PROGRESS REPORT
North Central Region
Sustainable Agriculture Research and Education (SARE) Program

Progress Report Year: 2013

Project Title: Phase 1: Truffle Orchard Establishment – The Burgundy Truffle as a new sustainable crop for the Missouri Ozarks

Project Number: FNC10-834

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1. Describe in detail your work activities and how you used your grant funds this year. (Use another sheet if necessary.)

Initial Site Selection

In the evaluation of a suitable truffle orchard site several criteria are determinate. An important consideration is that the area has been free of tree roots (such as is the case for an established pasture) for a period of years so as to reduce potential competition from non-commercial wild truffle varieties as well as other wild competing fungi present in the soil growing in symbiotic relationship with tree roots. Other considerations include keeping a minimum of 25 m away from the surrounding tree line, again to help minimize potential competition from wild mycorrhizal fungi. The type of soil is another very important aspect as this will determine the potential suitability for the Burgundy truffle to grow successfully and minimize the amount of soil mitigation necessary. In our case at Timber Farms, the Sinks, the selection was narrowed down to two slightly south facing slopes. A preliminary soil test was undertaken which showed similar silt-loam soil in both locations. [Appendix B: Initial Soil Test Results] The Walnut Knoll field was selected due to the opportunity for eventual orchard expansion as well as for the utility lines running past the site with a pole located handily at one corner of the orchard that will support the electrical panel for a well.

Fig 1: Site Options – Boyd Luck Field + Walnut Knoll Field

Fig 2: Selected Site – Walnut Knoll Field


Fig 3: Selected Site (view to NW)


Fig 4: Selected Site (view to NE)

- The next step was to lay out the boundaries of the orchard within the general site area and perform more detailed soil testing so as to get an actual profile of the area to serve as the basis for the required soil amendment regime. The orchard was laid out in a 50m x 50m square along cardinal directions. Three rows of soil sampling points were arbitrarily established (north, central and south. [See diagram, Figure 5] Along each row, samples were collected every 10 m; the samples for each row were combined and mixed for analysis, providing three sets of data for each depth sampled (generally 0 – 10 cm, 10 – 20 cm and 20 – 30 cm).
- Soil temperature sensors were placed at each corner of the site, 8 cm deep. Rainfall data are being collected at the greenhouse, approximately 1 km SW of the orchard site.

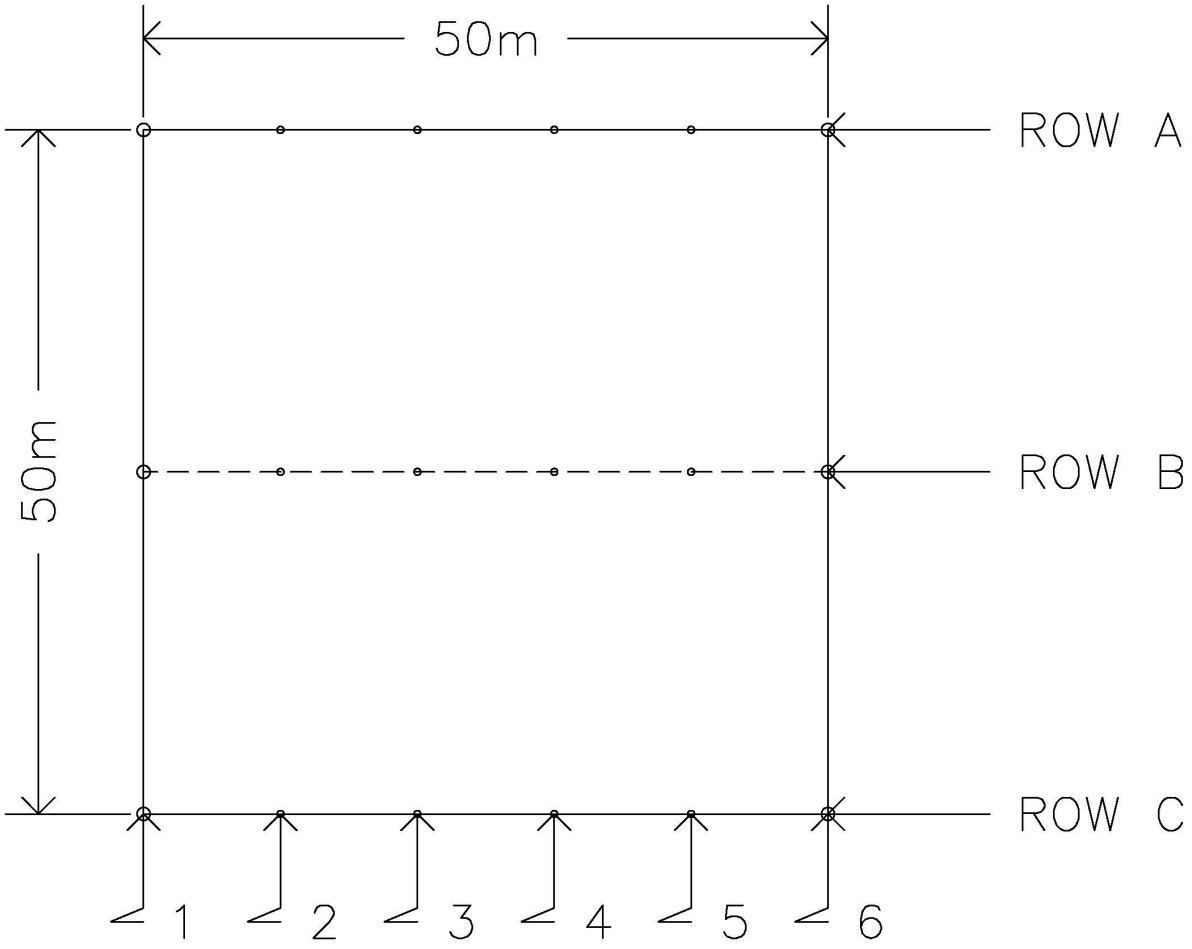


Fig 5: Truffle Orchard Layout

Lime Calculation and Application

Based on the results of the first comprehensive soil tests [Appendix B: Soil Test Results – 1], Dr. Bruhn recommended 0.7* US tons of lime ("white", low Magnesium) from the Conco Quarries, Springfield (Willard, MO) Stockpile no. 4, because it's the only source of low magnesium lime with an

adequately high "Fineness Factor". In addition, Dr. Bruhn recommended 9.2** US tons of the "red lime" from Skaggs Rock-n-Lime, Stockpile no. 3. The lime characteristics at each quarry were carefully vetted for their chemical composition prior to ordering.

* Can be rounded to 1 ton for ordering purposes.

** Can be rounded to 9 tons for ordering purposes

In addition to achieving a soil pH of 7.5 to 7.9, the objective is to approximate a Ca:Mg ratio of 40:1, which is well within the broad range reported from productive Sweden and French Burgundy truffle soils.

After the application of the lime and after careful consideration of the soil profile, the team realized that more clay and/or organic matter was needed throughout the upper 30 cm (= 12 in) of the soil profile, in order to raise the cation exchange capacity to permit the soil to hold at least 3,000 ppm of Ca (the current recommendation in France). The clay content was naturally higher in the 20 – 30 cm soil level, Rather than disking, or making the plowing implement that was originally envisioned, it was decided that a mold-board plow was the ideal piece of equipment to both mix in the lime deeper into the soil for a more uniform profile while at the same time mixing the deeper clay content throughout the soil.

After reviewing the soil tests results from November 9, 2011 (Appendix B - Soil Test Results – 2), it became clear that additional lime was needed due to the deep mixing of the soil. This was also seen as an advantage at this would create a deeper zone of soil with the proper soil characteristics and pH for truffle development. An additional 7 tons of white lime was applied on December 15, 2011 along with ¼ ton of limestone gravel for slow release pH buffering. This was then seeded with rye grass as a ground cover and to add additional organic matter once plowed in.

Lake Weed Harvest

As part of the organic matter supplement to the soil, the best and most cost effective options are to use resources close at hand. What often appears to be a nuisance or “weed” can also be looked at for its positive attributes. In our case, a nearby spring-fed lake has been choking with milfoil over the last 15 years or more. We had been looking at the lakeweed as a possible oyster mushroom substrate but in several experiments it proved too dense and too nutrient rich to use without excessive amendment. In the process, we had the dried lakeweed analyzed [Appendix C: Lakeweed Analysis] and were pleased to learn that it had collected quite a bit of calcium as a deposit from the spring water, and had a carbon to nitrogen ration of 15:1, very similar to horse manure. We quickly realized it could make an excellent fertilizer and compost while at the same time imparting a good deal of organic matter into the soil which was deficient for purposes of binding calcium needed for truffle cultivation.

After several trial and error mock ups, we purchased a used 9 horsepower outboard motor for a large john boat that we had on the property. We also purchased a Jenson Lake Weed Mower, powered by a marine battery that was the most cost-effective solution to harvesting the lake weed. The first step in the process was then to “mow” an area of the lake with the underwater sickle-type cutter. David Enloe then devised a capture-plow mounted in front of the johnboat which was used to corral the cut weed to shore. We then transported the cut weed to the greenhouse which was not being used during the summer. The lakeweed was spread out on the concrete floor to dry. Similar to making hay, the weed was flipped once or twice to thoroughly dry. The dried weed is quite fractious and light weight and was easy to shred in a leaf shredder after which it has the consistency of peat moss and the smell of alfalfa. This has been bagged for later application to the truffle orchard.

Fig 12: Lake Weed Processing

Fig 13: Lake Weed Plow

Fig 14: Mowing Lakeweed with Jenson Mower

Fig 15: Used Evinrude Outboard Motor

Fig 16: Lakeweed Drying

Fig 17: Shredded Lakeweed

2. List the results of your project and what you have learned so far.

With the deep plowing using the moldboard plow to mix in the clay throughout the upper 30 cm, the amount of lime originally calculated was not sufficient to raise the pH to the desired range. The effect of plowing in the weed grass to add organic matter also had an effect of lowering the pH but has helped raise the organic matter somewhat. The additional lime added on December 12, 2011 should raise the pH to the required level and also buffer a greater volume of soil benefiting truffle formation. Keeping the soil at the proper pH and calcium level will be one of the most important aspects of the project.

We discovered that after the third soil tests, we were still falling short of the targeted pH level we need to achieve before planting the trees and inoculating them. Johann recommended adding an additional final 5.5 T of MFA's finely crushed "white" dolomitic lime to the truffle orchard, mixing it as well as possible throughout the upper 30 cm. After the orchard was bush-hogged on August 11, 2012, lime was applied and the orchard was plowed and disked on August 30, 2012 and the soil tested again on October 29, 2012. The results of this test finally resulted in the pH range targeted. Overall, we have applied approximately 22.5 T of lime to the upper 30 cm of our ¼ ha orchard.

