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

Progress Report Year: 2011

Project Title: Phase 1: Truffle Orchard Establishment – The Burgundy Truffle as a new sustainable crop for the Missouri Ozarks Project Number: FNC Producer/Project Leader: Nicola Macpherson Hellmuth Address: Box 460, HC 62

City, State, Zip Code: Salem, Missouri 65560 Phone: 314-531-9935 E-mail: nicola@ozarkforest.com Website: www.ozarkforest.com

WORK ACTIVITIES

Initial Site Selection:

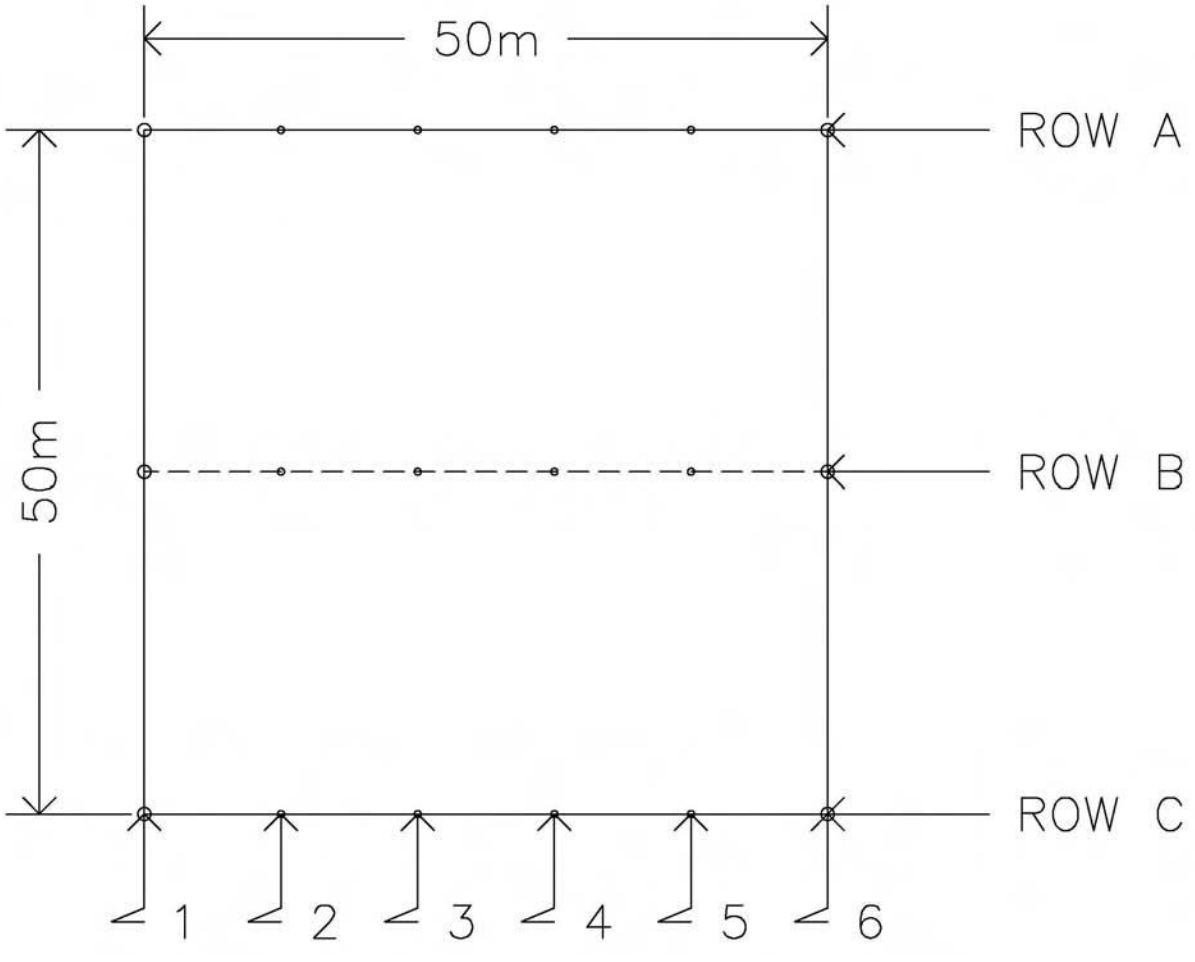
In the evaluation of a suitable truffle orchard site several criteria are determinate. An important consideration is that the area has been free of tree roots (such as an established pasture) for a period of years so as to reduce potential competition from wild truffle varieties as well as competitive fungi present in the soil growing in symbiotic relationship with tree roots. Other considerations include keeping a minimum of 25 feet away from the tree line also helps minimize potential competition. The type of soil is another very important aspect as this will determine the potential suitability for the 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 soil in both locations. [Appendix B: Initial Soil Test Results] The Walnut Knoll field was selected due its suitability for expansion as well as the utility lines running through and pole location that would be suitable for locating an 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 and divided into 3 rows with a soil test site every 10m along the row.

