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Determining the Feasibility of Implementing an Effective Fungiculture Program with the Peace Garden at Illinois Wesleyan University

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Abstract

The Peace Garden at Illinois Wesleyan University (IWU), the organic garden at the small liberal-arts university in Bloomington, Illinois, is devoted to growing nutritious, pesticide-free food to be sold locally in an attempt to counterbalance the various food-related issues which stem from conventional food systems. Mushrooms, fungi with many nutritional benefits, are not currently produced by the Peace Garden. However, the unique nature of mushrooms may be attractive to certain consumers and could further contribute to the Peace Garden's mission if produced. This study, conducted September to December 2013 is guided by the following question: ***What is the feasibility of implementing an effective fungiculture program at Illinois Wesleyan University's Peace Garden?*** A review of literature on mycology and fungiculture was conducted to develop a base understanding of these subjects, interviews with mushroom cultivation experts were conducted to explore the processes and challenges associated with fungiculture, managers of foodservice institutions were met with to gauge their likelihood of accepting mushrooms from the Peace Garden, a survey was developed and administered to a total of 43 shoppers in two farmers' market locations to gauge individual preferences of mushrooms and buying habits, and a focus group was held with the three employees of the IWU Peace Garden to determine the program's current strengths, weaknesses, and hopes for the future. Through these research methods, it has been determined that there are various barriers to implementing a successful fungiculture program at the IWU Peace Garden, including difficulties securing adequate labor, funding, and a stable location. However, if taking action to overcome these barriers is prioritized, the Peace Garden can gain sufficient funding through working with partner organizations, secure their location by developing a contract, and bring on a reliable labor force by offering a variety of student labor opportunities. If this is done, the expansion of the Peace Garden through implementation of new programs, such as a fungiculture program, is viable.

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Acknowledgments

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Introduction

To many people, mushrooms are an enigma. These strange organisms are often portrayed in the media as magical entities, from the size-altering mushrooms in Lewis Carroll's *Alice's Adventures in Wonderland* to the power-ups in the Mario video games made by Nintendo. The popular Button mushroom is easily recognized, and can be seen in an ordinary supermarket, salad bar, or resting on top of a veggie pizza. Occasionally, different kinds of mushrooms may be spotted growing in an outdoor area, though people may be wary of these strangers. It is not well-known that many mushrooms are not only edible, but are delicious and nutritious food items which exist in a variety of forms. Not only do different mushrooms take on various shapes, sizes, and colors, but each species grows in specific ways, has a particular flavor profile, and may even offer medicinal benefits. And health benefits aside, incorporating mushrooms into one's diet can open up seemingly endless culinary possibilities. The many benefits of the mushroom have been realized by humans for over 7000 years (Stamets 1), and interest eventually lead to the establishment of fungiculture programs to cultivate mushrooms and other beneficial fungi.

Though mushrooms appear in a variety of cuisines, many popular and accessible food options in the U.S. today are processed and unhealthy. Because of this, it is vital to introduce consumers to fresh, healthy alternatives. The Peace Garden at Illinois Wesleyan University, the organic garden at the small liberal-arts university in Bloomington, Illinois, is devoted to growing nutritious, pesticide-free food to be sold locally in an attempt to counterbalance the various food-related issues which stem from conventional food systems. Although the Peace Garden is north of the University campus and technically located in the adjacent Town of Normal, the Peace Garden is near the border of the two communities and is in close proximity to many important sites in both Bloomington and Normal. The Peace Garden workers have expressed interest in cultivating mushrooms since the spring of 2013, but sufficient time and manpower in order to fully invest in such an endeavor has been lacking. If the Peace Garden were to begin cultivating mushrooms by implementing a fungiculture program, the diversity of output of healthy food to the twin cities would increase, reinforcing the mission of the Peace Garden.

This particular project assesses the ability for the IWU Peace Garden, a small-scale university operation, to establish a fungiculture program, successfully grow mushrooms, and distribute them to foodservice institutions previously established by the Peace Garden workers. The research design and methodology is laid out to detail the process of exploring the feasibility of such a program, through examination of peer-reviewed sources in the Literature Review (see Appendix A), personal correspondence with community members, the conducting of a consumer study, and continuous check-ins with Peace Garden workers. The research findings are displayed and discussed, and conclusions and program recommendations are based on those findings. The limitations of both the research methods and the findings are discussed in order to highlight the potential fallacies of the study.

Illinois Wesleyan University's Peace Garden

The Peace Garden, located just a short walk from the Illinois Wesleyan University campus, is the product of IWU student and faculty desires to engage with the surrounding community through

food production. The IWU Peace Garden seeks to cultivate ecological awareness by exemplifying sustainable principles through practice, educating students and community members about sustainable food production and health, giving students the opportunity to make connections from the classroom in terms of health, sustainability, environment, social justice, and other subjects through practical means, and providing a space for university students to reflect and socialize while engaging in a respectful relationship with the environment (IWU Peace Garden). The unique nature of mushrooms may be attractive to certain consumers and could further contribute to the Peace Garden's mission if produced.

The Peace Garden sells produce at the Trailside Farmers' Market in Uptown Normal from early June to mid-September and has established a weekly market on IWU quad which runs from late August to late October. In addition, the Peace Garden has supplied local restaurants, charity organizations, and Sodexo—Illinois Wesleyan's own food service provider—with fresh produce.

Research Design and Methodology

Through extensive research and a partnership with Peace Garden workers and volunteers from September to December 2013, the viability and worth of growing mushrooms, maintaining them in an environmentally-friendly manner throughout the year, and distributing them locally was determined. To guide the project, a research question was asked: ***What is the feasibility of implementing an effective fungiculture program at Illinois Wesleyan University's Peace Garden?***

In order to begin answering this research question, a variety of research methods were used, including reviewing pertinent literature, interviewing key informants, surveying consumers through the Market Customer Questionnaire, and conducting a focus group with Peace Garden employees. These methods are described in more detail below.

Literature Review

A comprehensive literature review was conducted which explores characteristics, cultural and culinary history, and science behind a variety of edible mushrooms cultivable in central Illinois, as well as the costs, challenges, and benefits of cultivating certain varieties (see Appendix A).

Key Informant Interviews

Interviews were conducted with 12 key informants in order to provide expert information pertaining to different aspects of this research project. Key informants include gardeners and farmers in Central Illinois who are familiar with small-scale mushroom cultivation, managers of foodservice institutions which buy from the IWU Peace Garden, a University of Illinois Extension Educator, and Peace Garden collaborators at Illinois Wesleyan University. For a comprehensive list of names, see Appendix C. The gardeners and farmers were contacted through e-mail, over the phone, and in person with the goal of learning the best species to grow in Central Illinois and the most effective cultivation techniques. The heads of foodservice institutions which are established buyers of Peace Garden goods, or foodservice institutions, were then contacted by phone and approached at their places of business. These foodservice institutions include restaurants such as First Wok and Station 220, IWU's food service company Sodexo, and Clare House, a local charity organization. These brief, informal interviews had two goals: to gauge interest in purchasing mushrooms from the IWU Peace Garden, and

to determine which mushroom varieties were in demand. An in-depth interview was then conducted with Bill Davison, the University of Illinois Extension Educator, to determine the best way to grow mushrooms in a university garden environment to be distributed to the Bloomington-Normal community. Lastly, Peace Garden collaborators at Illinois Wesleyan University were interviewed in person to determine further barriers to establishing and maintaining a fungiculture program and how to overcome those barriers.

Market Customer Questionnaire Survey

As mentioned previously, the IWU Peace Garden also sells produce directly to community members through markets. The Market Customer Questionnaire was created in order to study these populations who are likely to encounter IWU Peace Garden produce if sold in a market environment such as the Normal Trailside or IWU Quad Markets.

The primary objective of the questionnaire was to determine the likelihoods of people purchasing and consuming certain mushroom varieties. The secondary objective of the questionnaire was to determine the consumers' familiarity and past consumption of certain mushroom varieties. The varieties of the mushrooms which are present in the questionnaire are: Button, Shiitake, Portobello, Maitake, and Shimeji. These varieties were isolated during exploratory conversation and interviews as varieties which were commonly cultivated and generally in-demand in the central Illinois area. (see Appendix D).

The Market Customer Questionnaire was administered on two separate occasions and focused on two unique samples. Thirty shoppers at the Downtown Bloomington Farmers' Market (see “Limitations of Research Methods”) and 13 shoppers at the IWU Quad Market were surveyed in person. The Farmers' Market customers were approached at random and asked to fill out the questionnaire on paper. The Peace Garden Quad Market customers were approached if they made a purchase at the market, and then asked to fill out the questionnaire electronically using Qualtrics, a software data collection program, through a laptop. The data was later analyzed through Qualtrics.

Peace Garden Employee Focus Group

The three Peace Garden employees were consulted throughout the research process with the goal of discovering the potential benefits and barriers of implementing a new fungiculture program in consideration of their current capabilities and challenges as an organization. Important information from the literature review, key informant interviews, and the results of the Market Customer Questionnaire was assembled together and was presented to the Peace Garden workers. This information included the varying costs and difficulties of cultivating various mushrooms via different methods, the potential profits of certain mushroom varieties, and the preferences of different consumers. The information was presented later to the three employees in a focus group to facilitate discussion. The discussion brought to light the workers' perceptions of the feasibility of a successful fungiculture program. Finally, the opinions and concerns of the Peace Garden workers were culminated with the research findings in order to develop program recommendations for the Peace Garden.

Limitations of Research Methods

The Trailside Farmers' Market, where the IWU Peace Garden normally sells produce, ends in mid-September. The Market Customer Questionnaire had not been completed in time to be administered to customers during the market's run. Customers of the Downtown Bloomington Farmers' Market were surveyed instead, as that market ends in late October. The extra time allowed for an appropriate questionnaire to be developed and administered.

In order to gauge consumer preferences for mushrooms, it was important to isolate populations of people who were likely to make purchases from the IWU Peace Garden specifically. A survey to reach a large sample size, like a phone or e-mail survey, would not have been effective in reaching these particular populations. The most effective method to reach this population was to administer a survey in-person and on-site. Due to limitations of time and manpower, only small survey samples were reached.

The time constraints for this project did not allow for implementation of mushroom test batches to experiment with growth methods and varieties. For example, it may take up to six months for inoculated logs to bear fruit. Because of this, the feasibility of a fungiculture program in terms of cultivation successes and failures was unable to be determined.

Research Findings

The research findings have been separated into three sections: initial setup of a fungiculture program, growth and maintenance of mushrooms, and mushroom distribution. The feasibility of implementing each integral component at the IWU Peace Garden is studied by assessing a multitude of factors. The findings are presented with specific focus on barriers and benefits of each possibility.

Initial Setup of a Fungiculture Program

The first factor which must be taken into consideration is the feasibility of preparing to cultivate mushrooms. This includes securing a location, gathering materials, and assessing overall cost. Under each subheading, local findings of mushroom cultivation setup will initially be addressed.

Location

Upon conducting a local investigation of small-scale mushroom cultivation programs in Central Illinois, significant variance in location of growth was found. Tina Sipula, the owner of Clare House in Bloomington, Illinois, successfully grew Shiitake and Oyster mushrooms in her basement with mushroom kits purchased from retail companies. Stu Hummel of Epiphany Farms Enterprise successfully grew Lion's Mane, Shiitake, and Oyster mushrooms from kits. Jan Turner and Julian Gorski of Normal, Illinois grow Shiitake mushrooms together behind Turner's home to be sold at the Downtown Bloomington Farmers' Market. Turner's backyard, which is roughly 350 ft^2, has been remade into a garden space. The space is hedged by a bushes and trees of varying heights, which provide ample shade for the mushrooms, grown to the rear of the space on inoculated hardwood logs. The area designated for mushroom cultivation is roughly 50 ft^2. About thirty of the logs are piled together in the darkest areas, while five lie partially submerged in a plastic kiddie pool filled with water

to help retain moisture. Turner and Gorski work together to inoculate the logs on Turner's driveway. A much larger operation was explored, run by a mushroom grower in the Central Illinois area who wishes to remain anonymous. This grower owns a business which occupies roughly eight acres of land. A large portion of the land is forested and well-shaded, and almost ten stacks of fifteen inoculated logs each occupy the forested area. Mainly Shiitake is grown, but growth of Lion's Mane and Oyster mushrooms has also been attempted. A patch of ground roughly 100 ft^2 rests near the edge of the forested area, and has been covered with a woodchip substrate, inoculated with Shiitake spawn, and covered with straw for insulation.

