The Shiitake Mushroom Marketing Guide for Growers
- A Book Review -


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The "Shiitake Mushroom Marketing Guide for Growers" is a practical, down to earth discussion of marketing principles.

(Continued on Page 4)

Laying of logs after inoculation. Cover with shade cloth when daytime temperatures approach 70° F.

Taheli Fujimoto
"High Speed Year-Round Shiitake Cultivation"

English translation edited by Bob Harris

CHAPTER 14: Calendar of Year-round Fruiting

I. Spring: March, April, and May:

A. Spawning:

Spawning should be finished by March at the latest and February ideally.

(Continued on Page 2)
weeks after felling, this determines the date by which inoculation should be completed. If inoculation is done later in the year, the logs cannot be placed in the temporary laying yard since the rains and temperature are so favorable to the growth of contaminants.

B. Management After Spawning:

The logs should be placed into the laying yard as soon as possible after inoculation. If this cannot be done the logs should be spread out as much as possible. They should not be piled up or stacked nor should they be covered over. The laying yard must be weeded and pruned before the logs are stacked in it.

C. Shade:

Shade must be provided after the temperature reaches 70° F. even for one day. This will usually be by April. Logs which are stacked in a forest such as pine, or a deciduous forest, are well protected but logs stacked out in the open will need the shade cloth by this time.

D. Spring Natural Fruiting:

The period of natural fruiting in the spring will depend on the temperature and rain that year. The season usually begins with a rain exceeding 2.5 inches and the average daily temperature is above 43° F. These two factors must coincide for the real fruiting to begin.

This typically will be from March to May for most areas - until the temperature reaches 55° F. to 60° F. The natural fruiting may be concentrated into a large flush or may continue sporadically for a period.

The price of the fresh mushrooms at the market will be a function of how concentrated a flush is produced. If the flush is very concentrated the price drops sharply and many of the mushrooms are dried and additional labor may be needed. If possible it is best to anticipate this.

Often, if a grower is producing for the fresh market, the mushrooms will be stored for 5-10 days in the refrigerator until the price rises a bit. These mushrooms will last best if they have a lower moisture content and are kept at 36-40° F. It is necessary to plan on this if there is a large spring production.

By contacting different markets at this time, in areas where production has not started or has finished, more of the mushrooms can be sold. If possible the logs should be kept from fruiting at this time of year to avoid the expenses while returning a lower dollar value.

There is a tendency to delay soaking logs at the time of peak natural production since everyone is so busy harvesting, but this is the time to soak since right after this time the market prices rise and there is an increased demand that can be filled immediately if the logs are soaked ahead of time.

E. Fruiting After the Natural Fruiting Period:

Once the temperature rises above about 55-60° F., the natural fruiting declines and the production slows down while the price rises. This is the time to have fresh mushrooms for sale from the logs soaked during the natural fruiting period. The highest production will come from soaking logs with a year-round strain [851, 510] that has not been previously fruited.

F. Testing the Spawn Growth:

How well the spawn is growing into the log can be seen within two weeks to a month after inoculation in spring or fall, and those inoculated in winter can be inspected by spring.

This of course depends on the vigor of the strain, as some grow more rapidly than others. By inspecting the spawn at the inoculation site, or splitting the wood or cutting through the log at the spawn site, the growth can be seen.

The logs which will produce well later show good signs of growth and the edge of the growth is a black line, while near the spawn, the mycelium turns yellow-white and the logs become decomposed. If too much time is elapsed before checking, it will be too hard to discern where the growth came from. If the growth is poor, then a determination of the cause must be found and corrected. If the spawn has not grown at all, it may be necessary to soak the logs and re-inoculate with new spawn in a new hole.

II. Summer: June, July, and August:

A. Weeding:

In summer the weeds grow faster, and from June to August, weeding must be done at least three to four times. If weeding is not required then the area is too shady for good Shiitake growth. The weed growth is also a function of the rains and so weeding should be done after warm and rainy weather.

B. Pruning and Thinning:

Laying yards in deciduous forests will have to be pruned after the leaves come out since it is only possible to judge the shade cover at that time. During the summer pruning and thinning will have to be done two to three times. If the trees are growing in clumps, removing some of them will be helpful. One caution: if insects attack deciduous forests the shade can be lost and insecticide may have to be applied.

C. Fruiting in Summer, Harvest and Transportation for Market:

In May after the natural fruiting period, virgin logs should be used for soaking [851, 856, 510]. During mid-summer from July to August, the same logs can be fruited a second time, or logs that were fruited once in November to December.

Until mid-August, the temperature usually rises and it is hard to fruit (Continued on next page)
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Shiitake especially when the weather is clear. During this period the logs should be sprinkled two to three days before soaking to increase fruiting. The logs should also be stored in a laying yard that faces north or east at this time, or a double layer of shade cloth should be used. Harvesting should be done later in the day and the Shiitake should be kept refrigerated. Transportation to market should be done after dark.

D. Determining the Location of Next Year’s Laying Yard:

After the middle of August the farm enters a resting period so this time is used to contract the logs for next year and to locate the site for the next laying yard. This allows time to prepare the site properly.

E. Preparation of the Logs:

Since mid to late August is the slack time, and it is the time to make contracts for next year’s logs, this may be the time to prepare the falling site after the contract is made. By removing and clearing the forest before winter, easier access can be made later.

F. Shade Cloth Repair:

If shade cloth is used in summer, it should be doubled up especially during June, July, and August. This is the time to make repairs in the cloth and to fix any areas where sun shines through in the natural shade areas. After June the growth of the mycelium should be checked on logs inoculated in winter. These logs should show growth almost touching the ground and should not be moved. The shade must be provided so these logs are not damaged.

G. Checking the Condition of the Dried Shiitake:

Sometimes the dried Shiitake that have been stored away for sale later can be invaded by insects during the summer. The mushrooms should be checked on a day with good weather. If insects are apparent these must be eliminated and if mold appears, the mushrooms need to be re-dried.

III. Fall: September, October, and November:

A. Fruiting in Fall:

There are two periods within this time: the period right after the summer season from mid August until the end of October, and the second part which is November.

