



cenusa bioenergy

Quarterly Progress Report

Agro-ecosystem Approach
to Sustainable Biofuels Production via
the Pyrolysis-Biochar Platform

April 2014

Agriculture and Food Research Initiative Competitive Grant
No. 2011-68005-30411

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Exhibit 2. Dr. Keri Jacobs Questionnaire ""Competition for land use: Why would the rational producer grow switchgrass for biofuel?"

Exhibit 3. Using Biochar in Gardens – 2013 Minnesota State Fair, Survey Results

Exhibit 4. Integrated Agricultural Landscapes for Profit & Risk Management, Survey Results

Exhibit 5. CenUSA October 2013 Bioenergy Field Day Evaluation Results (Purdue).

Exhibit 6. Establishing and Managing Perennial Grasses for Bioenergy, Survey Results

Exhibit 7. E3 Conference Accepted Abstracts

NOTICE

This quarterly report was prepared by Iowa State University and CenUSA Bioenergy research colleagues from Purdue University, United States Department of Agriculture-Agricultural Research Service, University of Illinois, University of Minnesota, University of Nebraska, Lincoln, University of Vermont, and the University of Wisconsin in the course of performing academic research supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the United States Department of Agriculture National Institute of Food and Agriculture (“USDA-NIFA”).

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Agro-ecosystem Approach to Sustainable Biofuels Production via the Pyrolysis-Biochar Platform (AFRI-CAP 2010-05073)

Quarterly Report: February 1, 2014 – April 30, 2014

PROJECT ADMINISTRATION

▪ Project Organization and Governance

Ken Moore (Professor, Iowa State University) continues as the CenUSA Bioenergy Project Director with Anne Kinzel as the Chief Operating Officer. Jill Cornelis (ISU Bioeconomy Institute) provides assistance with project financial matters.

• Featured Third Quarter Activities

- ✓ CenUSA Co-Project Directors have worked extensively on the reapplication for project year 4 funding. The work has been accomplished with the assistance of Lynn Jelinski (Sunshine Consulting). We are on track for completing the re-application by the required submission date.
- ✓ **Proposed Commercialization Objective.** We have continued the necessary preparatory work for our new Commercialization Objective. The projects described in Table 1 projects remain on track for an August 1, 2014 debut.

Table 1. Proposed CenUSA Commercialization Projects	
Partner	Project Description
ADM	Recovery of high value products from ADM's biorefinery co-product streams
Renmatix	Switchgrass in the Plantrose™ Process
Vermeer	Establishment of a 30+ acres across from the Vermeer Global Pavilion in Pella, Iowa. Planting will take place in May 2014.
ARS-Lincoln*	<ul style="list-style-type: none"> • Pelleting perennial feedstocks for bioenergy evaluations. • Perennial grass biochar commercialization for field and greenhouse evaluations and comparison to hardwood biochar • Bio-oil production of herbaceous feedstocks processed in the Battelle mobile pyrolyzer • Bio-oil production of herbaceous feedstocks processed in the Battelle mobile pyrolyzer • Feasibility of perennial grass feedstocks to supply combined heat and power to an advanced ethanol fermentation plant. • Grazing mitigates risk potential for perennial warm-season grasses grown for biomass energy
*We will be releasing names during the 4 th quarter	

- **2014 CenUSA Annual Meeting**

Planning continues for the 2014 CenUSA 2014 annual meeting will be held at the Minnesota Landscape Arboretum in Chaska Minnesota July 30 to August 1, 2014. The focus will be on our Extension and Outreach objective and the new Commercialization Objective. Extension Master Gardener “Citizen Scientist” volunteers will be leading a horticultural garden field tour, among other activities.

- **CenUSA Bioenergy Advisory Board**

We have added two new advisory board members. Christopher Clark, Global Change Research Scientist, EPA adds significant expertise in the area of water quality and watershed management and Tom Shannon, Research Technical Leader, ADM will provide commercialization expertise.

- **Coordination, Collaboration, and Communication**

✓ **Communication Team.** The Communications Team has designed a newsletter, BLADES for distribution to the interested public. The newsletter has been professionally designed and will be published bi-monthly. We use the Constant Contact communications platform to manage newsletter distribution with the newsletter directly emailed to a list that currently numbers 523 individuals and organizations. The newsletter is also available via the CenUSA website. Two issues have been distributed to date (February and April 2014) and have been well received.

Analysis shows that the newsletter has been significant in attracting additional visits to our website, YouTube and Vimeo webinar/video distribution channels as well as to our Twitter account and Facebook page.

We plan on adding the following outreach/communications efforts in the months ahead:

- CenUSA Infographic.
- Monthly press releases on significant CenUSA activity to a growing regional media list (See Exhibit 1).
- Expand and refine CenUSA Media List
- Short videos with CenUSA collaborators and students to share the CenUSA story on social media.
- Website redesign.

- ✓ **Executive Team Meetings and CenUSA Research Seminar.** The Co-Project directors representing each of the nine objectives continue to meet monthly with Ken Moore and Anne Kinzel via online meetings held in CenUSA's dedicated Adobe Connect meeting room. The virtual meeting room allows for documents to be viewed by all participants, enhancing communications and dialogue between participants. Tom Binder, the Advisory Board chair also attends these meetings, to ensure there is an Advisory Board presence during these important project gatherings. The monthly research seminars will go on hiatus for the summer months and will resume in August 2014.
- **Financial Matters.** The Administrative Team continues to monitor all project budgets and subcontracts to ensure adherence to all sponsor budgeting rules and requirements. We will also be working to create the new Commercialization Objective budget.

GERMPLASM TO HARVEST

Objective 1. Feedstock Development

Feedstock Development focuses on developing perennial grass cultivars and hybrids that can be used on marginal cropland in the Central United States for the production of biomass for energy. In 2014, the focus is on the establishment of new breeding and evaluation trials.

1. Significant Accomplishments Summary

- This research provides important information on the arthropods associated with bioenergy grasses.
- These studies provide valuable information on the host suitability of switchgrass and other bioenergy grasses to four aphids within a system that has been largely overlooked and indicate that there are genetic differences among switchgrass populations for resistance.
- The ultimate goal of this project is to develop effective and sustainable management strategies for the key arthropod pests affecting switchgrass.
- Four switchgrass strains, which include 'Kanlow' and 'Summer', were found to be completely susceptible to infection by PMV; i.e. 100% of plants from each strain became infected after inoculation with the virus. The results suggest that complete immunity to PMV does not exist in 'Kanlow' and 'Summer' or their derivatives, and that other switchgrass populations need to be explored for sources of resistance to PMV.

- Unlike reports from southern or southeastern states that *Puccinia emaculata* was the sole or primary rust species affecting switchgrass, both *P. emaculata* and *Uromyces graminicola* were confirmed as pathogen species causing severe rust disease in Nebraska breeding nurseries and experimental plots. Therefore, switchgrass populations being developed or deployed in the upper Great Plains must have resistance to both rust species.

2. Planned Activities

- **Breeding and Genetics – ARS-Lincoln, Nebraska (Mike Casler and Rob Mitchell)**
 - ✓ Finish grinding and scanning 2013 biomass samples.
 - ✓ Complete all seed packeting for 13 locations of new switchgrass and big bluestem trials to be planted in April-June 2014.
 - ✓ Submit SWAG DNA samples to UWBC sequencing facility for exome capture sequencing of 1 million SNP markers for use in genomic selection.
 - ✓ Prepare data sets for arrival of visiting biometrician, Dr. Zulfi Jahufer, who will conduct statistical analyses related to: (1) N-use efficiency in switchgrass breeding, (2) relationship among biomass quality traits, and (3) genomic selection prediction models for biomass quality traits.
 - ✓ Finish flow cytometry on new southern lowland germplasm collections and begin writing manuscript (Rude & Casler).
- **Feedstock Quality Analysis (Bruce Dien – ARS Peoria & Akwasi Boateng – ARS Wyndmoor)**
 - ✓ Continue processing biomass samples for ester and ether linked hydroxycinnamic acids (e.g., ferulic acid). Samples have been successfully analyzed for these components.
 - ✓ Begin to process FY2014 samples as received from collaborators.
 - ✓ Samples are still in process; however, resources have been temporally re-directed to developing a biochemical based conversion assay for analyzing the samples for production of sugars by enzymatic hydrolysis following hydrothermal pretreatment.
 - ✓ Continue writing manuscript as described above (Boateng & Sarath).
 - ✓ Switchgrass samples from Dr. Casler's group will be analyzed by py-GC/MS. There are also additional plans to understand the relationship between mineral content/ash

content in the biomass and pyrolysis product yield. Analysis of mineral content in all switchgrass samples will be performed by ICP-OES. This analysis is in preparation.

- **Plant Pathology and Entomology - University Nebraska-Lincoln (Tiffany Heng-Moss and Gary Yuen)**

- ✓ Continue processing samples from sampling year 3 to identify potential pests and beneficial arthropods and characterize their seasonal abundance.
- ✓ Continue to screen selected switchgrass, big bluestem, and indiangrass cultivars and experimental lines for their susceptibility to sugarcane aphids.
- ✓ Completed greenhouse inoculation of 4 switchgrass strains with *Panicum mosaic virus* (PMV) and satellite PMV to determine relative resistance to infection by the viruses.
- ✓ Confirm identity of rust species infecting switchgrass breeding and yield plots in Nebraska.

3. Actual Accomplishments

- **Breeding and Genetics – Lincoln, Nebraska (Mike Casler and Rob Mitchell)**

- ✓ Grinding and scanning of 2013 biomass samples is 90% complete.
- ✓ Seed packeting and shipment for 2014 trials was completed.
- ✓ Final selections made in overwintered switchgrass and big bluestem nurseries.
- ✓ All SWAG DNA samples for genomic selection were submitted to the UW Biotech Center for sequencing.
- ✓ Data sets for Zulfi Jahufer's sabbatical have been prepared.
- ✓ Flow cytometry has been initiated on new southern switchgrass collections.

- **Feedback Quality Analysis (Bruce Dien and Akwasi Boateng)**

- ✓ Analysis of switchgrass samples from Ken Vogel's group has been completed. These data are being summarized for publication
- ✓ Switchgrass samples from Dr. Casler's group have been analyzed by py-GC/MS. Analysis of mineral content in all switchgrass samples is currently being performed by ICP-OES.

- ✓ Manuscript with Sarath and Boateng is still in preparation
- **Pathology and Entomology - University Nebraska-Lincoln (Tiffany Heng-Moss and Gary Yuen)**
 - ✓ All pitfall and sticky traps have been sorted and identified. We are in the process of summarizing the data to compare the results from this year with our findings from last year.
 - ✓ We collected similar arthropod families from Nebraska and Wisconsin.
 - ✓ We are also in the process of analyzing the data to compare the influence of stand age and stand diversity on arthropod abundance and seasonal distribution.
 - ✓ We have completed the evaluation of the switchgrass cultivars and experimental strains for their susceptibility to greenbugs and sugarcane aphids. We are now in the process of screening the remaining big bluestem and Indiangrass cultivars and experimental lines for their susceptibility to these aphids. To date, 'Kanlow' switchgrass exhibits the highest level of resistance to the both aphids.
 - ✓ Assayed PMV and satellite PMV greenhouse inoculated switchgrass strains for presence of; found all 4 switchgrass to be completely susceptible to infection by PMV; PMV alone was found to be as infectious as PMV in combination with satellite PMV
 - ✓ Both *Puccinia emaculata* and *Uromyces graminicola* were verified by morphological methods as pathogens causing rust in Nebraska switchgrass plots. The former species was confirmed by DNA sequences.

4. Explanation of Variances

None to report.

5. Plans for Next Quarter

- **Breeding and Genetics (Mike Casler and Rob Mitchell)**
 - ✓ Plant new field trials.
 - ✓ Apply all management treatments as required for the 2014-growing season.
- **Feedstock Quality Analysis (Bruce Dien and Akwasi Boateng)**
 - ✓ Complete processing first 50 switchgrass samples (e.g. collected by Kenneth Vogel's laboratory) for ester and ether linked hydroxycinnamic acids (e.g. ferulic acid).

- ✓ Begin to apply hydrothermal biochemical assay to switchgrass samples.
- ✓ Conduct rechecks on prior year sample set as warranted by discussions with collaborator (A. Boateng).
- ✓ The results from the switchgrass samples from Ken Vogel's group will be put together for publication.
- ✓ The data from switchgrass samples from Dr. Casler's group will be finalized.
- **Pathology and Entomology (Tiffany Heng-Moss and Gary Yuen)**
 - ✓ Collaborate with Drs. Mitchell and Casler to develop insect sampling plans for year 4.
 - ✓ Begin sampling nurseries for insects and other arthropods in late May 2014.
 - ✓ Complete evaluation of big bluestem and Indiangrass cultivars and experimental line for their susceptibility to greenbugs and sugarcane aphids.
 - ✓ Coordinate with project collaborators in other states to obtain pathogen samples
 - ✓ Sample switchgrass plants for the presence of PMV and satellite PMV to investigate changes in virus titer during from plant dormancy through the growing season.
 - ✓ Obtain DNA sequences for *Uromyces graminicola* and use DNA sequences from *U. graminicola* and *Puccinia emaculata* in developing multiplex PCR method for identifying both rust species in infected switchgrass plants.