The IWU Peace Garden is located on a half-acre plot of land which is currently being leased from the Immanuel Bible Foundation (IBF), a Christian non-profit organization. The Peace Garden has agreed to lease the land from the IBF for three years, from spring 2012 to spring 2015, paying $300 per year. The garden consists of a hoop house containing four garden plots, 13 garden plots outside of the hoop house, and five small compost heaps. A shed containing donated tools sits to the near southeast of the garden. Two 90-gallon rain barrels are attached to the shed's gutters, and supply the garden with water. A secondary water source, a spigot to the south of the garden, supplies the garden with water from early April until mid-October. In addition, there is roughly 500 square feet (50ft x 10ft) of unoccupied shaded area near Osage orange trees which may be utilized for mushroom growth.

Centralizing food growth outdoors seems preferable to the Peace Garden workers. Although outdoor growth does have its benefits, there are also difficulties which must be addressed. There is no dense forested area near the garden which would provide constant shade for mushroom varieties which grow well in darkness or low light. Continuing with shade issues, the Peace Garden does not own a barn on the leased property, and the small shed would not be ideal for mushroom growth as it is already full of tools and other miscellaneous items. There are also potential issues with the usage of the IBF's land. The agreement between IWU and the IBF states that there will be no digging around the land's 20-foot perimeter. Although outdoor mushroom cultivation may not include digging into the soil, such as with log culture, there is the potential that cultivation space may be limited. In addition, according to a *Pantagraph* article by Mary Ann Ford, the IBF has been reviewing their assets with the intent of planning for the future. Even though the contract for the Peace Garden to use the land for three years is still active, it is currently unknown if the IBF will decide to uphold the contract. It is known as of now that the IBF has gotten the land appraised, and may be interested in selling the land which the Peace Garden occupies. The Peace Garden workers have discussed a contingency plan in case the land is sold to an entity other than the University, though no dependable plan has been agreed upon.

Although the IWU Peace Garden is largely outdoors, there is potential for indoor growth as well. During the focus group with Peace Garden workers, it was mentioned that growing in multiple locations may be difficult, and a simple program which existed in the main outdoor space would be preferable. However, indoor spaces would allow for implementation of alternative growth methods, some which require climate control, sterilization, and extra space.

Central Illinois generally has a cooler climate during the late fall, winter, and early spring, so climate-controlled indoor spaces should be considered for growth of mycelium and fruiting of warm-climate fungi. The Peace Garden has set up a small plant nursery in a greenhouse located in IWU's Center for Natural Sciences (CNS) to begin the growth of herbs, peppers, and tomato plants. In the greenhouse, workers have the possibility of adjusting temperature and humidity. The challenge with

setting up a mushroom cultivation area in CNS is that the space is largely occupied by plants grown by IWU classes and changes in the interior climate may not be preferable to other growers utilizing the space. In addition, it is difficult to control luminescence in the greenhouse area. Another option is to grow in the basement of Wilder House, a guest house a mere half-mile south of the Peace Garden. Eric Nelson, the Grounds Crew Manager at the IWU Physical Plant, has agreed to let the Peace Garden grow mushrooms in the basement of the guest house, which is largely unoccupied and undisturbed by passersby. The guests who utilize the house occupy the upstairs area. The basement space is large enough to support shelf cultivation and/or bag growth, which would be easy in particular due to large metal hooks screwed into the walls. The area could easily be sectioned off from the rest of the house as well, perhaps with a cheap curtain. The difficulties with using Wilder House as an indoor space is that temperature and humidity cannot be altered to the point where the climate becomes uncomfortable for any guests occupying the house. Any odd odors released from the mushrooms must be neutralized as to not bother the inhabitants. The times to maintain the mushrooms would have to work around the schedules of the guests. In addition, it would be difficult to deter curious guests from tampering with the mushrooms. This could pose a potential risk to both the mushrooms and the guests.

Materials

The local growers who were interviewed successfully grew mushrooms using kits purchased from retailers, by log culture, or through bed-style culture. Everything necessary to grow mushrooms came prepared in the kits, so no additional materials were necessary to obtain. For log culture, however, growers purchased mushroom spawn from retailers. While spawn can be purchased in the form of plugs, thimbles, sawdust, grain, or pegs, local growers opted for sawdust spawn. Jan Turner and Julian Gorski attempted to inoculate logs with pegs in the past, but decided to purchase sawdust spawn from Field and Forest to see if growth was more successful. Past grower Bill Davison also purchased inoculated sawdust from Field and Forest to grow Shiitake. Another Central Illinois grower remarked that sawdust spawn “works faster than plugs” (Anonymous). In addition to the spawn, growers obtained hardwood logs of different varieties. Turner and Gorski experiment with different hardwoods, including oak, maple, and cherry. “We argue a lot about wood,” Gorski stated. “There are a lot of variables to consider with [mushroom] growth.” Oak seemed to be the most popular type of wood for log growth because it's incredibly dense and provides consistent, long-term growth (Anonymous). Using a drill, holes are put into the logs, and the spawn is punched into the holes using an inoculation tool, also available from many mushroom spawn retailers. Finally, using daubers, growers seal the holes with wax melted on a hot plate. The daubers and wax are also available for purchase through retailers like Field and Forest, and hot plates are sold in retail and hardware stores. The anonymous mushroom grower also attempted to grow King Stropharia mushrooms directly in the ground using bed-style culture. The stropharia spawn was mixed with a woodchip substrate and insulated with straw.

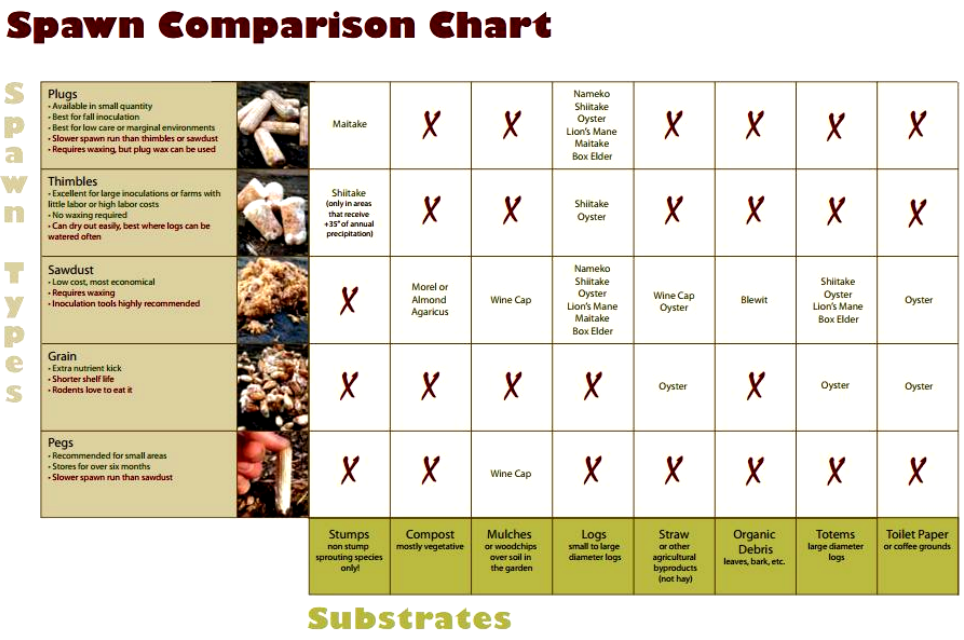
The IWU Peace Garden workers do not currently have mushroom kits or spawn as the interviewed growers do, but they have at their disposal a shed containing useful tools such as spades, rakes, hoes, buckets, and a drill. Compost is available and is turned with a hand-crank tumbler. Water is collected from a spigot or two rain barrels, depending on the season. There are also a few dozen straw bales surrounding the hoop house. For little to no cost, the Peace Garden can obtain llama manure from a nearby llama farm. Bill Davison recommended obtaining free woodchips from the Normal Public

Works Department.

All other materials, such as spawn, must be purchased. *Growing Gourmet and Medicinal Mushrooms* by Paul Stamets offers a comprehensive guide to growing mushrooms and includes all materials a grower needs to grow mushrooms via a variety of methods. The following is an abridged list of materials which the IWU Peace Garden must obtain, should they choose to follow the methods outlined in *Growing Gourmet and Medicinal Mushrooms*.

If the IWU Peace Garden workers choose to generate their own spawn, then a large number of materials must be purchased. Mushroom spores, if not collected by live mushrooms, must be purchased from a retailer. Spores must be transferred to a petri dish with an inoculation loop or a syringe to germinate on a nutrient-rich agar medium, typically a mixture of water, agar, barley malt sugar, and yeast. Once the mycelium grows in the petri dish, it is transferred to a jar or bag filled with enriched sawdust or grain to allow the mycelial mass to grow. This process generates what is called spawn, a vehicle to be eventually dispersed into a substrate. Much of the spawn generation process is delicate and requires sterilization to prevent contamination, so materials such as a glove box, a Bunsen burner, and bleach must be used. If the Peace Garden workers opt to avoid this process, spawn may be purchased from a retailer.

Figure 1: Spawn Comparison Chart, Field and Forest



Source: Spawn Comparison Chart. www.fieldforest.net: Field & Forest Products.

The spawn can be plugged into logs, grown on a tray, or further expanded on a bulk substrate for wall, column, bag, or bed-style culture. Different mushrooms can be grown in a variety of ways, and different methods of growth require certain types of spawn. The Spawn Comparison Chart from Field and Forest displays which spawn type is appropriate for different growth methods (Figure 1). For log growth, the Peace Garden must purchase logs, wax, and daubers. If plug or thimble spawn is

purchased, a hammer is necessary. An inoculation tool is necessary if sawdust spawn is purchased. For the other growth methods, the spawn must be mixed with a substrate. Column culture requires a long piece of plastic ducting, which will then be filled with inoculated substrate to create a hanging vertical column. Bag culture requires bags and tray culture requires trays. Wall culture is usually created by stacking bags of inoculated substrate, but shelving units are sometimes necessary for stability. A knife must be purchased to harvest the mushrooms, and a refrigerator is useful for keeping them fresh before selling.

Cost

One of the most important aspects of determining the feasibility of a fungiculture program is considering the overall cost of implementing a successful program. Each interviewed local mushroom grower had purchased spawn and other materials from either Field and Forest Products or Fungi Perfecti. Mushroom kits, if not purchased from these two retailers, were purchased in retail stores.

Dr. Craig Broadbent, Assistant Professor of Economics at IWU, was consulted in regard to determining the financial sustainability of implementing a successful fungiculture program with the Peace Garden. According to Broadbent, financial sustainability will be attained if the revenues from the fungiculture program are equal to or greater than the total costs. The IWU Peace Garden is primarily attempting to earn enough to sustain the current operation, so any new program must at least balance out its own costs.

In April 2013, the McLean County Wellness Coalition (MCWC) offered many community gardens in the county grants, including the IWU Peace Garden. The Peace Garden was awarded $456.98, and all of that money goes toward garden development. Dr. James Simeone, the Peace Garden's Faculty Advisor, stated that the Peace Garden currently has about $2400 in their budget, and may be able to secure an additional $3000 from the IWU Provost “if the students had a show of support for the [Peace] Garden.” If the Peace Garden workers feel that a fungiculture program would be feasible, some of that money may be available to put towards such a program.

Cost of materials is the primary cost which must be taken into consideration. A shortlist of materials which are necessary for different types of cultivation is listed under the “Materials” subheading on page five. From that shortlist, the costs of mushroom cultivation materials from reputable retailers were explored. Tables 1 and 2 compare costs of materials from Field and Forest and Fungi Perfecti. While there are many retailers of mushroom spawn and related material, these two companies were most frequently recommended by farmers and gardeners who are familiar with small-scale mushroom cultivation.