Fig 5: Truffle Orchard Layout



Lime Calculation and Application

Soil tests were taken at each of the quadrants shown in the layout above and temperature and rainfall sensors were placed at each corner of the site. 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". If they only sold by the full ton, one ton works fine. In addition, Dr. Bruhn recommended 9.2 US tons of the "red lime" from Skaggs Rock-n-Lime, Stockpile no. 3. Which again if only sold by the full ton, nine tons works fine. The lime characteristics at each quarry were carefully vetted for their chemical composition prior to ordering.

In addition to achieving a soil pH of ___, 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 was needed throughout the soil mix and it was already present in higher concentration at the 8-12 inch 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 but also to mix the lower clay content throughout the soil.

After reviewing the soil tests results from 11/9/11 (Appendix B - Soil Test Results – 2) it became clear that additional lime would be 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 the truffles. An additional 7 tons of white lime was applied on 12/15/11 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 supplementation. In the process we had the dried lakeweed analyzed [Appendix C: Lakeweed Analysis] and interestingly enough it contained 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 so 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 on our case for purposes of truffle cultivation.

After several trial and error mock ups, we were able to get a used 9 horsepower outboard motor for a large john boat that we had on the property and 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 then could be used to corral the cut weed to shore. We then transported the cut weed to the greenhouse which is not used at present during the summer. The lakeweed was spread out on the concrete floor and air-dried. Similar to making hay, the weed was flipped once 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 6: Lake Weed Processing Fig 7: Lake Weed Plow

Fig 8: Mowing Lakeweed with Jenson Mower Fig 9: Used Evinrude Outboard Motor


Fig 8: Lakeweed Drying Fig 8: Shredded Lakeweed

RESULTS

With the deep plowing using the moldboard plow to mix in the clay below 12 inches, the amount of lime originally calculated was not sufficient to reduce 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 12/12/11 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 will be one of the most important aspects of the project.

WORK PLAN FOR 2012

The first task for spring 2012 will be to take soil tests as soon as the ground thaws to verify final pH levels ready for planting. Based on the results the soil will be finally amended as needed. This will essentially complete Phase I of the Truffle Orchard establishment.

Based on research during a recent trip to France and Sweden, Johann Bruhn has recommended using chipped spent shiitake logs as a soil amendment to increase the soil organic matter and cation exchange. The shredded lake weed will be used as a surface compost rather than a soil amendment and will be part of an organic management trial. One of the key elements in the approach has been to use organic amendment techniques throughout the process as well as locally available "waste" materials as opposed to shipping in materials or using petroleum based products.

OUTREACH

On 10/29/11, Mary Hendrickson, from University of Missouri, Columbia, and David English a prospective truffle grower with a farm near Columbia, Missouri came down to the farm with Dr. Johann Bruhn along with a group of his research students looking at the interdisciplinary effect of truffle cultivation in the State of Missouri including the economic, eco-tourist, agricultural and agroforestry benefits.

Fig 8: Tour of Indoor Shiitake Production *Fig 8: Tour of Outdoor Shiitake Production*

Fig 8: Truffle Orchard Orientation

Fig 8: Digging up the Temperature Sensors

Fig 8: Preparing new holes Fig 8: Placing new sensors and getting soil samples

Columbia-Missourian Article

On 1/21/12, 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 02/09/12 along with an online component below:

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

Phase 1: Truffle Project Open House – Summer 2012

Per the SARE grant proposal, an on-farm open house and truffle production seminar will be conducted (with the participation of Dr. Bruhn and advertisement by The Center for Agroforestry at the University of Missouri) to: 1) tour the prototype truffle orchard site; 2) look at the test results for the soil before and after amendments; and 3) look at next steps for the establishment of a truffle orchard. Posters will be prepared to show the soil sampling procedures and soil test results, soil amendment procedure, lake-weed harvesting, processing, composting and application, and eventual layout of the truffle orchard.

Plans for Phase 2 of the truffle orchard establishment will also be presented at the open house as a collection of photographs and diagrams describing fencing and irrigation, seedling production, planting bed preparation and planting. Phase 2 will entail setting up a drip irrigation system, fencing around the orchard, inoculating and planting the truffle tree seedlings and maintaining weed control without chemicals. Dr. Bruhn will be on hand to answer questions, and his new booklet (currently in preparation) will be distributed, entitled "Agroforestry in Action: Burgundy Truffle Cultivation in an Agroforestry Practice in Missouri".

The potential of Burgundy Truffles as a specialty crop in the Missouri Ozarks will be discussed as well as its potential for agro-tourism.