The first part is the time of the natural outdoor fruiting when the price for fresh mushrooms is very low [851, 856, 510, 855 yoshun]. These strains can be fruited on old logs outdoors which previously resisted fruiting. So, this is the time to use the old logs.

The second part is the time when it is harder to fruit the logs and the price rises. This is the time to fruit virgin logs two-years-old or virgin logs that were inoculated last winter. Old logs do not fruit well at this time.

B. Test Fruiting of Virgin Logs which were Spawned the Same Year:

Logs which were inoculated during winter to spring of that year can be tested for fruiting at the end of September to the beginning of October for fruiting in November. Logs inoculated last November and December of year-round strains [851, 510] will produce 70-100 mushrooms. Logs inoculated January to February will produce 10-20 mushrooms and those inoculated by March will produce few, if any. The testing at this time will determine which logs to use for winter fruiting.

C. Preparation of the Greenhouse:

In November the night temperatures start to drop and heat will be required in the greenhouse. If heat is not used the humidity will rise too much at night and condensation will cause the mushrooms to get soggy. So, October is the time to prepare the heating system. The production of mushrooms per log is less in winter than summer so more greenhouse space is needed in winter to produce the same number of mushrooms as in summer.

D. Planning for Spawning:

Depending on the location, trees may be felled as early as October and then spawning will begin immediately. The spawning begins on a large scale in November. Spawn should be or-

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The Forest Resource Center Page 3 Lanesboro, Minnesota.
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dered three months in advance and be stored for use later. October is the time to buy logs. Have the place to inoculate the logs and the laying yard prepared, as well as the labor, for the inoculation. Since fall harvest is in full swing by this time, the preparations for inoculation should be arranged by September.

IV. Winter: December, January, and February:

A. Winter Fruiting:

The best logs to use for winter fruiting are year-round strains [851, 855, 510] on logs that have passed two summers or are virgin logs after the first summer. Winter strains [854, 855] should be inoculated on winter logs that are one-year-old. Old logs can be fruited outdoors after January.

Because the temperature is cold in winter, logs should be soaked in the afternoon or after placing in a greenhouse when they are warmest. Since the price is high in November, to get the highest production it is best to use thick diameter virgin logs which have gone past two summers with year-round strains [851, 510, 856].

These logs will produce 200-300 mushrooms in a flush. After this, use year-old logs of year-round strains [851, 510] which were inoculated from November to January the year before. After this use winter strains which have been inoculated the past winter [855, 854].

B. Felling the Trees and Spawning:

The trees are felled after the leaves turn and all winter long. They should be cut into lengths as soon as they are felled. All this must be planned in advance along with the labor as this is the time when most of the inoculation is done.

C. Bookkeeping for the Year:

This is the time to find out where the operation did well and where money was spent unnecessarily so improvements can be made.

* * *

(Editor's Note: Chapter 14: Calendar of Year-round Fruiting, is the last chapter in Tahel Fujimoto's book: "High Speed Year-round Shiitake Cultivation." The Fujimoto series began in the August 1988 issue of "Shiitake News" and has run as a serial in each successive issue since that time (eight issues). Back issues of "Shiitake News" are available for $4.00 each. If you would like to fill out your Fujimoto collection, or if there is a "Shiitake News" that you don't have but would like, send a check or money order (or VISA/MASTERCARD) to: "Shiitake News," Forest Resource Center, Rt. 2, Box 158A, Lanesboro, MN. 55949.)

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Written by Patricia Melville and Ann Potter in 1987 for the Forest Resource Center, the guide gives its readers a great deal of valuable information. The eight chapters in the notebook provide a complete discussion of marketing.

The opening chapter of the marketing guide deals with the market overview. It covers market definitions, market planning, and how one begins to position him or herself in the marketplace. This chapter also gives the reader some insight into consumer perceptions of Shiitake mushrooms. This insight is valuable information to the astute marketer. The authors, however, and rightfully so, state that the results of the survey may not be representative of all target markets as the research was only done in St. Paul/Minneapolis and Rochester, Minnesota areas.

Chapter Two of the marketing guide discusses in some length, market assessment or market analysis. It gives the reader a solid background on market analysis - defining marketing channels, and implementing a strategy that will lead to successful sales.

The guide lays out a step by step procedure to develop a complete analysis. This Chapter also has a worksheet that is quite useful.

Chapter Three discusses distribution channels. This chapter gives insight in how to select various distribution channels and describes some of the basic characteristics of these channels. The channels of direct marketing, wholesale markets, retail markets and exports are explained. This chapter also has discussions of various storage, shipping, and handling requirements of Shiitake mushrooms.

Chapter Four is devoted to packaging. Information in this chapter includes discussions on boxes, plastics, wraps, labels and various grading standards and their applications to the wholesale and retail distribution system. Again, as in previous chapters, worksheets are available.

Pricing is discussed in Chapter Five. The marketing guide explains, at some length, the concepts of mark-ups and margins, establishing operating costs, how to react to falling prices, and negotiating a price that is equitable for the seller and the buyer. This chapter provide some good "food for thought."

Chapter Six is a very thorough chapter on the promotion of Shiitake mushrooms. The concept of dealing with promotion as communication is excellent and well taken.

Promotion involves knowing the target audiences or target clientele and how to set up strategies that will reach this target market. Of specific
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The final chapter is a supplementary section. It contains an excellent article on financial analysis of three small Shiitake mushroom enterprises. This is important information and could be used by Shiitake mushroom producers with the understanding that the figures will vary from state to state.

Also included in this chapter is a definition of terms, a discussion of the methodology used for the research covered in the guide, a bibliography, and some acknowledgements.

Overall, the "Shiitake Mushroom Marketing Guide for Growers" is well laid out, easy to read, and has some very practical and useful information.

The guide, however, does take a while to read from cover to cover. It is not the type of reading, nor should it be, done in just one evening.

Shiitake mushroom producers who are interested in developing a solid marketing program, should read each chapter and think it through.

The marketing guide is published in a loose-leaf notebook format and is easy to update. The cost of the book is $23 for 'Shiitake News' subscribers, and $30 for non-subscribers. In either case, it is considered a real bargain.