Table 1: Cost of materials, Field and Forest

	Materials for Log Culture						Materials for Bed-Style Culture
Mushroom Variety	Sawdust Spawn (5.5 lb bag, will inoculate approx. twenty-five 4″ by 40″ logs)	Plug Spawn (two units of 750 plugs each, will inoculate approx. thirty 4″ by 40″ logs)	Thimble Spawn (two sheets of 600 thimbles each, will inoculate approx. twenty-four 4″ by 40″ logs)	Sawdust Inoculator (requires a 7/16 drill bit for drilling holes)	Cheese Wax (10 lbs, will cover 1000 plugs)	Wax Daubers (4 ct.)	Grain Spawn (4 lb bag, will inoculate 40-80 lbs of wet pasteurized substrate)
Shiitake	$24.00	$64.00	$64.00	$32.00	$31.50	$1.00	--
Button/Portobello	$24.00 (almond agaricus)	--	--				--
Maitake	$24.00	--	--				--
Shimeji	--	--	--				--
Oyster	$24.00	$64.00	$64.00				$24.00
Morel	$24.00	--	--				--

Source: "Buying Products." 2013. Field and Forest Products. <http://www.fieldforest.net/Buying-Products/departments/2/>.

Table 2: Cost of materials, Fungi Perfecti

	Materials for Log Culture					Materials for Bed-Style Culture			Materials for Column Culture
Mushroom Variety	Sawdust Spawn (5 lb bag, will inoculate approx. twenty-four 4″ by 40″ logs	Plug Spawn (1000 plugs, will inoculate approx. twenty 4″ by 40″ logs)	Plug Spawn Kit (A 5⁄16” steel drill bit with stop-collar, a rubber mallet, one pound of soy-based Sealing Wax, a 1" brush for applying wax	Sawdust Palm Inoculator (requires a 7/16 drill bit for drilling holes)	Sealing Wax (10 lbs, will cover 1000 plugs)	Grain Spawn Master Bag (1.5 gallon, can expand up to 1000 times its mass)	Hardwood Sawdust (10 lb bag)	Hardwood woodchips (10 lb bag)	12" Punched Ducting, 20' length
Shiitake	$20.00	$44.95	$14.95	$34.95	$34.95	$69.00	$7.50	$12.95	$12.95
Button/Portobello	--	--				--			
Maitake	--	$44.95				--			
Shimeji	--	--				--			
Oyster	$20.00	$44.95				$69.00			
Morel	--	--				$69.00			

Source: "Shop." Fungi Perfecti LLC. 2013. <http://www.fungi.com/shop.html>.

Both retailers offer competitive prices for their products, and pricing is very similar. However, it is important to note that certain materials are only available through a certain retailer. For example, Field and Forest offers many more varieties of sawdust spawn, while Fungi Perfecti sells more products for bed-style culture and column culture. The total cost of materials to start a basic fungiculture program at the IWU Peace Garden would likely be around $100, depending on the desired scale of growth.

The only growth and maintenance costs will be for labor. During the spring of 2013, two IWU students were hired to work at the Peace Garden for ten hours per week. They earned minimum wage, taking in about $900 each for the semester. According to Dr. James Simeone, this was paid for by IWU's Action Research Center (ARC), though future funding for the Peace Garden is unlikely to be offered. If the Peace Garden cannot secure funding through ARC or another organization, it is unlikely that student workers will be hired in the future (Simeone). The Summer Intern is paid through the sale of produce in the summertime.

The final cost which must be considered is cost of distribution. According to Carolyn Ashley, the Peace Garden must pay $125 to participate in Normal's Trailside Market each year. This money comes directly out of the Peace Garden's budget, and it is likely that the Peace Garden will participate in the Trailside Market whether or not a fungiculture program is implemented. There is no cost to distribute to foodservice institutions or sell on the IWU Quad.

Overall, the only extraneous costs for the IWU Peace Garden in implementing a fungiculture program would be about $100. If additional labor is needed due to the new program, the costs may total about $1000 if the student is a paid worker.

Growth and Maintenance of Mushrooms

The secondary factor which must be taken into consideration is the feasibility of growing and maintaining the mushrooms after the necessary materials have been assembled. Local findings of mushroom growth and maintenance are addressed first, followed by an assessment of a variety of growth and maintenance options.

There are many different ways to grow mushrooms, both indoors and outdoors. Mycologists and commercial growers often begin by preparing their own mycelial spawn from spores in a sterile indoor environment, though this may be too difficult and time-consuming for the small-scale grower (Stamets 59-60). Each Central Illinois mushroom grower who was interviewed had their own methods to grow and maintain mushrooms and each enjoyed growing different varieties. The mushroom varieties which interviewed cultivators have attempted to grow include Shiitake, Oyster, Lion's Mane, and King Stropharia. Mushroom cultivation methods which were witnessed include log culture (using plug or sawdust spawn to inoculate hardwood logs), bed-style culture (using grain spawn to inoculate soil) and column culture (filling a hanging bag, or “column,” with inoculated sterilized grain). It seemed that the most popular type of mushroom between small-scale growers in the Central Illinois area is Shiitake using log culture methods.

When choosing a type of mushroom to cultivate, it is important to note how complex the growth process is. According to the Fungi Perfecti website, it is relatively simple to grow Shiitake and Oyster mushrooms due to their versatility, while Maitake is more difficult due to its specific growing nature. In

his book, *Growing Gourmet and Medicinal Mushrooms*, Paul Stamets notes that Oyster mushrooms are "by far the easiest and least expensive to grow," and continues by claiming that "for small cultivators with limited budgets, Oyster mushrooms are the clear choice for gaining entry into the gourmet mushroom industry" (282). Other mushrooms, such as the Morel, are rare and extremely coveted, and have only recently been successfully cultivated. Even to mushroom expert Paul Stamets, these mushrooms are "one of the most enigmatic of all fungi" (422). *Growing Gourmet and Medicinal Mushrooms* offers the growing parameters for a plethora of mushroom varieties and should be a resource for those interested in fungiculture.

In regard to the IWU Peace Garden, labor is one of the most important factors to consider when determining the feasibility of growing and maintaining mushrooms. The Peace Garden currently has two student workers and one faculty member. Volunteers help with the garden at times, but according to Peace Garden Manager Carolyn Ashley, it has been difficult securing volunteer commitment. It should be taken into consideration that Dr. Simeone, the Peace Garden's Faculty Advisor, will be going on sabbatical during the spring semester of 2014. He will be replaced by Dr. William Munro, who plans to be the "institutional anchor," providing guidance and coordination when necessary. Unlike Dr. Simeone, Dr. Munro has relatively little gardening experience and expects the Peace Garden to be largely student-run (Munro). In addition, Carolyn Ashley will be retiring her position as Garden Manager after the fall semester of 2013. Garden Manager is an internship position, and the position is currently unfilled. During the focus group conducted with Peace Garden workers, lack of labor was mentioned multiple times as one of the biggest obstacles to maintaining a successful garden. When asked how this issue may affect the implementation of a fungiculture program, the workers worry about who will carry a new project in light of their current struggle to maintain their current operation (Ashley, Dyar, and Simeone).

Mushroom Distribution

The third factor which must be taken into consideration before implementing a fungiculture program is the feasibility of distributing the mushrooms after they have been grown and harvested. In order to have a successful crop, what is grown must sell or be used. Local findings of mushroom distribution are addressed first, followed by an assessment of a variety of distribution outlets for the IWU Peace Garden.

Local growers Jan Turner and Julian Gorski sell their mushrooms at the Downtown Bloomington Farmers' Market along with other items. Another Central Illinois gardener mainly grows for personal consumption, but has sold mushrooms in the past. Stu Hummel, Vice President and Chef de Cuisine at Station 220 Restaurant calls mushroom cultivation an "extremely lucrative" business, bringing to light the high demand for gourmet mushrooms and the lack of cultivators in the Bloomington-Normal area. To assess the preferences of market customers who may buy Peace Garden produce directly, shoppers at the Downtown Bloomington Farmers' Market and the Peace Garden Quad Market were given a short survey titled The Market Customer Questionnaire. To assess the preferences of the other foodservice institutions, managers of the organizations were contacted directly.

Market Customer Preferences

Tables 3 and 4 display the likelihood that consumers will *purchase* different varieties of mushroom in the future, and tables 5 and 6 display the likelihood that consumers will *consume* different varieties of mushroom in the future. In question 3 of the questionnaire, respondents were presented with one or two stock photographs of five varieties of mushroom along with a short culinary description of each. Respondents were asked to rank the likelihood of purchasing and consuming each variety by selecting either "Not Likely," "Fairly Likely," "Somewhat Likely," "Very Likely," or "Extremely Likely." Each response in likelihood of purchase was also given a numerical value, ranked 1 to 5, 1 being least likely to purchase and 5 being most likely to purchase and consume. The means were then calculated for each mushroom variety. The means here provide a solid basis for empirical comparison between mushroom varieties and between samples, though it is important to note that attributing numerical value to qualitative responses may produce inaccuracies. In addition, the values of each response were not presented to the respondents.

Table 3: Likelihood of Purchase (Downtown Bloomington Farmers' Market sample)

N=30	Mushroom Variety	Not Likely (value = 1)	Fairly Likely (value = 2)	Somewhat Likely (value = 3)	Very Likely (value = 4)	Extremely Likely (value = 5)	Total Responses	Mean
	Button Mushroom	5	1	0	13	11	30	3.80
	Shiitake Mushroom	7	1	10	7	5	30	3.07
	Portobello Mushroom	4	3	6	8	7	28	3.39
	Maitake Mushroom	11	7	8	2	2	30	2.23
	Shimeji Mushroom	12	7	5	5	1	30	2.20

Table 4: Likelihood of Purchase (Peace Garden Quad Market sample)

N=13	Mushroom Variety	Not Likely (value = 1)	Fairly Likely (value = 2)	Somewhat Likely (value = 3)	Very Likely (value = 4)	Extremely Likely (value = 5)	Total Responses	Mean
	Button Mushroom	6	1	4	2	0	13	2.15
	Shiitake Mushroom	6	2	4	1	0	13	2.00
	Portobello Mushroom	8	0	2	1	2	13	2.15
	Maitake Mushroom	9	1	2	0	1	13	1.69

Table 5: Likelihood of Consumption (Downtown Bloomington Farmers' Market sample)

N=30	Mushroom Variety	Not Likely (value = 1)	Fairly Likely (value = 2)	Somewhat Likely (value = 3)	Very Likely (value = 4)	Extremely Likely (value = 5)	Total Responses	Mean
	Button Mushroom	3	1	0	11	13	28	4.07
	Shiitake Mushroom	5	2	8	7	8	30	3.37
	Portobello Mushroom	2	4	4	6	12	28	3.79
	Maitake Mushroom	7	6	11	1	4	29	2.62
	Shimeji Mushroom	10	7	6	3	4	30	2.47