Representatives of the following entities will be invited to the open house:

- Top of the Ozarks RC and D
- Lincoln University Extension
- MU Extension
- Missouri Farmers Union
- NRCS, Eminence, Missouri Office
- Soils and Water Conservation, Eminence Missouri Office
- Missouri Department of Conservation, Forestry Division, Eminence Missouri Office

- The Center for Agroforestry, University of Missouri, Columbia Missouri
- Regional Commerce and Development, Houston, Missouri
- Missouri Division of Economic Development, Tourism

Appendix A: Data

- Farm Soil Map

- Weather Data – Eminence

• Rainfall Record – Farm Data Appendix B: Soil Test Results
- Initial Soil Test Results
- • Soil Test Results – 1

- o Soil Temperature Readings

- Soil Test Results - 2
- • Soil Test Results – 3 (not yet measured) Appendix C:

- • Lakeweed Analysis

- Raw Materials and Biochar Appendix D:

- Costs to Date Appendix E:

• Project Schedule

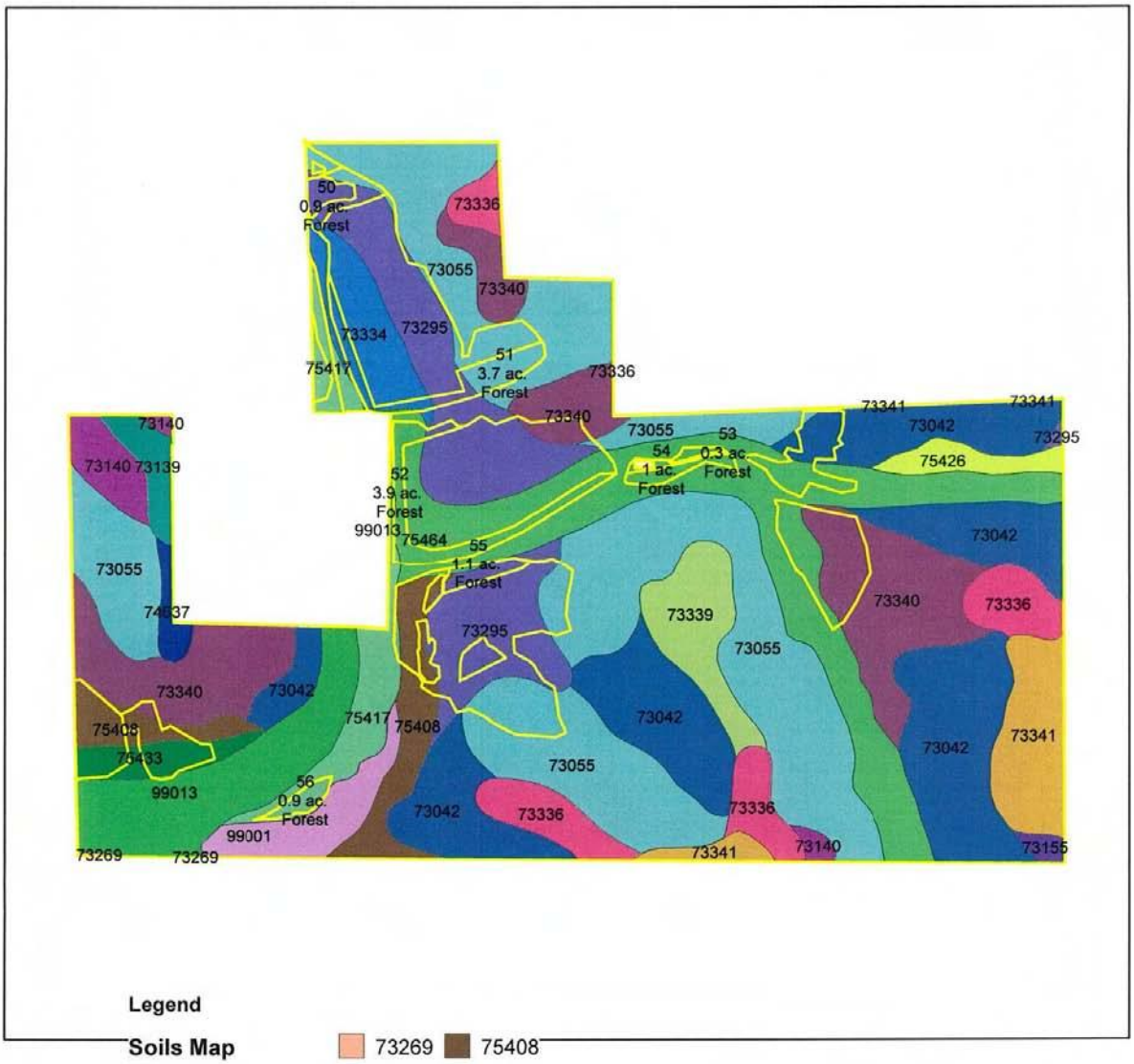
Soils Map

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

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 inches. The natural drainage class is “well drained”.

