RESEARCH GUIDE

CULTIVATION OF SHIITAKE MUSHROOMS

AS AN AGROFORESTRY CROP IN THE NORTHEAST

Thank you for choosing to take part in the Shiitake Enterprise Assessment Research project. Over the next three years, with your help, we hope to establish an accurate analysis of what it takes to grow shiitake mushrooms in the northeast and how best to do it. The Northeast Sustainable Agriculture, Research and Education foundation (SARE) has funded us not only to help farmers like you start commercial Shiitake farming, but also to document the process so we can make recommendations to others based on your experience.

Cornell University College of Agriculture and Life Sciences

NORTHEAST SARE Sustainable Agriculture Research & Education

COMMUNITY 4-H & YOUTH ENVIRONMENT AGRICULTURE FOOD
UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

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WELCOME…

Welcome to the project! We are excited to have your help. Over the following pages we will outline the project, what steps you need to take, what information we need from you, and how to properly organize and record that information.

We have tried to make the process as simple as possible, but if you have any questions or concerns about how to fill out the paperwork, please contact Bridgett Jamison, Research Assistant at the Center for Sustainable Agriculture, at either 267-374-9436 or bridgettjamison@gmail.com.

Thank you for your participation in the coming months.

Sincerely,

Bridgett Jamison *(bridgettjamison.shiitake@gmail.com)*
Ken Mudge *(kwm2@cornell.edu)*
Allen Matthews *(allen.matthews@uvm.edu)*

PROJECT OVERVIEW

In 2011, you will acquire and inoculate at least 100 logs with Shiitake spawn. During that time, you will also receive a site visit by one of the experienced project staff. Later, during 2011, you will need to attend a forest mushroom enterprise development workshop. By summer of 2012 or sooner your original 100 logs will be ready for forced fruiting, and you will begin the process of harvesting and marketing.

One of our most important goals is to help you start a commercial shiitake mushroom farm and to document the process as you go. So, record keeping is extremely important. Rather than having you collect and report information on every logs' production, we would like you to organize your 100 logs into five log stacks. All the logs in a single stack will have similar characteristics including tree species, felling date, and inoculation date. The project staff person who visits your farm during inoculation in 2011, will record the diameter of each of your 100 logs. We will use this information to estimate the total log volume of each stack. As the experiment progresses, you will collect, record and report information about each stack of logs -- when a stack was shocked, the daily production of each stack during the fruiting stage, etc. The information will enable us to gain insight as to what species of tree to produce the greatest yields and what sort of profits small scale growers scan expect. In addition to production information, we are also very interested in the time and money you spend during your enterprise development and how this affected the net profit. We therefore also need you to record the number of hours you, your family, friends and/or employees spend on different aspects of the project and the cost of the equipment and supplies purchased. We would like you to generalize what aspect of the project these actions served – the inoculation stage or harvest stage or sales stage for example. Lastly, we need to know where and how you sold your mushrooms.

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It's a lot of information, but it shouldn't take more than one hour a week to record everything. To help you along, one member of our team will visit your site in the spring of 2011 and the summer of 2012. In addition, we will host two workshops that we expect everyone to attend.

GET CONNECTED

JOIN THE MUSHROOM LISTERV

If you have not joined the Mushroom Listserve that we've set up for this research, please feel free to do so today. To get connected to the Mushroom list serve:

Send an email to **listserv@list.uvm.edu**

Leave the Subject line Blank

In the body of the e-mail, type: **subscribe MUSHROOMS *YOUR NAME***
("YOUR NAME" is your first and last name). For example:
subscribe MUSHROOMS Jane Doe

If you receive a confirmation message from LISTSERV asking you to verify your identity, just follow the instructions in the message.

VISIT THE NORTHEAST FOREST MUSHROOM GROWERS NETWORK WEBSITE

The Northeast Forest Mushroom Growers Network website is the official online meeting place for the NE SARE-funded project, *Cultivation of Shiitake Mushrooms as an Agroforestry Crop for New England*. The aim is to provide information about the cultivation of specialty forest mushrooms and foster communication and cooperation among amateur and professional mushroom growers.

The website is located at **http://mushrooms.cals.cornell.edu**. The web site is primarily funded by Northeast Sustainable Agriculture and Education (NE SARE). It also received funding from Hatch, MacIntire Stennis, and Smith Lever grants awarded to Ken Mudge.

You can find a detailed tutorial regarding how to use the site on the homepage. The two most important tools on the website are the map-based directory of mushroom growers, and growers-to-be (SARE project participants) and a Message Board to facilitate communication and networking among growers. Other features you may find useful include:

- A detailed shiitake mushroom cultivation guide
- Videos featuring cultivation procedures including inoculation and harvest technique
- Interactive maps showing the location other shiitake mushroom growers in the Northeast
- Marketing suggestions and a list of selling points
- A message board for connecting with other mushroom farmers and enthusiasts
- A calendar of upcoming workshops and event related to the forest farming of mushrooms.

The following two pages outline the features of the website and provide directions for using the map and message board.

http://mushrooms.cals.cornell.edu

SIDE BAR RESOURCES

Cultivated Mushrooms
Short descriptions about the classification and biology of several forest cultivated mushrooms

Cultivation Guides
Our own step by step instructions for cultivation of several of several mushroom species. Various laying yard methods for stacking logs are covered, including a hillside staking method used in Japan.

Growers Map: A Google based map showing the location and contact information for forest mushroom cultivators in the Northeast. Any forest mushroom cultivator is welcome to be included in the map directory (see details below).

TOP BAR RESOURCES

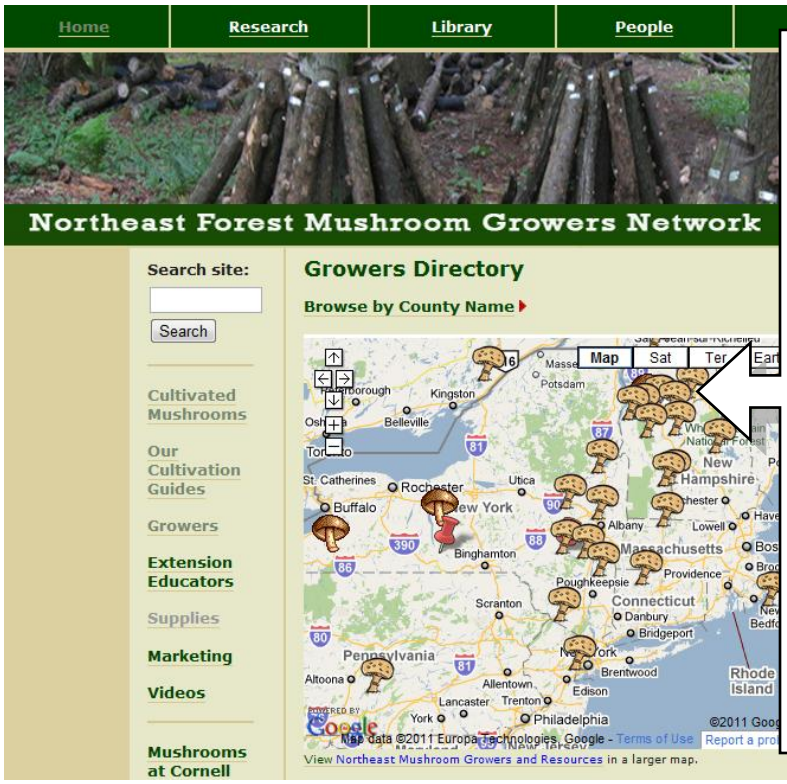
The ***Research*** button will take you to a page summarizing some of the research that has been going on at Cornell by Ken Mudge and his team of graduate and undergraduate students and other research staff. We welcome research submissions by others.

The ***Library*** button will take you to a long list of books, extension publications, and other print and online sources of information about cultivation of forest mushrooms.

The ***People*** button will introduce you to many of the people, past and present, involved in the shiitake research and extension efforts at the University of Vermont and at Cornell, as well as the 4 experienced commercial farmers directly involved in the SARE project as Farmer Advisors.