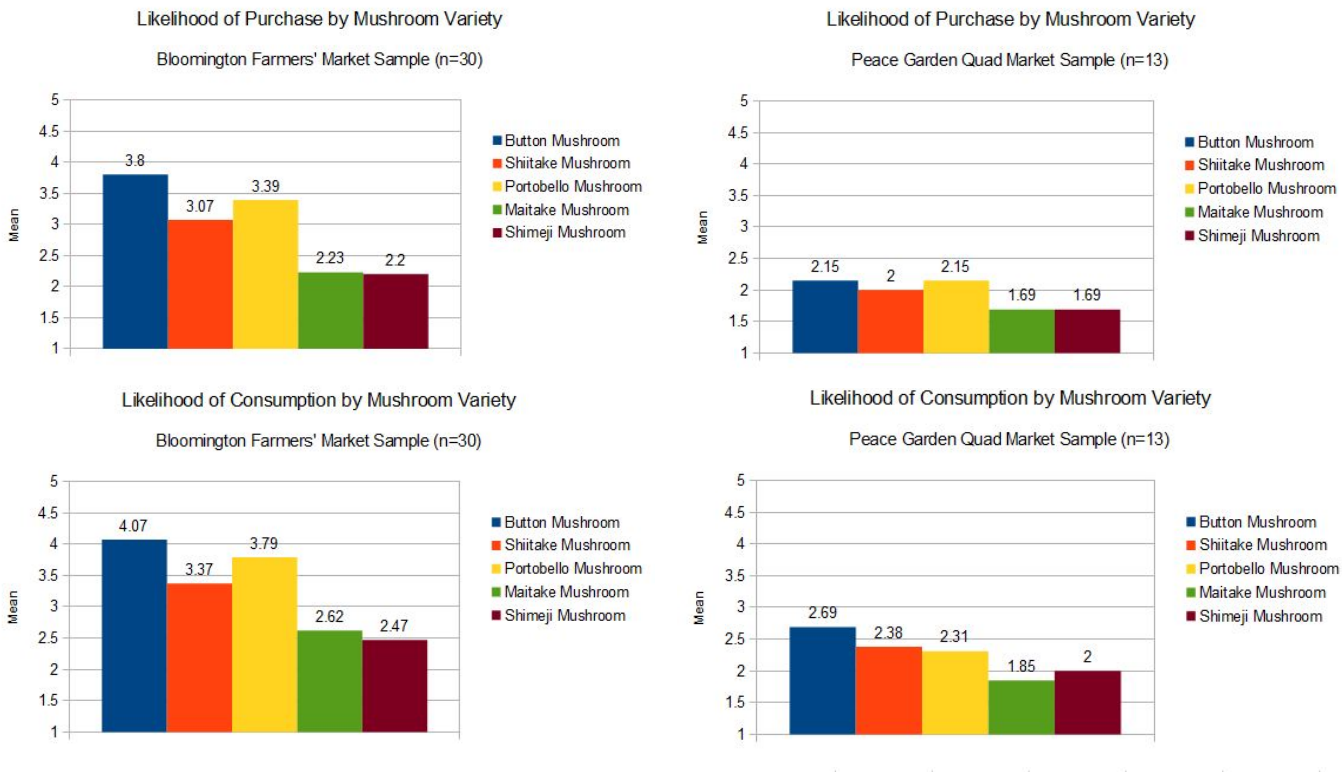
Table 6: Likelihood of Consumption (Peace Garden Quad Market sample)

N=13	Mushroom Variety	Not Likely (value = 1)	Fairly Likely (value = 2)	Somewhat Likely (value = 3)	Very Likely (value = 4)	Extremely Likely (value = 5)	Total Responses	Mean
	Button Mushroom	5	1	0	13	11	30	3.80
	Shiitake Mushroom	7	1	10	7	5	30	3.07
	Portobello Mushroom	4	3	6	8	7	28	3.39
	Maitake Mushroom	11	7	8	2	2	30	2.23
	Shimeji Mushroom	12	7	5	5	1	30	2.20

In both the Downtown Bloomington Farmers' Market and the IWU Quad Market samples, for all mushroom varieties, respondents were slightly more likely to consume each mushroom than to purchase it. This is interesting to note, as customers perhaps would rather eat a mushroom which is given to them or presented to them in a prepared dish as opposed to purchasing the mushroom themselves.

The likelihoods of both purchasing and consuming different mushroom varieties were visually represented in bar charts using the data collected. The results are separated by sample. Figure 2 shows the charts side-by-side for easy comparison.

Figure 2: Likelihood of Purchase vs. Likelihood of Consumption, by sample



The respondents were also asked to rank their personal familiarity with each mushroom variety by selecting either “This mushroom is familiar to me,” “This mushroom is somewhat familiar to me,” or “This mushroom is not familiar to me.” At the Downtown Bloomington Farmers' Market, most customers responded that they were familiar with mushrooms of the Button, Shiitake, and Portobello varieties. Not many were familiar with Maitake or Shimeji. The results were similar with surveyed customers the Peace Garden Quad Market, though overall the average familiarities were lower for every mushroom except Shimeji.

Respondents were then asked to rank their past consumption of each mushroom variety by selecting either “I have consumed this mushroom,” “I'm not sure if I have consumed this mushroom,” or “I have not consumed this mushroom.” Similar to familiarity, most customers at the Downtown Bloomington Farmers' Market, responded that they had previously consumed mushrooms of the Button, Shiitake, and Portobello varieties. Not many had consumed Maitake or Shimeji. The results were similar with surveyed customers the Peace Garden Quad Market, though overall consumption of Button, Shiitake, and Portobello mushrooms were lower.

Short, informal interviews were conducted with the managers of foodservice institutions which the Peace Garden had established a partnership with: Clare House, Station 220, First Wok, and Sodexo. The goal of these interviews was to determine the preferences of each institution and gauge the likelihood of the organization accepting mushrooms from the Peace Garden.

The Chinese restaurant First Wok, located just blocks from the IWU campus, has accepted bok choy from the Peace Garden in the past. The owner of the restaurant remarked that they would purchase only “snow white” mushrooms to be used in the restaurant's cuisine. Further research showed that both the shimeji and the enoki mushroom are referred to as “snow white.” Jack Zhang, the owner of First Wok, commented that he would purchase mushrooms of any variety to bring home to his family. The likelihood of First Wok accepting mushrooms from the Peace Garden is high.

Station 220 is a farm-to-plate restaurant located in downtown Bloomington, about one mile south of the IWU campus. Much of the food prepared at the restaurant is grown at a farm operated by the same owners, under the name Epiphany Farms Enterprise (EFE). In the past the IWU Peace Garden has supplied the restaurant with mache, spinach, Japanese turnips, and purple misticanza in exchange for seeds. Stu Hummel, the company's Vice President and Chef de Cuisine, expressed that the ultimate goal of EFE is to grow all ingredients on the farm to be served at the restaurant, eliminating the need to purchase food from outside organizations. Mushrooms are not currently produced by EFE, so about $400 per week is spent on purchasing mushrooms from local farmers to help create a variety of dishes. Even so, Hummel reiterated the importance of self-reliance, expressing that in-house mushroom cultivation is a goal for EFE. Because of this, it is unlikely that Station 220 will accept mushrooms from the Peace Garden.

Clare House, a Catholic Worker house in Bloomington which operates a food pantry and a soup kitchen, has accepted various produce items from the Peace Garden in order to feed those in need. A phone interview was conducted with Tina Sipula, the owner of Clare House. She stated that Clare House would be happy to accept mushrooms of any variety and in any quantity to be used in lunches and at the soup kitchen. If the Peace Garden were to provide mushrooms of varieties which were unfamiliar to the cooks, Sipula requested that some information regarding kitchen preparation be provided. The likelihood of Clare House accepting mushrooms from the Peace Garden is very high.

Sodexo is the food service company which supplies meals to students, faculty, staff, and visitors of Illinois Wesleyan University. The Peace Garden has sold Sodexo herbs and potatoes in the past. Management at Sodexo expressed interest in purchasing button, Shiitake, and Oyster mushrooms, though food safety concerns about the mushroom project were also asserted. Because of these concerns, potential risk was brought up for discussion with Carl Teichman, IWU's Director of Government and Community Relations.

Food Safety Concerns

In consideration of Sodexo's concerns about potential health risks associated with consuming mushrooms grown by the IWU Peace Garden, Carl Teichman acted as a liaison between this project and Illinois Wesleyan University's attorney about any potential legal risks associated with a future fungiculture program. After consultation it was determined that legal risk to the University was present if the mushrooms were to be sold to students either directly or through Sodexo, IWU's food service provider. While ultimately any food-related health issue would be the responsibility of the grower and/or the distributor, the University may still be held liable if someone were to get sick from the mushrooms. Carl Teichman remarked that if mushrooms were to be distributed to students, giving the mushrooms away directly without a third party like Sodexo would present the least legal risk to IWU. Because of this, the likelihood of Sodexo accepting mushrooms from the Peace Garden is low.

Sustainability of Fungiculture Program

In order for a fungiculture program to adhere to the goals of the Peace Garden, the program should be sustainable. The potential for a fungiculture program to be sustainable in consideration of current limitations was discussed in both the focus group and interviews with the Peace Garden workers. It was found that the primary issue which threatens the program's sustainability is lack of adequate labor to effectively maintain the program. Currently the “full-time” (5-10 hours per week) workers are the faculty advisor and two students, along with three volunteers who are not on a set schedule and help out for a few hours when needed. With the labor force available, the Peace Garden workers feel that they are only able to sustain their current operation, remarking that they feel “pushed to the max” (Ashley, Dyar, and Simeone). The secondary issue which threatens the program's sustainability is lack of funding. The less money the Peace Garden has to spend, the less likely the fungiculture program will be able to be sustained.

Discussion of Findings

Small-scale fungiculture programs are scattered all around Central Illinois and have proved to be successful operations for many. There is a clear interest to establish a fungiculture program with the IWU Peace Garden, and the findings from this research suggest there are various benefits to implementing such a program, and some barriers which may make implementation difficult.

There are three main barriers to the initial setup of a fungiculture program at the IWU Peace Garden: location constraints, location insecurity, and insecure funds. First, the Peace Garden workers made it clear that it is preferable to confine growing operations to the outdoor space, eliminating the possibility for indoor growth at this time. However, the outdoor property which the Peace Garden currently sits on may not be ideal for certain kinds of mushroom cultivation. This is because there is no dense forested area near the garden which would provide constant shade for mushroom varieties which grow well in darkness or low light. In addition, the land which the Peace Garden currently occupies is owned by the IBF, and the agreement between IWU and the IBF states that there will be no digging around the land's perimeter, which limits space for bed-style culture. Second, it is currently unknown if the IBF will decide to uphold the contract, as they may be interested in selling the land which the Peace Garden occupies. There is no solid contingency plan if the land is sold. Third, the Peace Garden does have a solid budget to draw from for purchasing materials, though it is unclear whether the Peace Garden will have future financial support from ARC or the IWU Provost. If the Peace Garden can secure the land from the IBF, perhaps with a new contract, there will be opportunities for mushroom growth, so long as the fungiculture program doesn't infringe on the limitations of the contract. In regard to funding, there should be no cost issues with financial support from IWU, ARC, MCWC, or other organizations.

Growing mushrooms and maintaining growth systems would perhaps be the most difficult aspect of implementation. Although the cost of materials for starting up a small fungiculture program would be manageable for the Peace Garden at around $100, there are currently labor issues. The Peace Garden workers frequently mentioned lack of labor as their biggest challenge, and it could prove to be a significant barrier to implementing a fungiculture program. Attracting volunteers to help make the Peace Garden's current processes run smoothly is crucial before the implementation of any new program is considered. If a solid labor force is secured, hiring a paid worker or an intern who has

interest in and is knowledgeable about fungiculture could be a way to further overcome this barrier. However, this could drive up costs as a paid student worker costs $900 per semester. In regard to choosing how and what to grow, it is important to consider the difficulties and rates of success with different mushroom varieties and growing methods. Certain methods of cultivation are better for those new to fungiculture. Based on the findings, growing Shiitake or Oyster mushrooms may be best for a new program, as the success rate of growth for these varieties are relatively high.

Distributing the mushrooms is perhaps the most feasible aspect, as the IWU Peace Garden has already developed positive relationships with a variety of foodservice institutions throughout the Bloomington-Normal community and successfully distributes produce to a variety of organizations and customers. The Market Customer Questionnaire illustrates the demand for mushrooms by farmers' market customers, which is generally high for mushrooms of the button, Shiitake, and Portobello varieties. The demand for mushrooms by students, as seen in the Peace Garden Quad Market data, is significantly less than that of the Farmers' Market customers, so perhaps the Quad Market wouldn't be the best way to distribute the mushrooms. It is also shown in the Market Customer Questionnaire data that market customers are also more likely to consume mushrooms than to purchase them, showing that market customers would perhaps rather eat a mushroom which is given to them or presented to them in a prepared dish as opposed to purchasing the mushroom themselves. This reinforces the importance of distributing mushrooms to local restaurants or food service organizations like Sodexo, which could serve the mushrooms to people as part of a meal. However, Sodexo's food safety concerns are a distribution barrier, and they currently would not accept Peace Garden mushrooms due to health and legal concerns. University of Illinois Extension Educator Bill Davison stated in an interview that due to the liabilities and purchasing power of large corporations, it is often important to work out a contract between the grower and the business. By maintaining total transparency with Sodexo and other potential buyers through public viewing and open communication, it may be likely that a contract could be established for the protection of all parties involved.