Rain Fall Record

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2
July 31, 2011		1/8
August 4, 2011		3/5
August 5, 2011	1	1/4
August 7, 2011		2/5
August 8, 2011	1	1/2
August 13, 2011	1	1/10
August 17, 2011		1/4
August 19, 2011		1/2
August 20, 2011	1	
August 24, 2011		1/2
September 7, 2011		1/2
September 15, 2011		1/4
September 21, 2011	1	
September 25, 2011	1	1/2
October 12, 2011		1/2
October 26, 2011		1/2

Report For: Johann Bruhn

110 Waters Hall

Soil Test Results

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2
July 31, 2011		1/8
August 4, 2011		3/5
August 5, 2011	1	1/4

Lab

Sample NO3-N NH4-N Sand Silt Clay Number Identification ppm ppm % % % 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

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2
July 31, 2011		1/8
August 4, 2011		3/5
August 5, 2011	1	1/4
August 7, 2011		2/5

Lab

Sample B SO4-S NO3-N NH4-N Sand Silt Clay Number Identification ppm ppm ppm ppm % % % 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

Soil Test Results

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2
July 31, 2011		1/8
August 4, 2011		3/5
August 5, 2011	1	1/4
August 7, 2011		2/5
August 8, 2011	1	1/2
August 13, 2011	1	1/10
August 17, 2011		1/4

Lab Sample C N Sand Silt Clay Number Identification % % C/N % % % 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

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

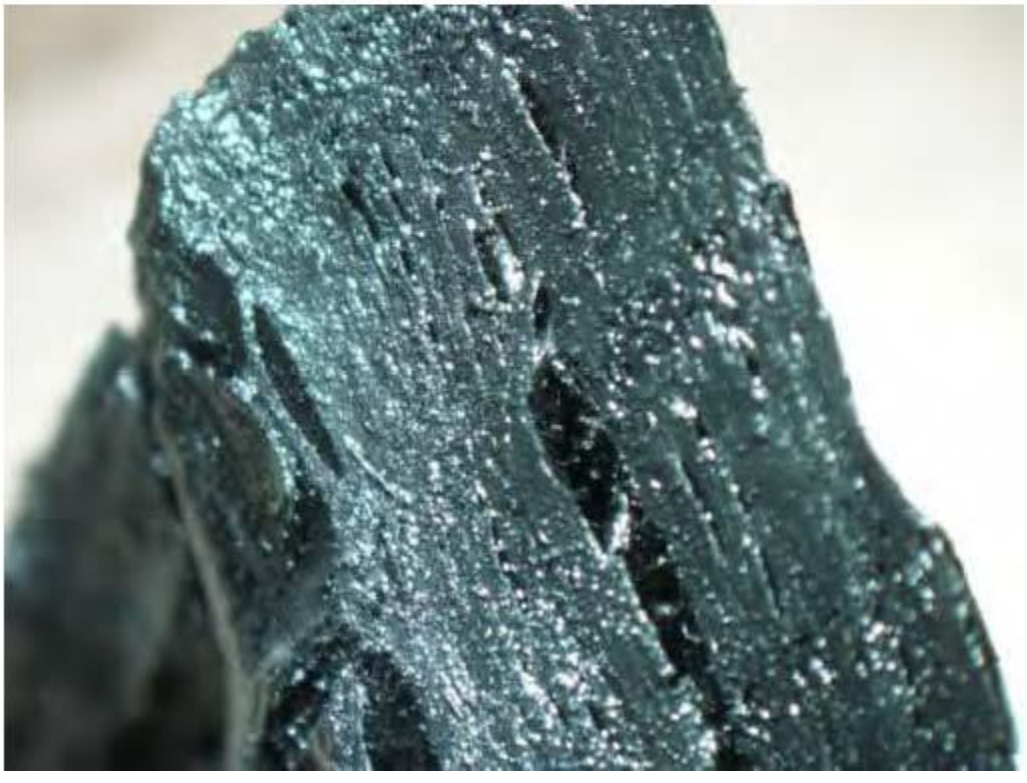
To: Daniel Hellmuth
4112 W Pine Blvd
Saint Louis, MO 63108
Phone: 314-531-9935
Email: Daniel@ozarkforest.com