6. Publications / Presentations/Proposals Submitted

Dien, D., Anderson, W.F., O'Bryan, P.J. & Cotta, M.A. *Effect of agronomics on production and conversion quality of Napiergrass*. Symposium on Biotechnology for Fuels and Chemicals, April 28, 2014, Clearwater Beach, FL. (Poster presentation).

Objective 2. Sustainable Feedstock Production Systems

The Sustainable Feedstock Production Systems objective focuses on conducting comparative analyses of the productivity potential and the environmental impacts of the most promising perennial grass bioenergy crops and management systems using a network of 14 fields strategically located across the Central United States. The overarching goal is to produce a quantitative assessment of the net energy balance of candidate systems and to optimize perennial feedstock production and ecosystem services on marginally productive cropland while maintaining food production on prime land.

▪ Iowa State University

The winter quarter was devoted to laboratory and greenhouse research efforts, data analysis and interpretation, and preparation of manuscripts for publication. No fieldwork was done during the winter quarter.

Biochar is hypothesized to age in soil environments due to hydration, physical breakdown of particles, oxidation of surfaces and labile components, adsorption of dissolved organic compounds on biochar surfaces, and colonization of biochar surfaces by soil microorganisms. Because of these changes aged biochars are anticipated to influence soil quality and plant growth differently from fresh biochar. Most biochar studies published to-date have used fresh biochar, hence there is uncertainty about the applicability of published results using fresh biochar on soil response several years after a biochar amendment. We completed a greenhouse study during the winter quarter comparing the effects of fresh and field aged (3 years) biochar and nitrate versus ammonium fertilizer applications on soil quality parameters, nitrate and ammonium leaching, plant growth, and both nitrogen and water use efficiency. The study used eroded Clarion soils from central Iowa and biochar supplied by ICM Corporation. The soils having aged biochar were collected from plots amended with biochar in 2010. Fresh biochar was added to non amended soil collected from locations adjacent to the biochar plots. Much of the data from this study is still being evaluated and both soil and plant tissue samples have yet to be analyzed. Included below are some preliminary results from the study showing the impact of biochar aging on soil properties and nutrient leaching.

• Soil bulk density

We measured bulk density of the soil in the columns by using the known mass of soil in the columns and estimating the soil volume by measuring the volume of headspace in the columns and deducting that from the total column volume. All soils in the column study were packed to an original bulk density of 1.1 g cm^{-3} . Over time and as a consequence of periodic leaching events, soil in the columns consolidated. Shown below (Fig. 1) are soil bulk densities measured just before planting and post harvest.

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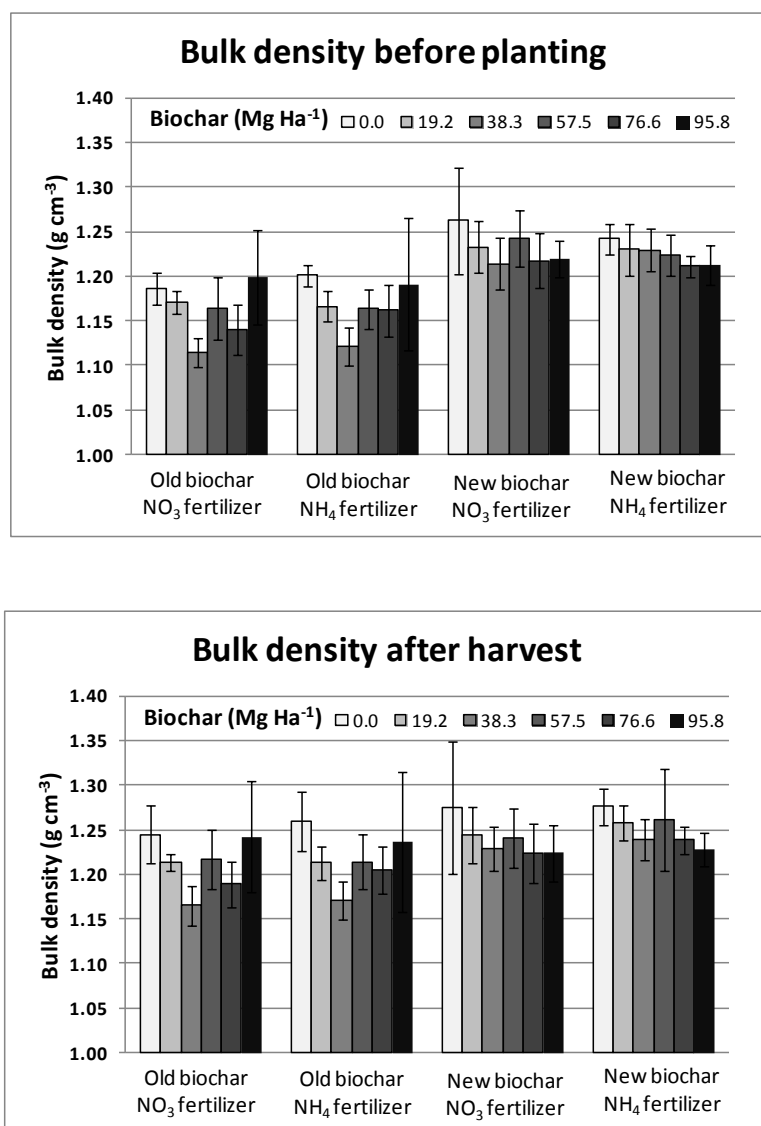


Fig. 1. Soil bulk densities measured just before planting and post harvest.

The results indicate that soil bulk densities continued to increase during crop growth. Soils amended with the fresh (new) biochar showed a small decrease in bulk density with increasing levels of biochar amendments. Biochar is a relatively low-density material and therefore a decrease in soil bulk density with increasing levels of biochar amendments was anticipated. By contrast, soils amended with the aged (old) biochar showed a decrease in bulk density between the control and 38.3 Mg ha⁻¹ treatments but increasing bulk density for soils amended with higher rates of biochar. Why soil bulk density increased for biochar amendments greater than 38.3 Mg ha⁻¹ is not clear.

- **Saturated hydraulic conductivity**

Saturated hydraulic conductivity was measured after the initial incubation/leaching phase of the experiment and just before planting. Columns were saturated from the bottom up and then allowed to drain freely. The rate of head fall was measured during free drainage.

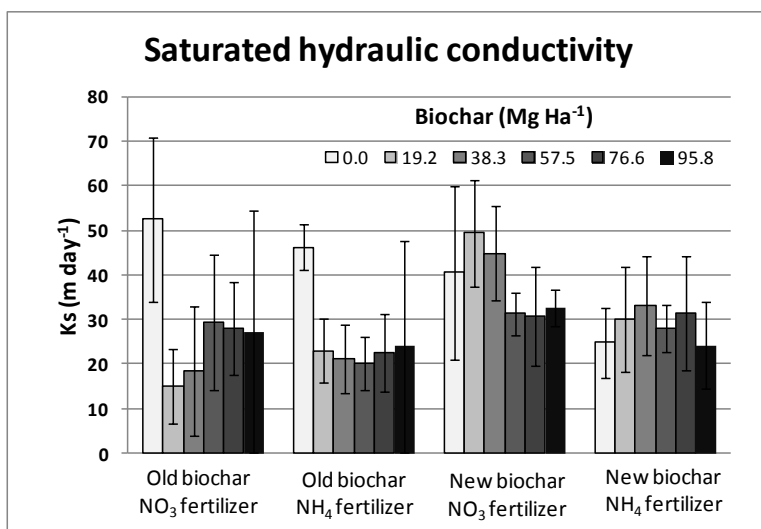


Fig. 2 Saturated Hydraulic Conductivity

The fresh biochar amendments had no significant effect on saturated hydraulic conductivity; however the aged biochar substantially reduced saturated hydraulic conductivity relative to the controls. The fresh biochar amendments had no significant effect on saturated hydraulic conductivity; however, soils amended with aged biochar had substantially reduced saturated hydraulic conductivity relative to the controls (Fig. 2).

Furthermore, a small amount of aged biochar (19.2 Mg ha⁻¹) was as effective as large amounts of aged biochar (95.8 Mg ha⁻¹) in reducing saturated hydraulic conductivity. The evidence suggests that aged biochar has a capacity to imbibe water and swell, thereby restricting the free flow of water through soil macropores.

- **Volumetric water content**

Several previous reports indicate that biochar amendments may increase the capacity of soils to retain water. No prior reports have investigated the effects of fresh versus aged biochar on the ability of soils to retain gravity-drained water. Columns were leached with dilute CaCl₂ and then weighed 24 hr later after free drainage ended.

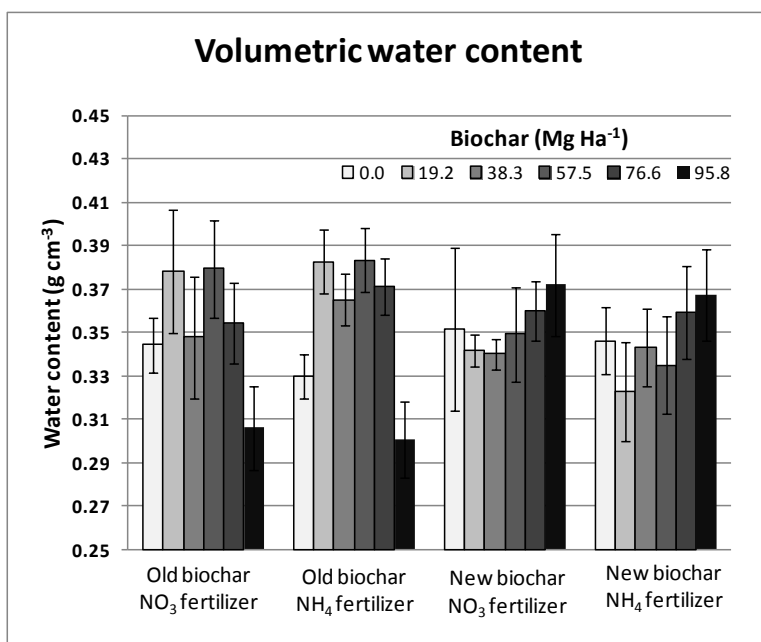


Fig. 3 Volumetric Water Content

Our results indicate no significant effect of fresh (new) biochar on the ability of soil to retain gravity-drained water (Fig. 3). However, soils amended with aged (old) biochar showed a significant increase in gravity-drained water content at the 19.2 through 76.6 Mg ha⁻¹ levels. Soils amended with the highest level of aged biochar (95.8 Mg ha⁻¹) retained less gravity drained water than the controls.

- **Leaching loss of NO₃ and NH₄**

The leaching of nitrate and ammonium during 7 leaching events over 60 days after fertilization but before planting was quantified (Figs 4 and 5). For each leaching event

columns were leached with 250 mL of 0.001 M CaCl_2 . The volume of leachate was determined gravimetrically and averaged about 150 mL per column. The balance of water was lost to evaporation between leaching events. Nitrate and ammonium concentrations in the leachate were determined by steam distillation.

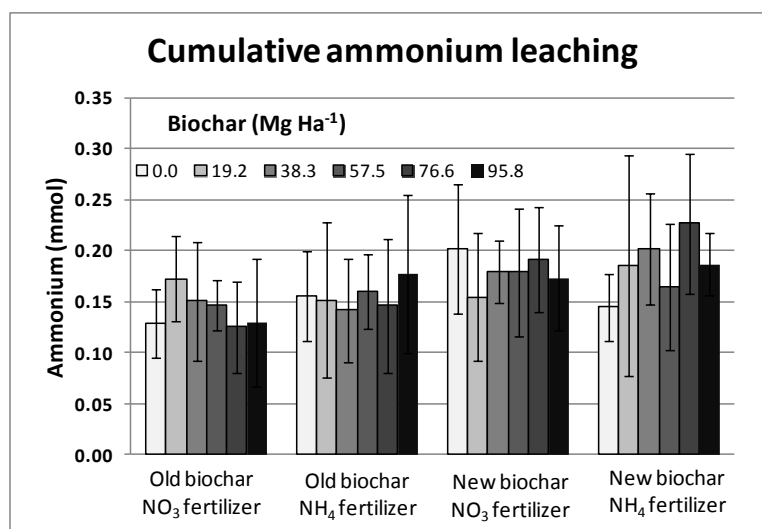


Fig. 4. Cumulative Ammonium Leaching

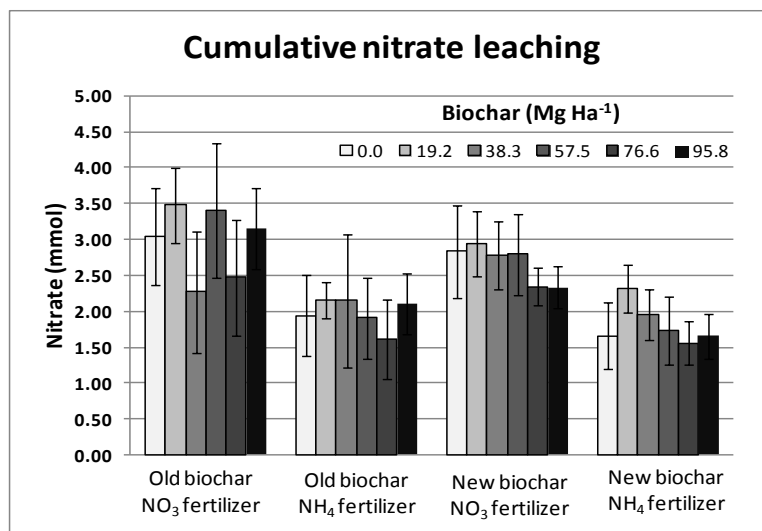


Fig. 5. Cumulative Nitrate Leaching

The total mass of N leached ranged between 31 and 97% of the amount of fertilizer N added to the columns. Columns receiving NO_3 fertilizer lost more total NO_3 to leaching than columns receiving NH_4 fertilizer. Ammonium leaching was about 5% of NO_3

leaching and was not influenced by choice of NO_3 or NH_4 fertilizer. There was no significant effect of biochar on cumulative N leaching in this study.