Limitations of Findings

Although the findings illustrate many benefits and barriers to potential implementation of a fungiculture program, the research had certain limitations which are equally important to consider.

The Market Customer Questionnaire was administered to customers at the Downtown Bloomington Farmers' Market instead of to customers at the Trailside Farmers' Market due to time constraints. It was assumed that the both consumer populations were parallel due to their proximity (about three miles apart). However, no evidence affirms the parallelism between the two populations. Therefore, the findings from the surveyed population at the Downtown Bloomington Farmers' Market may not be similar enough to the population of the Trailside Farmers' Market in order to act as an accurate representative sample.

In order to gauge consumer preferences for mushrooms, it was important to isolate populations of people who were likely to make purchases from the IWU Peace Garden specifically. A survey to reach a large sample size, like a phone or e-mail survey, would not have been effective in reaching these particular populations. The most effective method to reach this population was to administer the Market Customer Questionnaire in-person and on-site. Due to limitations of time and manpower, only small samples were reached.

At the Downtown Bloomington Farmers' Market, the consumers were approached at random and asked to fill out the Market Customer Questionnaire on paper. Because of this it was easy to survey multiple people at once, and oftentimes those who shopped in pairs or groups took the questionnaire along with their partner(s). The consumers at the Peace Garden Quad Market were only approached to fill out the questionnaire if they made a purchase from the market, and the questionnaire was administered electronically using a laptop. This made it impossible for more than one person to fill out the questionnaire at one time. In addition, the consumers who were likely to make purchases from the IWU Quad Market were friends of those present behind the table, including the researcher. The instance of personal relationship between researcher and respondent was high, largely due to the small campus population at IWU. These differences in surveying methods between the two consumer samples may have impacted the results.

Program Recommendations

Though there are barriers to the implementation of a fungiculture program at the IWU Peace Garden, a small startup program can be actualized if certain conditions are met.

Funding

It would be in the IWU Peace Garden's best interest to primarily ensure that they have funds to sustain their entire operation if a fungiculture program is implemented. The past Action Resource Center funds gave the Peace Garden relative financial stability, though additional funding from them is unlikely. Finding ways to receive additional funds, such as through the IWU Provost, the McLean County Wellness Coalition, or another organization, will give the Peace Garden flexibility to expand their current operation by implementing new programs.

Labor

To address labor issues, the Peace Garden workers should do whatever they can to attract student volunteers and interns at IWU to assist with the garden's various operations. If finances are available, student workers should be hired as well. It would be helpful if the workers or interns are knowledgeable about or have a desire to learn about mushroom cultivation. If the workers read this report and familiarize themselves with related texts, especially those written by Paul Stamets, the chances of success for the fungiculture program are higher. Ideally, one or more students with a good understanding of mushroom cultivation will be able focus their efforts on setting up and maintaining a fungiculture program.

Location

The current Peace Garden location must be secured from the Immanuel Bible Foundation (IBF) before implementing a fungiculture program which could yield mushrooms for years. To do this, it is important to remain in communication with the IBF concerning future plans for the land which the Peace Garden occupies. It may also be in the Peace Garden's best interest to work with the IBF to create a new longer-term contract which would also allow flexibility for expansion.

Mushroom Varieties and Growth

If adequate labor, funding, and a stable location have been secured, implementing a small startup fungiculture program will be feasible. It will be crucial to begin with a small-scale and simple fungiculture program in consideration of the Peace Garden's current limitations. It would be ideal for the Peace Garden to initially focus on growing only one or two varieties, and choosing mushrooms which are both easy to grow and are in-demand would be ideal options. Shiitake mushrooms would be the best, considering they have been successfully cultivated and recommended by Central Illinois growers and are relatively in-demand. Oyster mushrooms, though they are less in demand, are another option, as they are the easiest to grow. The Peace Garden should grow either or both of these mushrooms using log culture. If the Peace Garden wants to try bed-style culture, growing *Agaricus brunnescens* mushrooms (Button/Portobello) would be ideal, though success is more unpredictable than Oyster or Shiitake. As the Peace Garden workers become more familiar with growth techniques, growing more challenging varieties via other methods may be attempted.

Growing mushrooms outdoors using logs would be ideal, as log growth requires very little labor input and prior mushroom cultivation knowledge. After inoculation and sealing, almost no labor input is necessary, and the logs may bear fruit for years. The materials required for log growth would be easy to obtain for the Peace Garden and would not be incredibly cost-prohibitive. In addition, the Peace Garden could develop relationships with local mushroom cultivators who use log culture with the intention of learning from experienced growers and sharing tactics. Bed-style culture is another option, especially as the Peace Garden can obtain llama manure and woodchips at little cost. However, bed-style culture is more labor-intensive, and the Peace Garden would have to make sure that there are enough workers to successfully cultivate mushrooms via this method in addition to sustaining the garden's other operations.

Distribution

If mushrooms are successfully grown, the Peace Garden should distribute to consumers who are most interested in purchasing mushrooms, such as farmers' market customers and First Wok, as they are likely to help the project become financially sustainable. Although the Market Customer Questionnaire data shows that the sale of mushrooms at the IWU Quad Market may not be as successful when compared to other outlets, introducing students to mushrooms which they may not be familiar with could prove to be an education opportunity which could lead to culinary revelations. This is also an opportunity to establish a relationship with the IWU community via new and interesting foods. Another way to establish a relationship with the campus community is to supply Sodexo with mushrooms and other foods. Due to the liabilities and purchasing power of large corporations like Sodexo, a contract between the Peace Garden and Sodexo would be the most appropriate way to establish a reliable business connection. If Sodexo still feels that mushrooms create health concerns, set up a food safety inspection to get the fungiculture program evaluated. Involving the McLean County Health Department to inspect the program and the mushrooms served through Sodexo

Conclusions

After conducting a review of literature on mushrooms and cultivation, interviewing mushroom cultivation experts and managers of foodservice institutions, gauging demand for mushrooms through the Market Customer Questionnaire, and consulting IWU Peace Garden employees about the current strengths and limitations of their operation, it has been determined that the largest barriers to implementing a successful fungiculture program at the IWU Peace Garden are difficulties securing adequate labor, funding, and a stable location. While it is important to consider these difficulties, these barriers can be overcome. The Peace Garden can gain sufficient funding through working with partner organizations, secure their location by developing a contract, and bring on a reliable labor force by offering a variety of student labor opportunities. If this is done, the expansion of the Peace Garden through implementation of new programs, such as a fungiculture program, is viable.

That being said, the Peace Garden should first put time and resources into ensuring that their current operation is sustainable before considering implementing a new program which requires further input of money and labor. If a fungiculture program is implemented prematurely without first attaining the proper funds, securing the location, or establishing a dependable labor force, the Peace Garden will risk failure of the new project and further complicate the existing system.

A fungiculture program has the ability to benefit the IWU Peace Garden, the IWU campus community, and the greater Bloomington-Normal community through the growth and distribution of a healthy, savory, and potentially lucrative variety of unique organisms. If implemented correctly, the advantages of such a program may prove to be highly profitable in many ways. If the Peace Garden begins producing and selling mushrooms, they will gain access to a market which has few competitors yet has been a worthwhile endeavor for many Central Illinois growers. All things considered, it is helpful to consider a fungiculture program as a fungus itself: it is beautifully unique, it can take many forms, and most importantly, it will not bear fruit without a strong (mycelial) network.

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Appendix A — Literature Review

Assessing the Dimensions of Successful Small-Scale Fungiculture Programs through Exploration of Mushrooms and Mushroom Cultivation Methods

There are thousands of types of mushrooms which are valued as culinary delights, including the common Button mushroom, the bright yellow Chanterelle, the Shiitake—an Asian favorite, and the elusive Morel. Some of these mushrooms, like the Chanterelle and the Morel, are found in the wild and commercially harvested. Others, including the Button and the Shiitake, are commonly cultivated. Because mushrooms of many types are coveted by people all around the world, mushroom cultivation is a common practice, both in the large- and small-scale.

In order to understand the value and process of cultivating mushrooms, one must first understand mushrooms themselves. The mushroom's biology, morphology, growth systems, ecological significance, and benefit to humans are discussed first, followed by an investigation into a variety of cultivation methods. The benefits and barriers of mushroom cultivation on a small-scale will be the focus of this literature review.

Overview of Mushroom Biology and Morphology

Fungi are neither plants nor animals. They don't contain chlorophyll like green plants, and therefore cannot photosynthesize (Arora 4; McFarland 3). Modern studies have placed fungi in a separate kingdom called the Kingdom Myceteae. The cell wall of fungi are different in composition from that of plants and have a heterotrophic mode of nutrition, which, unlike animals, is absorptive rather than digestive (Chang 1-2). Some sources use the term Kingdom Fungi (Arora 4; McFarland 3), which is synonymous to Kingdom Myceteae.

“Mushroom” is a word to describe the fruiting body of a fungus. In this sense, a mushroom is only a part of a larger organism (Arora 4, Chang 2). However, many fungi do not produce fruiting bodies, such as Athlete's foot fungus, bread molds, yeasts, and mildews (Arora 4). The term “mushroom” can also be applied in a more restrictive sense, as fleshy fungi which produce umbrella-shaped fruiting bodies (Arora 4, Chang 3). Chang continues by stating that the definition of the word mushroom has varied throughout history and between different countries, yet explicitly defines the term in his book: “a mushroom is a macrofungus with a distinct fruiting body which can either be epigeous (above ground) or hypogeous (under ground) and large enough to be seen with the naked eye and to be picked by hand” (2).

Although mushrooms vary in size, shape, texture, and color depending on the species and growing conditions, there are some common characteristics. David Arora states that the gilled mushroom is the most common type of fruiting body, consisting of a cap, gills, and usually a stalk. The cap supports the spore-producing gills. A veil may also be present, which is the tissue which protects the mushroom as it develops. As the mushroom continues developing the veil sometimes ruptures and

leave remnants, a ring (annulus) when clinging below the cap on the stalk or a volva when at the base of the stalk (Arora 4, 15-16).

Growth

Having a basic understanding of mycelial and mushroom growth is imperative before attempting to cultivate mushrooms. David Arora clearly lays out the growth for gilled mushrooms in *Mushrooms Demystified*: Once spores land in an environment with favorable growing conditions, they may germinate by sending out a germ tube which branches to form hyphae, which are a series of threadlike cells. Once two spores of different but compatible strains germinate close to each other, the hyphae merge and grow rapidly to form a complex network called mycelium or spawn. If the mycelium has enough energy to continue growing, some hyphae will bundle together and form fruiting bodies (Arora 5). Paul Stamets in *The Mushroom Cultivator* makes it clear that the mycelium will only produces fruitbodies "under optimum conditions of temperature, humidity and nutrition" (5). Arora continues by explaining that when a young fruiting body has established its cap and stem which are not fully expanded, it is called a button. The stem elongates and pushes the cap above the surface of the ground (or other substrate). The cap opens up and the veil (if present) breaks, exposing the gills on which spores form (Arora 5). Stamets encapsulates magnitude of mycelial growth in *Growing Gourmet and Medicinal Mushrooms* by expressing that mycelial colonies are interspersed within all landmasses, with more than a mile of cells in a cubic inch of soil (xiii).

Natural, Cultural, and Ecological Significance

Cultivating mushrooms outdoors is dubbed "natural culture" in *Growing Gourmet and Medicinal Mushrooms*. It is the process of establishing a sustainable mycological landscape by allowing a continual flow of organic debris to feed the mushrooms (21). Whether one is a small-scale gardener or a commercial farmer, it is essential to understand the ecological behaviors of mushrooms in order to successfully grow them.