- Shiitake Calendar of Events -

(If you would like to list your event in the Shiitake Calendar of Events, write or call the Forest Resource Center, Rt. 2, Box 156A, Lanesboro, MN. 55949. (507) 467-2437. Deadlines are Feb. 1 - for March issue; July 1 - for August issue, and October 1 - for November issue.)

Nov. 17: Florida Mushroom Growers Association Fall Workshop, Perry, FL. For more information, contact Clay Olson, County Extension Director, at (904) 584-4345 in Perry.

Dec. 1: Joint Shiitake Growers Meeting, Minnesota Exotic Mushroom Growers Association (MEMGA) Organizational Meeting, and FRC expanded Shiitake Mushroom Demonstration Project Open House, Forest Resource Center, Lanesboro, MN. The FRC, the Midwest Specialty Mushroom Growers Association, SHI-GAW, and the Geode Specialty Mushroom Growers Association of Iowa will meet on Saturday, Dec. 1, beginning at 10 a.m. There is a $12/person registration fee which includes lunch. Also at 10 a.m., an organizational meeting of the "Minnesota Exotic Mushroom Growers Association" (MEMGA) will be held.

The FRC will also host an Open House, beginning at 2 p.m. for interested persons who would like to see the recently completed new 4,600 square-foot indoor fruiting building that has been under construction this summer at the FRC. The new building will allow the FRC to expand its research and education capabilities at the Shiitake Mushroom Demonstration Project.

Feb. 17-21, 1991: AML 9th North American Mushroom Conference, San Antonio, TX. The American Mushroom Institute, sponsor of the event, will add a one-day "Specialty Mushroom Program," with emphasis on Shiitake and Pleurotus, to its conference agenda. This program will take place on Feb. 20. For more information, contact: The American Mushroom Institute, 907 E. Baltimore Pike, Kennett Square, Pennsylvania. 19348.

Saturday, Feb. 23, 1991: The Shiitake Mushroom Cultivation Seminar, at the Forest Resource Center, Lanesboro, MN. The Forest Resource Center is the leading research center in the United States for Shiitake mushroom cultivation on hardwood logs. Since the Shiitake Mushroom Demonstration Project began in 1982, the FRC has been researching 52 different strains of Shiitake on a log population of 10,000 logs. Many different species of wood are being used in the research project. These wood species have revealed some very interesting, surprising and successful results. Mitch Gilbert, Shiitake Mushroom Project Director, will lead the seminar which will focus on Shiitake mushroom cultivation techniques suitable to the midwestern climate. Dr. Mel Baughman, Minnesota Extension Forestry Specialist, will give a lecture on forest management practices for Shiitake log production. And FRC executive director, Joe Deden, will give a lecture on marketing Shiitake.

Following the morning class session, a luncheon featuring several different delicious Shiitake recipes will be served. An afternoon tour of the FRC’s newly expanded Shiitake Mushroom Demonstration Project will follow. At that time, participants will receive hands-on training in inoculation, laying yard and cultivation techniques. Advance registration is required. A registration fee of $50 per person will be charged and includes classroom materials, lunch and lab materials. Participants will inoculate their own logs during the afternoon session. The registration deadline is Feb. 11. (See article on page 14 for more information).

March 2, 1991: 4th Annual West Virginia Shiitake Conference, 10 a.m. to 4 p.m., at the Cedar Lakes 4-H Center, Ripley, WV. Call Paul Goland (304) 567-2727 for more information.
A Nutritional Analysis and Development of Promotional Materials for Shiitake Mushroom Producers in Wisconsin

(Editor's Note: The following research study, released in September, was conducted by Janice Timmer, Ph. D.; Anita Pershern, Ph. D.; and Marty Ondrus, Ph. D.; University of Wisconsin-Stout. The study was completed for SHII-GAW, the Shiitake Growers Association of Wisconsin, and was funded by a University of Wisconsin - System Applied Research Grant.)

These gourmet mushrooms commanded a premium price in specialty markets and were sold for over 16.6 million dollars (Anonymous, 1989).

In Wisconsin, Shiitake mushroom cultivation is a growing agribusiness that is well-suited for the state because of the abundance of specific oak species that can be used for Shiitake mushroom production.

Currently, Wisconsin is producing Shiitakes according to consumer demand but it is estimated that with current facilities, production could increase by one-third or more if consumer demand increased.

Increased consumer awareness of Shiitake mushrooms is necessary for the expansion of the industry in Wisconsin and elsewhere.

SHII-GAW (Shiitake Growers Association of Wisconsin) provides its members with marketing information that is used to promote sales.

Shiitake mushrooms are relatively unknown to the average consumer so marketing information should include printed material on product storage and incorporation of Shiitakes into recipes.

In addition, with an increasingly nutrition-conscious public, accurate information on the nutritional composition of Wisconsin-grown Shiitake mushrooms is essential.

The nutrient content of Shiitake mushrooms has been studied by several researchers but the results vary considerably according to method of analysis and area of cultivation. Therefore, it was necessary to evaluate the Wisconsin-grown Shiitake mushroom for its nutritional content so promotional materials can supply nutrition information that is current, specific, and accurate. Complete and reliable information about this product can be used to promote Wisconsin-grown Shiitake mushrooms and increase the likelihood of purchase.

Research Objectives

1. To perform nutritional analysis on Wisconsin-grown Shiitake mushrooms in both the fresh and commercially freeze-dried forms including the following nutrients: protein, fat, carbohydrate, amino acids, fatty acids, vitamins A, B, C, ergosterol (pro-vitamin D), and minerals.

2. To develop promotional materials incorporating nutritional analysis, storage information, and recipes.

Nutritional Analysis

TriPLICATE analyses were performed on fresh and commercially freeze-dried Shiitake mushrooms and the samples were evaluated for protein, fat, carbohydrate, moisture, amino acids, and fatty acids.

The vitamins analyzed included vitamin C, riboflavin, thiamin, niacin, ergosterol (pro-vitamin D), b-carotene (pro-vitamin A), and vitamin E. The minerals analyzed included sodium, copper, magnesium, iron, calcium, potassium, manganese, and zinc.

The Shiitake mushrooms were obtained from Field and Forest Products, Inc., Peshtigo, Wisconsin.