Overall the preliminary results of the greenhouse column study indicate the importance of using aged biochar when analyzing the impact of biochar amendments on soil quality and soil processes. The results suggest that aged biochar may be more effective for reducing soil bulk density and increasing soil water retention than fresh biochar. Results obtained from studies using fresh biochar may not be representative of the long-term effect of biochar amendments on soil quality or soil processes.

- **System Plots on the Armstrong Research and Demonstration Farm**

Decagon probe sensors have been installed at four depths of 4, 10, 17, and 24 inches in May of 2013 in all 32 subplots. Soil moisture, temperature, and electrical conductivity are being recorded every 30 minutes. Soil moisture readings are then averaged over 24-hour periods. Currently data are being sorted and statistically analyzed. Preliminary analyses indicate that cropping system, time period, and depth have an effect on soil moisture content between biochar-amended and unamended subplots. The figure below summarizes soil moisture fluctuation among biochar amended and unamended plots for different cropping systems (Fig. 6).

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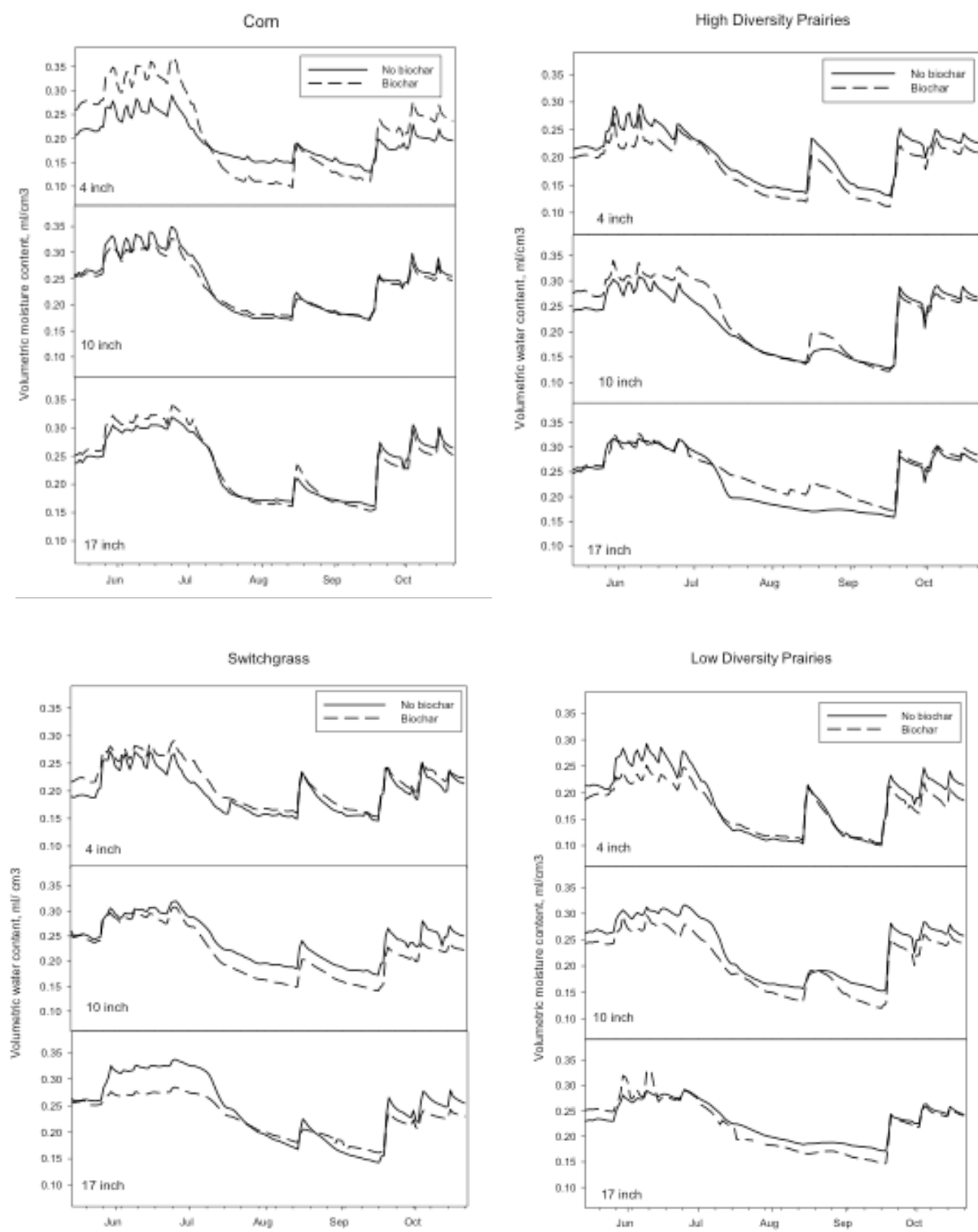


Fig. 6 Summary of soil moisture fluctuation among biochar amended and unamended plots for different cropping systems. (Armstrong Farm)

Work will continue on evaluation and interpretation of the soil moisture data from the system plots. It should be noted that stand establishment on these plots was poor in 2012 due to drought. The switchgrass plots were reseeded in 2013 and there was substantial weed pressure in the low and high diversity prairie plots. We anticipate that data collected in 2014 from the moisture probes will be more representative of the treatment effects.

▪ **Purdue University**

Progress has been made on laboratory analyses of biomass samples acquired in late fall 2013 and that were processed for analysis during the early part of 2014. The initial analyses have focused on tissue fiber and mineral analyses. Where complete, the results are presented below in Tables 2-5 and Figure 7 and 8.

Table 2 shows that *Miscanthus* had the high NDF, ADF, and lignin concentrations, but relatively low hemicellulose concentrations. Maize had low concentrations of all fiber components and lignin because of the high grain concentrations of the biomass. Switchgrass and the prairie had similar concentrations of fiber reflecting their similar plant species makeup. Fiber composition of sorghum was intermediate between maize and the herbaceous biomass species.

Table 2. Tissue neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose (NDF-ADF) and lignin concentrations for biomass from the Systems Analysis plots at the Water Quality Field Station in 2013. The least significant difference (LSD) at the 5% level of probability is provided. *Miscanthus* had the high NDF, ADF, and lignin concentrations, but relatively low hemicellulose concentrations. Maize had low concentrations of all fiber components and lignin because of the high grain concentrations of the biomass. Switchgrass and the prairie had similar concentrations of fiber reflecting their similar plant species makeup. Fiber composition of sorghum was intermediate between maize and the herbaceous biomass species.

Species	NDF	ADF,	Hemicellulose	Lignin
----- g/kg Dry Matter-----				
Switchgrass	721	395	326	67.9
<i>Miscanthus</i>	808	527	281	100.7
Native prairie	752	440	312	71.3
Maize, tot biomass	329	180	169	20.1
Sorghum, tot. biomass	488	261	226	30.8
LSD 0.05	30	32	25	7.8

Table 3 shows that yield of Miscanthus and maize were similar, and very high, but yield of fiber components of maize were intermediate because of low fiber concentrations in the maize biomass. The native prairie had low yields of fiber components, largely because of low DM yields despite having high fiber concentrations. Lignin yield per ha were very high in Miscanthus because of both high DM yields and high lignin concentrations.

Table 3. Dry matter (DM) and fiber yield (DM x fiber concentration) for biomass from the Systems Analysis plots at the Water Quality Field Station in 2013. The least significant difference (LSD) at the 5% level of probability is provided.

Species	DM Yield,	NDF	Hemicellulose	Lignin
	----- kg/ha -----			
Switchgrass	7233	5209	2354	491
Miscanthus	22787	18417	6386	2300
Native prairie	4285	3221	1334	304
Maize, tot. biomass	23179	8085	3922	465
Sorghum, tot. biomass	14640	7182	3326	455
LSD 0.05	2419	1615	640	213

Table 4 shows NDF concentrations ranged from 732 to 801 g/kg and did not differ substantively among species. The big bluestem/indiangrass mixture tended to have low ADF concentrations and this resulted in high hemicellulose concentrations in biomass of these species.

Table 4. Concentrations of neutral detergent fiber (NDF), acid detergent fiber (ADF), and hemicellulose of biomass from the Factor Analysis plots at the Northeast (NE Purdue Ag Center), Throckmorton (Thr. Purdue Ag. Center), and Southeast (SE Purdue Ag. Center) Purdue Ag Centers in 2013.

Site	Species	NDF	ADF	Hemicellulose
		----- g/kg Dry Matter -----		
NE Purdue Ag Center	Switchgrass	801	475	327
	BB/IG Prairie	756	416	342
	Miscanthus	801	543	258
Thr. Purdue Ag Center	Switchgrass	759	465	295
	BB/IG Prairie	756	439	318
	Miscanthus	748	476	272
SE Purdue Ag	Miscanthus	732	463	270

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Table 4 shows samples that were analyzed for neutral detergent fiber (NDF) and acid detergent fiber (ADF), and where hemicellulose concentrations were calculated. Dry matter yield of switchgrass was high at NE and Thr. Purdue Ag Centers, but did not establish well on the landfill marginal site at the SE Purdue Ag Center even after three attempts. Miscanthus established at all three locations, and had exceptional yields at the Thr. Purdue Ag. Center. The big bluestem/indiangrass prairie mixture was low yielding at NE and Thr., and like switchgrass, this mixture did not establish well at the SE Purdue Ag Center. Yields of NDF and hemicellulose tracked dry matter yields.

Table 5. Dry matter (DM) and fiber yield (DM x fiber concentration) for biomass from the Factor Analysis plots at the Northeast (NE Purdue Ag Center), Throckmorton (Thr. Purdue Ag. Center), and Southeast (SE Purdue Ag. Center) Purdue Ag Centers in 2013.

Site	Species	DM Yield	NDF	Hemicellulose Yield
----- kg/ha -----				
NE Purdue Ag Center	Switchgrass	12739	10211	4155
	BB/IG Prairie	4380	3336	1502
	Miscanthus	8657	6932	2338
Thr. Purdue Ag Center	Switchgrass	12611	9559	3698
	BB/IG Prairie	4444	3368	1417
	Miscanthus	19486	14572	5302
SE Purdue Ag	Miscanthus	5190	3801	1392

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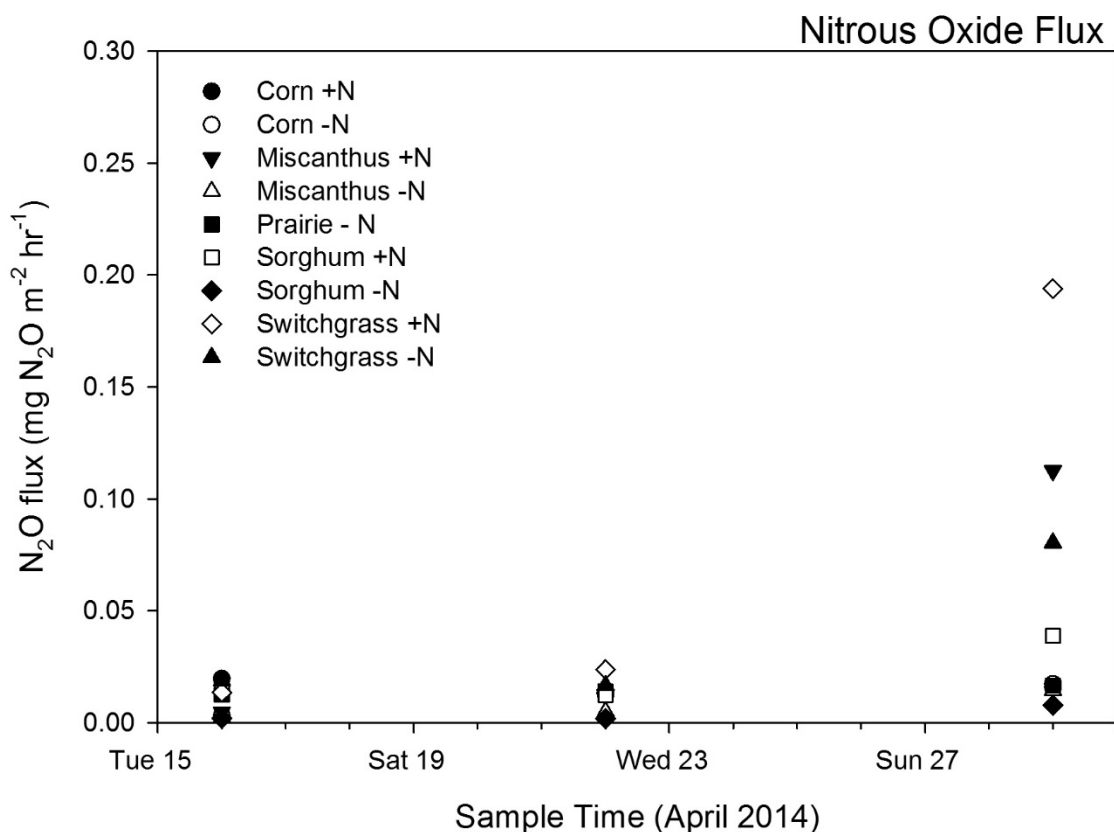


Fig. 7. Greenhouse gas emissions from the Systems Analysis plots at the Water Quality Field Station for the first three sampling dates in April 2014. High rates of nitrous oxide emissions were observed in N-fertilized plots of switchgrass and Miscanthus. The low emissions of maize and sorghum plots is due, in part, to N not yet being applied by the time of these measurements.