Similar to most lifeforms, the ecological significance of the mushroom mainly revolves around feeding behaviors. Shu-Ting Change describes in his book *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact* that unlike plants with chlorophyll, fungi derive their food from complex organic matter found in dead or living tissues of plants and animals (6). McFarland, Arora, and Stamets all consider fungi to be "nature's recyclers," feeding on dead (and occasionally living) matter to reduce complex organic compounds to simpler forms to be utilized by plants (4; 6; xiii). McFarland highlights the importance of this task by explaining that if fungi didn't exist, much of the nutrients would be locked inside dead plant material, causing new plants to starve in the depleted soil (4). Fungi can be separated into three distinct categories based on how they feed: saprophytic, mycorrhizal/mutualistic symbiotic, and parasitic.

Saprophytic

According to *Growing Gourmet and Medicinal Mushrooms*, most gourmet cultivated mushrooms are saprophytic (Stamets 11). Saprophytic fungi obtain their nutrients from dead organic material, such as wood debris (Arora 6-7). Because of this, they are generally known as wood-

decomposing fungi, though some varieties can grow in agricultural crop residues, animal dung, or other material (Chang 7). Stamets separates saprophytic fungi into three groups: primary, secondary, and tertiary decomposers. Primary decomposers are fast-growing and are first to attach mycelium to plant tissue using enzymes. Oyster mushrooms and Shiitake are primary decomposers. Secondary decomposers grow from a composted material and increase available nitrogen, releasing heat, ammonia, and carbon dioxide. The Button Mushroom is a secondary decomposer. Fungal tertiary decomposers are typically soil-dwellers, such as *Panaeolus subbalteatus*, which causes annoyance for mushroom cultivators by growing in the discarded compost from Button mushrooms (Stamets, "Growing Gourmet" 11-12).

Mycorrhizal/Mutualistic Symbiotic and Parasitic

Arora, McFarland, and Stamets define mycorrhizal fungi as fungi which form a symbiotic relationship with rootlets of trees and other plants (6-7; 5-7; 5). The mycelia of the mychorrizal mushrooms either form a sheath over the root or invade the root (Stamets, "Growing Gourmet" 5) to accelerate plant growth by increasing the plant's absorption of nutrients, nitrogenous compounds, and other essential elements, as well as aiding in disease resistance (Arora 6-7). Parasitic fungi feed on living organisms and cause harm to, and sometimes kill, the host (Arora 7; Chang 7). According to Arora, very few types of parasitic fungi are mushrooms and not many are edible (7).

Impact on Human Welfare: Past, Present, and Future

Mushrooms have played an important role throughout human history, beginning in ancient times (Stamets, "The Mushroom Cultivator" xv). Beginning in the Paleolithic era, mushrooms were first consumed by foragers. A cave painting dating back to 5000 years B.C. depicts mushrooms with electrified auras. The over-5000-year-old iceman who was discovered in the Italian Alps in 1991 was equipped with a string of dried mushrooms and tinder fungus. The fungi are thought to have had spiritual significance in addition to practical, perhaps used for starting fires or medicine for treating wounds. Enemies of Claudius II and Pope Clement VII killed each of them with poisonous mushrooms, and legend tells that Buddha died from consuming an underground mushroom which was given to him by a peasant (Stamets, "Growing Gourmet" 1-2).

Mushroom cultivation in particular has a diverse history full of varying practices from all around the world. Chang states that mushroom cultivation began in China in A.D. 600 when *Auricularia auricula* was grown on wood logs (1). Arora states that the Shiitake mushroom may have been the first mushroom cultivated by humans (31). Chang continues by explaining that the biggest advance in mushroom cultivation occurred in France around 1600 when *Agaricus bisporus* was cultivated on a large scale on composted substrate. This mushroom would eventually become the most popularly cultivated mushroom in the world, today known as the Button Mushroom (Chang 1). According to "Growing Mushrooms Commercially—Risks and Opportunities" commercial production began in the United States in the 1880s, and today is a crucial part of many American diets (Barney 1).

Mushroom production and consumption tendencies vary all around the world, though it is clear that the edible mushroom market is an economically successful one. Chang states that in 1999, over 7 million tons of mushrooms were cultivated globally, which is estimated to value more than $30 billion.

In regards to developing countries, mushroom cultivation and processing has been economically beneficial for countries such as China and India, and the economic growth has resulted in social and health improvements (Chang 11). In the United States, there is a large market for mushrooms as well. According to the National Agricultural Statistics Service, the value for the 2012-2013 season mushroom crop totaled $1.11 billion. This amount mainly accounts for *Agaricus* varieties, though $64.7 million was generated by specialty varieties, including Shiitake, Oyster, and other exotics (Mushrooms).

In consideration of current advances in biotechnology and mushroom technology, there is great potential for mushrooms to make a significant impact in the future (Chang 11-24). According to Chang, mushrooms have been proven to convert large amounts of lignocellulosic biomass waste from food processing into human food and produce biomedicinal products. Instead of carelessly disposing of by-product materials such as coffee grounds or cereal straw, the "waste" can be used to grow mushrooms, and the residue can be composted for later use as fertilizer. Not only is this biomass a sustainable energy source, but the conversion can both decrease pollution and supply extra food and medicine to be made available to growing populations (Chang 11, 23). Stamets supplements these claims by stating that "working with mushroom mycelium *en masse* will empower every county, farm, recycling center, and individual with direct economic, ecological, and medical benefits... As we begin a new century, myco-technology is a perfect example of the equation of good environmentalism, good health, and good business" ("Growing Gourmet" xiii).

Common Edible Species

There are thousands of varieties of mushroom which are consumed by humans. According to *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact*, the most commonly consumed mushroom around the world is *Agaricus bisporus*, which is also known as the Button or Portobello mushroom (21). The Shiitake mushroom, *Lentinus edodes*, accounted for about 25% of the world's cultivated mushroom in 1997 (Chang 237). The Oyster mushroom, *Pleurotus*, is the third most popular mushroom worldwide, and there are over 1000 varieties of *Pleurotus* alone (Chang 315). These three varieties are most consumed because they are the most commonly produced, and therefore have widespread availability. There are also mushrooms which are cultivated on the small-scale or harvested in the wild for commercial purposes. The Maitake mushroom, *Grifola frondosa*, is often found in large quantities at the base of oak trees, but can be cultivated by experienced growers as well (Chang 376-378). The Morel, *Morechella*, is one of the most coveted mushrooms, with mushroom hunters fetching more money for this mushroom than any other. "Morels are one of the most enigmatic of all fungi," and much of its growth processes remain a mystery to even the most experienced cultivators (Stamets, "Growing Gourmet" 422). Other mushrooms have never been successfully cultivated by humans due to their complex and sensitive growing habits. One example of this is the Chanterelle, or *Cantharellus*. The Chanterelle is one of the most popular mushrooms to be collected in the wild, generating a "multi-million dollar business" (Stamets, "Growing Gourmet" 8). However, humans have yet to successfully grow this mushroom to fruitbody stage (8).

Nutrition

Mushrooms of all kinds are nutritious in many ways. The basic nutritional information of

mushrooms can be found in Appendix F.

Other Properties

Medicinal

Since ancient times mushrooms have been revered for their therapeutic (Chang 1) and medicinal value, and researchers are still recognizing medicinal benefits today. *Ganoderma* mushrooms have been valued in China for their medicinal properties for over 2000 years (Chang 22) and, according to Arora, modern studies have shown that these mushrooms may strengthen the immune system. The Japanese attribute similar health benefits to Shiitake (Arora 30). Galactomannan is a complex sugar found in Yellow Morel mushrooms which can stimulate the immune system (McFarland 17). The medicinal value of certain types of mushrooms makes them a sought-after commodity, and valuable merchandise to the growers.

Toxic

Certain mushrooms can be harmful to humans if consumed, and some sources make a point to address this very real danger. Mushroom cultivators should be especially aware of this information. Arora defines a mushroom toxin as a compound within a mushroom which produces an abnormal effect on the body when consumed (892). Arora, Chang, and McFarland agree that there are many types of mushroom toxins, each with varying effects and intensities, generally resulting in nausea, diarrhea, and vomiting. In some cases death may occur (892; 5; 20). Arora states that most cases of mushroom poisoning are a result of hypersensitivity (similar to allergies), overindulgence, or food poisoning (892). McFarland points out that some toxins, such as ibotenic acid, can cause hallucinations, convulsions, and anxiety by attacking the nervous system (20). Carelessness and ignorance when consuming mushrooms are frequently the causes of mushroom poisoning, and mushrooms should never be consumed unless its edibility is verified (Arora 892-896). Some toxins, like psilocybin, may produce hallucinogenic symptoms. Arora states that mushrooms containing psilocybin or psilocin are well-known for their psychedelic properties and are often consumed recreationally. The symptoms of ingesting hallucinogenic mushrooms are similar to LSD, and include heightened color perception, visual distortions, hallucinations, and delusions. Hallucinogenic mushrooms were used during the religious rituals of Native Americans in Mexico and Central America (Arora 895). Although some are dangerous, Chang eases one's mind by pointing out that poisonous mushrooms represent less than 1% of the world's known mushrooms, yet it is important to recognize such potentially harmful species (Chang 5).

Small-Scale Cultivation

Although scientists have identified over 10,000 mushroom species, only about 100 have been successfully cultivated by humans (Stamets, “Growing Gourmet” 17). After coming to an understanding of the mushroom's biology, morphology, ecological significance, and benefit to humans, it is reasonable to delve into the different cultivation methods of mushrooms for a small-scale operation. Addressing mushroom cultivation before ensuring at least a basic understanding of fungi and

mushrooms as organisms may result in failure to successfully cultivate them.

Paul Stamets' *The Mushroom Cultivator* and *Growing Gourmet and Medicinal Mushrooms* offer comprehensive guides to the cultivation of various kinds of mushrooms using multiple techniques. Stamets claims that no matter the species of mushroom, the steps to cultivate follow the same basic pattern: preparation and pouring of agar media into petri dishes, germination of spores and isolation of pure mushroom mycelium, expansion of mycelial mass on agar media, preparation of grain media, inoculation of grain media with pure mycelium grown on agar media, incubation of inoculated grain media (spawn), inoculation of grain spawn into bulk substrates, covering of substrate with a moist mix of peat and other materials, initiation—lowering temperature, increasing humidity to 95%, increasing air circulation, decreasing carbon dioxide and/or introducing light, and copping—maintaining temperature, lowering humidity to 85-92%, maintaining air circulation, carbon dioxide, and/or light levels (Stamets, "The Mushroom Cultivator" 3). A visual diagram of this process can be found in Appendix G.

Spawn is any type of mycelium which can be inoculated (mixed) into a substrate by a cultivator. For most cultivators, purchasing spawn from a company to inoculate a substrate seems to be the easiest way to cultivate mushrooms, as steps 1-4 would already be complete. It is important to consider, however, that spawn is a living organism and only remains in a healthy state for about 2 months. After that period, the spawn may become diseased. For the casual grower, purchasing commercial spawn is the best option. Commercial growers should generate their own spawn to assure quality control, generate proprietary strains, reduce expenses, increase colonization speed, and gain insight into the mushroom life cycle. (Stamets, "Growing Gourmet" 60-61)

Indoor Cultivation

According to "The Mushroom Cultivator", generating one's own spawn must occur indoors (Stamets 16). The air is filled with microscopic organisms who will compete with mushrooms for space and nutrients. The risk of contamination is high, so it is crucial that a sterile laboratory is constructed. To maintain sterility, the laboratory must be equipped with many tools, including a bunsen burner to sterilize tools, a spray bottle of 10% bleach solution for cleaning, sterile petri dishes, an agar knife, an inoculating loop, and an airtight glovebox for still air transfers (Stamets, "The Mushroom Cultivator" 16-28). The mushroom culture is generated either from a mushroom's spores after taking a spore print (23-28) or from live tissue of a mushroom (29-31). After the culture is developed in a petri dish, it is inoculated into sterilized grain media, such as wheat or rye, to generate mycelial growth. This procedure will result in grain spawn, which can be added to a variety of substrates to grow mushrooms (42-59).

If the cultivator decides to bypass the process of generating their own spawn, they may purchase spawn from a reputable retailer. After the spawn is obtained, either by generating or purchasing it, the spawn is placed in a substrate, usually consisting of compost or a wood-based substrate such as sawdust blocks or pasteurized straw. The mushrooms may be grown indoors in trays, on shelves, or in plastic bags. For optimal growth, the structure which contains the growing system should be well-ventilated, well-insulated, and allow for temperature and humidity control (Stamets, "The Mushroom Cultivator" 62-120).