The ***Calendar*** button will give you information about upcoming forest mushroom-related events. Feel free to submit new events to Ken Mudge, kwm2@cornell.edu.

The ***Contacts*** button is for user feedback to the web site manager about the functioning of the site itself, or you can contact other SARE project personnel about project-related issues. This is not the place to go to ask questions/comments about mushroom cultivation. Please direct mushroom-related questions/comments to the *Message Board* which can be accessed from the home page, as described below.



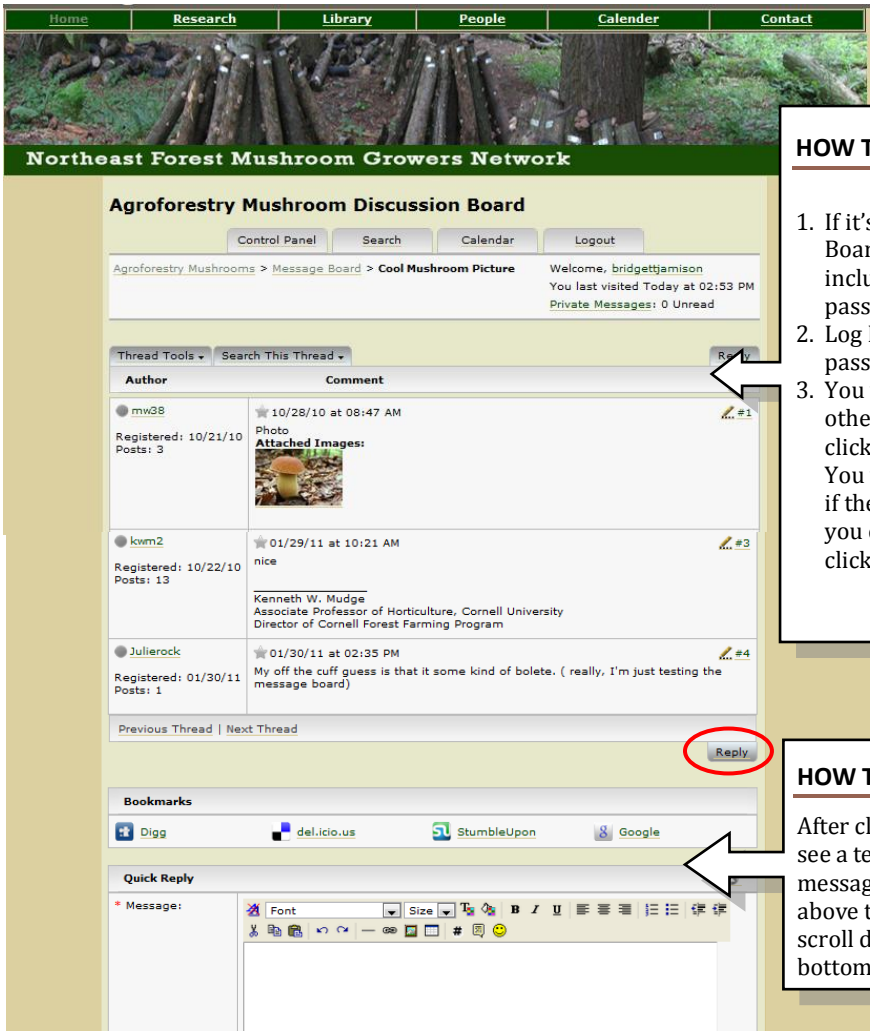
GROWER'S MAP

The basic map is shown in Figure 2. Mushroom icons represent the locations of mushroom cultivators in NY, VT, NH, PA, and MA, and we hope growers in other Northeastern states will join in as well

Clicking on any particular mushroom icon will bring up a window showing name, address, email, phone, web site, and a brief description of the enterprise. A small picture can also be included.

SARE project participants are already (1/2011) represnted by icon and name only. With your permission we will add additional information. Email kwm2@cornell.edu.

Let us know if you want to be removed from the map. If you would like to be added to the map (not just SARE participants) send us your contact information. Email kwm2@cornell.edu



HOW TO USE THE MESSAGE BOARD

1. If it's your first time at the Message Board, register to use the site, which includes choosing a username and password.
2. Log In with that username and password.
3. You will see a list of *Message Subjects* otherwise known as "threads". By clicking on the name of any thread. You will see the original posting and if there is a small thumbnail image, you can open the full sized picture by clicking once on the thumbnail.

HOW TO POST A MESSAGE

After clicking on the reply tab, you will see a text box where you can type your message, using any of the editing tools above the box. When you are done, scroll down to *Post Message* at the bottom of the page.

TASK LIST FOR 2011

- **Acquire 100 logs for the experiment. Be sure to take note of the date the trees were felled -**
  - Record the time it took you to fell and cut trees *(Labor)*
  - Record your expenses while cutting and felling trees *(Expenses)*
  - Record the species of the logs cut *(Stacks)*

- **Stack logs into five crib stacks. Each stack should contain 20 bolts.**
  - Record Tree Species *(Stacks)*
  - Record date the tree was felled *(Stacks)*

- **Inoculate the logs**
  - Set a date with you advisor to inoculate logs
  - Record how much time it took you to inoculate the logs *(Labor)*
  - Record your expenditures on equipment and supplies used during inoculating *(Expenses)*
  - Record the date the logs were inoculated *(Stacks)*

- **Send completed worksheets to Bridgett Jamison through email (bridgettjamison.shiitake@gmail.com) or snail-mail.**
  - Remove and mail the "Log Stacks", "Labor", and "Expenses" Worksheet and mail to
    Attn: Bridgett Jamison
    Center for Sustainable Agriculture
    Jeffords Building Room231
    University of Vermont
    63 Carrigan Drive
    Burlington VT, 05405

- **Attend a Enterprise Assessment and Marketing Workshop in late fall**
  - We will host a one day workshops regarding enterprise assessment at one location in VT and two in the Mid-Atlantic region.
  - Exact date and location will be announced later.

- **Optional: Participate in one of the Introduction to Growing Shiitake Mushrooms Workshops**
  - Exact date and location will be announced later.
  - Invite your friends and neighbors to your own inoculation day

TASK LIST FOR 2012

- ☐ **Begin shocking / forcing stacks of logs (one stack at a time)**
  - Set a date with your project advisor to begin stocking logs.
  - Record the time it took you to shock the logs *(Labor)*
  - Record the stack number and day that the logs were shocked *(Fruiting)*

- ☐ **Begin harvesting Shiitake mushrooms!**
  - Record the first day the logs begin to fruit *(Fruiting)*
  - Record the fresh weight of the mushroom harvested each day *(Fruiting)*
  - Record any expenses you incurred while harvesting mushrooms and preparing them for sale (Expenses)
  - Record the amount of time spent each day harvesting and preparing shiitakes *(Labor)*

- ☐ **Sell the Shiitake Mushrooms!**
  - Record the time it took for you to sell your mushrooms *(Labor)*
  - Record your expenditures on equipment and supplies that went toward sales *(Expenses)*
  - Record the date of sale, where the shiitakes were sold, how much were sold, and how much you made on the sale *(Fresh Sales or Value Added Sales)*

- ☐ **Send completed worksheets to Bridgett Jamison through email (bridgettjamison.shiitake@gmail.com) or snail-mail.**
  - Remove and mail the "Log Stacks", "Labor", and "Expenses", "Fruiting" and "Sales" Worksheets and mail to
    Attn: Bridgett Jamison
    Center for Sustainable Agriculture
    Jeffords Building Room231
    University of Vermont
    63 Carrigan Drive
    Burlington VT, 05405

- ☐ **Attend the *Best Management Practices for Commercial Shiitake Mushroom Production in the Northeast Conference* in late fall.**
  - Location and date to be announced later
  - If you are will to present slides and talk about your experience, please let your advisors know by June 2012.