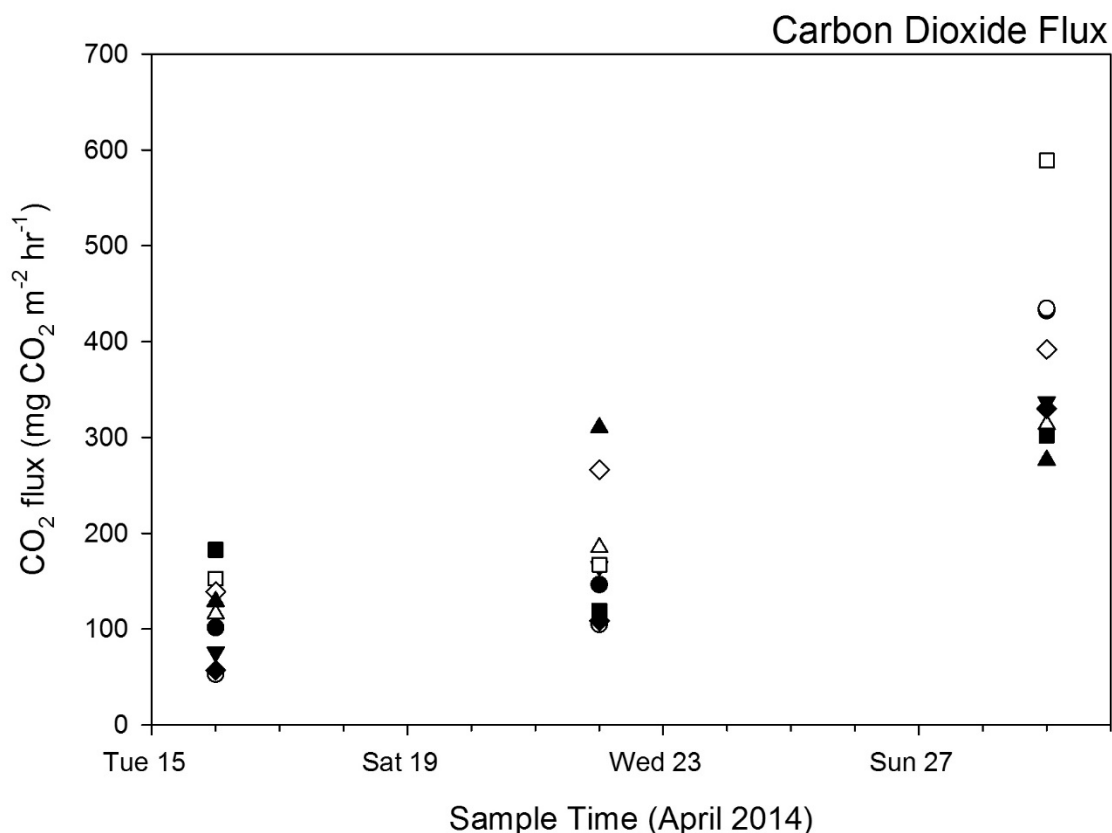


Fig. 8. Carbon dioxide emissions from the Systems Analysis plots at the Water Quality Field Station for the first three sampling dates in April 2014. No consistent pattern of emission rates was observed over the three samplings to date. Legend for treatments/symbols is identical to that shown in the figure above.

▪ University of Illinois Urbana-Champaign

• Factor Analysis Plots

- ✓ The plots were not harvested in 2013 because of the low biomass yield due to the drought during summer and weed pressure in the late-season. Both of the plots seeded in 2012 (reseeded in 2013) and 2013 were burned on March 20, 2014.
- ✓ The plots were sprayed with glyphosate and 2, 4-D on April 11, 2014 to manage weeds. Also the plots were spot-sprayed again on April 17 with glyphosate for cool-season grass control.
- ✓ Stand counts were collected on both of the plots on May 1, 2014 and stand counts will be measured again in mid-May.
- ✓ Further necessary weed controls will be applied to ensure good stands.

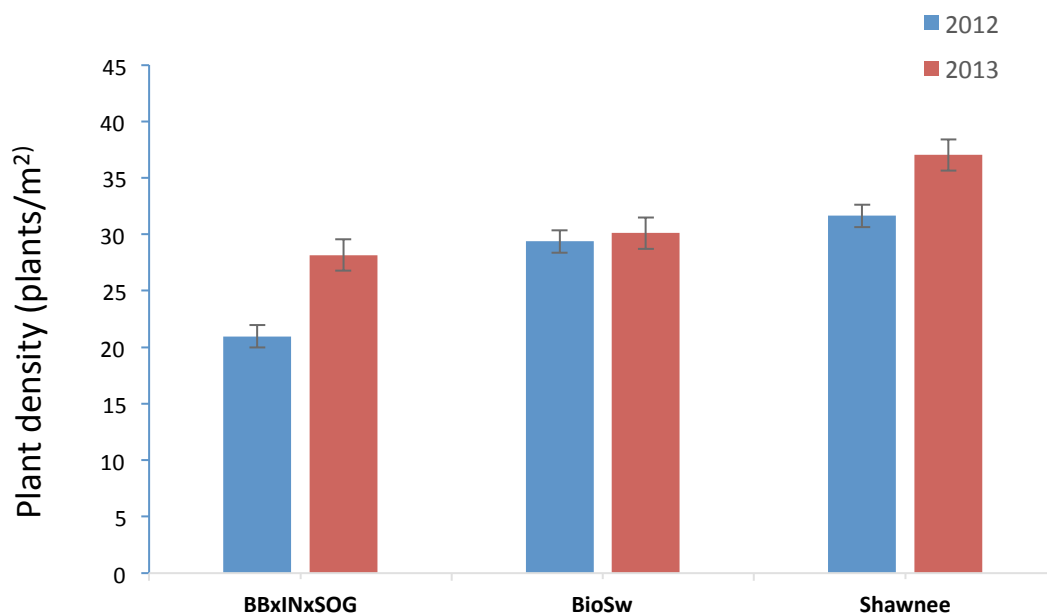


Fig. 9. Plant density measured using frequency grid for the factor analysis plots planted in 2012 (blue), and planted in 2013 (red).



Fig. 10. Prairie cordgrass and Shawnee switchgrass in Factor Analysis plots.
(Pictures taken on April 29, 2014)

- **Comparison Field Trial**

- ✓ Comparison field plots were burned on March 20, 2014.
- ✓ Field plots were sprayed with Prowl H₂O and 2, 4-D on April 29, 2014.
- ✓ Plots were spot sprayed with glyphosate on April 11, 2014 to ensure good weed suppression.
- ✓ Plant height data as well as light interception data were taken two times a week in the comparison field trial of Kanlow switchgrass (SW), IL ecotype big bluestem (BB), four populations of prairie cordgrass (20-107, 46-102, 17-109, 17-104), and *Miscanthus x giganteus* (Mxg).



Fig. 11. Prairie cordgrass was emerging from ground while all other grasses were still dormant when this picture was taken on April 13, 2014

• Abiotic Stress Trial

- ✓ Growth measurements were taken for prairie cordgrass in salt stress trial on salt affected soil ($EC > 20 \text{ dS m}^{-1}$) in Salem, Illinois. The Kanlow switchgrass has not yet emerged.
- ✓ The plots will be maintained and growth measurements will be taken periodically.
- ✓ The growth measurements were also taken in two field trials on poorly drained soils in Pana, Illinois and Urbana, Illinois.

- ✓ The plots will be maintained and growth measurements will be taken periodically.



Fig. 12. Seasonal flooding seen in the poorly drained soil in Urbana, IL.
(Picture taken on April 29, 2014)



Fig. 13. Prairie cordgrass stands in salt affected location in Salem, IL.
The Kanlow switchgrass had not yet emerged. (Picture taken on April 24, 2014)



Fig. 14. Prairie cordgrass stands in poorly drained location in Pana, IL. The Kanlow switchgrass had not yet emerged. (Picture taken on April 24, 2014)

▪ **University of Minnesota**

We are coming off a very cold winter and still enduring a very wet spring. In Lamberton, frost depth was 53 inches at the end of March 2014, and even still, there's frost from 39-49 inches. Becker does not record frost depth, but 5.4 inches of precipitation were recorded in April, including significant snowfall. Lamberton received 3.49 inches of precipitation in April, also including snowfall. To put this weather in perspective, only 4% of corn acres have been planted statewide, compared to a five-year average of 30% (1999-2004) (Dr. Jeff Coulter, Extension Corn Specialist).

As for activity over this past quarter, we have been grinding biomass samples collected last year for shipment to UNL and preparing for the upcoming field season. Our plans for the spring are as follows:

• **Factor plots at Lamberton, Minnesota**

Plans for spring 2014:

- ✓ Stand counts.
- ✓ A single application of Agrotain-coated urea in late May.
- ✓ As appropriate: Weed control in grass plots using 2,4-D. Weed control by hand in mixed perennial plots.

• **Factor plots at Becker Minnesota**

Plans for spring 2014:

- ✓ Stand counts.
- ✓ Split application of Agrotain-coated urea, due to excessively drained loamy sand soil. First application in late May, second in mid-June.
- ✓ As appropriate: weed control in grass plots using 2,4-D. Weed control by hand in mixed perennial plots.

▪ **USDA-ARS, Lincoln**

- All factor analysis plots seeded in 2012 and 2013 in Nebraska are fully established, with thin stands only in the bioenergy big bluestem plots. Both the 2012 and 2013 plots appear to have limited winter injury and are greening up. Fertilizer treatments will be applied by May 15, 2014. The feedstock samples collected in 2012 and 2013 from Nebraska have been processed and scanned and are awaiting prediction.
- The system analysis plots look very good. The corn check plots have been fertilized and planted. The triticale cover crop in the corn plots was poor due to the delay in seeding resulting from the government furlough. The large-scale perennial grass fields and harvest date by harvest height study appear to have limited winter injury and are greening up. Fertilizer treatments were applied on May 2, 2014. The feedstock samples collected in 2012 and 2013 from Nebraska have been processed and are waiting scanning and prediction.
- Greenhouse gas (GHG) sampling for the 2014 growing season is underway. Soil water content and GHG have been sampled at weekly intervals for about a month in the System Analysis plots to compare the perennial grass feedstocks and N rate to continuous corn. Cumulative N₂O and CO₂ emissions for 2013 are being summarized.
- We delivered six round bales each for switchgrass, big bluestem, and a low diversity prairie mixture to a pelleting facility near Lyons, Nebraska. About 12 tons (~4 tons per feedstock) was pelleted and bagged in 50 lb. bags. We are evaluating the compositional characteristics of the pellets and comparing the composition of baled and pelleted material. Additional projects are being considered.
- We installed a Loadrite loader scale on one tractor to increase bale-weighing precision and efficiency.
- We organized and completed the field layout for two herbaceous perennial feedstock research and demonstration sites in cooperation with Vermeer Manufacturing near Pella, Iowa.

- **Plans for Next Quarter**

- ✓ Finish grinding, scanning, and predicting biomass samples.
- ✓ Submit switchgrass and corn stover samples from long-term study for mineral analysis.
- ✓ Plant Vermeer Demonstration Plots near Pella, Iowa.
- ✓ Plant Abengoa Bioenergy Demonstration Plots near Farwell, Nebraska.
- ✓ Ship switchgrass bales to Iowa for feedlot feeding trial.
- ✓ Ship switchgrass, big bluestem, and low diversity mixture bales to Iowa for biochar project.

