species that can be isolated and expanded.

USING MUSHROOMS TO SOLVE COMMUNITY CHALLENGES

Mushrooms, as an organism, as well as in the context of production for sales or sustenance, offer several unique qualities that leave them poised to solve a range of community challenges in both rural and urban settings.



Nutritious Food & Powerful Medicine

Many communities face malnutrition and lack access to healthy foods. According to the USDA-ERS, 11.8 percent (15 million) of U.S. households were food insecure at some time during 2017. Communities of color are twice as likely to be food insecure, as compared to white households.

Mushrooms are often underappreciated for their substantial nutritional and medicinal qualities. They are an important source of protein that is naturally high in Vitamin D, potassium, magnesium, and many other nutrients. Mushrooms also contain all the essential amino acids. Extracts from common mushrooms are among some of the most powerful medicines, supporting a healthy immune system, lowering cholesterol, and fighting cancer cell development, among a long list of other medicinal attributes.

Mushroom cultivation, which can be done in small and repurposed spaces, offers great opportunities for individuals and communities to address food security issues.

Production systems are low-tech, easy to set up, and flexible

Unlike many food crops, little or no land is needed to grow mushrooms. The production space needs to be kept at a consistent temperature (65 – 70 degrees), high relative humidity, and have some form of light source. It also needs to be able to be cleaned periodically.



People are growing mushrooms in cities and in rural communities. They are growing them in converted buildings, shipping containers, basements, spare bedrooms, and hoop houses. You can start small, and scale up if desired. One could produce as much as 1 pound of mushrooms per square foot of space, per week, in a well-managed space.

Because of the flexibility and low cost of setting up production systems, along with the main raw input of low cost “waste” materials, the cost to start an operation is low, while prices for specialty mushrooms are high. For instance, ten pounds of a mixture might cost \$1 – \$10 to inoculate and should yield 5 – 10 lbs of mushrooms, which can be sold at a retail price of \$10 – \$12, yielding \$49 – \$120 worth of product.



Recycle local waste streams

Mushrooms (especially oyster) will consume almost anything that is high in carbon. Straw, sawdust, coffee grounds, shredded paper, grain hulls, wood, and even denim and cotton are all possible. Typically, oysters are grown on straw or sawdust mixture, and others like shiitake and lions mane do best on sawdust with nutritional supplements high in nitrogen.

Sawdust is a waste product of the forest and woodworking industries, and the supplemental material can be a wide range of local agricultural wastes, from soybean and cottonseed hulls, to coffee grounds or waste brewery grain.

Post-production mushroom substrates retain high value and can make excellent compost for community gardens and farms. Spent substrates have also been used as animal feeds, biological water filters, and feedstocks for worm composting systems.

Low carbon footprint and environmental impact

With climate change and environmental degradation often connected back to agriculture, it is remarkable that mushrooms offer one of the lowest environmental footprints when compared to many foods, especially animal proteins. A 2017 study of one third of the US mushroom industry calculated that the production of a pound of mushrooms requires only 1.8 gallons of water (compared to 500+ gallons for beer or 200+ gallons for soy), 1 kWh of energy, and generates only 7 pounds of CO₂ equivalent. (Note that this study examined only button mushroom operations, but values are likely similar or less for specialty mushrooms).

Mushrooms are a space- and resource-efficient way to grow high-quality proteins, especially close to where many people consume them – in cities – where production of other proteins is largely prohibitive due to a lack of land for animals or field crops.

Support healthy soils, plants, and forests

In nature, fungi and mushrooms are very important elements that decompose organic matter, harvest water and minerals from soil, support healthy plant roots, and balance population dynamics. Growers can harness these talents for a range of purposes, such as:



GAINING THE BENEFITS

In the ways described above, mushroom cultivation is not just another agricultural crop, but one that can be used in many ways to support a wide range of goals and values for farms and gardens. While the pathways are many, it is not easy to harvest ALL the benefits, but rather best to focus on those that best meet your goals.

For instance, using local waste materials or invasive plants for cultivation is not necessarily compatible with goals for consistent, high-yielding, commercial operations (at least not currently). If you want to utilize mushrooms to bioremediate and build soil health, in many instances (especially urban landscapes) these mushrooms should not be harvested as a food crop. If your interest is mainly around medicinal properties, then a grower must invest more time and learning in all the details, as the level of education to customers

- **Using decomposing mushrooms (Oyster, Agaricus, Wine Cap) in mulch to break down wood chips and compost, and build soil while producing food;**
- **Linking log and stump cultivation with sustainable forage management practices to support long-term forest health;**
- **Building biofilters to clean bacteria and particulates from stormwater;**
- **Remediating toxins such as oil, gasoline, and heavy metals in soil with mushrooms (not compatible with food production and needs to be done with the support of environmental monitoring agencies);**
- **Noxious and non-desirable plant species that grow rapidly (e.g. knotweed) can be harvested, dried, and utilized for cultivation of some specialty mushrooms (e.g. Oyster)**



or community members is much higher than when the focus is with selling mushrooms as an edible product. Whatever your aspirations, it's important to reflect on what personal and community problem(s) you are seeking to resolve.

This booklet has offered an overview of what mushrooms are; the past, present, and future status of the specialty mushroom industry; and the potential benefits mushrooms offer. Hopefully there is a deeper understanding of the opportunities to ally with mushrooms. The second booklet continues this discussion with mission and goal setting, design, and step-by-step instructions for inoculating and starting mushroom growing systems.



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