EQUIPMENT AND SUPPLIES

DETAILS PROVIDED FOR INFORMATION AND PLANNING PURCHASES ONLY

Field and Forest
Peshtigo, Wisconsin (USA)
http://www.fieldforest.net/store/index

Fungi Perfecti
Olympia, Washington (USA)
http://www.fungi.com/index.html

Mushroom People
Summertown, Tennessee (USA)
http://www.mushroompeople.com/

Mycosource
Toronto, Ontario (Canada)
http://www.mycosource.com/

WEBSITE PRICE COMPARISON

	Field and Forest	Fungi Perfecti	Mushroom People	Mycosource
Sawdust Spawn	$18 / 2 lb $23 / 5.5 lb $21 / 5.5 lb *(7-10 bags)* $15.75 / 5.5 l *(11-49 bags)*	$19 / 5 lb $17.10 / 5 lb *(10-24 bags)* $14.25 / 5 lb *(25-49 bags)*	$19 / kg $17 / kg *(10-19 bags)* $12 / kg *(20+ bags)* **1 kg = 2.2 lb**	$30 / 2.5 kg $25 / 2.5 kg *(5+ bags)* **1 kg = 2.2 lb**
Inoculator*	$35 (palm style) $33 (thumb style)	$34.95 (palm style)	$27 (palm style)	$27 (thumb style)
Drill bit - 7/16"	$9.50	--	$9.50	$15
Depth stop - 7/16"	$1.75	--	$2.50	--
Adaptor (for angle grinder)	$35	--	--	$40
Drill bit - 7/16" w/ depth stop (for angle grinder)	$13	--	--	$20
Adapted angle grinder	$125	--	--	--
Cheese Wax	$8.50 / 2.5 lb $15 / 5 lb $137.50 / 55 lb	$4.95 / 1 lb $34.95 / 10 lb	$3.20 / 1 lb	--
Wax Applicators	$1 / 4 $30 / 144	--	$0.30	--
Labels	$8.75 / 100 $44 / 500	--	$0.75 / 10 $6 / 100	--

* Everybody has their own favorite style of inoculation tool. Find the one that works best for you!

LOW END PRICE RANGE: Drill $40-$60+; angle grinder ~$60;

ELECTRONIC BALANCE: (1000g max, 1g resolution): $40-$60

ACQUIRING LOGS FOR THE PROJECT

TREES SPECIES

Oak is often considered the species of choice for shiitake production in North America. Research at the Center for Agroforestry by Johannis Bruhn has shown that red and white oak performed about the same as substrates for shiitake. Because oak is a valuable timber species, forest owners who include timber production as part of their woodland management goals may be reluctant to cut large amounts of young oak for shiitake cultivation. However, tops left after logging are often of an appropriate size to be used as bolts although timing might be less than optimal for mushroom production.

Sugar maple (*Acer saccharum*), Musclewood or American hornbeam (*Carpinus caroliniana*), and Hophornbeam (*Ostrya virginiana*) also performed very well. Mudge and coworkers at Cornell have found that American beech performs as well as, if not better, than red oak. Therefore, for the 100 logs you will be monitoring as part of this project, we would like you to use only tree species that have already been shown to be productive substrates for shiitake mycelium: oak, maples, beech, hornbeam, and hophornbeam. You are free to experiment with other trees species on logs not being monitored as part of this research project.

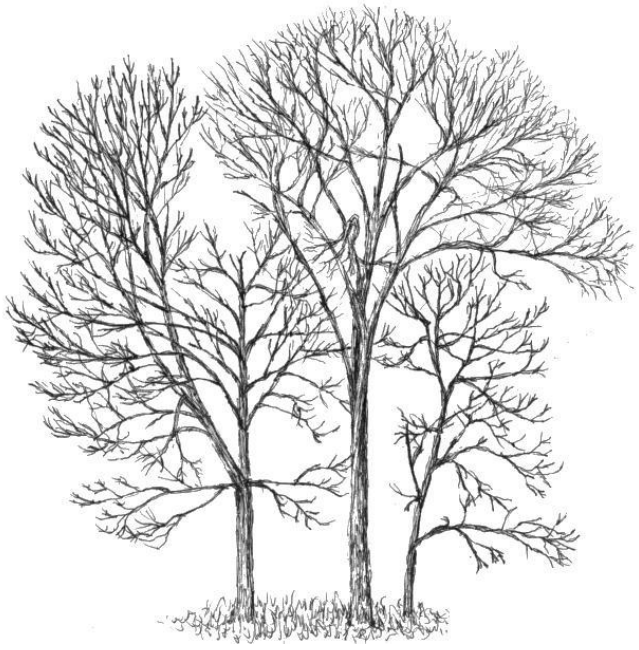
BUYING PRE-CUT LENGTHS (COST $1.00 - $2.00 / BOLT)

Buyers should try to purchase logs in good condition with the bark intact, and few places of rot or scarring. Be sure to ask when logs were cut, what the storage conditions prior to delivery or pick-up were . Remember that if the logs were stored in the sun, the moisture content is likely to be too low.

LOGGING TO OBTAIN BOLTS

Only healthy living trees should be cut down. Mushroom growers who are forest owners (or have a working relationship with forest owners) should establish a management plan for their woodlot and have training in the safe use of a chainsaw. Always remember that operating a chainsaw is can be dangerous if proper precautions are not taken.

- Do not operate a chainsaw if you have not had instruction in felling trees or proper safety training.
- Always wear appropriate safety gear including chaps, helmet, eye protection, and ear protection.
- Make sure the saw you are using is well maintained and has up-to-date safety features including a chain brake (the chain cannot move when this is on), a chain catcher (in the event the chain flies off the bar), and a safety throttle switch / throttle lock (must be depressed to initiate chain rotation). Be aware if your saw does not have these safety features.
- Consider how the selected tree fits into your overall stewardship plan as well as how its absence will affect the surrounding trees.
- Cut the tree following a directional felling plan that includes a planned escape route.
- Stay present and alert and stop before you get tired.



WHEN TO FELL

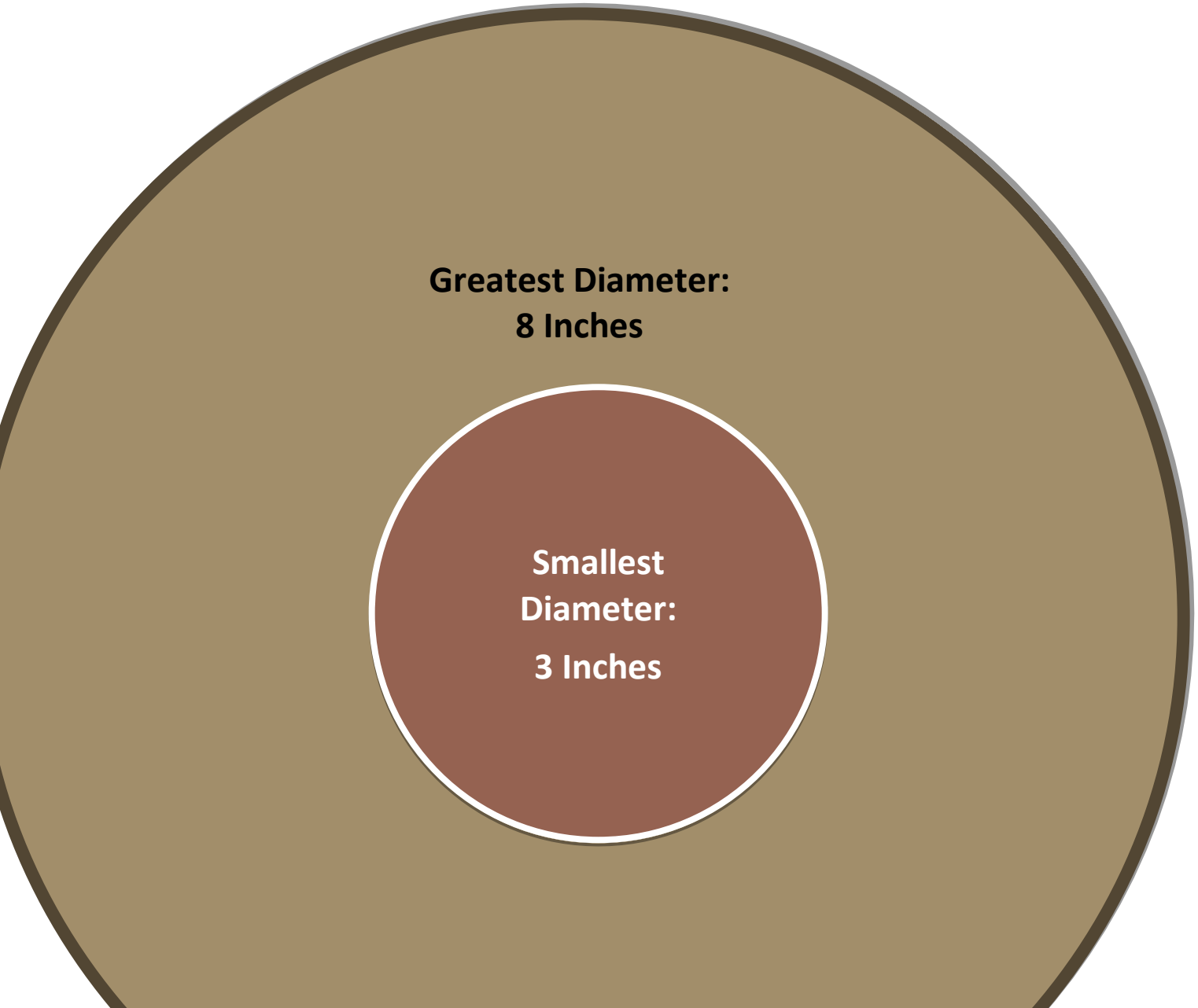
Early spring, before the trees leaf out, is the season most often suggested for felling trees and inoculating bolts for mushroom production. However, it is also possible to cut trees during the winter months and store the logs, out of the sun, for several months before inoculation in the spring. Farmers who tend to be very busy in the spring season may find this schedule more advantageous.