- **Publications, Presentations, and Proposals Submitted**

- Rogovska, N., Laird, D.A., Rathke, S.J. & Karlen, D.L. 2014. Biochar mediated changes in soil quality indicators and nutrient uptake by maize. *Geoderma*. (In press).

OBJECTIVE 3. FEEDSTOCK LOGISTICS

The Feedstock Logistics objective focuses on developing systems and strategies to enable sustainable and economic harvest, transportation and storage of feedstocks that meet agribusiness needs. The team also investigates novel harvest and transport systems and evaluates harvest and supply chain costs as well as technologies for efficient deconstruction and drying of feedstocks.

University of Wisconsin

1. Planned Activities

Planned research activities included:

- Analysis of data collected in 2013 and manuscript preparation;
- Development of machine configurations to size-reduce bales without grinding or shredding;
- Design and field test activities to increase bale density and package size;
- Design and field test activities to increase round bale density and re-shape into more favorable package for shipping; and

- Maintenance and new establishment of native grass fields for demonstration and research use.

2. Actual Accomplishments

We have statistically analyzed data from our work on bale aggregation, grass drying rate, and biomass size-reduction. The drying rate and bale aggregation data analysis is complete and manuscripts are almost completed for submission. The biomass size-reduction data remains under analysis. It has been determined that the size-reduction data is deficit in some areas and work in the summer of 2014 will be conducted to fill these gaps. Current efforts are focused on designing and fabricating ways to process bales by more efficient means than grinding and shredding. This system will involve decomposing bales by unrolling and using controlled and metered feeding into precision-cut chopping components

Large round bales (LRB) will likely be the dominant package form for perennial grasses grown on marginal land. As yield increases, so does the number of bales per unit area that need to be handled. We are investigating a “giant round baler” (GRB) concept that would create bales that weigh about 3-4 times that produced from the largest commercially available round hay baler depending upon achieved density in the GRB. We have begun baling experiments and will investigate and quantify area productivity, bale density, maintenance of shape, and storage characteristics.

Although the LRB will likely be the dominant package form for perennial grasses, round bales have some disadvantages compared to large square bales (LSB). Chief among these are lower density and less favorable cross-section –both of which lead to less than optimum transport weight. In other words, it is more likely that volume limited, rather than weight limited, transport will result. We have developed a process that compacts the LRB and reshapes it into a parallelepiped or cuboid shape similar to a LSB. This is envisioned to be a post-harvest, but pre-storage process that will increase the bale density that insures weight limited transport. The compacted and re-shaped bale will require less storage space. Additionally, we are investigating bale covering/restraint systems that will still allow low-cost outdoor storage despite the new parallelepiped or cuboid shape created. We have begun bale compaction experiments and will investigate and quantify power requirements; productivity; bale density; bale expansion rate; and storage characteristics.

Finally, we have rented 35 acres of marginal land in which there are established mixtures of switchgrass, big bluestem, and indiangrass. This land serves as a test site for our equipment and we have conducted outreach activities here as well. This spring we are managing weeds and fertility on grasses established in 2013. Additionally, we are establishing an additional 5-6 acres using the Liberty variety of switchgrass developed by CenUSA CoProject Directors Rob Mitchel and Ken Vogel (Objective 1, Feedstock Development).

3. Explanation of Variance

We are slightly behind in completing manuscripts for publication. The manuscripts are written, but need to be edited and properly formatted for submission. Additional data needs to be collected for the size-reduction research to encompass the full-range of size-reduction techniques. The fieldwork associated with establishing and maintaining our research and demonstration plots is delayed due to wet weather.

4. Plans for Next Quarter

Our efforts in the next quarter will include:

- Submitting manuscripts concerning results of grass drying systems and bale aggregation/logistics;
- Continuing to collect post-storage size-reduction energy requirements of bales focusing on precision-cut chopping;
- Evaluating a compaction and re-shaping system for round bales;
- Field evaluating a large-package option for baling grasses; and
- Performing field operations to insure successful establishment of *Liberty* switchgrass at our research/demonstration field.

5. Publications, Presentations, and Proposals Submitted

- Shinnars, K.J. & Lacey, N.C. (2014). *Improvements to a round bale press*. Invention Disclosure submitted to Wisconsin Alumni Research Foundation. WARF Case No. P140350.
- Shinnars, K.J. & Lacey, N.C. (2014). *Mobile round bale press*. Invention Disclosure submitted to Wisconsin Alumni Research Foundation. WARF Case No. P140351.

Iowa State University

In order to provide a continuous supply of biomass to biorefineries, harvest time and frequency must be optimized. Due to variation in harvest timing and frequency, the moisture content at the time of harvest may vary depending on the maturity stage of the crop. At young vegetative growth stage, moisture content of switchgrass averaged 70% (wet basis) and declined to 40 to 50% (wet basis) after flowering and seed set stage. Moisture content can further decline to less than 10% (wet basis) after a killing frost. For safe biomass storage, a moisture content of less than 18% is desirable.

The present feedstock supply chains based on conventional baling and storage, provide a variety of non-uniform biomass feedstock, with the potential for significant variability in physical and chemical characteristics, material quality, and stability. The “Uniform Format Bioenergy Feedstock Supply System” vision recommends the establishment of regional pre-processing depots that upgrade the raw biomass material into a uniform, standardized format to develop a commodity-scale feedstock supply chain.¹ The development of a commodity based biomass supply chain has significant benefits for bio-refineries, and could significantly reduce risks associated with quality and reliability of the feedstock supply chain. The main challenge with the commodity-scale feedstock supply chain is the relative costs related to the regional preprocessing.

1. Planned Activities

Planned research activities included:

- Development of improved dry matter loss models that can then be integrated into field harvest and logistics cost models. Crop characteristics such as yield, stem diameter, leaf to stem ratio, and swath structure can increase or decrease the moisture migration during field drying. Faster drying rates are obtained during sunny days, high temperatures, and dry soil when there is a thin swath. Less favorable conditions and periodic rainfall delays the drying process. Generally field-drying time of grasses varies from 2 to 7 days. Drying time is reduced to 2 to 4 days when the grasses are spread in thin layers and weather conditions are favorable.
- Analysis of harvest and logistics data for large-scale harvest and transportation of biomass materials, including the effect of local and regional preprocessing of feedstock supplies.

2. Actual Accomplishments

To evaluate the influence of factors affecting the drying rate of biomass, we designed and fabricated an environmental chamber. The environmental chamber can simulate the field drying conditions of temperature, humidity, wind speed and solar radiation. In the chamber, an air conditioning unit controlled the temperature and humidity. Wind speed was simulated by an axial fan, which was controlled by a variable frequency drive. A Quartz radiant heater simulated solar radiation and the intensity was controlled by a solid state variable heat controller. A series of 27 drying rate experiments were performed based on past weather conditions in Iowa. The experiments were run until the moisture content of biomass reached

¹ Hess, R.J, Kenney, K.L., Ovard, L.P., Searcy, E.M. & Wright, C.T. (2009). *Commodity-Scale Production of an Infrastructure-Compatible Bulk Solid from Herbaceous Lignocellulosic Biomass*, INL/EXT-09-17527. Prepared for the U.S. Department of Energy, Office of Biomass Program, Under DOE Idaho Operations Office Contract DE-AC07-05ID14517

a safe storage level of 15%. Effect of individual weather parameter on drying rate of biomass was evaluated and an empirical model relating drying rate of biomass with weather conditions and swath density was developed. We also conducted a separate set of 20 drying rate experiments to validate the model. The empirical model can predict the drying time of biomass based on the forecasted weather conditions so that the appropriate decisions can be made.

The environmental chamber developed in the present study can also be used to evaluate the drying potential of different varieties of biomass. It can also be utilized to evaluate the effect of field operations used to improve the drying potential of biomass such as conditioning, raking or turning, etc. The environmental chamber will also be used to study the influence of rewetting events due to rainfall or dew on drying rate of biomass.

A uniform format feedstock supply system would require the regional pre-processing of perennial grasses and other biomass feedstock from their raw form into a uniform format. The most likely conversion process is pelletization. The pelletization costs of switchgrass and other biomass materials have been evaluated at a number of scales, from mobile pelletization units that move from field based storage locations, to larger centralized pre-processing facilities capable of processing up to 120,000 tons per year. The cost analysis was based on commercially available pelletization units using manufacturers quoted prices for all unit operations required. The cost of switchgrass ranged from \$38.11 to \$52.96 per ton.

3. Explanation of Variance

Only minor variance in planned activities has been experienced. The large-scale collection of field logistics data was not as widespread as hoped due to inconsistent operation of logging devices.

4. Plans for Next Quarter

Research activities planned during next quarter include:

- Continue development, testing and evaluation of improved dry matter loss models and validation of the models in field harvest operations.
- Analysis of field scale machine performance and logistics data for large-scale harvest and transportation of biomass materials.

5. Publications, Presentations, and Proposals Submitted

None during this quarter.

OBJECTIVE 4. SYSTEM PERFORMANCE METRICS, DATA COLLECTION, MODELING, ANALYSIS AND TOOLS

This objective provides detailed analyses of feedstock production options and an accompanying set of spatial models to enhance the ability of policymakers, farmers, and the bioenergy industry to make informed decisions about which bioenergy feedstocks to grow, where to produce them, what environmental impacts they will have, and how biomass production systems are likely to respond to and contribute to climate change or other environmental shifts.

We focus on four overarching tasks:

- **Task 1. Adapt existing biophysical models to best represent data generated from field trials and other data sources**
- **Task 2. Adapt existing economic land-use models to best represent cropping system production costs and returns**
- **Task 3. Integrate physical and economic models to create spatially explicit simulation models representing a wide variety of biomass production options**
- **Task 4. Evaluate the life cycle environmental consequences of various bioenergy landscapes.**

Iowa State University

1. Planned Activities

The first two broad tasks under objective 4 are to adapt existing biophysical models to best represent field trials and other data and to adapt existing economic land-use models to best represent cropping system production costs and returns.

2. Actual Accomplishments

We have completed our first large scale scenarios using the detailed SWAT model for the Upper Mississippi River Basin and the Ohio Tennessee River Basin with USGS 12-digit subwatersheds. A paper was accepted at the Journal of the European Agricultural Economics Association and will be forthcoming this summer. That paper describes the results of baseline and switchgrass placement in the landscape to evaluate the water quality and carbon effects at the landscape level.

3. Explanation of Variance

No variance has been experienced.

4. Plans for Next Quarter

Continue work on the first two tasks: 1) to adapt existing biophysical models to best represent field trials and other data and 2) to adapt existing economic land-use models to best represent cropping system production costs and returns. We are developing a set of scenarios to represent how farmers indicate that they plan to respond to climate change over the next few decades. Preliminary results may be completed in the next quarter.

5. Publications, Presentations, and Proposals Submitted

- Kling, C.L., Panagopoulos, Y., Valcu, A.M., Gassman, P.W., Rabotyagov, S., Campbell, T., White, M., Arnold, J.G., Srinivasan, R., Jha, M.K., Richardson, J., Moskal, L.M., Turner, G. & Rabalais, N. (2014) Land Use Model Integrating Agriculture and the Environment (LUMINATE): Linkages between Agricultural Land Use, Local Water Quality and Hypoxic Concerns in the Gulf of Mexico. Journal of the European Association of Agricultural Economics, forthcoming 2014.
- Kling, C.L. *Linking Externalities from the Land to their Consequences in the Sea: A Model of Land Use, Costs, Hydrology and the Gulf of Mexico Hypoxic Zone*. Presented at the Water Resources Conference, Saint Paul, Minnesota.
- Kling, C.L. *The Potential for Agricultural Land Use Changes in the Raccoon River Basin to Reduce Flood Risk: A Policy Brief for the Iowa Flood Center*. Presentation, available at <http://www.card.iastate.edu/environment/presentations.aspx>.
- Kling, C.L. National Science Foundation, “Climate and Human Dynamics as Amplifiers of Natural Change: A Framework for Vulnerability Assessment and Mitigation Planning, (Principal Investigator), 2012-2016, \$480,000.
- Schilling, K.E., Gassman, P.W., Kling, C.L., Campbell, T., Jha, M.K., Wolter, C.F. & Arnold, J.G. (2013). The Potential for Agricultural Land Use Change to Reduce Flood Risk in a Large Watershed,” Hydrological Processes. Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/hyp.9865
- Valcu, A. M. Agricultural Nonpoint Source Pollution and Water Quality Trading: Empirical Analysis under Imperfect Cost Information and Measurement Error. PhD dissertation, Iowa State University, 2013.

University of Minnesota

1. Planned Activities

Planned activities for this quarter include continued work on Task 1 (Adapt existing biophysical models to best represent data generated from field trials and other data sources), Task 2 (Adapt existing economic land-use models to best represent cropping system production costs and returns), Task 3 (Integrate physical and economic models to create spatially-explicit simulation models representing a wide variety of biomass production options), Task 4 (Evaluate the life cycle environmental consequences of various bioenergy landscapes), and Task 5 (Employ the modeling systems to study the design of policies to cost effectively supply ecosystem services from biomass feedstock production).