Outdoor Cultivation

For outdoor growth, a cultivator may also begin with spawn which has been personally generated or purchased from a retailer. The spawn must be placed in a substrate or within logs which allows for mycelial growth and ultimately fruiting.

In addition to indoor cultivation, Stamets offers comprehensive step-by-step guides for outdoor cultivation in both *The Mushroom Cultivator* and *Growing Gourmet and Medicinal Mushrooms*. The processes he suggests for outdoor growth are concisely summarized in Barney's "Growing Mushrooms Commercially—Risks and Opportunities". For log growth, which is common for cultivating mushrooms which naturally grow on trees and stumps (such as Oyster or Shiitake mushrooms), log sections are inoculated with spawn (a starter mix of fungal mycelium and sawdust or grain) and set aside to allow the fungi to develop. Shade cloth is often used to keep environments moist and dark when growing on outdoor logs. The development period (spawn run) can last 6 to 18 months, depending on the log species, diameter, moisture, and temperature. At the end of the spawn run, the logs are transferred to a cool, moist area where the fruiting bodies develop and are harvested (Barney 3-4)

The process of cultivating mushrooms in blended substrates consisting of agricultural byproducts is also comprehensively addressed by Stamets, yet it is also beneficial to consider outside studies, such as the Basal, Peker, Yalinkilic, Temiz study on the "Cultivation of Oyster mushroom on waste paper with some added supplementary materials". After experimenting with Oyster mushroom spawn in a variety of substrates, they concluded that the addition of peat and chicken manure resulted in yield losses, perhaps due to the high nitrogen content. Basal et al. concluded that addition of rice husk to the substrate positively affected the cultivation properties (97). It is worth noting that the spawn used in this experiment was supplied by Fungi Perfecti, a company founded by Paul Stamets himself.

Common Cultivable Species

Arora sums up the mushrooms which are easy to cultivate. Shiitake, one of the first cultivated mushrooms, is native to Japan but is now commonly grown in the United States (31). The Oyster mushroom can be cultivated in a wide variety of substrates, making this mushroom one of the easiest to grow. Although Oyster mushrooms are typically seen growing on trees in the wild, they are often cultivated on coffee grounds, sawdust, magazine paper, or logs, and can produce many large clusters of fruiting bodies regularly (134). The Button mushroom is nicknamed "the cultivated mushroom" because it is one of the most commonly commercially-cultivated mushrooms. The United States alone cultivates over a half billion pounds of Button mushroom per year. Although major fruiting occurs in the fall and winter, large-scale cultivators are able to produce this mushroom year-round using indoor cultivation methods (Arora 318-319). Table 1 lists some growth parameters of the three most cultivated mushroom varieties, found in Paul Stamets' *The Mushroom Cultivator*.

Table 1: Growth Parameters by Variety

Variety	Spawn Medium	Fruiting Substrate	Spawn Run	Pinhead Initiation	Cropping
Shiitake *(Lentinus edodes)*	Pre-soaked wooden dowels or a 4:1 sawdust/bran mixture	Oak or adler logs, 4-6 inches in diameter, 3 foot lengths	Relative humidity: 60-75% for logs; 90% for sawdust Substrate temperature: 77°F Duration: 6-12 months for cut logs; 30-60 days for sawdust blocks Light: None required	Initiation: Submerge logs and blocks in cold water for 24-72 hours Relative humidity: 95% Duration: 7-14 days after soaking Light: Ambient natural light	Relative humidity: 85-90% Air temperature: 59-68°F Duration: 3-5 years on oak logs; 2-3 years on adler Light: Ambient natural light
Oyster (*Pleurotus ostreatus*)	Rye grain	Cereal straw, 75% moisture, pasteurized by submerging in a 160°F water bath for 30-45 min	Relative humidity: 90-100% Substrate temperature: 78-84°F Duration: 10-14 days Light: Incubation in total darkness	Relative humidity: 95% Air temperature: 55-60°F Duration: 7-14 days Light: 2000 lux/hour for 12 hours/day	Relative humidity: 85-92% Air temperature: 60-64°F Duration: 5-7 weeks Light: 2000 lux/hour for 12 hours/day
Button (*Agaricus bisporus*)	Rye grain buffed with calcium carbonate	Nitrogen-enriched wheat straw and/or horse manure	Relative humidity: 90-100% Substrate temperature: 76-78°F Duration: 2 weeks	Relative humidity: 95-100% Compost temperature: 65-70°F Air temperature: 62-65°F Light: None required	Relative humidity: 85-92% Substrate temperature: 62-65°F Duration: 7-10 days Light: None required

Source: Stamets, “The Mushroom Cultivator”

Conclusion

From the reviewed literature, it is evident that mushrooms and other fungi are organisms with many dimensions, all of which should be taken into account by those who are interested in cultivating them. Not only do mushrooms play an important role in nature as decomposers, but they have played an important role in the lives of humans for thousands of years. As the small-scale grower familiarizes themselves with the many aspects of the mushroom, from biology to history to nutrition to cultivation, their ability to successfully cultivate them increases.

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Appendix B — Research Timeline, September to December 2013

Week of September 8-14: Contact local mushroom experts by email, arrange meetings. Continue mushroom research. Meet with Dr. Simeone to discuss ideas, draft a fungiculture program plan, and compile list of potential mushroom buyers. Identify barriers.

Week of September 15-21: Continue research, begin compiling sources for Literature Review. Revise IRB Proposal. IRB Research Project Application due Thursday. Conduct phone interview with Tina Sipula of Clarehouse. Conduct exploratory research at Trailside Farmers' Market.

Week of September 22-28: Meet with Jan Turner at Downtown Bloomington Farmers' Market, continue exploratory research at Farmers' Market. Draft Market Customer Questionnaire. Draft interview questions for key informants. Set up meeting with Bill Davison. Continue research and finish Literature Review Outline, due Sunday.

Week of September 29-October 5: Interview Jan Turner and Julian Gorski, help with log inoculation. Meet with manager of First Wok. Interview Bill Davison. Meet with Peace Garden workers to discuss plan and duties. Research Project Proposal and (revised?) Literature Review Outline due Thursday. Revise Peace Garden consumer study.

Week of October 6-12: Peer response #1 due Monday. Revise Research Project Report. Meet with Eric Nelson. Interview Anonymous mushroom grower. Administer Market Customer Questionnaire at the Downtown Bloomington Farmers' Market.

Week of October 13-19: Complete rendering of questionnaire data. Revise report. Meet with Dr. Brown. Set up meetings with Dr. Simeone and Dr. Munro.

Week of October 20-26: Collect, analyze, render data. Write. Administer Market Customer Questionnaire at the IWU Peace Garden Quad Market. Meet with Dr. Simeone and Dr. Munro. Draft questions for focus group.

Week of October 27-November 2: Conduct focus group interview. Meet with Carl Teichman. Interview Dr. Brown and Carolyn Ashley.

Week of November 3-9: Research Project Report Draft due Sunday. Meet with Carl Teichman. Begin outline for PowerPoint presentation.

Week of November 10-16: Peer response #2 due Monday. Revise Research Project Report. PowerPoint presentation due Thursday. Practice presentation.

Week of November 17-23: Present to the class. Revise PowerPoint presentation. Continue revising Research Project Report. Interview Stu Hummel.

Week of November 24-30: Revised PowerPoint presentation due Sunday. Continue revising Research Project Report. Final Research Project Report due Tuesday. Practice PowerPoint presentation.

Week of December 1-7: Formal Community Briefing #1 on Tuesday.

Week of December 8-14: Formal Community Briefing #2 on Monday. Research diary and consent forms due Tuesday.

Appendix C — List of Key Informants

Farmers and Gardeners Familiar with Small-Scale Mushroom Cultivation
Bill Davison, Extension Educator, University of Illinois Extension, Champaign-Urbana, IL.
Julian Gorski, Gardener, Normal, IL.
Anonymous Grower, Central IL.
Stu Hummel, Vice President and Chef de Cuisine, Epiphany Farms Enterprise and Station 220 Restaurant, Bloomington, IL.
Jan Turner, Gardener and Vendor at the Downtown Bloomington Farmers' Market, Native Plants of Illinois, Normal, IL.
Tina Sipula, Owner, Clare House, Bloomington, IL.

Managers of Foodservice Institutions which Buy from the IWU Peace Garden
Stu Hummel, Vice President and Chef de Cuisine, Epiphany Farms Enterprise and Station 220 Restaurant, Bloomington, IL.
David Nicholson, General Manager of Residential Dining, Sodexo Campus Services at IWU, Bloomington, IL.
Tina Sipula, Owner, Clare House, Bloomington, IL.
Jack Zhang, Owner, First Wok, Bloomington, IL.

Peace Garden Collaborators at Illinois Wesleyan University
Carolyn Ashley, Garden Manager, IWU Peace Garden, Bloomington, IL.
Dr. Craig Broadbent, Assistant Professor of Economics, Illinois Wesleyan University, Bloomington, IL.
Dr. Laurine Brown, Environmental Studies Program Coordinator and Faculty, Illinois Wesleyan University, Bloomington, IL.
Dr. William Munro, Spring 2014 Peace Garden Faculty Advisor, Illinois Wesleyan University, Bloomington, IL.
Eric Nelson, Manager of Grounds Services, Illinois Wesleyan University, Bloomington, IL.
Carl Teichman, Director of Government and Community Relations, Illinois Wesleyan University, Bloomington, IL.

Extension
Bill Davison, Extension Educator, University of Illinois Extension, Champaign-Urbana, IL.

Appendix D — Market Customer Questionnaire

This questionnaire was administered to shoppers at the Downtown Bloomington Farmers' Market on October 12th, 2013 and at the Peace Garden Market on October 24th, 2013 to gauge customers' familiarity of mushrooms of particular varieties and to determine which mushroom varieties were likely to be purchased and consumed. The questions in the Market Customer Questionnaire were developed based on informal correspondence with vendors and customers at both the Trailside Farmers Market in Normal and the Downtown Bloomington Farmers' Market.

QUESTION 1: Hello, my name is Mack Rivkin, and I am a senior at Illinois Wesleyan University. I am conducting a research project for my Environmental Studies 480 Senior Seminar class, and I am interested in obtaining consumers' perception of their food. This research has been approved by the University's Institutional Review Board. This survey should take about 5-7 minutes. If you are able to fill it out, your help would be greatly appreciated. Any information you share will be anonymous and confidential; there will be no way to connect the information you have shared back to you. If you feel uncomfortable at any time you may refuse to answer questions or stop at any moment. If you have any questions, you may contact the professor of the course, Dr. Laurine Brown at 309-556-1067 or lbrown@iwu.edu. You may also contact the Chair of the IWU Institutional Review Board, Dr. Brian Brennan, at 309-556-3972 or bbrenna1@iwu.edu.
Thank you for your time. Do you give your consent?
○ Yes
○ No

QUESTION 2: What percentage of food would you say you purchase for your household?
○ Less than 50%
○ 50% or more

QUESTION 3: On the following page you will be presented with **FIVE (5)** variety of mushroom types, each with corresponding pictures and a short description. Please read the information presented, then mark whether you recognize the mushroom, whether or not you have consumed the mushroom, and then rank the likelihood of purchasing and consuming the mushroom.

Button Mushroom (*Agaricus brunnescens*)

One of the most popular mushrooms to be consumed in North America and Europe, the Button Mushroom has a mild flavor and a thick, smooth texture. It is commonly eaten in stir-fries, soups, and on pizzas.

Familiarity	This mushroom is familiar to me	This mushroom is somewhat familiar to me	This mushroom is not familiar to me
Please mark one	○	○	○
Consumption	I have consumed this mushroom	I'm not sure if I have consumed this mushroom	I have not consumed this mushroom
Please mark one	○	○	○

	Not Likely	Fairly Likely	Moderately Likely	Very Likely	Extremely Likely
Likelihood of Purchase	○	○	○	○	○
Likelihood of Consumption	○	○	○	○	○

Shiitake Mushroom (*Lentinula edodes*)

A traditional delicacy in Japan, Korea, and China, the Shiitake Mushroom is now the most popular gourmet mushroom. It is eaten all over the United States, commonly sauteed in oil, served in soups, and used as a meaty substitute in vegetarian dishes.