BARK DURABILITY

For a healthy mushroom log, the bark should be intact. Damaged bark allows for greater chance of invasion by 'weed' fungi species and increased moisture loss. Over time, bark will naturally begin to slough off, but care should be taken to keep it on the bolts as long as possible. Cutting time affects the likelihood of the bark falling off, or slipping. In the winter months of full dormancy, before bud swell, bark is tighter, and therefore cutting during these months may help in preserving bark integrity. Conversely, cutting in the summer months may lead to a greater incidence of bark slippage.

WHAT SIZE LOG SHOULD I USE?

All logs used in the experiment should be 36" in length. You can use logs between 3" to 8" in diameter.



CREATING LOG STACKS

WHAT IS A LOG STACK?

A stack of 20 logs with the following properties:

- Same species of tree
- Same date felled
- Same inoculation date
- Same inoculation strain
- All logs shocked on same day

Figure 1 - Arrangement of 20 logs in a crib stack or a rick stack.

WHY IS IT NECESSARY

Rather than collect information on every log in your experiment, you will collect and report information on log stacks. Log stacks consist of 20 logs that have similar characteristics including tree species, felling date, and inoculation date.

Through the duration of the experiment, a given stack will undergo the same treatments on the same days. For example, all the logs in a certain stack should be shocked on the same day in the same manor for the same length of time. Please keep track of log stacks by clearly marking each stack with a sign, tag, or flagging.

FREQUENTLY ASKED QUESTIONS

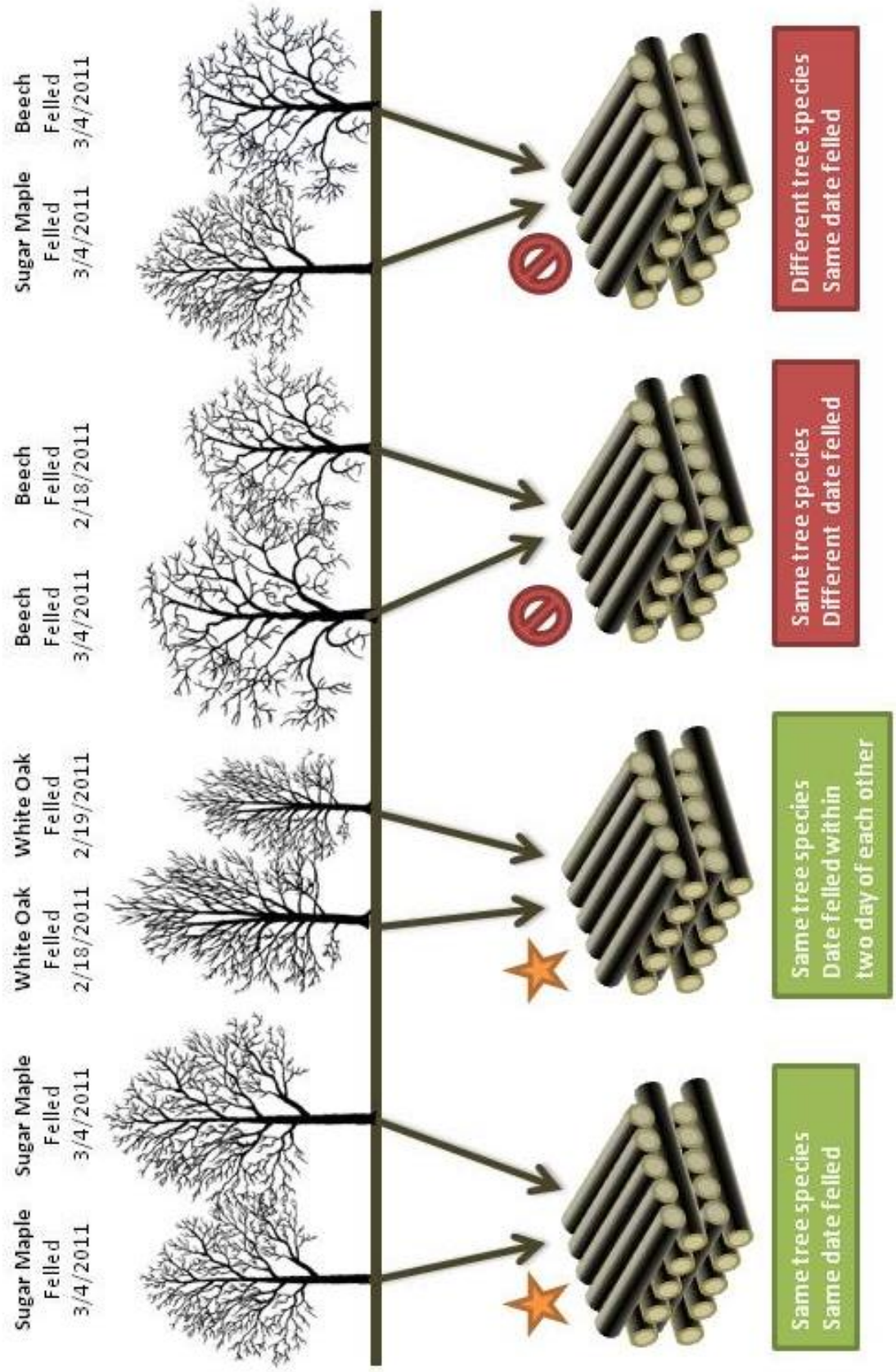
Do the logs need to be same size?
All logs in a given stack need to be between 3 and 8 inches in diameter and 36 inches long.

Do all the logs in a log stack need to be from the same tree?
No. Logs can come from any number of trees so long as all the logs are from the same species of tree. If possible though, try to use as few trees as possible in a stack.

Do all the logs in a log stack need be from trees felled on the same day?
Yes. It is important that factors like the times of year the tree was cut and the length of time the tree was lying around before being inoculated be standardized.

How should I mark the stacks?
We recommend using metal tags/ labels to mark the stacks. They can be purchased online for about $0.10 each. However, there are many other ways to mark the stacks. For example, you could also try spraypainting the logs or creating durable plastic signs that are always placed near or on the stack.