The Macronutrients: Moisture, Protein, Fat, and Carbohydrate

Shiitake mushrooms, like most food, contain mainly moisture, protein, fat, and carbohydrate. The relative percent breakdown of these macronutrients for both fresh and freeze-dried Wisconsin-grown Shiitake mushrooms is shown in Figure 1. The moisture content was determined by vacuum drying both the fresh and freeze-dried mushrooms and the average moisture content of the samples was 83.92% and 7.06% mois-

(Continued on next page)
A nutritional analysis and promotional materials development for Wisconsin Shiitake mushroom producers, continued

ture, respectively. The carbohydrate content was determined by subtracting the protein, fat and moisture from the total product. The calculated values for carbohydrate were 14% for fresh and 75% for freeze-dried Wisconsin-grown Shiitake mushrooms.

Protein and Amino Acids

The protein content of Wisconsin-grown Shiitake mushrooms was determined using the Kjeldahl method which is commonly used to quantify the nitrogen content of foods. After the Kjeldahl analysis, the nitrogen value was multiplied by 6.25 to calculate the crude protein because nitrogen is only 16% of the total protein found in most foods (16 X 6.25 = 100%). The crude protein content of fresh and freeze-dried Wisconsin-grown Shiitake mushrooms was 2.14% and 16.00%, respectively.

However, Shiitake mushrooms contain an alternate source of nitrogen called chitin which accounts for approximately 30% of the total nitrogen. Chitin is not digested in the human body so the actual digestible protein supplied by Shiitake mushrooms may be only 70% of the total protein calculated. If the nitrogen is multiplied by a digestibility factor of 4.38 (70% of 6.25 = 4.38) then the actual digestible protein content of Shiitake mushrooms is 1.50% for the fresh product and 11.21% for the freeze-dried product.

In order to access the quality of the Shiitake mushroom protein, the amino acid content was analyzed. The amino acid profile of Wisconsin-grown Shiitake mushrooms was determined using High Pressure Liquid Chromatography (HPLC) which can separate and detect precise quantities of amino acids. The amino acids were identified by their ability to absorb ultraviolet light. Each amino acid absorbed and retained a particular quantity of ultraviolet light under controlled conditions. The HPLC system uses predetermined standards to compare with an unknown sample. By matching the ultraviolet light retention rate of the unknown sample with that of a known substance, specific amino acids were identified. HPLC methods were used for the fatty acid and vitamin analyses as well.

The amino acid profile for freeze-dried Wisconsin-grown Shiitake mushrooms is illustrated in Figure 2.

Sixteen amino acids were identified with glutamic acid being the most abundant. Essential amino acids were over 40% of the total amino acid composition of the protein. Because methionine is present in the smallest amount, it is designated as the limiting amino acid.

Fat and Fatty Acids

The fat content of freeze-dried Shiitake mushrooms was determined by extraction of the crude fat with a solvent and then saponification with sodium hydroxide to purify the samples.

This procedure required that the samples be dehydrated prior to analysis. Consequently, the fat content of fresh Shiitake mushrooms was determined by extrapolating from the freeze-dried mushrooms analysis.

Wisconsin-grown Shiitake mushrooms were found to be low in fat with the fresh mushroom being approximately 0.46% fat and the freeze-dried mushroom being 2.45% fat.

The fatty acid profile for Wisconsin-grown Shiitake mushrooms was determined using the HPLC system and those fatty acids identified included linoleic acid (75%), palmitic acid (12%), stearic acid (1%), and oleic acid (0.5%) (Figure 3). Linoleic acid was present in the greatest amount. Linoleic acid is the only undisputed essential fatty acid and is considered by be a required nutrient. Hashiguchi et al. (1984) also found linoleic acid to be the predominant fatty acid in Shiitake mushrooms.

Vitamins: Water Soluble and Fat Soluble.

Using the HPLC system, several water soluble and fat soluble vitamins were quantified in fresh and freeze-dried Wisconsin-grown Shiitake mushrooms. Niacin and ergosterol (pro-vitamin D) were present in the largest quantities and b-Carotene (pro-vitamin A) and atocopherol (vitamin E) were barely measurable at less...
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than 0.01 mg. per 100g. sample (Figure 4).

Water Soluble Vitamins: Ascorbic Acid, Riboflavin, Thiamin, and Niacin.

Small amounts of water soluble vitamins were detected in Wisconsin-grown Shiitake mushrooms except for niacin which was present in substantial quantities. When comparing the reported values for ascorbic acid, riboflavin, and thiamin, most of the data generated by the University of Wisconsin-Stout was similar to that of the USDA (Haytowitz et al., 1984) and Crisant and Sands (1978) (Figure 5). The ascorbic acid (vitamin C) content of Wisconsin-grown Shiitake mushrooms was 2.72mg. per 100g. fresh, and 3.45mg. per 100g. freeze-dried product. For riboflavin (vitamin B2), the fresh and freeze-dried Wisconsin-grown Shiitake mushrooms contained 0.19mg./100g. and 1.67mg./100g., respectively. The thiamin (vitamin B1) content was 0.08mg. in the fresh and 0.53mg. in the freeze-dried Wisconsin Shiitakes. Several reports in the literature stated that Shiitake mushrooms contained vitamins B6, B12, and Folacin but no specific amounts were listed (Breene, 1989). It would be advantageous to develop methods to analyze for these vitamins in future research.

The comparison of the reported niacin values in Figure 6 shows that the Wisconsin-grown Shiitake mushrooms have a substantially greater proportion of niacin compared to previous literature values. The niacin contents of fresh and freeze-dried Wisconsin-grown Shiitake mushrooms were 6.2 and 27.83mg., respectively, per 100g. sample. The 1989 U.S. Recommended Daily Allowance (USRDA) for Niacin was 20 mg. per day, so 100g. of fresh Shiitake mushrooms provides 30% of the USRDA.

Fat Soluble Vitamins: Vitamin E, Ergosterol, and b-Carotene

Except for ergosterol, the fat soluble vitamins in Wisconsin-grown Shiitake mushrooms were present in very small quantities (Figure 4). Previous analysis of Shiitake mushrooms (Crisan and Sands, 1978) indicated that the fat soluble vitamins A and D are fairly uncommon but b-Carotene (a precursor to vitamin A) was present in detectable amounts. The analysis of Wisconsin-grown Shiitake mushrooms showed very little b-Carotene in either the fresh or the freeze-dried samples (0.01mg./100g.).