3. Describe your work plan for next year.

As part of the Phase II grant, Johann, Nicky and I met up last Thursday in Elsberry, MO with Wayne Lovelace, owner of Forrest Keeling Nursery along with Lars Ingman, a truffle consultant from Finland who was in town with his wife, Eva, visiting Johann. We are now targeting this fall for the tree planting and are coordinating with Wayne and his staff on the exact numbers and varieties of trees which will be similar to those proposed for Phase II. Lars, Eva and Johann then came down to the farm to look at the truffle orchard and compare strategies for the planting and maintenance of the trees.

The well driller is expected to get started as soon as his rig is repaired, after which we will get the well pump, etc., installed. We still need to increase the percentage of organic matter in the soil and will be working this spring and summer on this, after which we will get the planting beds made, irrigation system laid out and deer fence up all ready for planting.

We plan on doing a larger educational open-house event right after the trees are planted this fall which we think will be a bigger draw than just the "prepped" field.

4. How did you share information from your project with others? (Include the number of people who attended field days or demonstrations.) What plans do you have for sharing information next year?

a. On October 29, 2011, Mary Hendrickson (sustainable Agriculture program, University of Missouri), David Emerich (Biochemistry and Bacteriology, University of Missouri), and David English (a prospective truffle grower with a farm near Herman, Missouri) came down to the farm with Dr. Johann Bruhn along with his Mizzou Advantage Undergraduate Research Team students looking at the interdisciplinary effect of truffle cultivation in the State of Missouri including the economic, eco-tourist, agricultural and agroforestry benefits.

Fig 18: Tour of Indoor Shiitake Production

Fig 19: Tour of Outdoor Shiitake Production

Fig 20: Truffle Orchard Orientation

Fig 21: Digging up the Temperature Sensors

Fig 22: Preparing new holes

Fig 23: Placing new sensors and getting soil samples

b. Columbia-Missourian Article

On January 21, 2012, two reporters, Anna Boiko-Weyrauch and photographer Sam Gause from the Columbian-Missourian came down to the farm with Dr. Johann Bruhn to write an article on the potential and current status of growing truffles not only at Timber Farms the Sinks but also at other sites across the state. The article "Missouri Farmers lay Groundwork for Truffle Market" appeared in print on February 9, 2012, along with an online component below:

http://www.columbiamissourian.com/stories/2012/02/09/missouri-farmers-prepare-tackle-truffle-market/

See Appendix E for full article.

c. On May 12, 2012, we hosted Brandi and Tory Meyr, who are interested in the possibility of trufficulture on Tory's family's farm in the bootheel. They were accompanied by Dr. Johann Bruhn who would also be assisting them in establishing another Missouri Burgundy Truffle cultivation site.

d. Assoc. Prof. Dr. Azmy Mohamed (Faculty of Forestry, University Putra, Malaysia) came down to the farm to tour the truffle orchard site with Dr. Johann Bruhn on June 16, 2012.

e. National Small Farm Trade Show & Conference

A detailed presentation was given on Friday, November 2, 2012, to a group of 30 or more attendees of the National Small Farm Trade Show & Conference in Columbia, Missouri at the NCR-SARE Farmers Forum. The presentation covered the state of the art understanding of burgundy truffle culture as well as the process and results to date of the Phase 1: Truffle Project.

Fig 24: Burgundy Truffle Production Presentation at the National Small Farm Trade Show & Conference

Appendix

Appendix A: General Data

- Farm Soil Map
- Weather Data – Eminence
- Rainfall Record – Farm Data

Appendix B: Soil Test Results

- Initial Soil Test Results
- Soil Test Results – 1
    - Soil Temperature Readings
- Soil Test Results - 2
- Soil Test Results – 3
- Soil Test Results - 4

Appendix C:

- Lakeweed Analysis
- Raw Materials and Biochar

Appendix D:

- Costs to Date

Appendix E:

- Columbia-Missourian Article

Appendix A: Farm Soil Map

Soil Type Definition

Soil type at truffle orchard is 73295 Taterhill Silt Loam

Parent material is loamy slope alluvium. Depth to a root restrictive layer is greater than 60". The natural drainage class is "well drained".

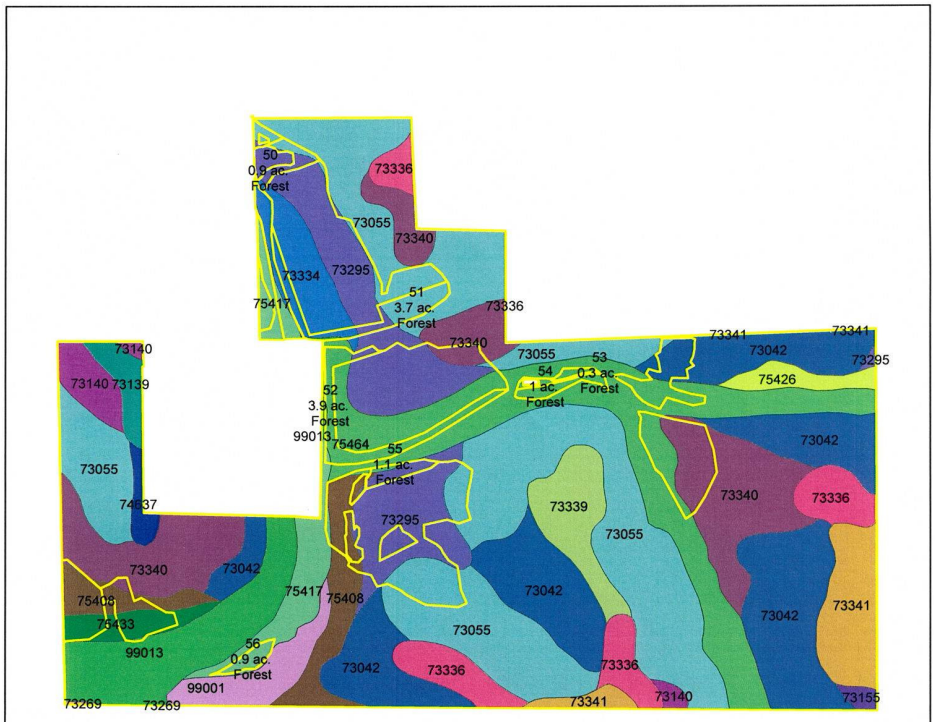
Soils Map

Date: 8/17/2011

Customer(s): TIMBER FARMS THE SINKS LLC
District: SHANNON COUNTY SOIL & WATER CONSERVATION DISTRICT
Approximate Acres: 11.8
Legal Description: F#2754 T#6681

Field Office: EMINENCE SERVICE CENTER
Agency: NRCS
Assisted By: TERRY BETZ

Land Units:



Legend

Soils Map

<all other values>

MUSYM

73042
73055
73139
73140
73155
73269
73295
73334
73336
73339
73340
73341
74637
75408
75417
75426
75433
75464
99001
99013

480 0 480 960 1,440 1,920 Feet

N

APPENDIX A: WEATHER DATA - EMINENCE, MISSOURI

(232619) EMINENCE 1 N_MO

Total Precipitation(in)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
2000	1.05	4.30	2.47	0.62	4.11	5.82	4.01	2.59	2.67	1.50	3.44	0.18	32.76
2001	0.79	4.72	0.75	1.99	5.47	4.51	7.77	1.76	4.05	2.85	2.97	4.91	42.54
2002	3.56	1.29	7.60	5.79	11.18	3.09	2.62	4.02	2.26	3.08	0.81	4.77	50.07
2003	0.36	4.04	2.63	4.49	3.65	4.65	2.16	4.34	3.37	2.55	6.91	4.17	43.32
2004	2.01	1.17	4.62	5.20	6.10	1.63	3.54	2.37	0.04	5.43	6.48	1.54	40.13
2005	5.21	2.57	2.08	2.25	1.33	1.82	6.05	6.50	5.50	0.61	9.03	0.48	43.43
2006	3.18	0.95	6.25	2.85	7.62	2.90	5.34	5.28	3.23	7.12	5.00	4.78	54.50
2007	3.81	2.81	2.48	3.14	6.38	1.51	2.59	1.73	4.11	3.52	1.15	6.42	39.65
2008	0.73	4.85	12.20	7.81	4.24	3.94	4.91	3.27	5.82	1.70	1.39	3.74	54.60
2009	2.37	1.87	3.75	3.88	5.60	4.77	5.62	2.45	4.50	13.77	1.56	2.75	52.89

(232619) EMINENCE 1 N_MO

Temperature(F)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
2007	-999	-999	55.0	53.7	69.5	74.5	77.0	82.8	72.3	61.0	46.6	37.2	-999
2008	33.0	34.6	46.3	54.9	64.7	74.8	78.1	75.6	69.5	57.0	44.1	33.4	55.5
2009	29.7	39.0	49.6	55.5	65.5	76.7	74.4	75.1	70.1	53.5	50.6	32.9	56.0

Appendix A: Rainfall Record - Farm Data

Date	Rain Fall (In)	Date	Rain Fall (In)
06/13/11	1.00	03/11/12	1.00
06/18/11	1.00	03/16/12	1.50
06/21/11	0.25	03/21/12	0.75
06/27/11	0.40	03/23/12	0.50
06/28/11	0.10	04/07/12	0.40
07/04/11	0.25	04/15/12	1.25
07/06/11	0.30	04/25/12	0.50
07/07/11	0.20	05/06/15	0.60
07/12/11	0.70	05/29/12	0.13
07/13/11	0.50	05/30/12	0.50
07/24/11	2.50	06/11/12	1.25
07/31/11	0.13	06/18/12	2.00
08/04/11	0.60	07/06/12	0.50
08/05/11	1.25	07/08/12	0.50
08/07/11	0.40	07/09/12	0.10
08/08/11	1.50	07/26/12	0.75
08/13/11	1.10	07/29/12	0.13
08/17/11	0.25	08/04/12	0.50
08/19/11	0.50	08/16/12	1.75
08/20/11	1.00	08/25/12	0.25
08/24/11	0.50	08/26/12	0.75
09/07/11	0.50	08/31/12	1.00
09/15/11	0.25	09/01/12	1.50
09/21/11	1.00	09/06/12	0.75
09/25/11	1.50	09/07/12	0.50
10/12/11	0.50	09/15/12	0.75
10/26/11	0.50	09/20/12	0.50
11/15/11	0.75	09/26/12	1.50
11/20/11	0.75	09/28/12	1.00
11/21/11	1.50	10/13/12	0.50
11/26/11	0.75	10/17/12	0.50
11/28/11	0.25	11/22/12	0.50
12/04/11	1.00		
12/05/11	1.00		
12/13/11	0.75		
12/14/11	1.00		
12/19/11	0.75		
12/26/11	0.50		
01/10/12	0.50		
01/12/12	0.50		
01/26/12	2.00		
02/10/12	0.25		
02/13/12	4.00		
02/28/12	0.50		
03/01/12	0.20		
03/08/12	0.50		

Appendix B - Initial Soils Analysis

Report For: Johann Bruhn
110 Waters Hall
Columbia, MO 65211

Soil Testing Laboratory
University of Missouri
23 Mumford Hall
Columbia, MO. 65211
573-882-0623