EXAMPLES OF GOOD AND BAD LOG STACKS



HYPOTHETICAL LAYING YARD IN YEAR TWO (2012)

INOCULATING THE LOGS

HOW SOON AFTER FELLING THE TREE TO BEGIN INOCULATION

We recommend that the logs be stored between two to six weeks before being inoculated.

Regardless of how long you wait to inoculate, do not store bolts in the sun. If a log is cut and left to sit for an extended period of time before inoculation other species of fungi can invade the log or log can dry out. It is undesirable for other species of fungi to be growing in the shiitake logs because they will be using the same food source, the cellulose and lignin in the log, and will therefore be in competition with the shiitake mycelium. If the log moisture content becomes too low, the mycelium will not colonize the log or will do so more slowly.

HOW TO STORE THE SPAWN

Once spawn has been purchased, it is important to store it in conditions that will keep it alive. The spawn should be kept at about 4 C (39 F); too warm and it will grow mushrooms which will rot, too cold and mycelium may stop growing and die. Keep the spawn in a sealed plastic bag (try wrapping a second bag around an already opened batch) to prevent moisture loss. Small, deformed mushrooms may begin to grow in a bag of sawdust spawn. If this happens, simply break them up through the bag.

DRILLING HOLES FOR SPAWN

We recommend reviewing the video at http://mushrooms.cals.cornell.edu/cultivation.htm for step by step directions regarding drilling and inoculation.

The first step in inoculation is drilling holes into the bolt. Outfitting an angle grinder with a drill bit is another method of drilling holes into the log. (This required an adaptor for the angle grinder. See page 10 for more information and a cost estimation.) While equipping an angle grinder with a drill bit is expensive, it is possible to move very quickly with this tool, reducing the time spent per log. They are especially useful for larger operations.

For sawdust-based inoculation, use a 7/16" drill bit size and drill to a depth of 1.25". We recommend a drill bit with a built in drill stop; it is better than the adjustable drill stop you purchase in a common hardware store. (See page 10 for more information and a cost estimation.) More holes are not detrimental and in fact are likely to speed up colonization of the log. However, as spawn is an input cost, ideally the system is optimized for minimal use of spawn and maximal colonization.

After the holes are drilled, it is time to place the spawn in the holes, bringing the shiitake mycelium in contact with its new food source (substrate), the log. Stab the inoculation tool into the spawn and pound it once or twice to inject the spawn [difficult to describe, but shown in online video], taking care that the tool is full place the tool over the hole and depress the plunger at the top to compact the spawn into the hole; the hole should be full so that the spawn is level with or just below the surface of the log. Repeat this process for all holes.

WAXING

Waxing the holes helps seal in moisture so that the spawn does not dry out. By sealing off the holes, the chance of contamination by competing fungi species is reduced.

During this step each hole is completely sealed using food grade wax. There are a number of different types:

- Food grade Cheese wax (cost: $27.50 - $35.00 / 10 lb)
- Beeswax (cost: $65 + / 10 lb)
  It may be possible to get lower quality beeswax leftovers from a local beekeeper for a lower price.

Electric skillets work particularly well to melt the wax however, you have to put a pot on the electric skillet to hold the wax. A skillet alone is too shallow and dangerous. They are sturdy, portable, and the temperature control is easy. You can also heat the wax in a pot over a portable propane or white gas stove. Wax should be heated to 350-400 degrees (wisps of smoke). If using cheese wax, the wax should be a clear liquid when applied.

Never leave melting wax unattended.
Wax is highly flammable.

You can apply the wax in a number of different ways. Foam paint brushes ($0.50 - $0.80 / brush) are very effective and many people already own a foam paint brush. One inch brushes work best. These can be reused many times (until the brush comes off of the wooden handle). Cotton daubers ($30.00 / 144 pc = $0.21 / 1pc)) are cheaper than foam paint brushes, these small cotton balls on the end of a wire handle are available from select mushroom product suppliers. (See page 10 for more information and cost estimations) They can be reused and are very effective.

To apply the wax, use the chosen applicator to transfer the hot wax onto each hole in the log. Care should be taken to seal the hole. One dip of the applicator should complete a few holes. Re-dip the applicator and continue until all holes are covered.

© Allen Matthews, University of Vermont

ENDS OF THE LOG: TO WAX OR NOT TO WAX

Some growers choose to wax the ends of each mushroom log either by dipping the log directly into the pot of melted wax or by painting each end with a paint brush soaked in wax. Other growers choose to skip this step. The importance of this step may vary based on climate, which largely governs how crucial it is to strictly manage moisture levels. Waxing the ends will keep moisture in and prevents competitive fungi from gaining a foothold. However wax also is one of the main production costs and the waxing process adds considerable time to the inoculation process. A cost-benefit analysis of additional wax cost and shiitake yield has not yet been conducted.

THE LAYING YARD

WHAT IS A LAYING YARD?

A laying yard is the outside space in which mushroom production takes place. After bolts are inoculated they are placed in a laying yard to allow the mycelium to colonize the log. This period of time is called spawn run and takes five to seventeen months. The logs usually remain in the laying yard for the rest of their productive lifetime, which includes both fruiting and harvest.

SHADE

Adequate shade is crucial to mycelium growth. Because the mushroom mycelium will die if the log becomes too dry, it is important not to expose logs to sustained direct sunlight. An evergreen canopy is ideal because it provides year-round shade. A deciduous canopy provides shade during the late spring, summer, and early fall months, but not in the winter when the trees have lost their leaves. During the winter months it is therefore necessary to provide extra shade.

WATER

A water source is necessary for forced fruiting (shocking) as well as for maintaining a threshold moisture level in the logs. Take into consideration how close and convenient each possible water source is. Particularly think about moving materials through the laying yard and common use patterns. If there is a dry spell and the logs must be wetted to maintain moisture levels, logs may be submerged under water or dampened under a sprinkler. Research at Cornell has shown that sugar maple logs soaked for 2 hours once every 2 weeks, produced significantly more shiitake mushrooms (after the usual overnight shocking) than logs that were not soaked every two weeks. It is critical that the moisture content of the logs does not fall below a threshold level necessary for the survival of the mycelium. Logs typically begin at about 40 -45 % moisture content and should not drop below 25%.

STACKING METHOD

CRIB STACK (RICK STACK)

- Crib stacks are simple and quick to make. First four to five logs are laid down on a flat surface, then four to five logs are placed on top of them in the opposite direction; the pattern is continued for about five levels.
- Crib stacks are a very space efficient way to keep logs as they make use of vertical space, compactly storing large numbers of logs.
- This stacking method is excellent for the spawn run period.

© Laskovski Nicholas – Dana Forest Farm

HIGH A-FRAME

- A high A-frame consists of logs leaning upright on one or two sides against a supporting beam, such as a cut sapling lashed horizontally onto two trees or a taut wire.
- This stacking method works well for the fruiting and harvest stages. Logs are well aerated, mushrooms are easily visible, and picking is easy as there is maximum access to each log. Because the log is vertical, slug damage to mushrooms may be less than when logs are fruiting closer to the ground.
- Because logs stacked in A-frames take up a lot of space in a laying yard, they are usually not left on the A-frame for any other part of the process; this is especially true for a forced production model.

© Steve Sierigk, Hawk Meadow Farm

JAPANESE HILLSIDE STACKING METHOD

- This stacking method is more complex to set up, and only recommended for steep hillsides.
- This technique creates a very stable, aerated stack in which mushrooms are highly visible and easy to pick. The majority of logs are raised off the ground, potentially reducing slug damage.
- For more information on this stacking method see "Our Cultivation Guides" featured on the Northern Mushroom Growers Website at http://mushrooms.cals.cornell.edu/

Photograph **Side View** **Overhead View**

© Rachel Brinkman, Cornell University

SLUG-FEST!

Frogs and Toads are great allies in controlling slugs! Toads especially enjoy dining on slugs... encourage their presence in your fruiting yard by providing simple habitat for them. Adult toads typically live 7-14 years... some individuals have reached 40 years of age!