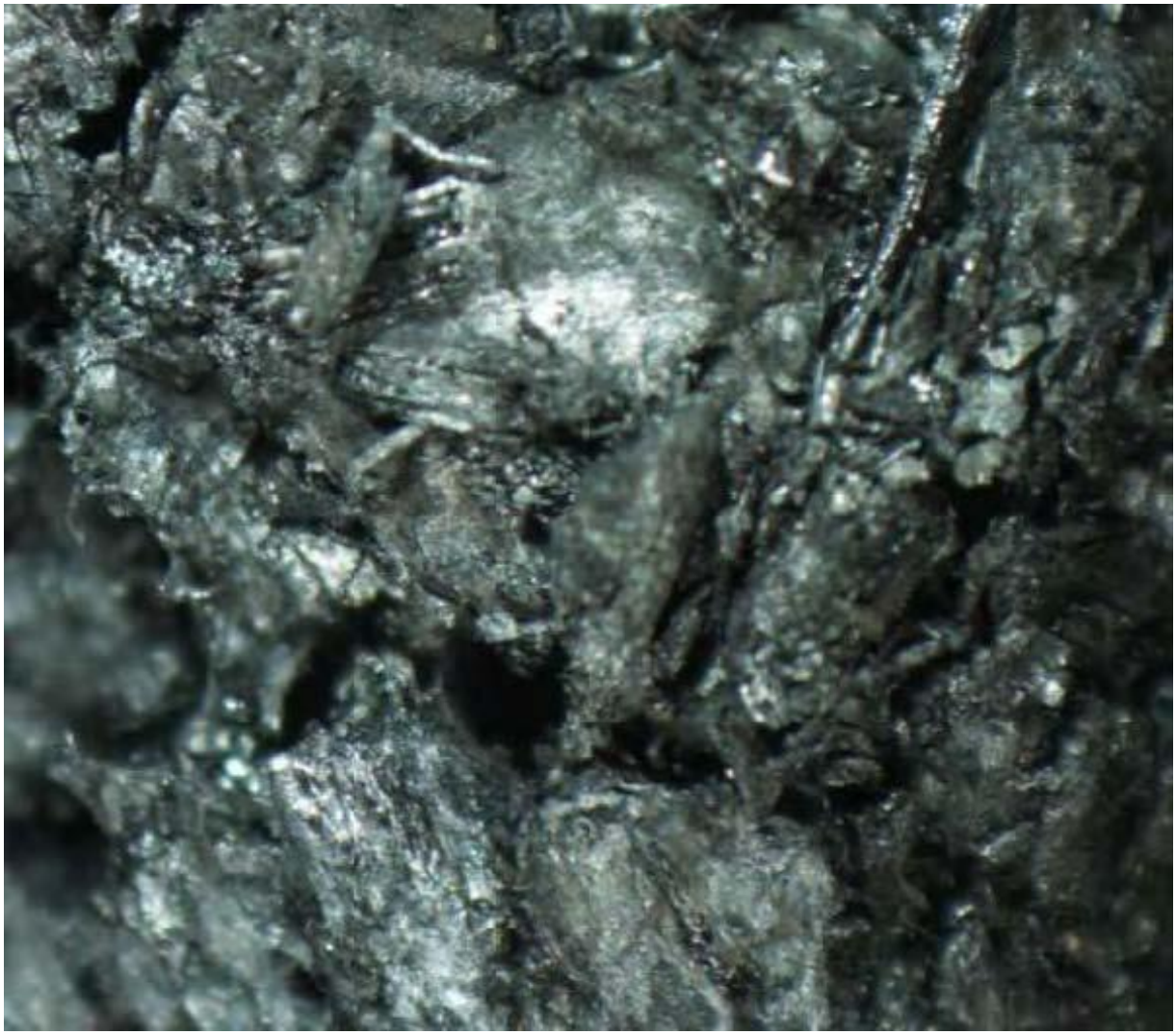
Date received: 06/21/10
Date completed: 06/24/10
Lab No: C10036
Sample ID: 2
File Name: DanielH2.doc

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	

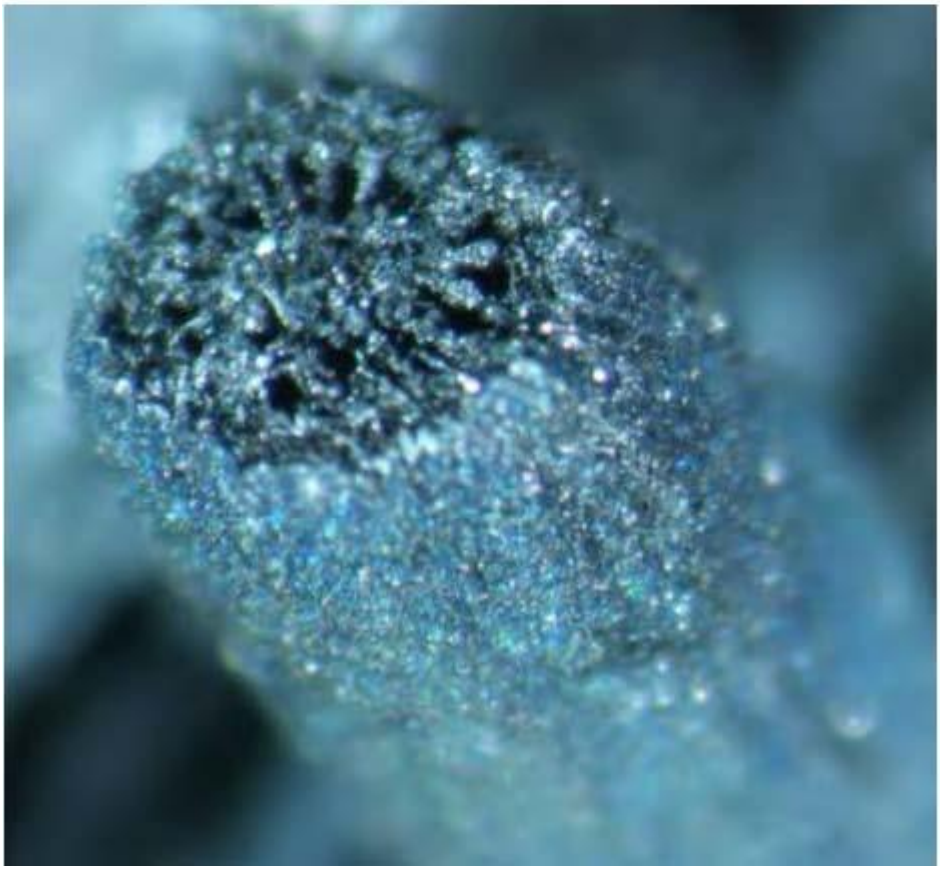
Note: Interpretation for nitrate-N is for growing media only. If this material is to be used as soil amendment, the interpretation for nitrate-N is not applicable.