Printed: 5-20-10

Lab Number	Sample Identification	pHs	pHw	N.A. meq/ 100g	O.M. %	Bray I P ppm	Ca ppm	Mg ppm	K ppm	CEC meq/100 g	Zn ppm	Fe ppm	Mn ppm	Cu ppm
C1008810	BOYD_LUCK 0-10	7.2	6.6	0.5	3.4	11	2147	509	65	8.1	1.4	14.8	12.4	0.26
C1008811	BOYD_LUCK 10-20	7.3	6.6	0.5	1.1	7	1335	366	41	5.4	0.5	7.1	6.3	0.10
C1008812	BOYD_LUCK 20-30	7.2	6.5	0.5	2.0	8	1592	385	48	6.1	0.8	11.5	11.3	0.15
C1008813	WALNUT_KNOLL 0-10	7.1	6.3	1.5	3.6	18	1941	461	52	8.3	1.1	17.8	56.0	0.39
C1008814	WALNUT_KNOLL 10-20	7.0	6.2	1.5	1.8	13	1662	418	54	7.5	0.6	10.6	47.7	0.49

Lab Number	Sample Identification	NO3-N ppm	NH4-N ppm	Sand %	Silt %	Clay %	Texture
C1008810	BOYD_LUCK 0-10	3.4	2.5	32.5	55.0	12.5	silt loam
C1008811	BOYD_LUCK 10-20	0.7	5.4	27.5	55.0	17.5	silt loam
C1008812	BOYD_LUCK 20-30	3.1	4.4	27.5	60.0	12.5	silt loam
C1008813	WALNUT_KNOLL 0-10	2.0	4.4	15.0	72.5	12.5	silt loam
C1008814	WALNUT_KNOLL 10-20	0.9	8.2	15.0	65.0	20.0	silt loam

Soil Test Results

Report For: Johann Bruhn
110 Waters Hall
Columbia, MO 65211

Soil Testing Laboratory
University of Missouri
23 Mumford Hall
Columbia, MO. 65211
573-882-0623

Printed: 10-13-10

Lab Number	Sample Identification	pHs	pHw	N.A. meq/ 100g	O.M. %	Bray I P ppm	Ca ppm	Mg ppm	K ppm	CEC meq/100 g	Zn ppm	Fe ppm	Mn ppm	Cu ppm
C1014862	1 (North strip 0-10 cm)	7.0	6.3	0.5	3.2	18	946	241	67	7.4	0.6	18.6	36.6	0.68
C1014863	2 (North strip 10-20 cm)	7.1	6.3	0.5	1.9	12	905	258	50	7.3	0.7	10.2	34.7	0.52
C1014864	3 (Middle strip 0-10 cm)	6.9	6.2	0.5	3.2	23	923	226	78	7.2	0.6	17.0	38.1	0.47
C1014865	4 (Middle strip 10-20 cm)	6.9	6.1	0.5	1.7	22	786	220	68	6.4	0.2	10.2	33.0	0.38
C1014866	5 (South strip 0-10 cm)	6.9	6.1	0.5	2.9	16	892	224	58	7.0	0.5	17.7	31.3	0.37
C1014867	6 (South strip 10-20 cm)	6.8	6.1	1.0	1.6	14	701	205	52	6.3	0.1	10.7	26.7	0.41

Lab Number	Sample Identification	B ppm	SO4-S ppm	NO3-N ppm	NH4-N ppm	Sand %	Silt %	Clay %	Texture
C1014862	1 (North strip 0-10 cm)	0.4	6.7	5.5	2.6	17.5	70.0	12.5	silt loam
C1014863	2 (North strip 10-20 cm)	0.4	5.3	3.3	3.4	12.5	67.5	20.0	silt loam
C1014864	3 (Middle strip 0-10 cm)	0.4	6.2	5.6	3.1	17.5	70.0	12.5	silt loam
C1014865	4 (Middle strip 10-20 cm)	0.4	4.5	2.9	3.1	12.5	72.5	15.0	silt loam
C1014866	5 (South strip 0-10 cm)	0.4	5.5	5.2	3.6	7.5	80.0	12.5	silt loam
C1014867	6 (South strip 10-20 cm)	0.3	3.5	3.7	3.4	17.5	65.0	17.5	silt loam

Appendix B: Soil Temperature Readings Minimum Temperatures

Min temps	Deployed 9 Oct 2010; Recovered 16 Apr 2011			
	SW @ 8-cm	SE @ 8-cm	NE @ 8-cm	NW @ 8-cm
date/time	SN9741025	SN9741026	SN9741027	SN9741028
10/1/2010 0:19	21.76	22.046	21.664	21.76
10/2/2010 0:19	19.948	20.138	19.758	19.853
10/3/2010 0:20	17.665	17.855	17.379	17.475
10/4/2010 0:21	18.806	18.996	18.616	18.711
10/5/2010 0:22	18.996	19.187	18.711	18.806
10/6/2010 0:23	20.043	20.329	19.948	20.043
10/7/2010 0:23	20.996	20.234	21.378	20.901
10/8/2010 0:24	18.236	18.331	18.14	17.95
10/9/2010 0:25	15.569	15.76	15.378	15.282
10/10/2010 0:26	16.237	16.427	15.951	15.855
10/11/2010 0:27	16.332	16.618	16.237	15.951
10/12/2010 0:27	16.141	16.427	15.951	15.664
10/13/2010 0:28	16.427	16.808	16.332	16.141
10/14/2010 0:29	13.076	13.461	13.173	12.787
10/15/2010 0:00	12.883	13.365	12.98	12.594
10/16/2010 0:01	12.207	12.69	12.207	11.916
10/18/2010 0:02	14.613	15.091	14.517	14.421
10/19/2010 0:03	15.378	15.855	15.378	15.282
10/20/2010 0:04	12.497	13.076	12.497	12.207
10/21/2010 0:05	12.304	12.98	12.304	11.916
10/22/2010 0:05	13.173	13.75	13.173	13.076
10/23/2010 0:06	15.473	15.951	15.473	15.378
10/24/2010 0:07	16.523	16.999	16.427	16.427
10/25/2010 0:08	16.523	16.999	16.427	16.427
10/26/2010 0:09	14.804	15.187	14.996	14.421
10/27/2010 0:09	11.722	12.207	11.819	11.041
10/28/2010 0:10	10.259	10.846	10.455	9.571
10/29/2010 0:11	8.382	8.779	8.581	7.882
10/30/2010 0:12	7.983	8.481	8.182	7.582
10/31/2010 0:13	9.275	9.866	9.373	9.077
11/1/2010 0:13	11.431	11.916	11.431	11.334
11/2/2010 0:14	11.819	12.401	11.916	11.625
11/3/2010 0:15	11.431	12.013	11.528	11.236
11/4/2010 0:16	10.063	10.846	10.063	9.768
11/5/2010 0:17	8.481	9.275	8.581	8.082
11/6/2010 0:17	6.471	7.28	6.775	6.166
11/7/2010 0:18	6.877	7.682	7.079	6.573
11/8/2010 0:19	7.381	8.182	7.582	7.179
11/9/2010 0:20	8.282	9.077	8.481	8.182
11/10/2010 0:21	10.259	11.139	10.455	10.357
11/11/2010 0:21	11.041	11.819	11.236	11.139

11/12/2010 0:22	10.944	11.722	11.041	10.944
11/13/2010 0:23	9.965	10.553	10.259	9.866
11/14/2010 0:24	7.079	7.682	7.381	6.573
11/15/2010 0:25	8.082	8.68	8.282	7.882
11/16/2010 0:25	8.879	9.472	9.176	8.68
11/17/2010 0:26	6.573	7.079	6.674	5.962
11/18/2010 0:27	8.978	9.571	9.373	8.879
11/19/2010 0:28	7.481	7.983	7.682	6.978
11/20/2010 0:29	7.179	7.682	7.381	6.775
11/21/2010 0:29	9.965	10.455	10.063	9.768
11/22/2010 0:00	13.173	13.654	13.173	13.269
11/23/2010 0:01	9.866	10.259	10.161	9.669
11/24/2010 0:02	8.581	8.879	8.779	8.382
11/25/2010 0:03	7.481	7.882	8.082	7.179
11/26/2010 0:03	4.934	5.347	5.45	4.519
11/27/2010 0:04	4.102	4.519	4.727	3.998
11/28/2010 0:05	4.102	4.519	4.623	4.102
11/29/2010 0:06	6.37	6.877	6.674	6.37
11/30/2010 0:07	4.311	4.623	4.831	4.102
12/1/2010 0:07	2.837	3.155	3.367	2.73
12/2/2010 0:08	2.943	3.261	3.472	2.943
12/3/2010 0:09	2.73	3.049	3.155	2.73
12/4/2010 0:10	4.102	4.519	4.727	4.207
12/5/2010 0:11	3.049	3.472	3.683	3.261
12/6/2010 0:11	1.872	2.303	2.41	2.088
12/7/2010 0:12	1.548	1.98	1.98	1.764
12/8/2010 0:13	1.33	1.764	1.764	1.656
12/9/2010 0:14	1.439	1.764	1.656	1.548
12/10/2010 0:15	1.656	2.088	1.98	1.872
12/11/2010 0:15	3.578	3.893	4.102	3.788
12/12/2010 0:16	1.656	2.088	2.303	1.872
12/13/2010 0:17	0.893	1.33	1.33	1.112
12/14/2010 0:18	0.674	1.112	1.112	0.893
12/15/2010 0:19	0.563	1.003	1.003	0.784
12/16/2010 0:19	0.674	1.112	1.003	0.784
12/17/2010 0:20	0.784	1.221	1.003	0.893
12/18/2010 0:21	0.784	1.221	1.003	0.893
12/19/2010 0:22	0.784	1.221	1.112	0.893
12/20/2010 0:23	0.893	1.439	1.33	1.003
12/21/2010 0:23	1.221	2.624	2.195	1.221
12/22/2010 0:24	2.624	3.155	2.943	2.73
12/23/2010 0:25	2.195	2.837	2.624	2.624
12/24/2010 0:26	2.41	2.943	2.73	2.624
12/25/2010 0:27	2.195	2.624	2.624	2.517
12/26/2010 0:27	1.439	1.872	1.872	1.764
12/27/2010 0:28	0.893	1.221	1.112	1.221
12/28/2010 0:29	0.784	1.112	1.003	1.003