Familiarity	This mushroom is familiar to me	This mushroom is somewhat familiar to me	This mushroom is not familiar to me
Please mark one	○	○	○
Consumption	I have consumed this mushroom	I'm not sure if I have consumed this mushroom	I have not consumed this mushroom
Please mark one	○	○	○

	Not Likely	Fairly Likely	Moderately Likely	Very Likely	Extremely Likely
Likelihood of Purchase	○	○	○	○	○
Likelihood of Consumption	○	○	○	○	○

Portobello/Portabella (*Agaricus brunnescens*)

This mushroom is actually a fully-grown Button Mushroom. The meaty Portobello is frequently stuffed, sliced for a stir-fry, or grilled as a substitute for meat in vegetarian dishes. Its mild flavor and thick flesh allow for versatility in the kitchen.

Familiarity	This mushroom is familiar to me	This mushroom is somewhat familiar to me	This mushroom is not familiar to me
Please mark one	○	○	○
Consumption	I have consumed this mushroom	I'm not sure if I have consumed this mushroom	I have not consumed this mushroom
Please mark one	○	○	○

	Not Likely	Fairly Likely	Moderately Likely	Very Likely	Extremely Likely
Likelihood of Purchase	○	○	○	○	○
Likelihood of Consumption	○	○	○	○	○

Maitake/Hen-of-the-Woods Mushroom (*Grifola frondosa*)

This protein-rich mushroom is commonly sought after in Japan and the United States, not only because it is delicious, but because it has a variety of medicinal and immune-system boosting qualities. The Maitake can be sauteed like Shiitake, or stuffed and baked like Portobello.

Familiarity	This mushroom is familiar to me	This mushroom is somewhat familiar to me	This mushroom is not familiar to me
Please mark one	○	○	○
Consumption	I have consumed this mushroom	I'm not sure if I have consumed this mushroom	I have not consumed this mushroom
Please mark one	○	○	○

	Not Likely	Fairly Likely	Moderately Likely	Very Likely	Extremely Likely
Likelihood of Purchase	○	○	○	○	○
Likelihood of Consumption	○	○	○	○	○

Shimeji/Beech Mushroom (*Hypsizygus tessulatus*)

This firm-textured mushroom, originally from Japan, is now popular in Asian-American cuisine. When eaten raw, the mushroom is slightly crunchy and has a mild nutty flavor. When cooked in soups or paired with meat, the flavor dimensions of this mushroom undergo a variety of interesting changes.

Familiarity	This mushroom is familiar to me	This mushroom is somewhat familiar to me	This mushroom is not familiar to me
Please mark one	○	○	○
Consumption	I have consumed this mushroom	I'm not sure if I have consumed this mushroom	I have not consumed this mushroom
Please mark one	○	○	○

	Not Likely	Fairly Likely	Moderately Likely	Very Likely	Extremely Likely
Likelihood of Purchase	○	○	○	○	○
Likelihood of Consumption	○	○	○	○	○

QUESTION 4: Are there any other varieties of mushroom which you would be interested in purchasing and/or consuming? If so, please list below.

DEMOGRAPHIC INFORMATION

QUESTION 5: How would you best describe yourself?
○ Male
○ Female
○ Other
QUESTION 6: What is your highest level of education completed?
○ Some High School
○ High School Graduate or Equivalent
○ Some College
○ College Graduate
○ Some Post Graduate Work
○ Post Graduate Degree
QUESTION 7: What is your annual household income?
○ Less than $24,999
○ $25,000 to $49,999
○ $50,000 to $74,999
○ $75,000 or more
QUESTION 8: Which community do you live in?
○ Bloomington/Normal IL
○ Other (please specify) _____

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

Appendix E — Demographic Results from the Market Customer Questionnaire

Downtown Bloomington Farmers' Market

Question 2: What percentage of food do you purchase for your household?

N = 30	Answer	Response	%
	Less than 50%	7	24%
	50% or more	22	76%
	Total	29	100%

Question 14: How would you best describe yourself?

N = 30	Answer	Response	%
	Male	12	40%
	Female	17	57%
	Other	1	3%
	Total	30	100%

Question 15: What is your highest level of education completed?

N = 30	Answer	Response	%
	Some High School	0	0%
	High School Graduate or Equivalent	0	0%
	Some College	11	37%
	College Graduate	12	40%
	Post Graduate Work	1	3%
	Post Graduate Degree	6	20%
	Total	30	100%

Question 16: What is your household income?

N = 30	Answer	Response	%
	Less than $24,999	6	21%
	$25,000-$49,999	5	18%
	$50,000-$74,999	5	18%
	$75,000 or more	12	43%
	Total	28	100%

Question 17: What community do you live in?

N = 30	Answer	Response	%
	Bloomington/Normal, IL	24	80%
	Other (please specify)	6	20%
	Total	30	100%

Peace Garden Quad Market

Question 2: What percentage of food do you purchase for your household?

N = 13	Answer	Response	%
	Less than 50%	11	85%
	50% or more	2	15%
	Total	13	100%

Question 14: How would you best describe yourself?

N = 13	Answer	Response	%
	Male	3	23%
	Female	10	77%
	Other	0	0%
	Total	13	100%

Question 15: What is your highest level of education completed?

N = 13	Answer	Response	%
	Some High School	0	0%
	High School Graduate or Equivalent	0	0%
	Some College	12	92%
	College Graduate	1	8%
	Post Graduate Work	0	0%
	Post Graduate Degree	0	0%
	Total	13	100%

Question 16: What is your household income?

N = 13	Answer	Response	%
	Less than $24,999	3	25%
	$25,000-$49,999	1	8%
	$50,000-$74,999	1	8%
	$75,000 or more	7	58%
	Total	12	100%

Question 17: What community do you live in?

N = 13	Answer	Response	%
	Bloomington/Normal, IL	9	69%
	Other (please specify)	4	31%
	Total	13	100%

Appendix F — Nutritional Information

Protein	The protein content of mushrooms, in general, are around 3.5 to 4% their fresh weight. That 2 times the protein of asparagus, 4 times that of oranges, and 12 times that of apples. The protein content of dried mushrooms is 19 to 35%, which is compared to 13.2% in wheat and 25.2% in milk. In crude protein, mushroom rank below meats but higher than most other foods. (Chang 28)
Essential Amino Acids (EAA)	The most abundant EAA found in mushrooms is lysine (Chang 30)
Fat	The fat content of mushrooms of different varieties ranges from 1.1 to 8.3% on a dry weight basis, averaging 4%. At lease 72% of these fatty acids have been found to be unsaturated. Unsaturated fatty acids are essential in our diet, whereas saturated fatty acids, found in high amounts in animal fats, may be harmful to our health. This is a significant factor in regarding mushrooms as a health food. (Chang 31)
Vitamins	Edible mushrooms are a good source of thiamine (vitamin B1), riboflavin (vitamin B2), niacin, biotin, and ascorbic acid (vitamin C). (Chang 31)
Fiber	The fiber content in *Pleuotus* species ranges from 7.4 to 27.6%, as compared to 10.4% in *A. bisporus*. Fiber is an important ingredient in a balanced diet. (Chang 34)

Figure 1: Nutrition Facts for White Button Mushroom

Nutrition Facts

Serving Size 5 medium (84g/3.0 oz)
Servings Per Container about 5

Amount Per Serving

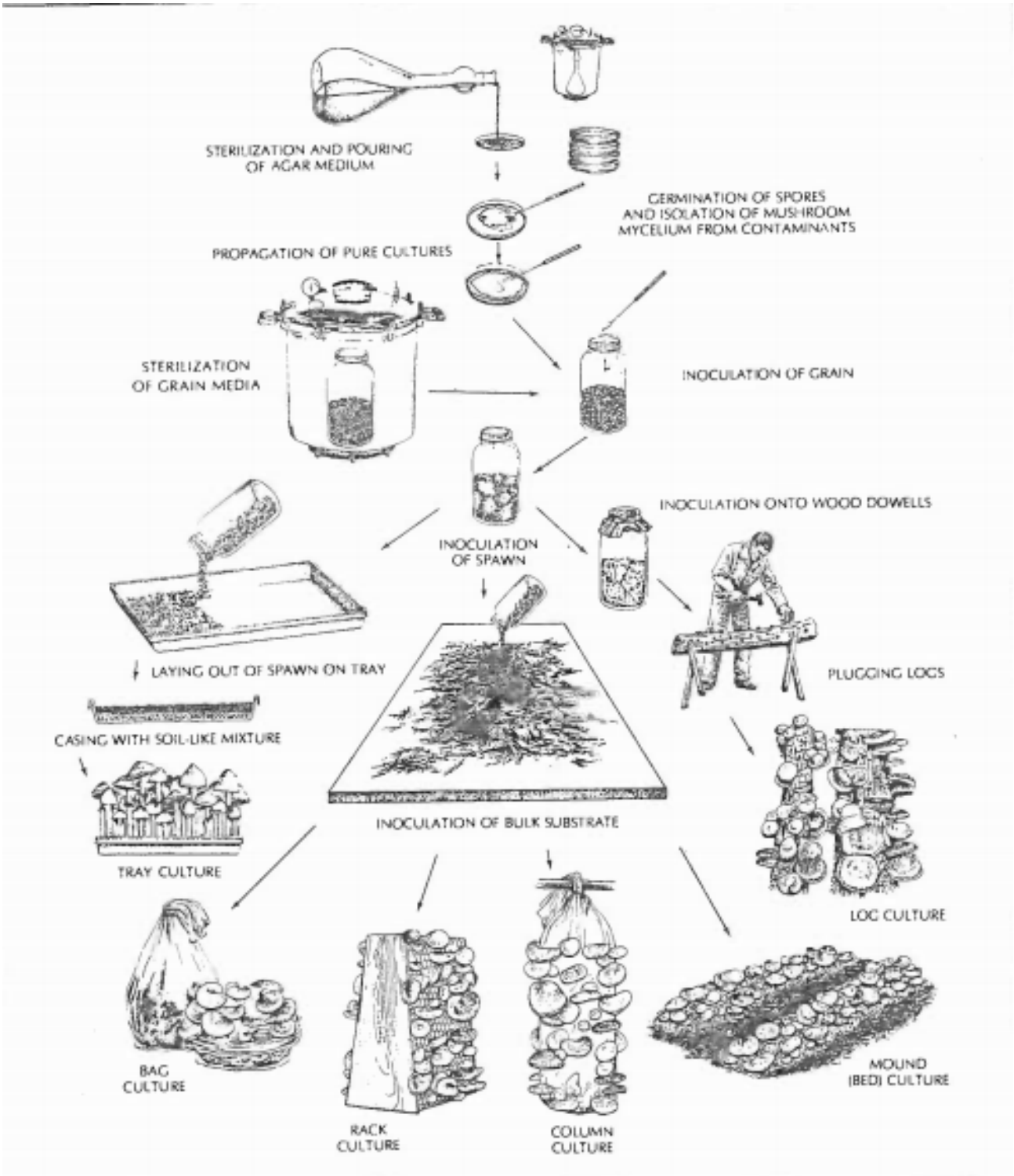
Calories 20	Calories from Fat 0
	% Daily Value*
Total Fat 0g	**0%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 0mg	**0%**
Potassium 300mg	**9%**
Total Carbohydrate 3g	**1%**
Dietary Fiber 1g	**4%**
Sugars 0g	
Protein 3g	

Vitamin A 0%	• Vitamin C 2%
Calcium 0%	• Iron 2%
Vitamin D 2%	• Thiamin 4%
Riboflavin 20%	• Niacin 15%
Vitamin B6 4%	• Folate 4%
Pantothenic Acid 15%	• Phosphorus 8%
Magnesium 2%	• Zinc 2%
Selenium 10%	• Copper 15%
Manganese 2%	

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500 mg	3,500 mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Appendix G – Mushroom Cultivation Diagram



Source: Stamets, "The Mushroom Cultivator"