Conversely, ergosterol was present in considerable quantities in both the fresh (Figure 7) and the fresh Wisconsin-grown Shiitake mushrooms. Ergosterol is a compound that is converted to vitamin D when exposed to ultraviolet light. In Japan, Shiitake mushrooms are often treated with ultraviolet light and then marketed as a good source of vitamin D. If treated with ultraviolet light, it is estimated that one gram of ergosterol can be converted to 400 international units of vitamin D which is 100% of the USRDA. The ergosterol content of Wisconsin-grown Shiitake mushrooms is 52.28mg/g. fresh sample and 452.16mg/g. dried sample. These high levels have the potential to be converted to significant quantities of vitamin D but further research is needed on the conversion process. An additional area for research could be to consider the feasibility and effectiveness of sun-drying or ultraviolet irradiation of Shiitake mushrooms to enhance the conversion of ergosterol to vitamin D.

Minerals

Six minerals were studied in both fresh and freeze-dried Wisconsin-grown Shiitake mushrooms: sodium, copper, magnesium, iron, calcium, potassium, manganese, and zinc. The specific quantities of these minerals are presented in Figure 8. Magnesium and potassium were present in the greatest amounts. All minerals were quantified by using atomic absorption analysis. The fresh minerals were isolated from the organic compound using the dry ash method. For the freeze-dried mushrooms, two isolation methods were employed to ensure the accuracy of the data. For copper, iron, manganese, and zinc, the dry ash method produced the best results, whereas for the remainder of the minerals including sodium, magnesium, calcium, and potassium, a wet digestion method was used.

Fresh Wisconsin-grown Shiitake mushrooms have greater quantities of copper (1.19mg.), manganese (2.25mg.), and zinc (5.47mg.) per 100g. sample than previous research on these minerals in Shiitake mushrooms (Figure 9). In the freeze-dried mushrooms, Wisconsin-grown Shiitake contained 0.53 mg. copper, 1.49mg. manganese, and 4.41 mg. zinc per 100 grams of product. There were no dried sample values reported in the literature for these minerals.

A comparison of the reported values per 100g. sample for iron and calcium is shown in Figure 10. Wisconsin-grown Shiitake mushrooms contain 1.86 mg. iron and 1.79mg. calcium in the fresh and 1.16mg. iron and 14.87mg. calcium in the freeze-dried samples. Typically Shiitake mushrooms tend to be low in iron and high in calcium.

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In general, the reported values for sodium in Shilatke mushrooms are low with the Wisconsin-grown Shilatke mushrooms containing 30.50mg. In the fresh and 26.31mg. In the freeze-dried product. In contrast, magnesium is present in much greater quantities especially in Wisconsin-grown Shilatke which contain 86.42mg. and 151.25mg. for the fresh and freeze-dried mushrooms (Figure 11). The USRDA for magnesium is 400mg. so 100g. of Wisconsin-grown Shilatke mushrooms contains 22% of the USRDA for this essential nutrient.

Of all the minerals analyzed, potassium was found to be present in the greatest amount. The Wisconsin-grown Shilatke mushrooms seem to have considerably greater quantities of potassium than former reported values with the fresh mushrooms containing 2180.40mg. and the freeze-dried mushrooms containing 2397.25mg. per 100g. (Figure 12). Wisconsin-grown Shilatke mushrooms are a significant source of dietary potassium especially when compared with the National Research Council's recommendation of 1875-5625mg. for sage and adequate potassium intake.

### Promotional Materials

The second objective of this project was to develop promotional materials which incorporated nutritional analyses, storage information and recipes into marketing tools that would help encourage consumer demand for Wisconsin-grown Shilatke mushrooms. Specifically, these materials include foodservice recipe cards, value-added product formulations, and a promotional video. These promotional materials are targeted to foodservices and restaurants for quantity production using Shilatke mushrooms.

### Food Service Recipe Cards

Four consumer recipes featuring fresh Wisconsin-grown Shilatke mushrooms were scaled up to food service quantities. This was done by multiplying the recipe ingredients by the appropriate conversion factor and then testing the adjusted measurements with quantity food production equipment. After testing, the recipes were evaluated and adjusted accordingly.

Once the ingredient measurements were fixed, the recipes were formatted for use on five by eight index cards. The finished recipe card will have one side of the card with the ingredients, weights, measures, and directions. The opposite side will have a color photo of the recipe. In addition, a separate card was formatted to contain nutrition information and storage and handling Instructions. A color photo of the raw Wisconsin-grown Shilatke mushrooms will be featured on the reverse side.

### Value-added Products

In addition to the food service recipes, two value-added products containing Wisconsin-grown Shilatke mushrooms were developed for the consumer. These products were designed to make use of the commercially freeze-dried Shilatke mushrooms which are often produced during times of excess mushroom production or availability. The products are Pilaf of Shilatke and Barley and Shilatke Barley Rice Bake. These items could be marketed to consumers as prepackaged specialty products especially useful as convenience foods.

### References:


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Koyama, N., Y. Aoyagi and T. Sugahara. 1984. Fatty Acid Composi-

Figure 6
Comparison of Reported Values for Niacin Content of Shiitake Mushrooms

![Graph showing comparison of Niacin content in fresh and dried Shiitake mushrooms]

*The USDA values for the “Fresh” category reflect cooked Shiitake Mushrooms.