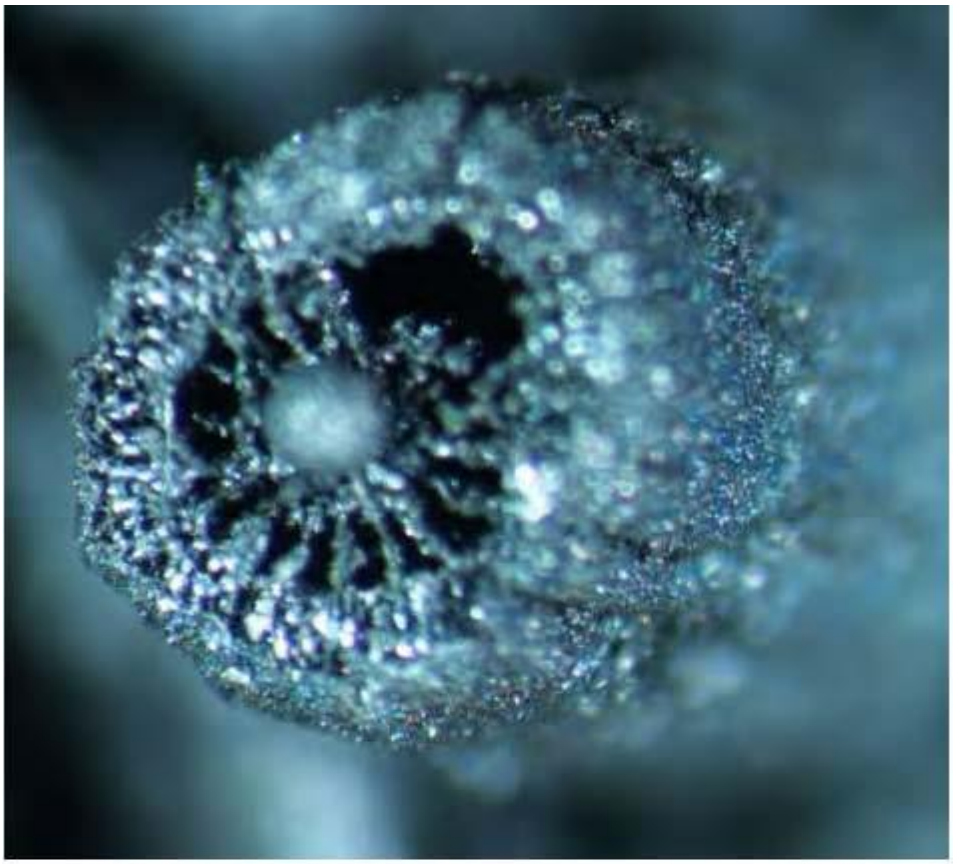
Non-degraded white oak sawdust Biochar from non-degraded white oak sawdust Biochar from spent oyster mushroom (*Pleurotus* sp.) substrate Dried flailed milfoil