12/29/2010 0:00	0.893	1.33	1.221	1.221
12/30/2010 0:01	3.578	4.311	3.998	3.998
12/31/2010 0:01	8.382	8.581	8.282	8.481
1/1/2011 0:02	3.261	3.472	3.788	3.788
1/2/2011 0:03	1.872	1.98	2.088	2.088
1/3/2011 0:04	1.33	1.548	1.439	1.548
1/4/2011 0:05	1.221	1.548	1.439	1.548
1/5/2011 0:05	1.33	1.656	1.548	1.764
1/6/2011 0:06	1.112	1.439	1.221	1.439
1/7/2011 0:07	1.33	1.656	1.439	1.656
1/8/2011 0:08	1.003	1.33	1.33	1.33
1/9/2011 0:09	0.674	1.003	0.893	0.893
1/10/2011 0:09	0.563	0.893	0.784	0.784
1/11/2011 0:10	0.563	1.003	0.784	0.893
1/12/2011 0:11	0.232	0.563	0.563	0.453
1/13/2011 0:12	-0.213	0.232	0.232	0.121
1/14/2011 0:13	-0.213	0.121	0.121	0.01
1/15/2011 0:13	0.121	0.343	0.232	0.232
1/16/2011 0:14	0.232	0.563	0.343	0.343
1/17/2011 0:15	0.343	0.674	0.563	0.453
1/18/2011 0:16	0.343	0.784	0.563	0.563
1/19/2011 0:17	0.453	1.221	1.003	0.784
1/20/2011 0:17	0.784	1.33	1.221	1.221
1/21/2011 0:18	0.784	1.112	0.893	1.003
1/22/2011 0:19	0.784	1.112	0.893	1.003
1/23/2011 0:20	1.112	1.656	1.33	1.439
1/24/2011 0:21	1.98	2.517	2.195	2.195
1/25/2011 0:21	1.221	1.548	1.33	1.548
1/26/2011 0:22	1.003	1.221	1.112	1.221
1/27/2011 0:23	1.112	1.33	1.112	1.439
1/28/2011 0:24	1.221	1.548	1.33	1.656
1/29/2011 0:25	1.548	1.872	1.656	1.98
1/30/2011 0:25	2.088	2.517	2.303	2.624
1/31/2011 0:26	3.578	4.207	3.893	4.102
2/1/2011 0:27	1.764	2.088	1.98	2.088
2/2/2011 0:28	1.221	1.439	1.33	1.548
2/3/2011 0:29	0.784	1.003	0.893	1.112
2/4/2011 0:29	0.674	0.893	0.784	0.893
2/5/2011 0:00	0.674	0.893	0.784	0.893
2/6/2011 0:01	0.674	1.112	1.003	1.003
2/7/2011 0:02	1.221	1.872	1.764	1.764
2/8/2011 0:03	0.893	1.33	1.221	1.33
2/9/2011 0:03	0.674	1.003	1.003	1.003
2/10/2011 0:04	0.563	0.893	0.784	0.893
2/11/2011 0:05	0.453	0.784	0.674	0.674
2/12/2011 0:06	0.453	0.784	0.563	0.784
2/13/2011 0:07	0.563	1.112	0.893	1.112

2/14/2011 0:07	1.656	2.195	1.98	2.195
2/15/2011 0:08	2.195	2.73	2.517	2.837
2/16/2011 0:09	3.683	4.311	3.893	4.102
2/17/2011 0:10	8.68	9.077	8.779	9.176
2/18/2011 0:11	8.68	9.176	8.978	9.373
2/19/2011 0:11	7.582	8.182	7.983	7.782
2/20/2011 0:12	6.471	6.978	6.674	6.674
2/21/2011 0:13	7.28	7.682	7.782	7.782
2/22/2011 0:14	3.998	4.415	4.311	4.519
2/23/2011 0:15	4.207	4.831	4.623	4.623
2/24/2011 0:15	5.552	5.655	5.552	5.962
2/25/2011 0:16	4.311	4.623	4.727	4.727
2/26/2011 0:17	4.102	4.519	4.415	4.415
2/27/2011 0:18	3.367	3.788	3.578	3.683
2/28/2011 0:19	6.166	6.573	6.877	7.179
3/1/2011 0:19	3.367	3.683	3.788	3.998
3/2/2011 0:20	3.893	4.311	4.207	4.311
3/3/2011 0:21	4.415	5.037	4.727	4.831
3/4/2011 0:22	7.682	8.082	7.882	7.983
3/5/2011 0:23	5.962	6.471	6.674	6.674
3/6/2011 0:23	4.727	5.244	5.347	5.244
3/7/2011 0:24	5.141	5.757	5.655	5.45
3/8/2011 0:25	6.471	6.978	6.775	6.573
3/9/2011 0:26	6.064	6.573	6.674	6.674
3/10/2011 0:27	4.831	5.45	5.552	5.552
3/11/2011 0:27	2.837	3.155	3.261	3.367
3/12/2011 0:28	4.727	5.244	5.141	5.244
3/13/2011 0:29	7.582	8.082	7.882	8.082
3/14/2011 0:00	5.244	5.552	5.757	5.552
3/15/2011 0:00	5.141	5.552	5.655	5.45
3/16/2011 0:01	3.683	4.102	4.102	4.102
3/17/2011 0:02	7.682	7.983	7.983	7.983
3/18/2011 0:03	11.041	11.431	11.236	11.431
3/19/2011 0:04	9.275	9.571	9.472	9.571
3/20/2011 0:04	8.581	8.978	8.879	8.779
3/21/2011 0:05	11.334	11.722	11.528	11.625
3/22/2011 0:06	12.401	12.787	12.594	12.69
3/23/2011 0:07	11.722	12.013	11.819	11.916
3/24/2011 0:08	8.282	8.978	9.176	8.978
3/25/2011 0:08	6.471	7.079	7.28	6.978
3/26/2011 0:09	5.45	5.962	5.757	5.962
3/27/2011 0:10	4.519	5.037	5.037	4.934
3/28/2011 0:11	5.552	6.064	6.166	6.064
3/29/2011 0:12	7.28	7.782	7.983	7.882
3/30/2011 0:12	6.268	6.877	7.079	6.877
3/31/2011 0:13	6.37	6.978	6.978	6.877
4/1/2011 0:14	6.877	7.381	7.381	7.28

4/2/2011 0:15	6.268	6.775	6.775	6.674
4/3/2011 0:16	9.176	9.768	9.768	9.866
4/4/2011 0:16	9.472	10.161	10.357	10.357
4/5/2011 0:17	6.471	7.079	7.079	6.978
4/6/2011 0:18	8.581	9.176	9.176	9.077
4/7/2011 0:19	9.275	9.866	9.669	9.768
4/8/2011 0:20	12.207	12.69	12.497	12.787
4/9/2011 0:20	15.855	16.141	15.951	16.427
4/10/2011 0:21	16.713	16.999	16.808	17.189
4/11/2011 0:22	15.664	16.237	16.237	16.618
4/12/2011 0:23	12.304	12.98	12.883	12.883
4/13/2011 0:24	12.497	13.269	12.98	13.269
4/14/2011 0:24	13.269	14.038	13.654	13.942
4/15/2011 0:25	13.654	14.325	13.942	14.134
4/16/2011 0:26	7.682	9.373	8.082	7.381
4/17/2011 0:27	0.674	1.003	0.674	0.232
4/18/2011 0:28	20.805	20.996	20.805	20.805
4/19/2011 0:28	21.091	21.282	21.091	21.091
4/20/2011 0:29	19.282	19.472	19.282	19.282

APPENDIX B: Soil Test Results - 2

Report For: Johann Bruhn
110 Waters Hall
Columbia, MO 65211

Soil Testing Laboratory
University of Missouri
23 Mumford Hall
Columbia, MO. 65211
573-882-0623

Printed: 11-9-11

Lab Number	Sample Identification	pHs	pHw	N.A. meq/ 100g	O.M. %	Bray I P ppm	Ca ppm	Mg ppm	K ppm	CEC meq/100 g
C1120694	0-4 N	7.3	7.0	0.0	2.5	12	1329	257	65	9.0
C1120695	4-8 N	6.8	6.3	1.0	2.0	7	1036	248	51	8.4
C1120696	8-12 N	6.8	6.2	1.5	0.9	4	909	295	53	8.6
C1120697	0-4 CTR	7.4	6.9	0.0	2.0	12	1055	202	31	7.0
C1120698	4-8 CTR	6.6	6.1	1.5	1.5	15	818	193	20	7.2
C1120699	8-12 CTR	6.8	6.2	1.5	1.0	11	865	232	31	7.8
C1120700	0-4 S	7.0	6.7	0.5	2.0	9	1092	263	56	8.3
C1120701	4-8 S	6.5	6.2	1.5	2.1	5	947	220	35	8.2
C1120702	8-12 S	6.8	6.2	1.5	0.9	5	996	283	51	9.0

Lab Number	Sample Identification	C %	N %	C/N	Sand %	Silt %	Clay %	Texture
C1120694	0-4 N	1.61	0.17	9.5	15.0	65.0	20.0	silt loam
C1120695	4-8 N	1.19	0.14	8.5	17.5	65.0	17.5	silt loam
C1120696	8-12 N	0.37	0.07	5.3	7.5	52.5	30.0	silty clay loam
C1120697	0-4 CTR	1.26	0.15	8.4	22.5	62.5	15.0	silt loam
C1120698	4-8 CTR	0.87	0.11	7.9	15.0	70.0	15.0	silt loam
C1120699	8-12 CTR	0.66	0.09	7.3	12.5	67.5	20.0	silt loam
C1120700	0-4 S	1.26	0.15	8.4	17.5	65.0	17.5	silt loam
C1120701	4-8 S	1.37	0.16	8.6	22.5	62.5	15.0	silt loam
C1120702	8-12 S	0.68	0.09	7.6	17.5	55.0	27.5	silty clay loam

APPENDIX B: Soil Test Results - 3

Report For: Daniel Hellmuth

Soil Testing Laboratory
University of Missouri
23 Mumford Hall
Columbia, MO. 65211

6/6/2012

Lab Number	Sample Identification	pHw	pHs	N.A. meq/100g	O.M. %	Bray I P lb/Ac	Ca lb/Ac	Mg lb/Ac	K lb/Ac	CEC meq/100 g
C1214007	HELMUTH 4"	7.8	7.2	0.0	1.8	19	5793	465	157	16.6
C1214008	HELMUTH 8"	7.3	6.8	0.0	1.8	16	2042	405	112	6.9
C1214009	HELMUTH 12"	7.2	6.7	0.5	1.5	16	1846	394	120	6.9

APPENDIX B: Soil Test Results - 4

Report For: Daniel Hellmuth

Soil Testing Laboratory
University of Missouri
23 Mumford Hall
Columbia, MO. 65211

10/29/2012

Lab Number	Sample Identification	pHw	pHs	N.A. meq/100g	O.M. %	Bray I P lb/Ac	Ca lb/Ac	Mg lb/Ac	K lb/Ac	CEC meq/100 g
C1220150	S1	7.9	7.4	0.0	2.1	21	3775	468	118	11.5
C1220151	S2	7.9	7.4	0.0	2.2	17	4134	510	100	12.6
C1220152	S3	7.8	7.4	0.0	2.0	15	2990	453	91	9.5
C1220153	C1	7.9	7.4	0.0	1.9	24	3886	396	107	11.5
C1220154	C2	7.9	7.5	0.0	2.2	26	3892	407	166	11.6
C1220155	C3	7.8	7.4	0.0	1.8	19	4186	423	102	12.4
C1220156	N1	7.8	7.4	0.0	2.2	26	3458	402	93	10.4
C1220157	N2	7.8	7.4	0.0	2.5	27	4222	433	132	12.5
C1220158	N3	7.5	7.2	0.0	1.6	22	2489	404	87	8.0