Figure 7
Comparison of Reported Values for Ergosterol Content of Dried Shiitake Mushrooms

![Graph showing comparison of Ergosterol content in fresh and dried Shiitake mushrooms]

Appendix B
Crude and Digestible Protein Contents of Wisconsin-grown Shiitake Mushrooms

<table>
<thead>
<tr>
<th>Protein Type</th>
<th>Fresh</th>
<th>Freeze-dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Crude Protein/Per Sample</td>
<td>2.24</td>
<td>0.80</td>
</tr>
<tr>
<td>% Digestible Protein/Per Sample</td>
<td>1.61</td>
<td>0.74</td>
</tr>
<tr>
<td>Average Crude Protein</td>
<td>2.14 ± 0.46</td>
<td>1.60 ± 0.27</td>
</tr>
<tr>
<td>Average Digestible Protein</td>
<td>1.50 ± 0.17</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8
Mineral Content of Wisconsin-grown Shiitake Mushrooms

![Graph showing mineral content in fresh and freeze-dried Shiitake mushrooms]

Appendix C
Amino Acid Contents of Freeze-dried Wisconsin-grown Shiitake Mushrooms

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Free Amino Acid (mg/kg)</th>
<th>Total Amino Acid (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>1.00</td>
<td>3.41</td>
</tr>
<tr>
<td>Prolin</td>
<td>0.08</td>
<td>2.90</td>
</tr>
<tr>
<td>Leucine</td>
<td>0.77</td>
<td>3.56</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.38</td>
<td>3.28</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.14</td>
<td>0.90</td>
</tr>
<tr>
<td>Valine</td>
<td>0.95</td>
<td>3.03</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.34</td>
<td>3.20</td>
</tr>
<tr>
<td>Aspartic</td>
<td>1.23</td>
<td>5.20</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.49</td>
<td>1.83</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>0.41</td>
<td>1.66</td>
</tr>
<tr>
<td>Proline</td>
<td>0.94</td>
<td>3.57</td>
</tr>
<tr>
<td>Alanine</td>
<td>0.90</td>
<td>4.10</td>
</tr>
<tr>
<td>Glutamine</td>
<td>0.80</td>
<td>4.01</td>
</tr>
<tr>
<td>Serine</td>
<td>0.50</td>
<td>1.88</td>
</tr>
<tr>
<td>Asparagine</td>
<td>0.80</td>
<td>14.17</td>
</tr>
</tbody>
</table>

Appendix D
Fat Content of Freeze-dried Wisconsin-grown Shiitake Mushrooms

<table>
<thead>
<tr>
<th>% Fat Per Sample</th>
<th>2.86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average % Fat</td>
<td>2.45 ± 0.31</td>
</tr>
</tbody>
</table>

Appendix A
Moisture Content of Wisconsin-grown Shiitake Mushrooms

<table>
<thead>
<tr>
<th>Moisture per Sample</th>
<th>Fresh</th>
<th>Freeze-dried</th>
</tr>
</thead>
<tbody>
<tr>
<td>82.77%</td>
<td>80.00</td>
<td></td>
</tr>
<tr>
<td>83.55%</td>
<td>82.55</td>
<td></td>
</tr>
<tr>
<td>83.66%</td>
<td>82.62</td>
<td></td>
</tr>
<tr>
<td>83.59%</td>
<td>83.25</td>
<td></td>
</tr>
<tr>
<td>85.75%</td>
<td>7.31</td>
<td></td>
</tr>
<tr>
<td>85.03%</td>
<td>7.32</td>
<td></td>
</tr>
<tr>
<td>85.43%</td>
<td>7.45</td>
<td></td>
</tr>
<tr>
<td>82.56%</td>
<td>7.55</td>
<td></td>
</tr>
<tr>
<td>82.62%</td>
<td>7.76</td>
<td></td>
</tr>
<tr>
<td>83.92%</td>
<td>7.95</td>
<td></td>
</tr>
</tbody>
</table>

Average % Moisture 83.92 ± 1.69 7.06 ± 0.62

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The Forest Resource Center
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Lanesboro, Minnesota.
Charts and Graphs for a nutritional analysis for Wisconsin Shiitake mushroom producers

Figure 10
Comparison of Reported Values for Iron and Calcium Contents of Shiitake Mushrooms

Figure 11
Comparison of Reported Values for Sodium and Magnesium Contents of Shiitake Mushrooms

Figure 12
Comparison of Reported Values for Potassium Content of Shiitake Mushrooms

*The USDA values for the "Fresh" category reflect cooked Shiitake mushrooms

Northwest Mycological Consultants researching alder sawdust substrate for Shiitake

By John Donoghue, Research Associate
Northwest Mycological Consultants, Inc.
Corvallis, OR.

The Shiitake industry is rapidly expanding and developing. New cultivation techniques and technologies are emerging as Shiitake production becomes established in new areas. At the same time, competition for raw materials and market share has increased. This increased competition requires producers to become more efficient at converting raw materials into top-quality mushrooms.

Applied research that specifically addresses production concerns is needed to improve crop efficiency. Unfortunately, applied research is often expensive and developing industries rarely can afford to foot the total bill for such work.

One solution is for industry to seek funding for applied research from outside interests which will benefit equally from industry growth. An example of applied research funding jointly by the Shiitake industry and outside sources is currently underway at Northwest Mycological Consultants, Inc. (NMC) in Corvallis, Oregon.

In December of 1989, NMC was awarded a research grant of $20,000 from the Applied Research Fund of the Linn-Benton Regional Strategy, the Oregon Shiitake Industry, the Northwest Shiitake Association, Inc., and NMC matched this with funds totalling $20,000.

The project, entitled: "Development of Shiitake Production Technology using Alder Sawdust as a Nutrient Base," is applied research designed to aid the developing Shiitake mushroom industry in Oregon.

The Regional Strategy is a state-wide Oregon Economic Development Department program supported by Oregon State Lottery revenue.

The Linn-Benton Applied Research Fund targets the transfer of technologies from research institutions to industry. The ultimate objective of the Linn-Benton Regional Strategy is to create new jobs by supporting applied research deemed critical by local industries for their further growth. To affirm the critical need for such research, industry support in the form of matching funds is required.

NMC's objective for this research project is to establish an economically profitable combination of Shiitake strain, substrate formulation and management techniques that will allow the substitution of alder (Alnus rubra) sawdust for oak (Quercus) sawdust as the primary raw material for Shiitake production in Oregon. The development of this technology is needed for continued growth of the Oregon Shiitake Industry.

As the industry grows, the need for a sustainable supply of suitable hardwood sawdust becomes critical. Locally, alder can meet that need; oak probably cannot. The results of this research will permit Shiitake farmers to use alder profitably and will provide the needed data to allow

(Continued on next page)
Northwest Mycological Consultants research, continued

other woods to be used, if future needs arise.

This 15-month research project is divided into three phases.

During Phase 1, now underway, 84 combinations of Shiitake strain, sawdust substrate formulation and incubation time are being tested for mushroom production at the NMC pilot facility.