2. Actual Accomplishments

We continued wrapping up manuscripts on the topics of bioenergy crop yield gaps, switchgrass production costs, implications of the Farm Bill for bioenergy, and regional changes in the biophysical exchange of carbon and water due to increased bioenergy production in the Midwest.

3. Explanation of Variance.

No variance has been experienced.

4. Plans for Next Quarter

Next quarter includes continued work on Tasks 1, 2, 3, 4, and 5.

5. Publications, Presentations, and Proposals Submitted

- Hill, J. *Use of Spatial and Temporal Data in LCA: Focus on Energy, Transportation, and Agriculture*. February 2014, Radboud University, Nijmegen.
- Hill, J. *Spatially and Temporally Explicit Life Cycle Impacts of Transportation on Air Quality and Human Health*. University of Leiden, March 2014.
- Hill, J. *Biofuels: The Past or the Future?* Wageningen University, March 2014.
- Hill, J. *Life Cycle Impacts of United States Light Duty Transportation on Air Quality and Human Health*. University of Utrecht, March 2014.
- Mullins, K. *Mapping Supply Chain Air Emissions in the United States*. Center for Sustainable Polymers Annual Meeting, Minneapolis, Minnesota, April 2014.

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Post-Harvest

OBJECTIVE 5. FEEDSTOCK CONVERSION AND REFINING: THERMO-CHEMICAL CONVERSION OF BIOMASS TO BIO-FUELS

The Feedstock Conversion and Refining Objective will perform a detailed economic analysis of the performance of a refinery based on pyrolytic processing of biomass into liquid fuels and will provide biochar to other CenUSA researchers. The team concentrates on two primary goals:

- Estimating energy efficiency, GHG emissions, capital costs, and operating costs of the proposed biomass-to-biofuels conversion system using technoeconomic analysis;
- Preparing and characterizing Biochar for agronomics evaluations.

Sub-objective 1. Perform Technoeconomic Analysis

1. Planned Activities.

Perform lignin catalytic pyrolysis experiments.

2. Actual Accomplishments

Study hypothesis and motivation

This study is aimed at finding methods to effectively convert lignin, the most recalcitrant component in biomass, into valuable bioproducts. Major challenges identified in lignin conversion are its low H/C ratio compared to carbohydrates, and a significant tendency to polymerize during pyrolysis reactions. Polymerization is thought to occur due to free radical formation and chain propagation reactions during lignin pyrolysis. A proposed solution to the problem is to hydrogenate the free radicals upon formation. However, this approach requires the use of expensive high-pressure equipment. As an alternative, we tested titanium hydride as a source of hydrogen to maintain the appropriate conditions for pyrolysis conversion. Titanium hydride has been reported as a stable hydrogen storage material, which desorbs hydrogen at temperatures observed under typical pyrolysis conditions.

Study Conclusions

The study shows that the titanium hydride hydrogenation activity can convert most of the phenolics formed during lignin and creosol (phenolic monomer) pyrolysis. Titanium hydride thermo-gravimetric analysis (TGA) experiments indicate that hydrogen desorption occurs between 525⁰C and 675⁰C. The hydrocarbon products of this process are phenol, benzene and toluene (BTX). However, titanium hydride conversion yields to BTX were lower than with zeolites. We were able to increase BTX yields by mixing titanium hydride with zeolites. Furthermore, the mixture of titanium hydride and zeolites improves the product H/C ratio due

to the hydrogenation effect of titanium hydride. These results suggest that the combination of titanium hydride and zeolite catalysts could lead to improved hydrocarbon yields from lignin pyrolysis.

Supporting Figures and Tables

Table 6. Experimental plan with operating conditions to analyze effect of titanium hydride in lignin catalytic pyrolysis	
Run details	Operating conditions
Organosolv lignin pyrolysis with titanium hydride	Temperature: 300 ⁰ C to 700 ⁰ C Mix ratio Lignin: Titanium hydride = 1:1 and 1:10
Comparison of organosolv lignin pyrolysis with zeolite (ZSM5) and titanium hydride	Temperature: 7000C Mix ratio Lignin: Titanium hydride = 1:10
Comparison of creosol pyrolysis with zeolite (ZSM5) and titanium hydride	Temperature: 700 ⁰ C Mix ratio Creosol: ZSM5 = 1:20 Creosol: Titanium hydride = 1:20
Influence of titanium hydride in catalytic pyrolysis of organosolv lignin with zeolite (ZSM5)	Temperature: 700 ⁰ C Mix ratio Lignin: Titanium hydride: ZSM5 = 1:10:10
Thermo gravimetric analysis (TGA) for titanium hydride	In nitrogen atmosphere until 900 ⁰ C

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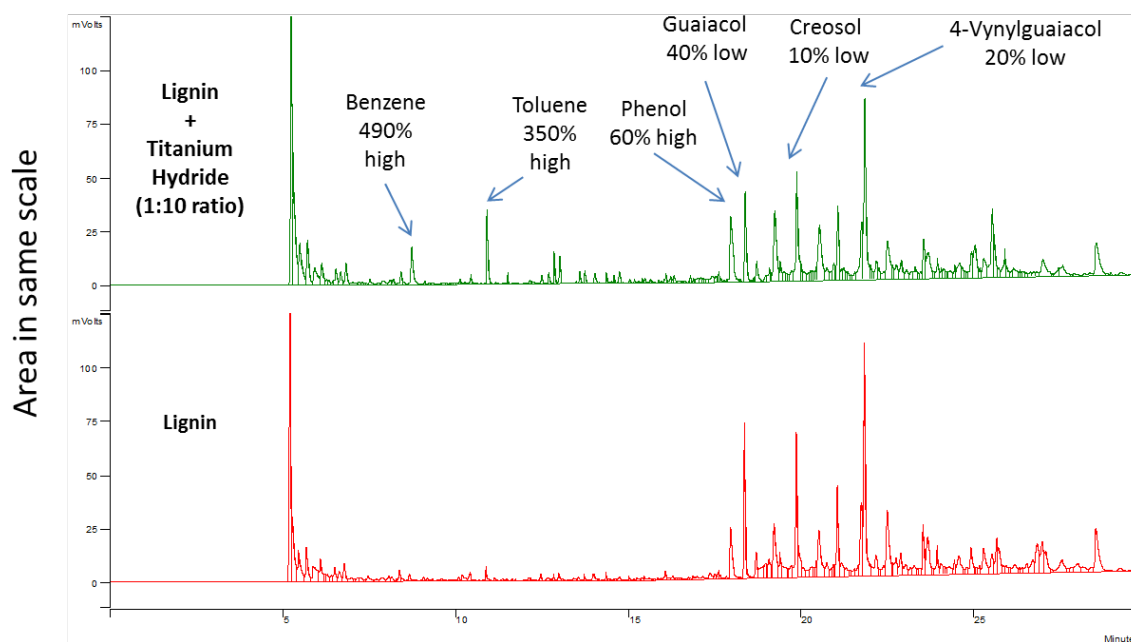


Fig. 15. Organosolv lignin pyrolysis with titanium hydride at 600°C

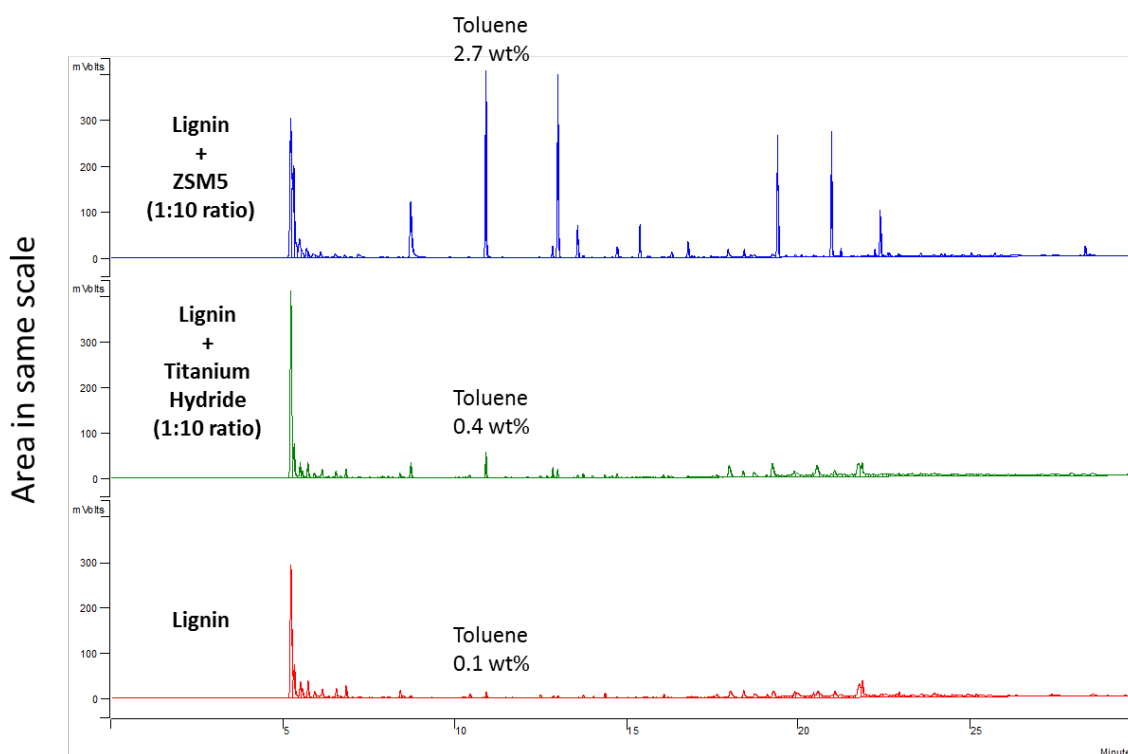


Fig. 16. Comparison of organosolv lignin pyrolysis with zeolite (ZSM5) and titanium hydride at 700°C

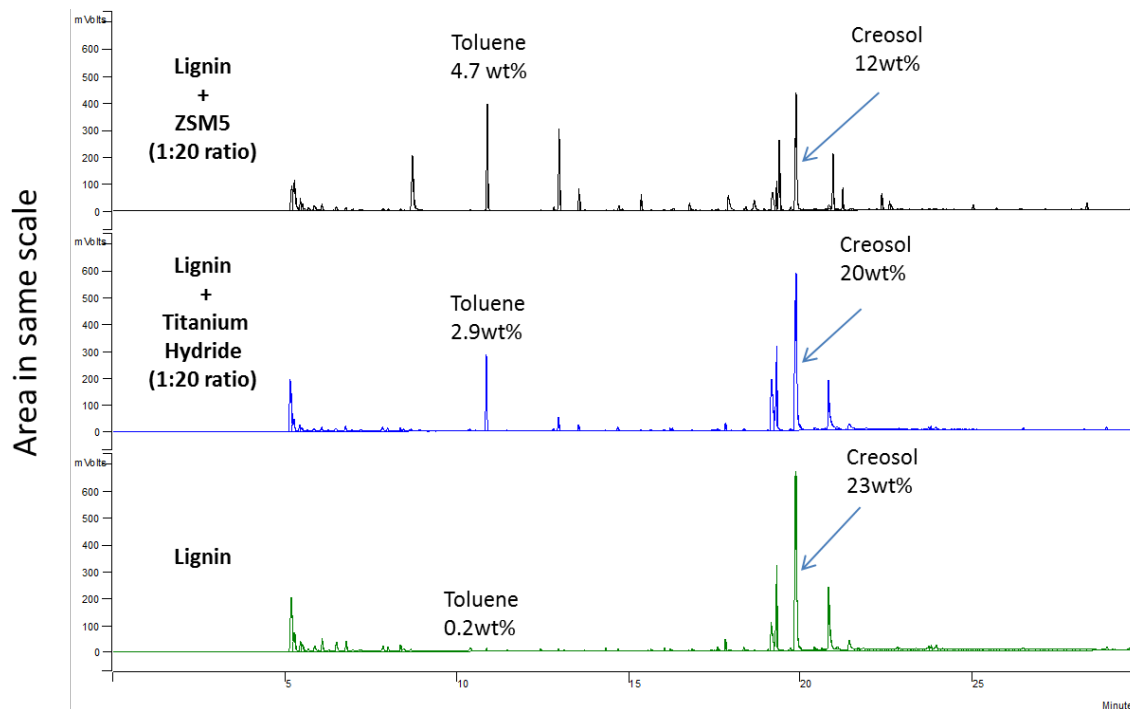


Fig. 17. Comparison of creosol pyrolysis with zeolite (ZSM5) and titanium hydride at 7000C