APPENDIX C: Lake Weed Analysis

MU Extension

Soil and Plant Testing Lab
Division of Plant Sciences
University of Missouri

23 Mumford Hall
Columbia, MO 65211
Phone (573) 882-0623
Fax (573) 884-4288

Compost Analysis Report

To: Daniel Hellmuth
4112 W Pine Blvd
Saint Louis, MO 63108
Phone: 314-531-9935
Email: Daniel@ozarkforest.com

Date received: 06/21/10
Date completed: 06/24/10
Lab No: C10035
Sample ID: 1
File Name: DanielH1.doc

Tests	Units	Test Results	Desired Range	Interpretation Low	Desired	High
pH		6.44	6.0 – 8.0		x	
E.C. - Saturaion Paste	mmho/cm	6.53	< 4			x
- 1 : 1	mmho/cm		<2.5			
- 1: 2	mmho/cm		<1.5			
Total Nitrogen (N)	%	2.075				
Total Phosphorus (P)	%	0.219				
Total Potassium (K)	%	0.902				
Total Calcium (Ca)	%	1.694				
Total Magnesium (Mg)	%	0.669				
Total Zinc (Zn)	ppm	23.2	< 2800			
Total Iron (Fe)	ppm	1376				
Total Manganese (Mn)	ppm	259				
Total Copper (Cu)	ppm	4.9	< 1500			
Total Carbon (C)	%	30.05				
C/N Ratio		14.5	< 25		x	
Nitrate-N	ppm		40 – 99 *			
Ammonium-N	ppm					
Moisture	%	5.7	< 50		x	

Note: Interpretation for nitrate-N is for growing media only. If this material is to be used as soil amendment, the interpretation for nitrate-N is not applicable.

MU Extension

Soil and Plant Testing Lab
Division of Plant Sciences
University of Missouri

23 Mumford Hall
Columbia, MO 65211
Phone (573) 882-0623
Fax (573) 884-4288

Compost Analysis Report

To: Daniel Hellmuth
4112 W Pine Blvd
Saint Louis, MO 63108
Phone: 314-531-9935
Email: Daniel@ozarkforest.com

Date received: 06/21/10
Date completed: 06/24/10
Lab No: C10036
Sample ID: 2
File Name: DanielH2.doc

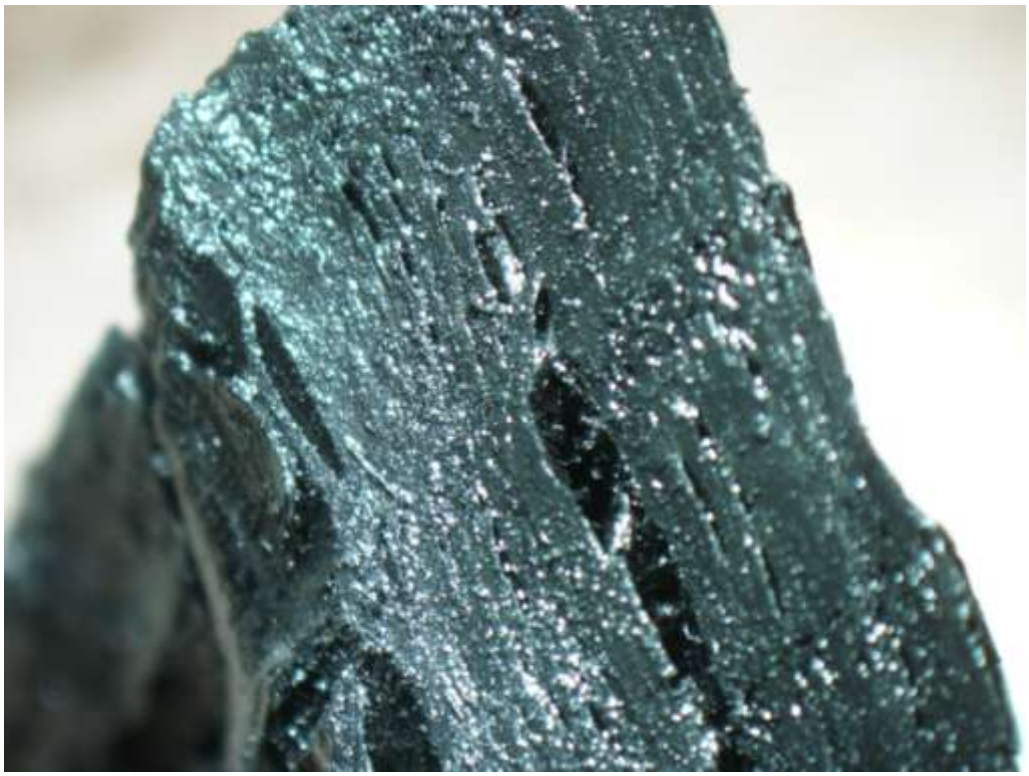
Tests	Units	Test Results	Desired Range	Interpretation Low	Desired	High
pH		6.53	6.0 – 8.0		x	
E.C. - Saturaion Paste	mmho/cm	4.66	< 4			x
- 1 : 1	mmho/cm		<2.5			
- 1: 2	mmho/cm		<1.5			
Total Nitrogen (N)	%	1.778				
Total Phosphorus (P)	%	0.123				
Total Potassium (K)	%	0.671				
Total Calcium (Ca)	%	5.294				
Total Magnesium (Mg)	%	0.684				
Total Zinc (Zn)	ppm	28.3	< 2800			
Total Iron (Fe)	ppm	800				
Total Manganese (Mn)	ppm	259				
Total Copper (Cu)	ppm	5.9	< 1500			
Total Carbon (C)	%	30.09				
C/N Ratio		16.9	< 25		x	
Nitrate-N	ppm		40 – 99 *			
Ammonium-N	ppm					
Moisture	%	6.0	< 50		x	

Note: Interpretation for nitrate-N is for growing media only. If this material is to be used as soil amendment, the interpretation for nitrate-N is not applicable.