FRUITING AND HARVESTING

In a natural production model, growers do not do anything to the mushroom logs to make them fruit. Logs are left to fruit naturally, flushing either when there is heavy rainfall or when a temperature change encourages fruiting. In a forced production model, growers control when logs fruit. Logs may sometimes also fruit naturally, (in fact, heavy rain can knock production schedule way out of whack) but the majority of harvests are induced according to a preplanned log rotation schedule. Because yields can be predicted and kept relatively constant in this model, it has greater retail potential.

SHOCKING

Shocking, or forcing, is the process used to force mycelium into fruiting body (mushroom) production. Soaking logs in cold water for an extended period of time is most typical means to induce fruiting. Place the logs in the coldest water you have available. Because temperature adjustment is not practical, we recommend a fast moving stream or tank kept out of sun. Leave the logs submerged in the water for 12 hours. The remove the logs from the water and stack them in an A frame conducive to the upcoming harvest. In 3 – 5 days, the log will begin pinning, or sending up the beginnings of mushrooms. These will grow and develop into full-sized shiitake mushrooms (See Harvest for when to pick).

HOW OFTEN TO SHOCK

After fruiting, logs need to be rested for 6 - 8 weeks before being forced again. The more often the logs are shocked, the shorter their lifetime is likely to be. We recommend only shocking once during first production year, then twice during year second and third.

Logs should be stacked in the laying yard so they are easily identified in order to establish a schedule for shocking and harvesting. This plan should take into account the number of times each log will be forced a season, when logs will be forced, how logs will move through the laying yard, when mushrooms are needed, when the plan predicts mushrooms will be available, and when logs will be retired at the end of their lifetime.

WHEN AND HOW TO HARVEST

It is not the size of the mushroom that determines when it is picked, but its growth progress. Gills should be visible and the outer edge of the mushroom should be slightly curled under, but not tightly so. If the edge has flattened out, the mushroom is slightly over ripe, but still edible. Shiitake are usually ready 7 - 10 days after shocking; colder temperatures will slow growth and ideal conditions will make it more rapid. Using a knife is quick, easy, and ensures a clean cut on the stem. It also does not rip or damage any bark.

HOW MUCH TO EXPECT

Mushroom production for a typical log will peak the second and third years. At this time it is reasonable to expect 0.25-0.5 lb per log or higher per flush, with the goal of doing two shockings per season.

STORING FRESH MUSHROOMS

Never store fresh mushrooms in a plastic bag. Use paper bags and keep them refrigerated. Mushrooms will keep under refrigeration for up to one week.

MARKETING AND CONSUMPTION

IDEAS TO HELP YOU DEVELOP A MARKET

- Talk with people in your area. Get your name and business out there so people know what you sell and how they can reach you. Be friendly, not pushy.
- Offer free samples, recipes, or pamphlets to help customers realize how tasty and fun mushrooms can be.
- Talk with local chefs to see it they might be interested in your product. It's nice if you have some information to leave them that has your contact info clearly visible.
- Ask if they would like you to bring in sample product. Perhaps they would like some to trial before they buy.
- If certain restaurants are willing to buy particularly large quantities, consider offering a bulk discount.
- Grocery stores will most likely pay lower prices than selling at other venues, but can handle a lot of product on a regular basis.
- Stores that put emphasis on buying locally or eating healthy foods are good choices for your product. At the right venue, your buyers will be pleased to have a great product like yours that makes the store look good to consumers.
- Make sure that the mushrooms you are selling are always top quality and as fresh as possible.
- Be considerate of your buyers. Communicate; listen to what your buyers need and when. Be open to hearing their thoughts.
- Try to be consistent with delivery times and quantities. If you have promised a certain amount of product, make sure you have planned that into your rotation schedule.

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VALUE ADDED PRODUCTS

Value added products can include dried mushrooms and any kind of cooked or baked product with mushrooms – a shiitake pâté or sauce for example. Value added products can be a great way to diversity your income and increase your profits. However, the production and sales of these types of processed foods is governed by state and federal regulations. Each state is different, so proper advice is needed from a specialist in each state. Some states allow sales at farmer's markets of select foods; others prohibit sales altogether.

In most cases, you will be required to process your product in a licensed kitchen. Home kitchens are not usually considered appropriate for processing purposes. In order to sell your homemade products on a commercial basis, in most states, you'll need to have your kitchen meet commercial grade kitchen standards and pass a health department inspection, like a restaurant. The process of converting a home kitchen can easily cost upwards to $50,000. However, there are ways around this:

- **Canneries and licensed kitchens** - One way around this is to prepare your batches in kitchen that is already licensed. Some people rent restaurant kitchens during their off-hours and do the prep and canning there. In some cases, a local cannery is the way to go. If they are licensed as a commercial kitchen (and many are), then you will be able to avoid the need and expense to rent a restaurant kitchen.
- **Copackers** manufacture and package foods for other companies to sell. These products range from nationally-known brands to private labels. Entrepreneurs choose to use the services of copackers for many reasons. Copackers can provide entrepreneurs with a variety of services in addition to manufacturing and packaging products. They can often help in the formulation of the product. The copacker may function only as a packer of other people's products or may be in business with his own product line. They may be, in fact, manufacturing several competing products. The range of services available from a copacker will vary depending on the size and experience of the copacker and the type of facilities and the capacity of their plant.

LEARN MORE ABOUT SELLING YOUR VALUE ADDED PRODUCT

- First stop is to see what the U.S. FDA has to say at "Starting a Food Business": **http://vm.cfsan.fda.gov/~comm/foodbiz.htm**
- If you are wanting to sell canned, low-acid or acidified foods, also see "Acidified and Low-Acid Canned Foods": **http://www.cfsan.fda.gov/~comm/lacf-toc.html**
- Search through some of the internet sites from Cooperative Extension Service programs or some other state-specific sites listed below. An excellent source is this web page from Penn State University Department of Food Science: **http://foodsafety.cas.psu.edu/processor/resources.htm#Before**
- Contact your county Cooperative Extension Agent to locate a program in your state or contact your state university's Food Science program. See: **http://www.csrees.usda.gov/Extension/index.html** for a clickable map of contacts who can lead you to the right person. (This site is maintained by USDA, not the NCHFP.)
- Check your state's Department of Agriculture for resources. The National Association of State Departments of Agriculture maintain a web site with links to state departments of agriculture at: **http://www.nasda.org/nasda/nasda/member_information/usmap.htm**
- Look for "Value Added" programs that encourage small scale processing of foods. An example of a value added process is when a strawberry grower turns his strawberries into jam. Many state universities Extension or other agriculture programs, state departments of agriculture or rural development centers have value-added initiatives and assistance. An internet search using terms such as "valued added agriculture" generates a list of web sites.
- Check to see if your state has an incubator kitchen program. Some states have programs that help entrepreneurs develop recipes to commercialize. These are usually test kitchens that share resources. Again, state Departments of Agriculture or a state university's food science department are good leads for finding incubator programs.

Text acquired from http://www.pickyourown.org/sell_your_homecanned_food.htm

BACKGROUND INFORMATION SHEET

Farm Name (Optional) _____

Farm Address _____

_____

Farmer Name _____

Is your farm organic, in transition or conventional? _____

Do you own or rent? _____

How long have you been at this location? _____

Have you grown any mushrooms before? If yes, please explain.

_____

_____

_____

How old is the farm / farm business? _____

How many areas of land is the farm? _____

How many areas of land are forested? _____

Do you have any employees? Are they full-time or part-time? How many months of the year do you employ help? Please explain.

_____

_____

_____

LABOR WORKSHEET DESCRIPTION

Please record the total number of hours you, your friends, or your employees spent cultivating and selling shiitake mushrooms.

FIELD DESCRIPTIONS

DATE: The date the work was completed

AFFILIATION CODE: The person or persons who completed the work. Please choose from the categories of Owner, Volunteer or Employee. See the chart below for more information.