These combinations include: three commercial Shiitake strains (CS-41, CS-53, and CS-235), four incubation times (40, 70, 100, and 130 days), and seven different substrate formulations with varying levels of supplementation (including a standard oak control). The carbon:nitrogen ratio of each substrate formulation was determined and used as a measure of supplementation to 109/1 (low supplementation).

The eight most productive combinations will be identified by monitoring the crop timing, yield, market grade, and the levels of contamination on each strain/media/incubation combination over several flushes.

During Phase 2, these combinations will be tested for yield and profitability on a larger scale at two cooperating Shiitake farms.

Phase 3 will meld the results of Phases 1 & 2 to produce a management plan for Shiitake production using alder sawdust.

With the cooperation of researchers, industry and the regional community, valuable applied research is being carried out to shed light on an important production concern in Oregon.

Ultimately, this type of research will promote the growth of the Shiitake industry. This growth will, in turn, benefit the communities that foster Shiitake production by providing new job opportunities.

U. of Kentucky Forestry Extension has successful Fall Shiitake harvest

By Carol Davis
University of Kentucky Forestry Extension

Shiitake mushrooms are popping up at the University of Kentucky’s Robinson Forest, the department of Forestry’s research forest.

During September and the first part of October, we harvested 56.36 pounds of Shiitake mushrooms from Black Oak (Quercus velutina), White Oak (Quercus alba), and Sweetgum (Liquidambar styraciflua) logs which were inoculated in the Spring of 1989.

Initial Shiitake production occurred in late September by soaking 20 logs for three days. The logs were then removed from the tank, and we harvested 13.12 pounds of Shiitake three days later.

As a result of a drop in temperature, 43.34 pounds of Shiitake were produced along with continuing precipitation.

This is the first sizable harvest at the Robinson Forest.

During the first harvest in late September, Deborah (Hill) just happened to be conducting a Shiitake mushroom tour for the Fall meeting of the East Kentucky chapter of the Society of American Foresters.

Most of the foresters were very curious about the mechanics and economics of Shiitake production and anxious to sample the mushrooms.

When we offered part of our harvest to the faculty and staff, the mushrooms disappeared (along with the Shiitake box) in a matter of minutes.

I sold a few pounds to local restaurants and a natural foods store.

Apparently, the fresh Shiitake supply has dried up in Lexington, and the market is wide open!

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The Forest Resource Center
The Vermilion County, Illinois, Shiitake Mushroom Project: A Report

By Ken Konsis - Research Forester
Vermilion County Conservation District
Westville, Illinois.

Shiitake mushroom production and research is nearing the end of the fourth year of fruiting at the Vermilion County Conservation District site near Darville, Ill.

Located at Kennekuk County Park, 850 logs were inoculated in 1986 with 15 different strains of Shiitake.

Slow production years from 1987 to 1989 produced only an average of 55 pounds of Shiitake on 850 logs.

The drought during 1988 contributed to this low productivity, even though soaking of the logs was performed.

Strains were isolated as being good producers, marginal, and poor for east-central Illinois, Shiitake growers.

For 1990, the production through July was up to 170 pounds of Shiitake. Two of the poorer strains have reversed their productivity levels and have become top producers in 1990.

This Fall our Shiitake mushroom production is projected to be well over 250 pounds.

Marketing is just as important as productivity to Shiitake growers. Likewise, it is an important part of our research project.

In the past, much of our mushroom crop was given away as promotion or sold locally to individuals.

With increased production, a food co-op was used as an outlet, but at a reduced rate.

We entered the dried market in 1989 and sell Shiitake for $15 per pound.

Even though the market price is much greater selling fresh Shiitake, the small harvests can be dried and saved until a substantial amount can be sold. This was income not realized before.

The Increase In productivity in 1990 allowed us to sell at a local farmer’s market. A notice in the newspaper helps with the advertising.

In July, 40 pounds of fresh Shiitake was sold in a two-hour period. A “waiting” list was compiled with more than 30 people wishing to purchase Shiitake mushrooms.

We feel that by selling to local patrons at the local farmer’s market, wholesaling at a food co-op, and selling dried Shiitake, we can market everything that we produce.

Other options, such as specialty food stores, gourmet restaurants, and local supermarkets remain for future markets.

In the meantime, our goal is not producing Shiitake mushrooms, but offering an alternative source of income to woodland owners to perform good forestry practices.

Hopefully, income from Shiitake mushroom production will be the economic incentive to carry these timber-stand-improvement practices out.

Appalachian Mushroom Growers Association has an up and down season

By Mary Ellen Lombardi, Secretary
Appalachian Mushroom Growers Association
Haywood, Virginia

The Appalachian Mushroom Growers Association has had a season of many ups and downs.

After getting off to a great start with our participation in a reception on Capitol Hill, and a very successful and well attended mushroom festival in Front Royal, VA., we were forced to cancel our Oct. 13 Conference due to a severe shortage of funds.

In addition to a low treasury, many of our members have been plagued by poor mushroom production. While we are continuing to try to find out why so many people have had problems this season, some of our research has led us to suspect problems with spawn quality and types of spawn being used and sold.

We are presently in the process of reorganizing and we are planning a general membership meeting in November.

On a positive note, our Organic Certification Program has been approved by the State of Virginia.

I look forward to reporting back, to the FRC and its "Shiitake News" readers, an optimistic forecast for our Association in the next issue of "Shiitake News."

We would welcome information from growers on spawn sources and strains they have found to be particularly successful and also any problems they may have had.

The Forest Resource Center
Lanesboro, Minnesota.
Forest Resource Center to present Shiitake Mushroom Cultivation Seminar Feb. 23

The Forest Resource Center (FRC), Lanesboro, MN., will conduct a one-day Shiitake Mushroom Cultivation Seminar on Saturday, Feb. 23, 1991. The morning session will be held at the Sons of Norway Hall in downtown Lanesboro. Registration will begin at 8:30 a.m. The seminar will begin at 9 a.m.

The FRC is the leading research center in the United States for Shiitake mushroom cultivation on hardwood logs. Last year, more than 5,000 people, representing every state in the U.S., as well as a number of foreign countries, visited the Forest Resource Center and toured the Shiitake Mushroom Demonstration Project.