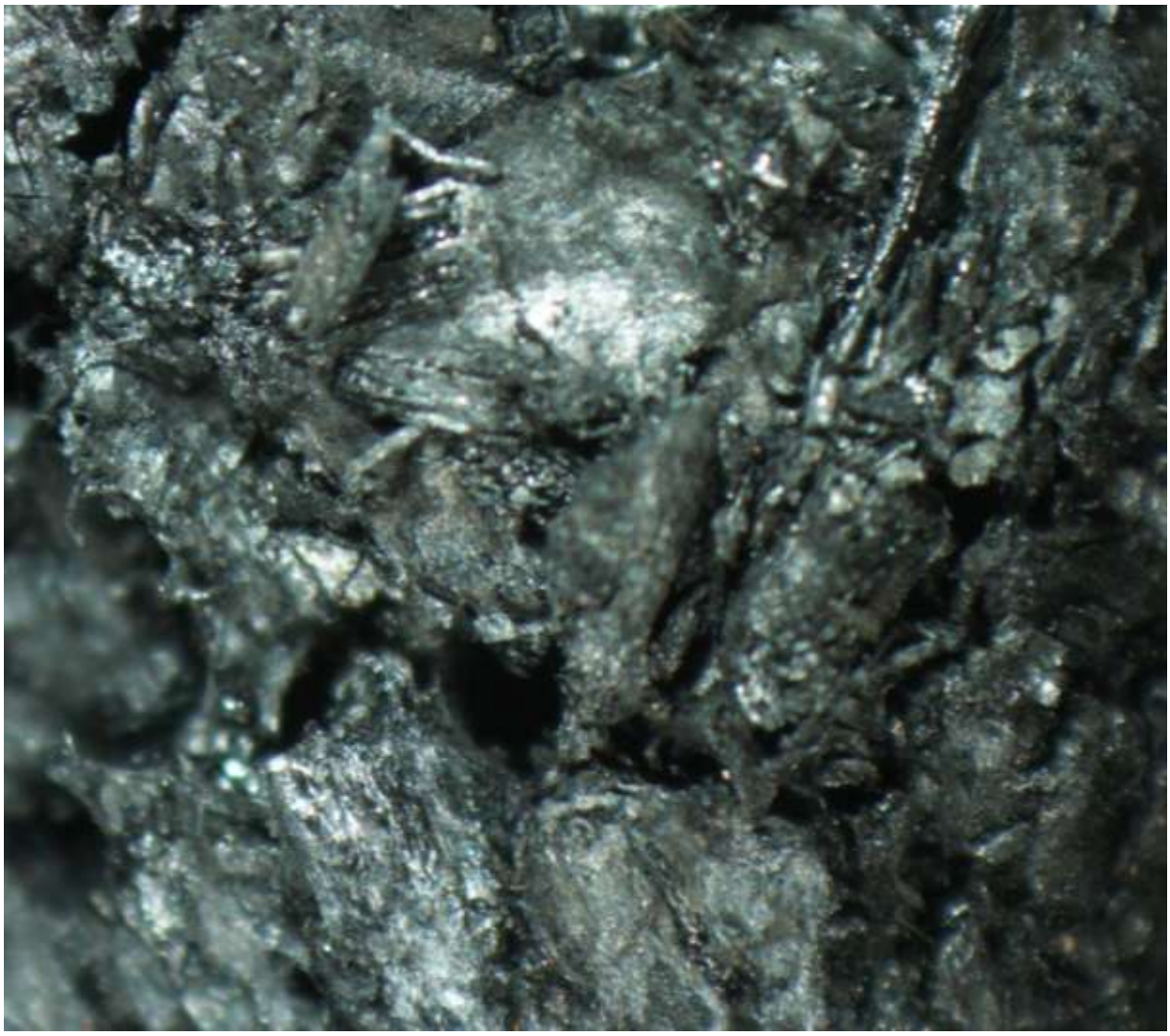
APPENDIX C: Raw Materials and Biochars

Non-degraded white oak sawdust

Biochar from non-degraded white oak sawdust

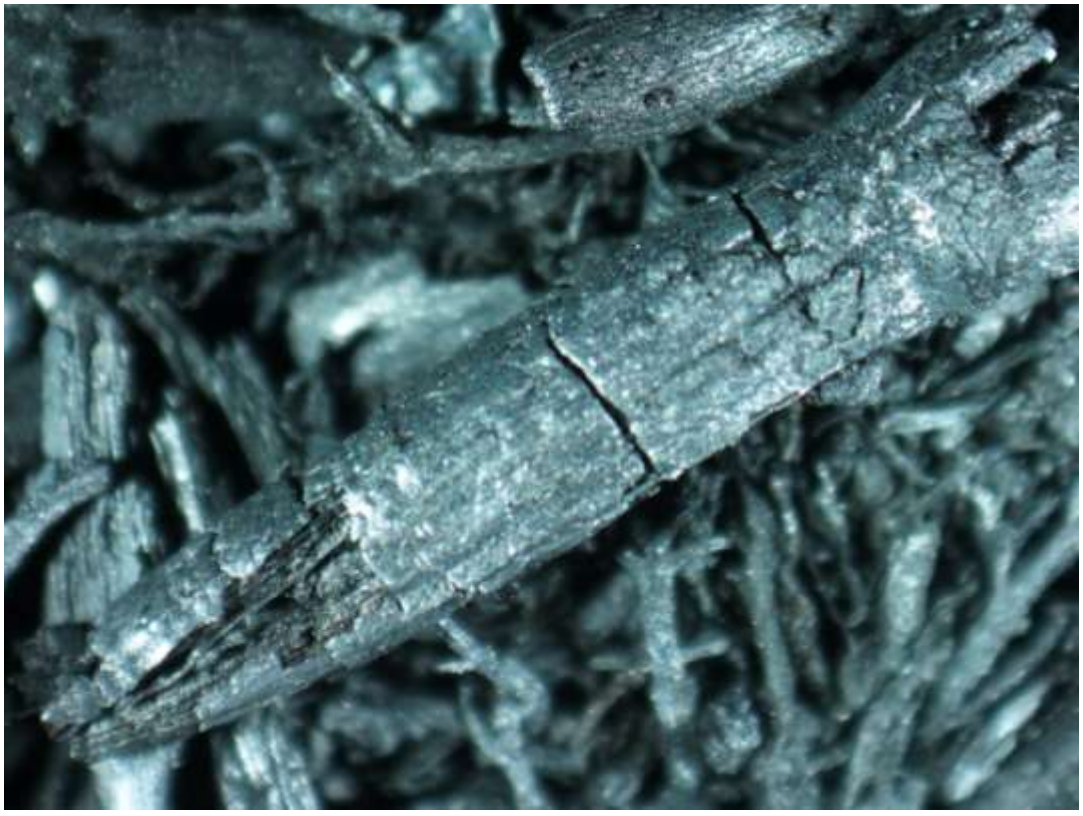


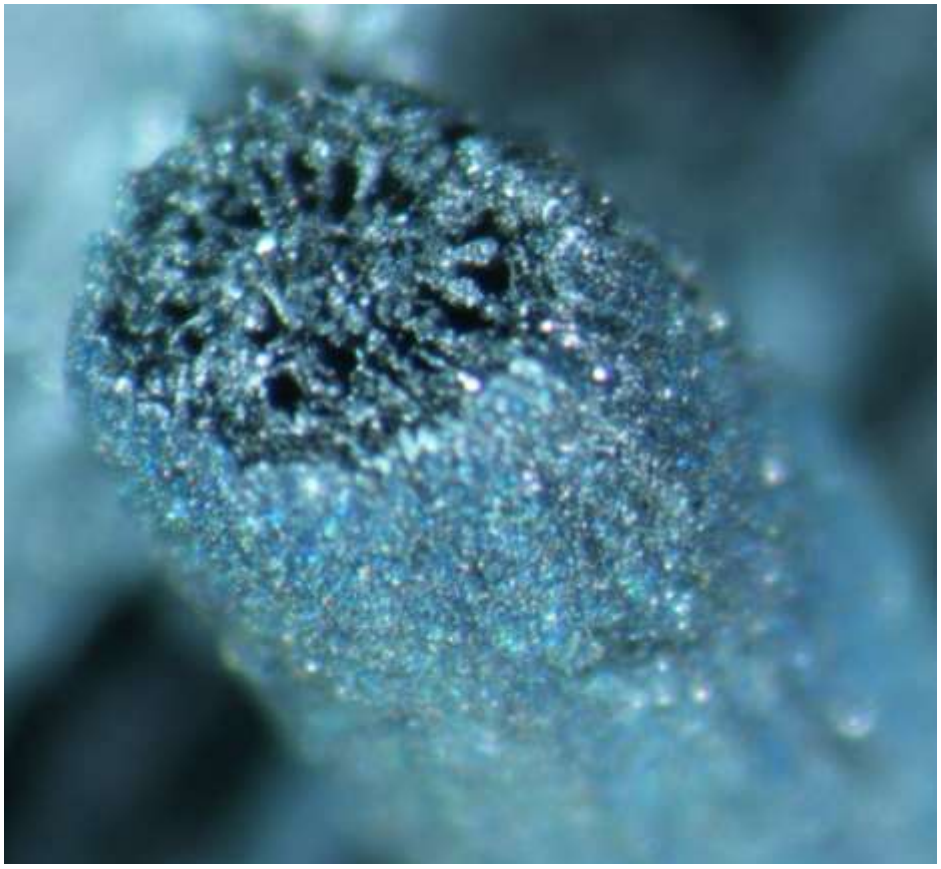
Biochar from spent oyster mushroom (*Pleurotus* sp.) substrate