CODE	DESCRIPTION
OW	**Owner** *You, your partner, or any family members not being paid to complete the task but expect to be compensated by profits generated from the enterprise.*
VO	**Volunteer or Friends** *Any person that is not being compensated with money and does not expect any portion of the net profit. This includes volunteers at a training event or gatherings wherein assistance on a task is obtained in return for something like pizza and beer.*
EM	**Employee** *Any person you employ or pay a wage. This may include family members or friends if that person is being paid any regular salary or stipend.*

NO. OF PEOPLE: The number people who completed the work who are of the same affiliation code.

HOURS: The number of hours spent working on a task

WAGE: The hourly wage your employee is paid. Leave blank for any work completed by owners, volunteers or friends

LABOR CODE: Generalize what task best describes the work.

CODE	DESCRIPTION	CODE	DESCRIPTION
LY	**Laying Yard Maintenance**	**PP**	**Processing and Packaging Shiitake** *Cleaning, Drying, Bagging and Boxing Shiitake for Sales*
CT	**Cutting and Felling Trees**	**AD**	**Advertising** *Talking to restaurant owners, stores, etc.*
IN	**Inoculating Logs**	**SA**	**Selling Mushrooms** *Time spent at Farms Markets or grocery stores*
SH	**Shocking / Forcing Logs**	**TR**	**Transporting Shiitake** *Driving to and from sales*
HA	**Harvesting Shiitake**	**OT**	**Other**

AN EXAMPLE

The owner of the shiitake business, his wife, and his four friends spend six hours inoculating logs on April 19th. Three days later, the owner pays his son fifty dollars to spend five hours to arrange the logs in the laying yard.

DATE	AFFILIATION CODE	NO. OF PEOPLE	HOURS	HOURLY WAGE	LABOR CODE
4/19/11	OW	2	6	n/a	IN
4/19/11	VO	4	6	n/a	IN
4/21/11	EM	1	5	10.00	LY

EXPENSES WORKSHEET DESCRIPTION

Please record all of your equipment and supplies expenses and what aspect of the operation they benefit.

FIELD DESCRIPTIONS

DATE: The date the item was bought

ITEM: A brief description of the item

Cost: Total cost of item or items.

DURABLE? Is the item a durable good? Write "Y" for yes and "N" for no. A durable good is one that does not quickly wear out or more specifically, one that yields utility over time rather than being completely consumed in one use. They are typically characterized by long periods between successive purchases or items that are not immediately consumed. If you are unsure if an item could be characterized as durable or non-durable, please write "?". Examples of durable goods include a chainsaw, a drill bit, a tub for soaking logs, and scale for weighing mushrooms. Examples of non-durable goods include chainsaw bar oil, cheese wax, and bags for mushrooms.

USE CODE: What area of production or sales is the item for? See the chart below.

CODE	DESCRIPTION	CODE	DESCRIPTION
LO	**Logs Purchases**	**PR**	**Processing (Cleaning, Drying Etc.)**
CT	**Tree/Log Cutting Equipment**	**PA**	**Packaging**
IN	**Inoculation Equipment**	**AD**	**Advertising**
SH	**Shocking/Forcing Supplies**	**TR**	**Transportation Costs**
HA	**Harvesting Supplies / Equipment**	**OT**	**Other**

AN EXAMPLE

The owner of the shiitake business buys a dehydrator for $50.00 and three boxes of plastic bags for $10.00 dollars each. He also pays a graphic designer $200.00 to design a label for his mushrooms and then buys 100 labels at $1.00 each.

DATE	ITEM	COST	DURABLE?	USE CODE
5/1/12	DEHYDRATOR	50	Y	PR
5/1/11	PAPER BAGS	30	N	PA
5/13/11	LABEL DESIGN	200	Y	AD
5/25/11	LABELS	100	N	PA

FEQUENTLY ASKED QUESTIONS

Should I add the cost of labor and wages?

No. Do not include any payments you make for labor in this chart. Please include that in the chart above.

Should I include mileage on my vehicle as an expense?

Yes. Include any mileage under the "Use Code" Transportation Costs at the rate of $0.50 per mile

Should I include items like chainsaws which have multiples uses?

Yes. Include these items. We will take that into account when we complete the overall analysis.

It this where I record supplies for making value added products (containers/jars, other food stuffs, cooking equipment)

Yes. Some of these expenses would be durable (cooking equipment) and some are not (containers, food stuffs).

LOG STACKS WORKSHEET DESCRIPTION

The following pages provide us with information about your log stacks.
You need to complete these records only once, in the spring, for every log stack.

FIELD DESCRIPTIONS

STACK NO: Number 1-5 correspond to the first year, 6-10 are for the second year, etc.

TREE SPECIES: The tree species the logs belong to

DATE FELLED: The date the trees which you obtained the logs for were felled.

DATE INOCULATED: The date the logs were inoculated with spawn.

IDENTIFYING: This field is for you to record how you are marking the logs for your identification purposed. This field is not required.

EXAMPLE

Jane cut down an oak tree on March 3rd and cut it into 27 logs. She inoculated the logs on March 23rd.

STACK NO.	TREE SPECIES	DATE FELLED	DATE INOCULATED	IDENTIFYING FEATURES
4	Oak	3/3/2011	3/23/2011	Blue slash

FRUITING WORKSHEET DESCRIPTION

Each time your shock your logs by submersing them in water, please record the day the log were submerged in the water and the log stack. After the logs are shocked and begin to fruit, you will need the weigh the mushrooms produced by log stack every day for the entire period they are fruiting.

FIELD DESCRIPTIONS:

STACK NO: The log stack number of the logs you are harvesting from

DATE OF SHOCKING: The date the logs were first submerged

SHOCKING DURATION: How many hours the logs were submerged in water

DAY 1 PRODUCTION: The fresh weight of all mushrooms produced by the log stack on the first day they begin to fruit.

DAY 2 PRODUCTION: The fresh weight of all mushrooms produced by the log stack on the second day since they begin to fruit.

FREQUENTLY ASKED QUESTIONS

What if my bolts fruit for more than 12 days?
If your logs produce shiitake mushrooms for more than 12 days, make a note on the worksheet and continue on the next line. Therefore, in the "Day One" box write the "Day 13" value for pounds of shiitakes produced. Be sure to make this clear on the worksheet by writing "Continued" in the "First Day Shocked" box.

I don't have a scale. What should I do?
You will need to purchase a scale in order to participate in the project. The scales should cost between $20.00 and $30.00 dollars. We recommended searching the term "Food Scale" online to see a variety of models. The one pictured to the right, for example, costs only 20 dollars.

Do I need to record everything in pounds?
No. You may record the shiitake weights in whatever units yours scale provides. Just make it clear what units you are using on the top of the worksheet.

I missed a day. What should I do?
If you skipped a day, simply write "0" in the box corresponding to that day and continue on.

SALES WORKSHEET DESCRIPTION

We would like you to record all of your shiitake mushrooms sales – specifically where you are selling your mushrooms, what quantity you are selling, and how much money you are making. For record keeping purposes, we'd like you to separate your sales of fresh mushrooms from your sales of value-added products like dried shiitake mushrooms, shiitake baked goods, shiitake pâté, etc.

FRESH SHIITAKE SALES WORKSHEET DESCRIPTION

Use the following worksheet to record your sales of fresh shiitake mushrooms. This is also the place where you will need to record the weight of any mushrooms culled (thrown-out).

FIELD DESCRIPTIONS:

Date: The date the sale took place.

Location Code: Where are you selling your product? Choose one of the codes below.

CODE	DESCRIPTION
RE	**Restaurant**
GS	**Grocery Store**
FM	**Farmer's Market**
DS	**Direct Sales** *Sales directly from your farm such as a farmer's stand*
OT	**Other**

Pounds Sold: Record the fresh weight, in pounds and ounces, of your shitake mushroom sales.

Pounds Culled: Record the fresh weight, in pounds and ounces, of any shiitake mushrooms that were culled (thrown out or unsellable).

Earnings: Record the amount of money you received through the sale of the shiitake product.