Since the FRC's Shiitake Mushroom Demonstration Project began in 1982, the FRC has been researching 52 different strains of Shiitake on a log population of 10,000 logs. Many different log species are being used in the research project. These wood species have revealed some very interesting, surprising and successful results.

Mitch Gilbert, Shiitake Mushroom Project Director, will lead the seminar which will focus on Shiitake mushroom cultivation techniques suitable to the midwestern climate.

Dr. Mel Baughman, Minnesota Extension Forestry Specialist, will give a lecture on forest management practices for Shiitake log production. And, FRC Executive Director, Joe Deden, will give a lecture on marketing Shiitake mushrooms.

Following the morning classroom session, a luncheon featuring several different delicious Shiitake recipes will be served.

An afternoon tour of the FRC's newly expanded Shiitake Mushroom Demonstration Project will follow. At that time, participants will receive hands-on training in inoculation, laying yard, and cultivation techniques. Participants will inoculate their own logs during the afternoon session.

Advance registration is required. A registration fee of $50 per person will be charged and includes classroom materials, lunch and lab materials.

The Forest Resource Center is located in the middle of a 900-acre section of the Richard Dorer Memorial Hardwood Forest near Lanesboro, MN. Lanesboro is approximately 40 miles south of the Rochester, Minnesota, International Airport which is served by several major airlines. There are several very nice "bed & breakfasts" in Lanesboro and in nearby communities in the Root River Valley.

The FRC, a forestry and environmental education organization, has developed more than 40 forestry demonstrations (the Shiitake Mushroom Project is one of them). Also at the FRC is seven miles of forest trails. Excellent cross-country skiing is possible on these trails, provided that Minnesota has a normal winter.

For more information on the Shiitake Mushroom Cultivation Seminar, contact the Forest Resource Center, Rt. 2, Box 156A, Lanesboro, MN. 55949. (507) 467-2437.

The deadline for registration is Feb. 1, 1991. We hope to see you at the FRC - bring your skills and make a weekend out of it.

Taylor County, Florida, Shiitake Mushroom Demonstration Project receives additional funding

Clay Olson, County Extension Director, Taylor County, Florida, reports that the Center for Cooperative Agricultural Programs has funded the Shiitake Mushroom Demonstration Area Project for another year.

The Shiitake Demonstration has a log population of 1,000 logs.

Olson also reports that the Florida Mushroom Growers Association met in September in Gainesville and developed plans for the Nov. 17, Fall Workshop in Perry, FL.

For more information on this workshop, contact Clay Olson, County Extension Director, P.O. Box 820, Perry, FL. 32347. Telephone: (904) 584-4345.

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Line classified advertising: If you subscribe to the Shiitake News you are entitled to one free line classified ad. Subscribers may place one free 20 word ad anytime during their membership year. Additional ads in that year run at a reduced subscriber’s rate.

Rates: SUBSCRIBERS: First ad free, 20 word maximum. All other ads, 25 cents per word.

Drills and Bits: Imported 10,000 rpm Shiitake drills, $280, & special Shiitake drill bits, $10. Write Daniel Green, 6010 Marshall Rd., Dexter, MI, 48130, or call (313) 663-4966.

For Sale: Shiitake mushroom enterprise due to knee surgery. Package deal consisting of 800 medium/large white oak logs (48") that produced 1,467 lbs. since Sept., 89. 800 medium/large logs (48") inoculated Jan., through May with Field & Forest strains WW-46/WR-46/CW-25/WW in oak and ironwood. First soak of 55 ironwood logs produced 40 lbs. of Shiitake. 130,000 BTU Johnson wood-burning furnace with blower; 2 - 12'-long soak tanks; 3 sawdust inoculating tools; wax pot & 10 lbs. bees wax; 8' chest freezer; 30 cu. ft. cooler with rolling glass doors; 2 - 20' belt drivers & 1 - 16' direct drive exhaust fan w/louverers; misc. related items; 55 log-standing racks, etc. $11,656.00 - F.O.B. Maquoketa, IA. For more info., contact: Dick Mason, Box 108, R.R. 1, Maquoketa, IA, 52060, or call (319) 652-4303.

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The Forest Resource Center
Page 15

Lanesboro, Minnesota.
Highly prized "spalted wood" is possible from Shiitake logs

(Editors Note: This letter to Joe Deden at the Forest Resource Center was written by Lawrence T. Beckerle, P.O.Box 118, Craigsville, VA. 26205)

Dear Joe,

I recently learned that some wood working craftsmen buy and/or help create "spalted" wood. Spalted wood is the result of fungi changing the color of wood as it first enters a log. This early staining effect can be very colorful and is highly desired by craftsmen as long as the wood is still sound enough to be carved or machined.

Maple is preferred. Apple, cherry and pear are in demand also. Elm and birch are in less demand. Oak is not used.

But, other woods used in Shiitake cultivation may be useful to craftsmen who want a good turning wood with color.

Spalted wood is sold as small as 4" X 4" turning squares, or in log lengths of 6, 12, or 18 inches, called "bolts."

If you inoculate your logs in rings, like I do, some of that wood between the rings in your contaminated logs may be of significant value to the craftsmen.

Forest Resource Center is seeking Shiitake Mushroom Project Assistant

The Forest Resource Center is looking for an individual who is serious about learning all aspects of the cultivation of Shiitake mushrooms. Those applying for the position should be interested in setting up their own Shiitake operation upon completion of this job.

The assistant's job will teach you Shiitake mushroom cultivation and marketing skills. The position is a full-time job, paid hourly, and has been set up to run for six-months to a year.

There is a substantial amount of lifting and handling of Shiitake logs involved. Applicants must be in good physical condition.

If you are interested in learning how to set-up and run a successful small business (Shiitake mushrooms), please send: a brief letter of introduction discussing why you are interested in Shiitake mushrooms, and a current Resumé detailing your work experience, to the Forest Resource Center, Rt. 2, Box 156A, Lanesboro, Minnesota, 55949. The FRC hopes to fill this position by Dec. 1.

The Shiitake News is published three times per year: March, August, and November. Initial subscription costs $25. Annual renewal $15. We invite your comments and submission of articles for possible publication.