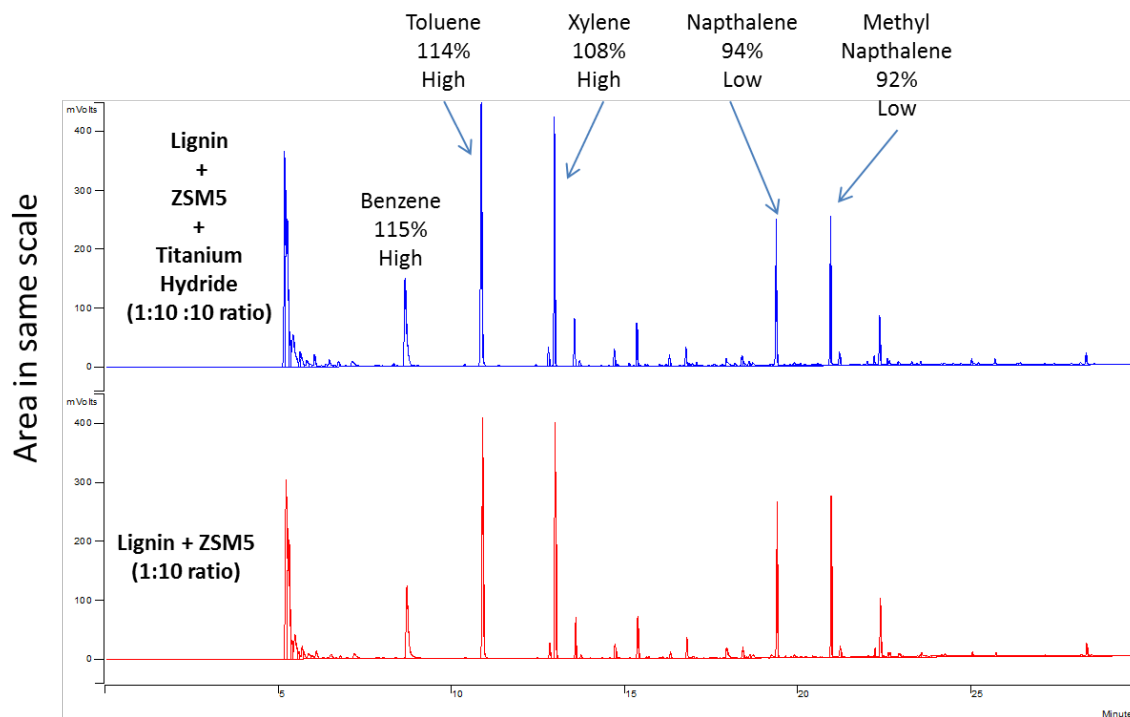


Fig. 18. Influence of titanium hydride in catalytic pyrolysis of organosolv lignin with zeolites (ZSM5) at 7000C

Table 7. Summary of experimental runs to analyze the effects of titanium hydride in catalytic pyrolysis of lignin

Operating Conditions	Summary
Organosolv lignin pyrolysis with titanium hydride at different temperatures from 300°C to 700°C	No significant changes observed below 600°C Optimal hydrocarbon yields achieved under 700°C and 1:10 biomass to catalyst mix ratio Observed that phenolic monomers deoxygenated to phenol, benzene and toluene
Comparison of organosolv lignin pyrolysis with zeolite (ZSM5) and titanium hydride and at 700°C	Zeolites achieve higher yield of aromatics than titanium hydride from lignin
Comparison of creosol pyrolysis with zeolite (ZSM5) and titanium hydride at 700°C	Zeolites achieve higher yields of aromatics than titanium hydride from creosol
Influence of titanium hydride in catalytic pyrolysis of lignin with zeolites (ZSM5) at 700°C	Product H/C ratio improves, due to hydrogenation effect of titanium hydride.
Thermo gravimetric analysis (TGA) for titanium hydride	Hydrogen desorption occurs in the temperature range of 525°C to 675°C

3. Explanation of Variance.

No variance has been experienced and accomplishments are on schedule.

4. Plans for Next Quarter.

Preliminary results indicate that lignin pyrolysis with zeolite catalysts could be improved with increasing hydrogenation activity. There are apparent limitations that constrain yields. During the next quarter, we will

- Conduct catalytic pyrolysis experiments with lignin model compounds to identify the limiting factors of using zeolites for lignin conversion; and
- Conduct experiments to understand the role of heat and mass transfer limitations of lignin catalytic pyrolysis using zeolites.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

Sub-objective 2. Prepare and Characterize Biochar

1. Planned Activities.

We will begin work on preparing a manuscript documenting the stability of biochar AEC in a harsh oxidizing environment. Additional chemical and spectroscopic analysis will be conducted as needed to complete this paper.

2. Actual Accomplishments

- A manuscript entitled *Anion Exchange Capacity of Biochar* by Michael Lawrinenko and David Laird was submitted to Environmental Science and Technology. The manuscript is currently under review.
- Research on the impact of oxidation treatments on the anion exchange capacity of biochars was completed and a draft report has been prepared. To complete this work fresh and oxidized biochar samples were analyzed by ^{13}C nuclear magnetic resonance (NMR) spectroscopy using a 100 MHz using a Bruker DSX400 spectrometer and a Bruker 4-mm ^1H – ^{13}C double-resonance magic angle spinning (MAS) probe head at 14 KHz. Following is an abstract of the report and highlights of the results.

Stability of Anion Exchange Sites during Chemical Oxidation of Biochar by M. Lawrinenko and D. A. Laird

Little is known about the stability of anion exchange capacity (AEC) of biochars and by what mechanisms AEC changes as biochar weathers in soil environments. Our goal in this study was to assess the effect of oxidation treatments on AEC of biochar. Biochars were oxidized by exposure to singlet oxygen in an alkaline (1 M NaOH) aqueous medium for 4 months to mimic what may occur in natural soil environments. Oxidation of biochars caused AEC to decline on average by 54%. Fourier Transform Infra-Red (FTIR) spectroscopy demonstrated that biochars produced at 700 °C (peak pyrolysis temperature) had greater levels of condensed aromatic C than biochars produced at 500 °C. Oxidation increased the intensity of FTIR bands for carbonyl and hydroxy groups in spectra of biochars produced at 500 °C and peroxy ether groups for biochars produced at 700 °C. Biochars produced at 700 °C exhibited a lower decline in AEC following the oxidation treatments in contrast to biochars produced at 500 °C. The AEC of an alfalfa meal biochar produced at 700 °C did not change significantly ($P = 0.19$) following oxidation. Stability of AEC in the high temperature alfalfa meal biochar is attributed to the highly condensed aromatic character of carbon in this biochar.

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Table 8. C, N, H, S and O contents of fresh and oxidized biochars							
Feedstock	HTT (°C)	Age	%C	%N	%H	%S	%O
Alfalfa	500	Fresh	66.03	3.40	2.43	0.18	*
Alfalfa	700	Fresh	68.80	3.23	1.45	0.25	*
Cellulose	500	Fresh	84.80	0.00	2.98	0.08	10.82
Cellulose	700	Fresh	90.30	0.01	1.72	0.12	6.12
Corn Stover	500	Fresh	75.45	1.48	2.67	0.08	*
Corn Stover	700	Fresh	77.54	1.23	1.48	0.13	*
Alfalfa	500	Oxidized	61.46	3.57	2.18	0.11	*
Alfalfa	700	Oxidized	68.01	3.39	1.22	0.15	*
Cellulose	500	Oxidized	83.68	0.00	2.76	0.02	13.54
Cellulose	700	Oxidized	81.83	0.01	3.56	0.07	14.53
Corn Stover	500	Oxidized	74.85	0.74	1.97	0.05	*
Corn Stover	700	Oxidized	71.25	0.00	1.62	0.10	*
* Not measurable							

Oxygen content of cellulose biochar increased significantly following oxidation treatments. Oxygen content of the other biochars could not be accurately determined because they contain significant levels of ash.

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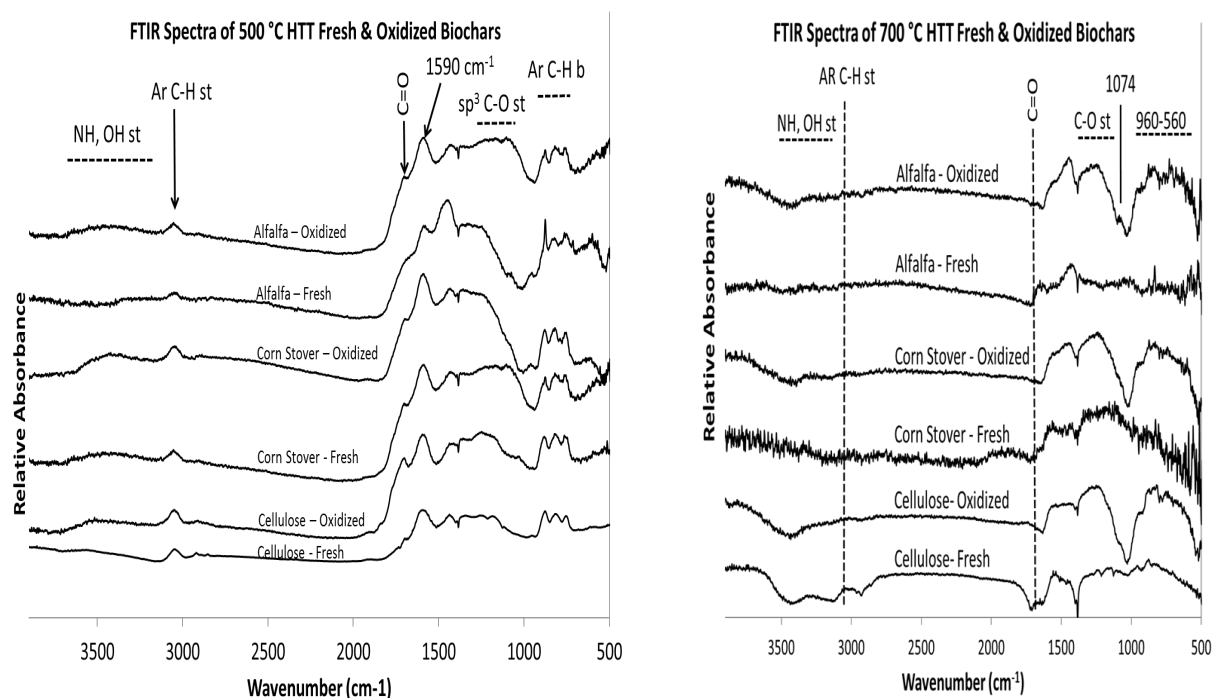


Fig. 19. FTIR analysis of fresh and oxidized biochars indicated increased intensity in stretching regions for hydroxyl, carbonyl and ether groups following oxidation treatments.

Table 9. ^{13}C NMR analysis indicated a small increase in aromatic C bound to O and carbonyl C and decreases in alkyl C and O-alkyl C in oxidized biochar relative to fresh biochar.

Carbon Moiety	Chemical Shift (ppm)	Fresh (%)	Oxidized (%)
Alkyl sp^3	0-61	5	4
sp^3 bound to O (ether, ester, alcohol)	61-90	2	1
Total Ar C with SSB	90-164	92	91
Total Ar C 2 bl from O	90-120	16	14
Total Ar C > bl from O	120-143	60	61
Total Arc bound to O	143-164	8	9
Non-pronated Total Ar C 2 bl from O	90-120	4	2
Non-pronated Total Ar C > bl from O	120-143	32	32
Non-pronated Ar C bound to O	143-164	8	9
Total carbonyl C	164-200	2	3

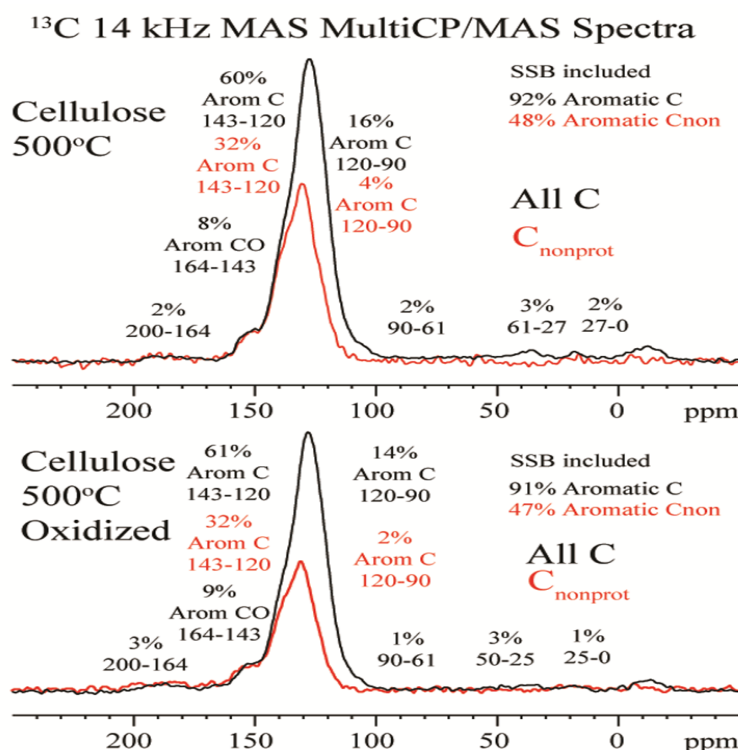


Fig. 20. ¹³C NMR analysis of oxidized and fresh biochar

Anion exchange capacity (AEC) of the biochars decreased an average of 42.3% following the 4-month oxidation treatments. However, the change in AEC varied substantially with feedstock and the highest heating temperature (HHT). The AEC of a 700°C HHT alfalfa biochar increased by 16.4% following the oxidation treatment.