EXAMPLE

The owner of the business sells 20 pounds of mushrooms each week to a local restaurant at $10.00 dollars a pound. She also attends a farmers market where she sells 10 pounds of fresh mushrooms at $15.00 per pound. After the market, she was left with 2 pounds of unsold mushrooms which, having sat in the sun all day, were no longer good enough to sell.

DATE	LOCATION CODE	POUNDS SOLD	POUNDS CULLED	EARNINGS
8/1/11	RE	20	0	200
8/4/11	FM	10	2	150

VALUED ADDED SHIITAKES SALES WORKSHEET DESCRIPTION

Use the following worksheet to record your sales of any value-added shiitake product including dried and processed mushrooms.

FIELD DESCRIPTIONS:

Date: The date the sale took place.

Location Code: Where are you selling your product? Choose one of the codes below.

CODE	DESCRIPTION
RE	**Restaurant**
GS	**Grocery Store**
FM	**Farmer's Market**
DS	**Direct Sales**
	Sales directly from your farm such as a farmer's stand
OT	**Other**

Description: Describe the product. Was it a spread, baked good, dried mushrooms, etc. Include an estimate of size, if applicable. For examples, how large was the jar of shiitake pâté?

Quantity: How many items or how many pounds of items did you sell?

Earnings: Record the amount of money you received through the sale of the shiitake product.

EXAMPLE

At a farmers market, the business owner sells 10 jars of tomato sauce with shiitake mushrooms. Each jar had approximately 2 pound of fresh mushrooms and sold for $8.00 a jar. In addition, he sells 15 pieces of Shiitake pizza at $4.00 dollars a slice. She estimates that every piece of pizza had 0.1 pounds of mushrooms on it. Lastly, he sells 5 pounds of dried mushrooms for $20.00 a pound.

DATE	LOCATION CODE	DESCRIPTION	QUANITY	EARNINGS
8/1	FM	16 oz jar of tomato sauce	10 jars	80
8/1	FM	Shiitake Pizza	15 slices	60
8/1	FM	Dried	5 pounds	100

LABOR WORKSHEET

DATE	AFFILIATION CODE	NO. OF PEOPLE	HOURS	HOURLY WAGE	LABOR CODE

AFFILIATION CODES: **OW:** Owner **VO:** Volunteer or Friend **EM:** Employee

LABOR CODES:
SH: Shocking **LY**: Laying Yard Maintenance **CT:** Cutting Trees **IN:** Inoculation
AD: Advertising **HA:** Harvesting Shiitake **PP:** Processing/Packaging **SA**: Sales
TR: Transporting **OT:** Other

LABOR WORKSHEET

DATE	AFFILIATION CODE	NO. OF PEOPLE	HOURS	HOURLY WAGE	LABOR CODE

AFFILIATION CODES: **OW:** Owner **VO:** Volunteer or Friend **EM:** Employee

LABOR CODES: **LY**: Laying Yard Maintenance **CT:** Cutting Trees **IN:** Inoculation
SH: Shocking **HA:** Harvesting Shiitake **PP:** Processing/Packaging **SA**: Sales
AD: Advertising **TR:** Transporting **OT:** Other

LABOR WORKSHEET

DATE	AFFILIATION CODE	NO. OF PEOPLE	HOURS	HOURLY WAGE	LABOR CODE

AFFILIATION CODES: **OW:** Owner **VO:** Volunteer or Friend **EM:** Employee

LABOR CODES:
SH: Shocking **LY**: Laying Yard Maintenance **CT:** Cutting Trees **IN:** Inoculation
AD: Advertising **HA:** Harvesting Shiitake **PP:** Processing/Packaging **SA**: Sales
TR: Transporting **OT:** Other

LABOR WORKSHEET

DATE	AFFILIATION CODE	NO. OF PEOPLE	HOURS	HOURLY WAGE	LABOR CODE

AFFILIATION CODES: **OW:** Owner **VO:** Volunteer or Friend **EM:** Employee

LABOR CODES:
SH: Shocking **LY**: Laying Yard Maintenance **CT:** Cutting Trees **IN:** Inoculation
AD: Advertising **HA:** Harvesting Shiitake **PP:** Processing/Packaging **SA**: Sales
TR: Transporting **OT:** Other

EXPENSES WORKSHEET

DATE	ITEM	COST	DURABLE?	USE CODE

USE CODES:

LO: Log Purchases	CT: Tree Cutting	IN: Inoculation	SH: Shocking
HA: Harvest	PR: Processing	PA: Packaging	AD: Advertising
TR: Transportation	OT: Other		

EXPENSES WORKSHEET

DATE	ITEM	COST	DURABLE?	USE CODE

USE CODES:

LO: Log Purchases
HA: Harvest
TR: Transportation
CT: Tree Cutting
PR: Processing
OT: Other
IN: Inoculation
PA: Packaging
SH: Shocking
AD: Advertising

EXPENSES WORKSHEET

DATE	ITEM	COST	DURABLE?	USE CODE

USE CODES:

LO: Log Purchases	CT: Tree Cutting	IN: Inoculation	SH: Shocking
HA: Harvest	PR: Processing	PA: Packaging	AD: Advertising
TR: Transportation	OT: Other		

EXPENSES WORKSHEET

DATE	ITEM	COST	DURABLE?	USE CODE

USE CODES:
LO: Log Purchases
HA: Harvest
TR: Transportation
CT: Tree Cutting
PR: Processing
OT: Other
IN: Inoculation
PA: Packaging
SH: Shocking
AD: Advertising

LOG STACKS WORKSHEET

STACK NO.	TREE SPECIES	DATE FELLED	DATE INOCULATED	IDENTIFYING FEATURES
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

FRUITING WORKSHEET

STACK NO.	DATE SHOCKED	DURATION SHOCKED	*Shiitake Fresh Weight Production per Day (lbs.)*											
			DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12

FRUITING WORKSHEET

STACK NO.	DATE SHOCKED	DURATION SHOCKED	*Shiitake Fresh Weight Production per Day (lbs.)*											
			DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12

FRUITING WORKSHEET

STACK NO.	DATE SHOCKED	DURATION SHOCKED	*Shiitake Fresh Weight Production per Day (lbs.)*											
			DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7	DAY 8	DAY 9	DAY 10	DAY 11	DAY 12

FRESH SHIITAKE SALES WORKSHEET

DATE	LOCATION CODE	POUNDS SOLD	POUNDS CULLED	EARNINGS

LOCATION CODE: **RE:** ***Restaurant*** **FM:** ***Farmer's Market*** **GS:** ***Grocery Store*** **DS:** ***Direct Sales*** **OT:** ***Other***

FRESH SHIITAKE SALES WORKSHEET

DATE	LOCATION CODE	POUNDS SOLD	POUNDS CULLED	EARNINGS

LOCATION CODE: RE: *Restaurant* FM: *Farmer's Market* GS: *Grocery Store* DS: *Direct Sales* OT: *Other*

FRESH SHIITAKE SALES WORKSHEET

DATE	LOCATION CODE	POUNDS SOLD	POUNDS CULLED	EARNINGS

LOCATION CODE: **RE:** ***Restaurant*** **FM:** ***Farmer's Market*** **GS:** ***Grocery Store*** **DS:** ***Direct Sales*** **OT:** ***Other***

VALUE ADDED SHIITAKE SALES WORKSHEET

DATE	LOCATION CODE	DESCRIPTION	QUANITY	EARNINGS

LOCATION CODE: RE: *Restaurant* FM: *Farmer's Market* GS: *Grocery Store* DS: *Direct Sales* OT: *Other*

VALUE ADDED SHIITAKE SALES WORKSHEET

DATE	LOCATION CODE	DESCRIPTION	QUANITY	EARNINGS

LOCATION CODE: **RE:** ***Restaurant*** **FM:** ***Farmer's Market*** **GS:** ***Grocery Store*** **DS:** ***Direct Sales*** **OT:** ***Other***

UVM Extension helps individuals and communities put research-based knowledge to work.

If you require accommodations to participate in this program, please let Ben Waterman (802-656-9142) know by July 1, 2011 so we may assist you.

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