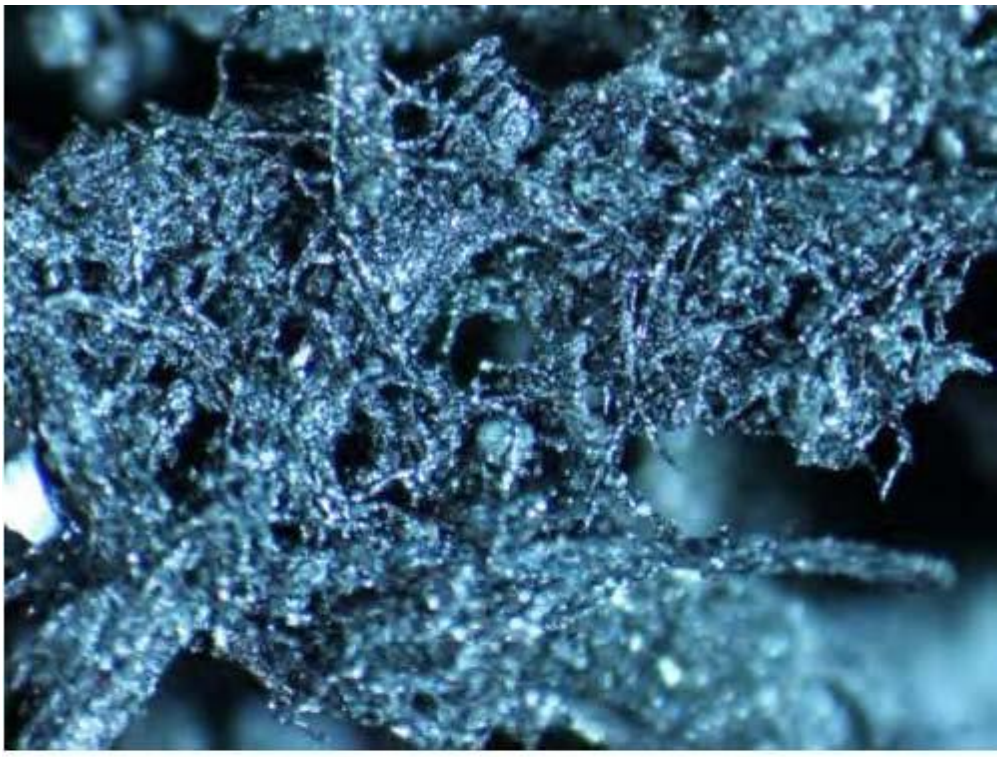


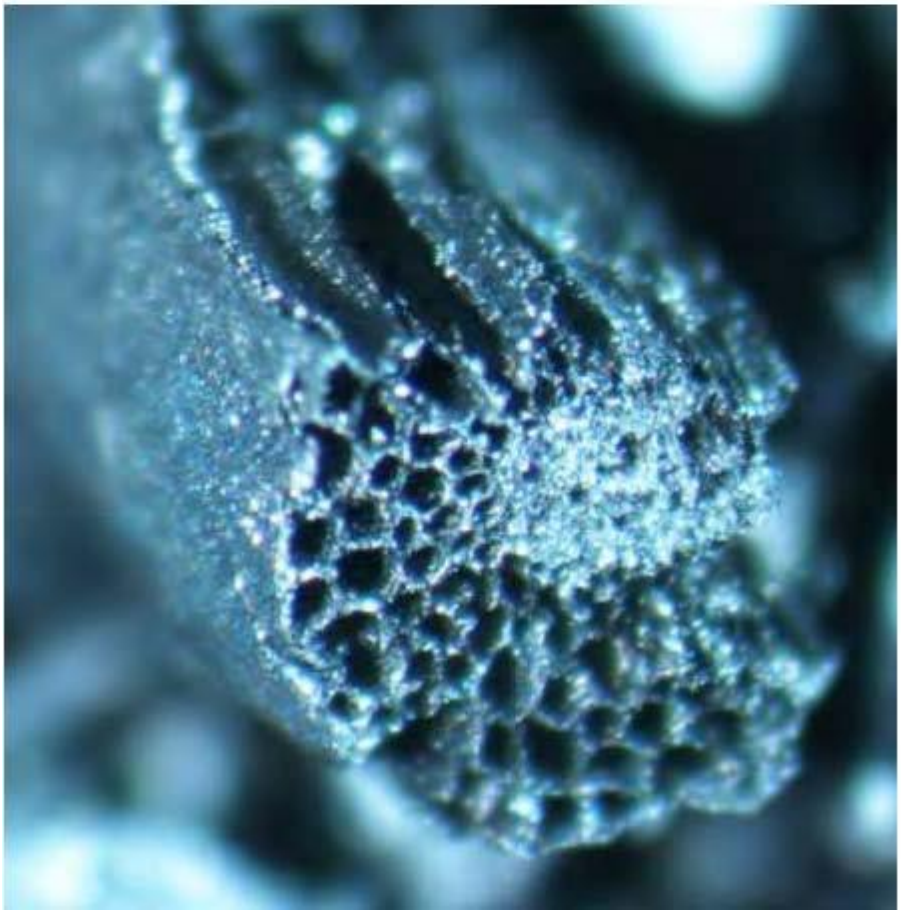


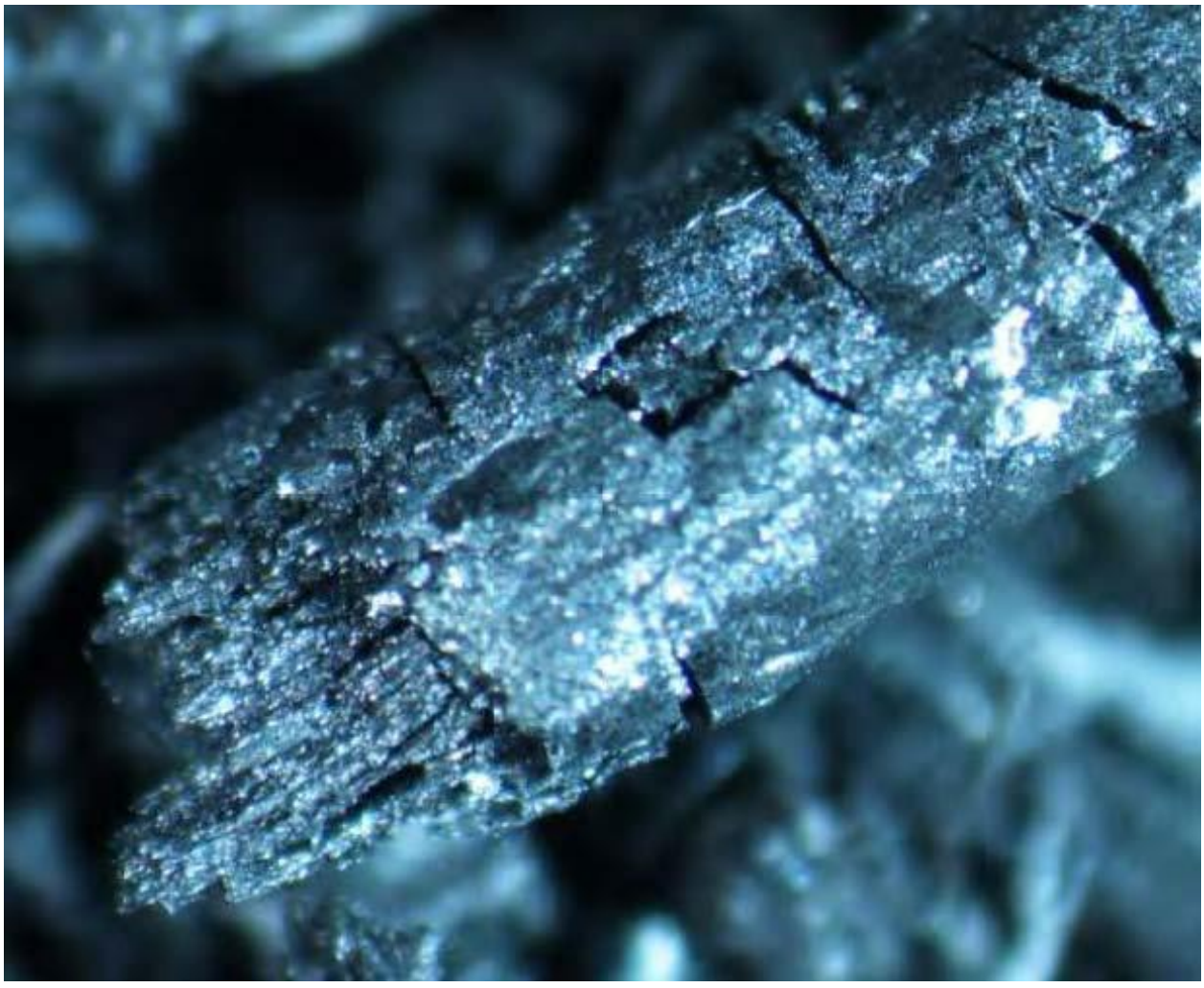
Biochar from dried flailed milfoil











2010 FARMER/RANCHER GRANT PROPOSAL
Ozark Forest Mushrooms, LLC
03.01.12

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

Expended Claimed SUPPLIES & EQUIPMENT $3,259.53 $2,137.03 LABOR COSTS $1,955.00 $1,955.00 TRACTOR HOURS $1,485.00 $1,485.00

TOTAL: $6,699.53 $5,577.03

Supplies + Equipment

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2

$3,259.53 $2,137.03

Labor Hours

$1,955

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2
July 24, 2011	2	1/2
July 31, 2011		1/8
August 4, 2011		3/5
August 5, 2011	1	1/4
August 7, 2011		2/5
August 8, 2011	1	1/2
August 13, 2011	1	1/10
August 17, 2011		1/4
August 19, 2011		1/2
August 20, 2011	1	
August 24, 2011		1/2
September 7, 2011		1/2
September 15, 2011		1/4
September 21, 2011	1	
September 25, 2011	1	1/2
October 12, 2011		1/2
October 26, 2011		1/2

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	

Tractor Hours

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	
June 21, 2011		1/4
June 27, 2011		2/5
June 28, 2011		1/10
July 4, 2011		1/4
July 6, 2011		3/10
July 7, 2011		1/5
July 12, 2011		7/10
July 13, 2011		1/2

Date	Rain F	all (In)
June 13, 2011	1	
June 18, 2011	1	