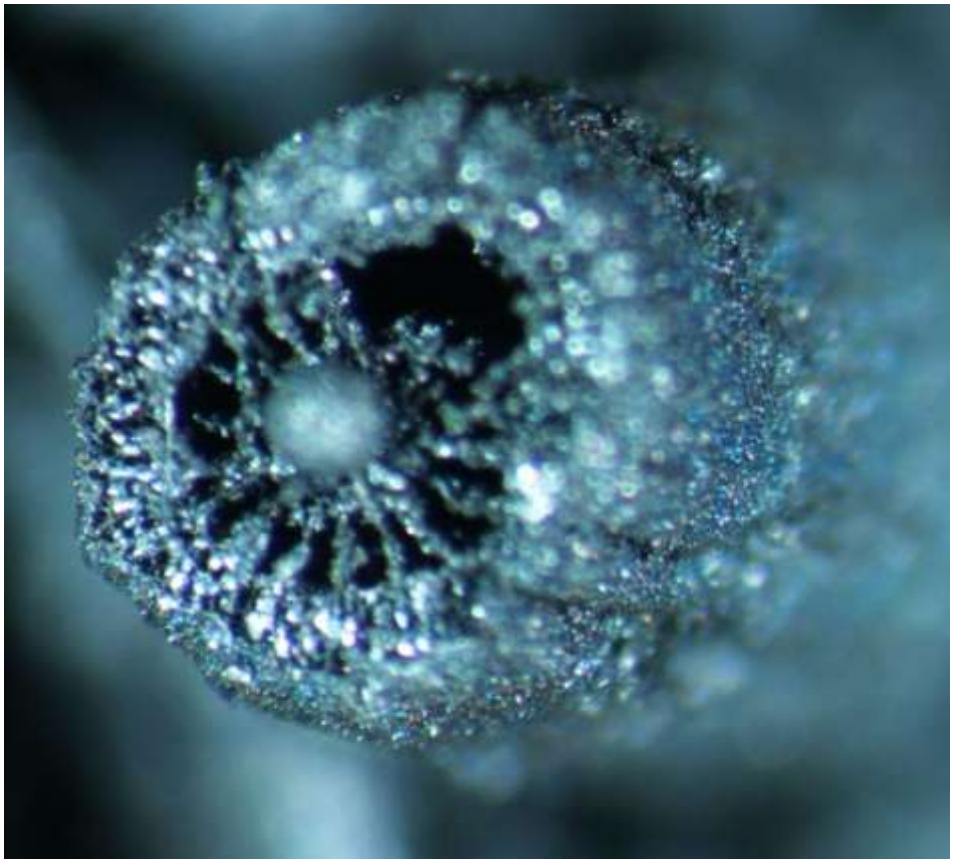


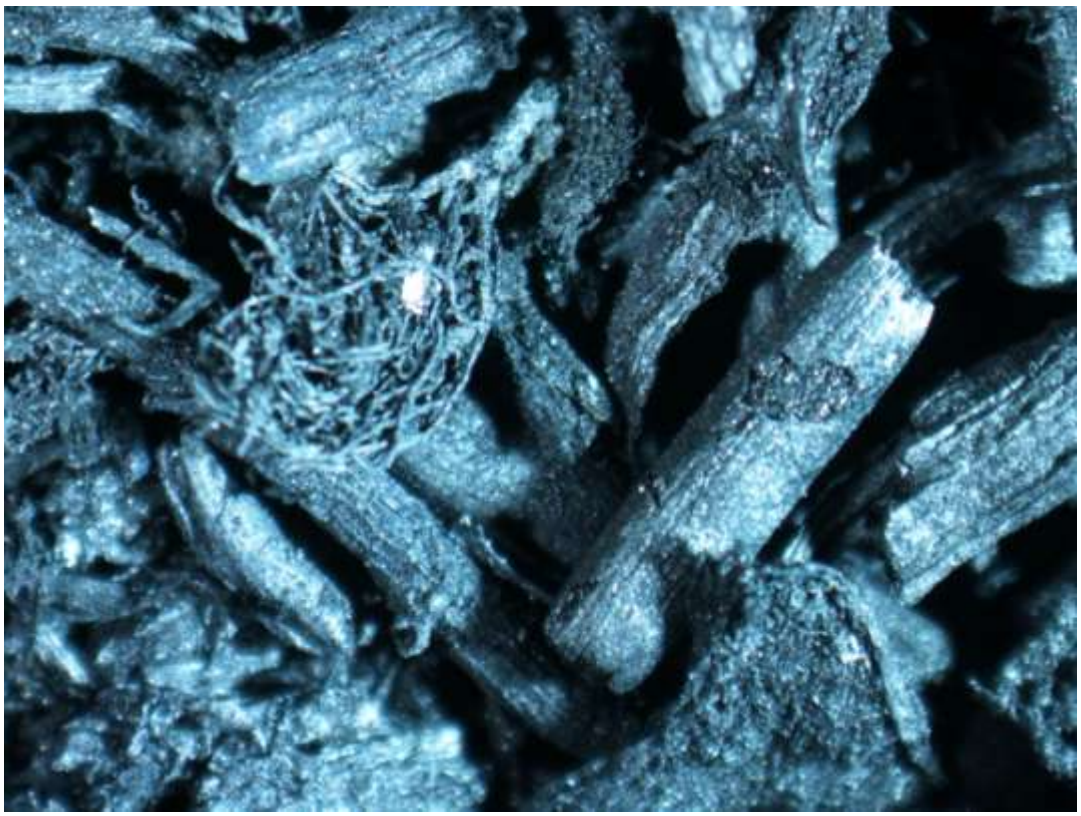
Dried flailed milfoil

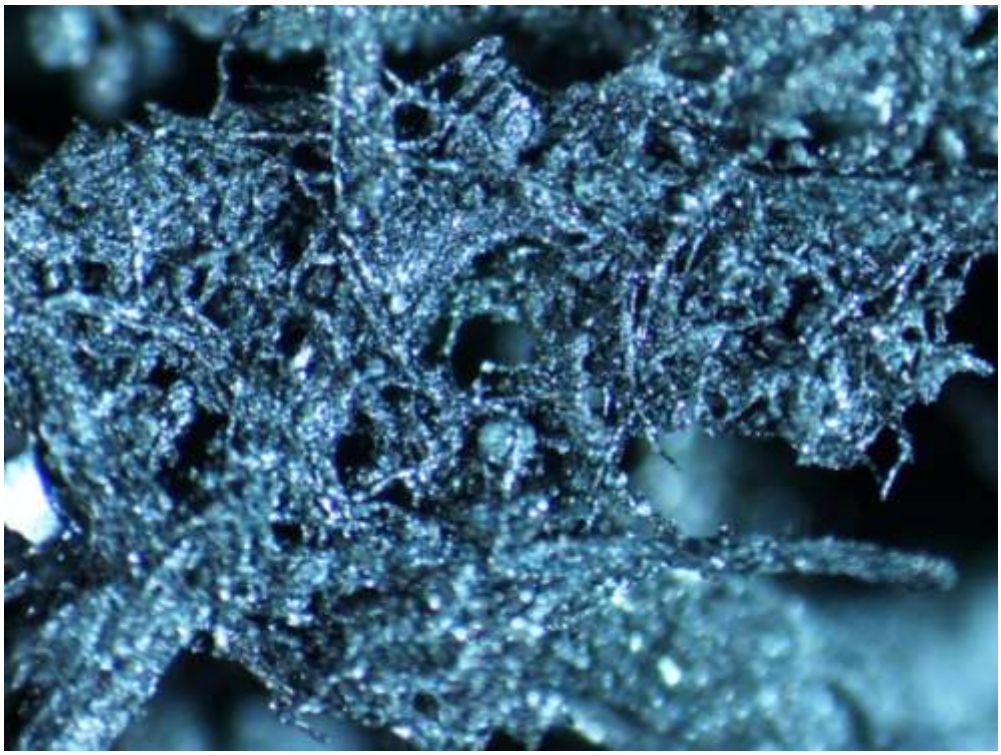
Biochar from dried flailed milfoil

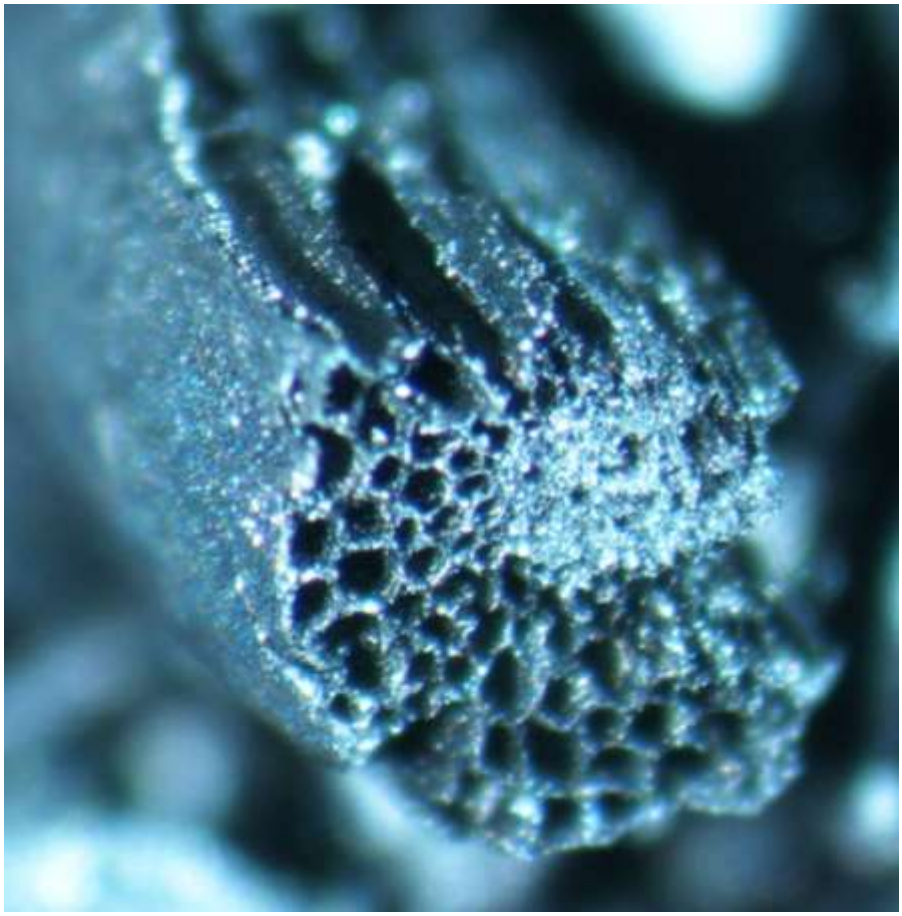


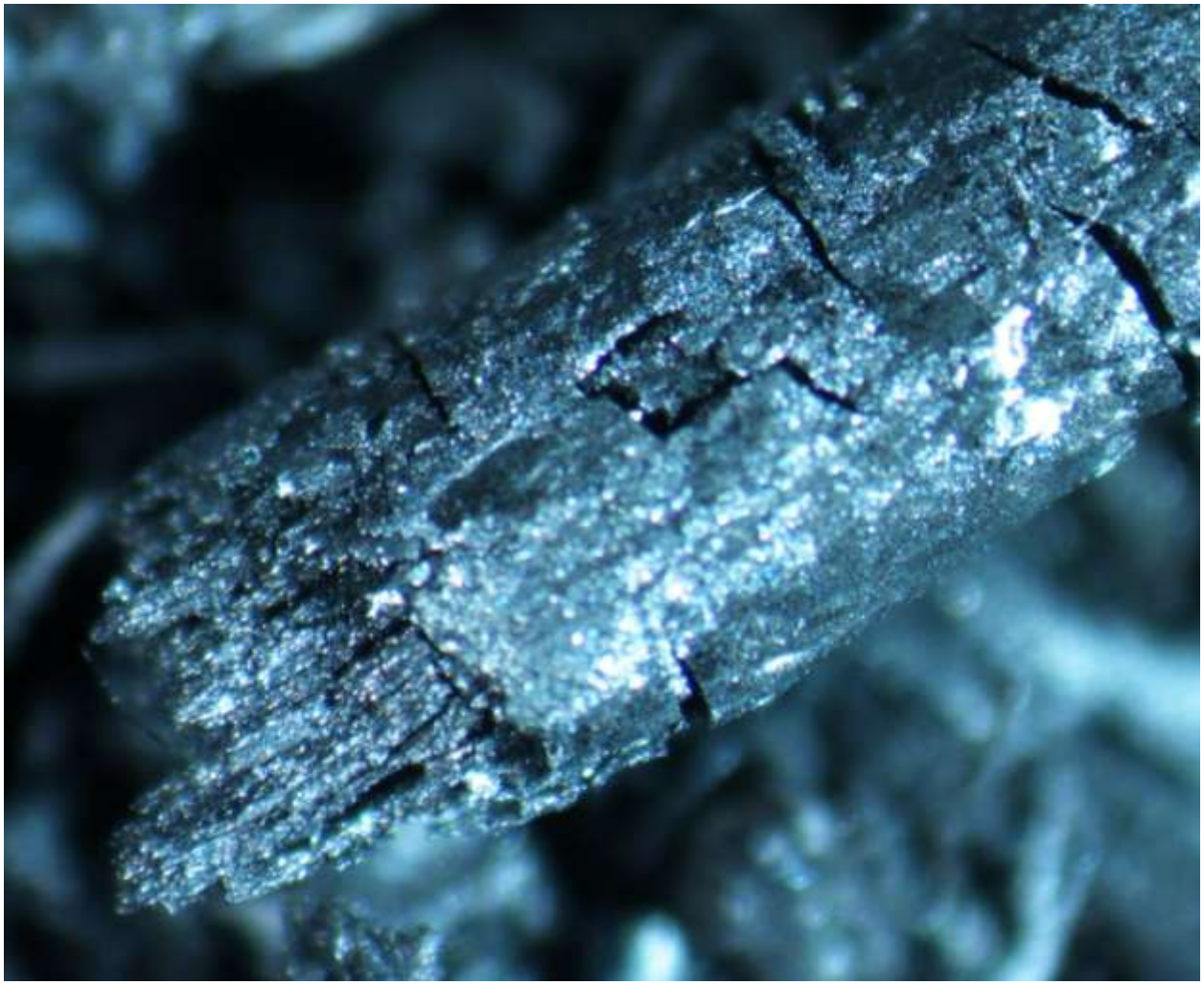












APPENDIX D: Project Costs - Summary

2010 FARMER/RANCHER GRANT PROPOSAL

Ozark Forest Mushrooms, LLC

1/5/2013

Phase 1: Truffle Orchard Establishment - The Burgundy Truffle as a new sustainable agroforestry crop for the Missouri Ozarks

	Expended	Claimed
SUPPLIES & EQUIPMENT	$3,862.60	$2,137.03
LABOR COSTS	$3,257.50	$1,927.97
TRACTOR HOURS	$1,935.00	$1,935.00
TOTAL:	**$9,055.10**	**$6,000.00**

APPENDIX D: Supplies + Equipment + Services

DATE	ITEM	DESCRIPTION	COST	SHARE		CLAIM
05.17.11	Albert Lea Seed	Annual Rye Grass	$28.00		$28.00	$28.00
05.24.11	Jenson Technologies Development	Jenson Lake Mower	$3,245.00	50%	$1,622.50	$500.00
05.24.11	The Pond Guy	Lake Weed Rake, Manual Cutter	$119.99		$119.99	$119.99
05.27.11	Lowe's Home Centers, Inc.	Boat Repair Kit, Flag Marker	$27.20		$27.20	$27.20
06.03.11	Batteries Plus #270	Weed Cutter Battery, Battery Charger	$158.05		$158.05	$158.05
06.11.11	Brannans Marine	Used Evinrude 9.5hp Outboard Motor w\ tank	$550.00	50%	$275.00	$275.00
06.30.11	M.F.A. Co-Operative Association	Bulk Lime, Delivery	$325.15		$325.15	$325.15
07.15.11	O'Reilly Auto Parts	Fuses for Lake Weed Cutter	$7.14		$7.14	$7.14
11.09.11	MU Soil Testing Laboratory	Soil Testing	$346.50		$346.50	$346.50
12.15.11	M.F.A. Co-Operative Association	Bulk Lime (Red + White), Lime Gravel, Delivery	$350.00		$350.00	$350.00
06.06.12	MU Soil Testing Laboratory	Regular + pHw Soil Test	$34.50		$34.50	$34.50
09.12.12	M.F.A. Co-Operative Association	Ryegrass Seed	$33.00		$33.00	$33.00
10.13.12	M.F.A. Co-Operative Association	Bulk Lime + Spreading	$432.07		$432.07	$432.07
10.26.12	MU Soil Testing Laboratory	Regular + pHw Soil Test	$103.50		$103.50	$103.50
					$3,862.60	$2,740.10
					Adjusted:	**$2,137.03**

APPENDIX D: Labor Hours

Date	Activity	Time (Hr)
David Enloe		
06/02/11	Repairing jonboat	3.5
06/08/11	Installing lakeweed mower	1.0
06/08/11	Overseeing lime spreading	1.0
06/09/11	Mowing lakeweed	5.0
06/14/11	Raking lakeweed	2.0
06/15/11	Mowing lakeweed	6.0
06/16/11	Pick up plow in Salem	2.0
06/20/11	Sowing rye grass and clover	1.0
06/27/11	Building make for boat and installing	6.0
06/29/11	Raking and cutting weeds	7.0
06/30/11	Cutting and Raking	3.0
07/06/11	Cutting and working on rake	3.0
07/14/11	Cutting weeds	3.0
07/15/11	Raking weeds	3.0
07/20/11	Cutting and Raking	4.0
07/22/11	Moving weed to Green House	2.0
08/03/11	Cutting weeds	1.5
08/04/11	Cutting weeds, raking and hauling to G House	4.5
08/12/11	Cutting, raking, hauling and grinding	4.0
08/18/11	Grinding and cutting weed	3.5
08/19/11	Raking and hauling weed to greenhouse	2.0
08/24/11	Cutting weed	2.0
08/25/11	Cutting, raking, hauling and grinding	8.0
09/01/11	Turning and grinding	2.0
09/02/11	Cutting and hauling	3.0
09/08/11	Cutting, turning weed and hauling	4.0
09/09/11	Cutting weed	2.0
09/16/11	Cutting and hauling	4.0
09/23/11	Grinding weed	2.5
03/09/12	Sowing rye grass	1.0
09/15/12	Sowing rye grass	1.0
10/05/12	Meet Black River Electric	1.0
		98.5
Nicola Hellmuth		
	Coordination	16.0
Daniel Hellmuth		
	Soil Sampling, Management	32.0
Johann Bruhn		
	Soil Sampling, Research	41.0

Personnel	Rate	Total
Nicola Hellmuth	$20	$320
David Enloe	$15	$1,478
Daniel Hellmuth	$20	$640
Johann Bruhn	$20	$820
		$3,258

APPENDIX D: Tractor Hours

Date	Activity	Time (Hr)
04/18/11	Bush hog truffle orchard	1.0
06/07/11	Bush hog truffle orchard	1.0
06/16/11	Plowing orchard	5.0
06/20/11	Disking orchard	2.5
08/09/11	Bush hog truffle orchard	1.0
08/11/11	Disking truffle orchard	1.0
10/25/11	Bush hog truffle orchard	1.0
07/11/12	Bush hog truffle orchard	1.0
07/30/12	Plowing and disking orchard	8.0
		21.5

Hourly Tractor Rate:	$90
Total:	$1,935

APPENDIX E: Columbia-Missourian Article

COLUMBIA MISSOURIAN

Missouri farmers lay groundwork for truffle market

By Anna Boiko-Weyrauch
February 9, 2012 | 6:00 a.m. CST

Three farms in Missouri are breaking ground to cultivate black truffles with the help of an MU researcher

Nicola Macpherson grabs a shiitake mushroom out of an oak log inside the greenhouse at Ozark Forest Mushrooms in the Big Springs region of the Ozarks on Jan. 22. The greenhouse is kept at 80 percent humidity to further help the mushrooms in their development. ¦ Sam Gause

The field doesn't look like much yet. At the flat top of a hill there is a three-fourths acre patch of grass clumps that have been slathered with limestone powder to alter the soil. Deer have left tracks in the soft dirt.

Ozark Forest Mushrooms co-owner Nicola Macpherson gets excited imagining what will come.

"I just dream of having a table here," she says. "Wouldn't that be fun? Just to have a glass of wine and a (piece of) truffle toast?"

If everything goes right, in five to six years this square of dirt will be an orchard of oak and hazelnut trees with lumpy black mushrooms growing underneath the soil at their roots. Ozark Forest Mushrooms, located near the Current River in southern Missouri, is preparing to be the first

commercial truffle farm in Missouri.

The farm is one of three businesses that are looking to start growing the prized fungus for the first time in the state. The cultivation efforts are a collaboration with MU plant pathologist and agroforester, Johann Bruhn, who has been researching truffles since 1999.

Bruhn is convinced he finally knows enough to help start "truffières," or truffle orchards. Bruhn and his colleagues have planted a research orchard at the MU Center for Agroforestry at New Franklin to see how the European mushrooms fare under Missouri conditions. He said he hopes the first truffles will develop as early as next year and hopes to use them to propagate more truffles.

There are at least 200 different species of truffle, Bruhn said. But of the three priciest gourmet varieties, the black Burgundy truffle — named after the Burgundy region of France – is best suited for Missouri weather. Burgundy truffles (or Tuber aestivum) mature in autumn, unlike another type of gourmet black truffle, which fruits in the winter and might be damaged by frozen ground or cold weather.

The truffles could fetch a nice price if the commercial operations are successful, Bruhn said. The Burgundy truffle sells for about $400 a pound, he said, or about $40 to $50 for one the size of a golf ball.

With a little luck, each acre could yield 10 to 20 pounds of truffles a year, he said.

In 2010, the U.S. imported more than 132,000 pounds of prepared truffles worth almost $3 million, mostly from France and Italy, according to U.S. Department of Agriculture statistics.

The Flavor

Andy Ayers, former chef of Riddle's Penultimate Cafe & Wine Bar in St. Louis, said truffles give food a powerful, unique flavor. "There's nothing that tastes like truffles but truffles," he said.

Ayers said he used to cook with black truffles from Oregon. He described the flavor as "earthy" or "cave-like" yet delicate. "It's amazing to me how pervasive and domineering the flavor can be and at the same time be so ephemeral," he said.

Pasta with cream sauce is his favorite way to cook the mushrooms, he said.

If you use them properly, the taste of truffles is "not so much resting on your tongue as radiating flavor gently throughout your mouth," Ayers said.

The smell is what sets the truffle apart from other culinary delights. The fragrance, which resembles the sex hormones of male pigs, is actually a survival mechanism, Bruhn said. The fungus spores are spread by animals, so truffles have to emit an odor mighty enough to convince wild critters to unearth them, he said.

Missouri's first commercial truffières

Nicola Macpherson jets among the rows of oak logs in the greenhouse at Ozark Forest Mushrooms. The stems of fuzzy brown shiitake mushrooms snap between her fingers.

"They look like velvet when you pick them," Macpherson said.

The 450-acre, 20-year-old Ozark Forest Mushrooms produces an average of 100 pounds of shiitake and 150 pounds of light yellow and gray oyster mushrooms a week in the winter.

Ten years ago, a chef friend of Macpherson's brought her an Italian company's brochure for truffle products and suggested she get into the business. Since then, her business has, well, mushroomed.

Macpherson buys truffles and truffle products, such as truffle shavings, oil and juice, from Italy and sells them to upscale restaurants and country clubs in St. Louis, she said. She makes her own truffle butter from canned truffles; a small tin goes for $5.

Now, Bruhn is working with Macpherson and her business partner and husband, Dan Hellmuth, to raise an orchard of oak and hazelnut trees that will foster their own black truffles.

Growing truffles is a tricky process. Truffles need trees to grow — they form a symbiotic, or mutually beneficial, relationship. The fungus' structure attaches to the tips of shallow tree roots in the first foot of soil below the surface. The fungus provides the tree with nutrients from the soil, such as phosphorous and iron, and the tree feeds the fungus carbohydrates.

Truffles are detail oriented. For example, the Burgundy truffle will hook up with some tree species more easily than with others; the soil has to be just so sweet with a pH of between 7.5 and 8. The baby truffles need moisture to survive the summer but not too much, Bruhn said.

If everything goes right, Burgundy truffles can fruit as early as four to five years after the orchard is planted — otherwise it could take up to a decade to know if something went wrong, Bruhn said. After the first crop, orchards can produce the truffles every year for a century between September and December, he said.

Missouri has an active community of mushroom-enthusiasts, but truffle cultivation is "a bit beyond our means for most members," Missouri Mycological Society Executive Secretary Patrick Harvey said.

"We're mostly amateurs," Harvey said.

Besides that, many amateur mycologists in the state prefer to hunt wild mushrooms for the experience, rather than grow their own, said Stan Hudson, foray coordinator for the Mid-Missouri Chapter of the Missouri Mycological Society.

“It’s kind of my stress relief, getting out and looking for mushrooms," Hudson said.

Down in the Ozarks, Macpherson said she might sell whatever truffles her farm produces to her clients in St. Louis or use them in her truffle butter. But she said she will wait and see how things grow.

As the owner of Eat Here St. Louis, chef Ayers works with gourmets across St. Louis to deliver locally grown food. He said he is interested in Missouri-grown black truffles.

“I would certainly try them, and I would sell them, and if I had a restaurant, I would serve them,” he said.

Chef Gerard Craft of the St. Louis gourmet restaurant Niche said his business doesn't normally use truffles "a ton" in part because they are so expensive and hard to get. Also, using foreign fungi doesn't fit in with the restaurant's image of "taking humble Midwest ingredients and elevating them," Craft said.

Missouri-grown truffles, however, are something he would use.

“To be able to get that locally and cultivated, most likely more affordably, would be fantastic,” he said.

At least two farms other than Ozark Forest Mushrooms trying to grow truffles also want to offer customers the experience of truffle hunting and tasting. Bruhn sees the potential for an agrotourism renaissance.

At Ozark Forest Mushrooms, visitors rent out a lakeside farmhouse near a pine grove of shiitake-sprouting logs. In the future, Macpherson hopes to host gourmet dinners with local chefs who will prepare a banquet for paying guests using the farm’s ingredients.

Persimmon Hill Farm near Branson also plans to break ground on a truffle orchard next year. The owner, Earnie Bohner, said 90 percent of his business comes from visitors who come to pick berries, tour the shiitake farm and eat homemade blueberry pancakes and muffins on the farmhouse porch. A truffle orchard would extend the farm's profitable season into the fall, he said.

"The interest factor is high,” Bohner said. "It’s going to be really fun for people, "What are truffles? How do you grow them?'"

They hope to train their two Labrador retrievers, Jake and Carolina, to sniff out truffles so they can help visitors with their hunts.

Tourism is not a primary concern for The Farm at Sugar Creek, which will break ground on a truffières in the spring or summer this year, owner David English said. He is a marketing consultant in St. Louis but wanted to turn his family's 200 acre farm southwest of Hermann into a profitable enterprise.

“I’ve always been fascinated by the idea of doing something, especially here in Missouri for Missouri, that maybe would set a precedent," he said. "I can’t imagine any more precedent setting than a truffières in Missouri.”

English said he is "really excited about the prospect" of a homegrown truffle industry in Missouri and thinks it will be positive for the state.

At Ozark Forest Mushrooms, the soil pH of the future truffle orchard is being adjusted with lime, and depending on the result, could be ready to host trees by fall.

The couple has already invested a lot of time, energy and at least $7,500, along with support from a grant, they said.

"It’s not a get-rich-quick scheme by any means," Hellmuth said.

Hellmuth said if the truffières works, cultivation could help boost the economy in the Ozark region. He said it’s a new agricultural product that would bring income, as well as “another reason to come down and spend money” in the Ozarks.

“I’m confident it has the potential," he said.