Table 10. AEC (cmol kg⁻¹ biochar) values for fresh and oxidized biochars measured at pH 6 Data presented as mean (standard deviation)

Feedstock	HTT (°C)	Fresh AEC	Oxidized AEC	%Change
Alfalfa	500	3.01 (0.279)	1.52 (0.164)	-50.8
Alfalfa	700	9.64 (108)	11.2 (1.39)	+16.4
Cellulose	500	2.63 (0.211)	0.726 (0.359)	-72.4
Cellulose	700	18.1 (8.66)	10.5 (15.4)	-42.1
Corn Stover	500	3.77 (0.658)	1.72 (9.01)	-54.5
Corn Stover	700	13.8 (4.23)	6.88 (0.733)	-50.2

AEC sites on the biochar surfaces are attributed to oxygen heterocycles known as oxonium groups. Oxonium groups on exposed aromatic rings are subject to nucleophilic

attack by OH⁻ groups and should rapidly degrade in alkaline aqueous environments. That some AEC of the biochars persisted following a 4 month treatment in 1 M NaOH with periodic addition of hydrogen peroxide indicates that some AEC sites are resistant to nucleophilic attack. We hypothesize that the stable AEC sites are oxonium groups in bridging positions in the condensed aromatic matrix of the biochar.

The study demonstrates that high-AEC biochars can be produced with AEC that is resistant to nucleophilic attack. The results suggest that biorefineries could be engineered to produce high-AEC biochars for high-value industrial and environmental applications.

3. Explanation of Variance.

No variance has been experienced and accomplishments are on schedule.

4. Plans for Next Quarter.

The work documenting the stability of AEC during oxidation of biochar will be prepared as a manuscript for publication. Investigations of the impact of iron and aluminum pretreatments on AEC of biochars will be conducted. The goal of these treatments is to further increase the AEC of biochars.

5. Publications, Presentations, and Proposals Submitted.

None submitted.

OBJECTIVE 6. MARKETS AND DISTRIBUTION

The Markets and Distribution objective recognizes that a comprehensive strategy that addresses the impacts to and requirements of markets and distribution systems will be critical to the successful implementation and commercialization of a regional biofuels system derived from perennial grasses grown on land unsuitable or marginal for the production of row crops. To create this comprehensive strategy the team focuses on two unifying approaches:

- The study and evaluation of farm level adoption decisions, exploring the effectiveness of policy, market and contract mechanisms that facilitate broad scale voluntary adoption by farmers; and
- Estimate threshold returns that make feasible biomass production for biofuels.

1. Planned Activities

Our team's anticipated activities for the 3rd quarter of year 3 (Y3 Q3) were:

- **Planned Activity A.** Prepare and finalize survey results from the Adoption of Switchgrass Production Survey at the 2013 ICM Conference at ISU (Jacobs).
- **Planned Activity B** Continue to interact with industry on a BEI project to model the use of feedstocks as a fuel source for fast pyrolysis. The business model involves a distributed system of fast pyrolysis that provides as byproducts char and bio-oil. Char will be sold as a soil amendment, and bio-oil will be sold for use in furnaces for heat. The group includes soil scientists, chemical engineers and mechanical engineers (Hayes).
- **Planned Activity C.** Continue modeling and analysis efforts of the regional supply curve for grasses and stover using a real options framework (Hayes). Present one of these at conference on this subject in 2013/2014. Publish two peer-reviewed papers in this area.
- **Planned Activity D.** Continue a project to study the transportation economics of CRP when filter strips and grassy plantings are harvested for biomass.
- **Planned Activity E.** Dermot Hayes has initiated a project to study the transportation economics of CRP when the filter strips and grassy plantings are harvested for biomass.

2. Actual Accomplishments

- **Planned Activity A.** The surveys have been analyzed in a fashion similar to the last round and results were presented during a CenUSA webinar (UNL). The full report is still being prepared and will be made available to collaborators and for distribution.
- **Planned Activity B.** Ongoing.
- **Planned Activity C.** Ongoing.
- **Planned Activity D.** Ongoing.
- **Planned Activity E.** Ongoing.

3. Explanation of Variance

None. All activities are moving according to the project schedule.

4. Plans for Next Quarter

- Finalize report of the survey results.
- All other planned activities will continue.

5. Publications, Presentations, and Proposals Submitted

- Jacobs, K. *Competition for land use: Why would the rational producer grow switchgrass for biofuel?* CenUSA webinar sponsored by UNL, April 29, 2014. (See Exhibit 2 for Questionnaire)
- Kauffman, N., Dumortier, J., Hayes, D.J., Brown, R.C. & Laird, D.A. Producing energy while sequestering carbon? (2014) The relationship between biochar and agricultural productivity. *Biomass and Bioenergy* 63: 167-176.

OBJECTIVE 7. HEALTH AND SAFETY

- The production of bioenergy feedstocks will have inherent differences from current agricultural processes. These differences could increase the potential for workforce injury or death if not properly understood and if effective protective counter measures are not in place.

The Health and Safety team addresses two key elements in the biofuel feedstock supply chain:

- The risks associated with producing feedstocks; and
- The risks of air/dust exposure.

1. Task 1 – Managing Risks in Producing Feedstocks

a. Planned Activities

The three-risk assessment tools (Frequency/Severity Analysis, Deviation Analysis, and Fault Tree Analysis) evaluation will continue and the criteria rubric will be tested and reevaluated. Additional detail necessary for analysis of risk assessment in the other major headings: Maintaining (weed control), Harvest, On-site processing and storage (stacking), and Transportation will occur.

The hierarchy of various subheadings will be reexamined for additional major actions and tasks associated with the establishment of biofeedstocks.

b. Actual Accomplishments

The three risk assessment tools (Frequency/Severity Analysis, Deviation Analysis, and Fault Tree Analysis) received a preliminary evaluation and the initial draft criteria rubric was tested. Both the approach and criteria rubric need additional refinement to be successful. The standardization of this evaluation process for purpose of creating repeatable results is a primary outcome for adoption. Current results indicate the expected

outcome from this preliminary evaluation is below expectations and needs additional refinement.

Additional actions and tasks for biofeedstock production was enlarged and further refined. Actions, the lowest level where potential risks are discernible, were being connected with critical elements needed for assessing risk like useable facts about exposures, frequencies, and severities. Both the critical elements associated with actions and the actions were expanded.

The cooperative arrangement with the investigator at Penn State University yielded one paper in press for the *Journal of Agromedicine* and one submitted to the *Journal of Agricultural Safety and Health*.

c. Explanation of Variance

None to report.

d. Plans for Next Quarter

The three-risk assessment tools evaluation will continue and the criteria rubric will be tested and reevaluated. Additional detail necessary for analysis in the other major headings: Maintaining (weed control), Harvest, On-site processing and storage (stacking), and Transportation will occur.

e. Publications, Presentations, and Proposals Submitted

- Schaufler, D. H., Yoder, A. M., Murphy, D. J., Schwab, C. V. & Dehart, A. F. (2014). Safety and Health Hazards in On-Farm Biomass Production & Processing. *Journal of Agricultural Safety and Health*. (Submitted 2/2014 with Peer Review pending).
- Yoder, A. M., Schwab, C. V., Gunderson, P. & Murphy, D. J. (2014). Safety and Health in Biomass Production, Transportation and Storage. *Journal of Agromedicine*. 19:2 (In press).

2. Task 2 – Assessing Primary Dust Exposure

a. Planned Activities

Seek new approval for modifications to the human subjects study to include the transportation location and potential subjects. Purchase the air sampling equipment and begin data collection for first few sample sites during field operations seedbed preparation.

b. Actual Accomplishments

The new approval for modifications to the human subjects study to include the transportation location and potential subjects was underway, but not completed during this quarter. Additional details about the changes and sampling equipment were being completed to assist in the new approval. The potential subjects and plot locations were being finalized.

The air sampling equipment vendor has been identified and pricing has been received.

c. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Plans for Next Quarter

Receive approval for modifications to the human subjects study. Have the air sampling equipment in hand and begin data collection for first few sample sites for harvesting operations and transporting materials.

e. Publications, Presentations, and Proposals Submitted

No publication, presentations or proposal submitted from this task.

OUTREACH AND EXTENSION

OBJECTIVE 8. EDUCATION

The Education Objective seeks to meet the future workforce demands of the emerging Bioeconomy through two distinct subtasks, as follow:

- To develop a shared bioenergy curriculum core for the Central Region.
- To provide interdisciplinary training and engagement opportunities for undergraduate and graduate students

Subtask 1 is **curriculum development**. Subtask 2A is **training undergraduates** via an 8-week summer internship program modeled on the highly successful NSF REU (research experience for undergraduates) program. Subtask 2B is **training graduate students** via a 2-week summer intensive program modeled on a highly successful industry sponsored intensive program in biorenewables the team led in 2009. Subtask 2C is **training graduate students via a monthly research webinar**. The next portion of this report is broken into subtasks.

Subtask 1: Curriculum Development

1. Planned Activities

- **Module 5. Integrating Bioenergy Production into Current Systems**

Complete all revisions and make module publicly available.

- **Module 6. Balancing Energy Demand with Food, Feed and Fiber Needs**

Complete internal review and begin making revisions, if needed.

- **Module 7. Developing a New Supply Chain for Biofuels: Contracting for Dedicated Energy Crops**

Complete all revisions and make module publicly available.

- **Module 8. Biofuels Policy: How Does Policy Affect the Market for Biofuels?**

Complete preliminary internal review, make necessary revisions and submit for internal project review.

- **Module 9. Enterprise budget**

Complete preliminary draft of module content and begin module development activities with Amy Kohmetscher.

- **Module 10. Genetics and Breeding of Perennial Grasses for Biofuel Production**

Complete internal review and make revisions as needed.

- **Module 11 Introduction to Biofuel: Perennial Grasses as a Feedstock**

Complete module development activities and submit for internal review.

- **Module 12. Perennial Grass Seed: Protection, Certification and Production**

Complete module development activities and submit for internal review.

- **Evaluation tasks**

Complete analysis of existing data sets.

2. Actual Accomplishments

- **Module 5. Integrating Bioenergy Production into Current Systems.**

Additional revisions were made.

- **Module 6. Balancing Energy Demand with Food, Feed and Fiber Needs**

Completed internal review.

- **Module 7. Developing a New Supply Chain for Biofuels: Contracting for Dedicated Energy Crops**

Additional revisions were made.

- **Module 8. Biofuels Policy: How Does Policy Affect the Market for Biofuels?**

Internally review partially completed.

- **Module 9. Enterprise Budget**

No work was completed on this module this quarter.

- **Module 10. Genetics and Breeding of Perennial Grasses for Biofuel Production**

Internal review completed.

- **Module 11. Introduction to Biofuel: Perennial Grasses as a Feedstock**

Complete module development activities and submit for internal review

- **Module 12. Perennial Grass Seed: Protection, Certification and Production** (authors Na and Guretzky)

Complete module development activities and submit for internal review.

- **Evaluation tasks**

Complete analysis of existing data sets.

3. Explanation of Variance

No work was completed on Module 9 this quarter. A content developer new to the project has been identified for this module, but they did not begin revising the existing content. It is anticipated that they will complete the revision to the content by the end of Q12.

4. Plans for Next Quarter

- **Module 5. Integrating Bioenergy Production into Current Systems**

Complete revisions.

- **Module 6. Balancing Energy Demand with Food, Feed and Fiber Needs**

Complete revisions.

- **Module 7. Developing a New Supply Chain for Biofuels: Contracting for Dedicated Energy Crops**

Complete revisions.

- **Module 8. Biofuels Policy: How Does Policy Affect the Market for Biofuels?**

Complete internal review and begin making revisions

- **Module 9. Enterprise Budget**

Complete draft of module content

- **Module 10. Genetics and Breeding of Perennial Grasses for Biofuel Production**

Complete revisions.

- **Module 11. Introduction to Biofuel: Perennial Grasses as a Feedstock**

Complete internal review and begin making revisions, if needed.

- **Module 12. Perennial Grass Seed: Protection, Certification and Production**

Complete internal review and begin making revisions, if needed.

5. Evaluation Tasks

- Complete analysis of new evaluation data sets
- Develop outline of journal article summarizing evaluation data sets

6. Publications, Presentations, and Proposals Submitted

None to report this period.

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Table 11. Status of Education Modules

Module	Subject	Design & Development Status	Review Status	Revision Status	Publishing Status
1	Perennial Grass Physiology, Growth and Development	Complete	Complete	Complete	Published in PSSEL ¹ ; Partially published in NSE ²
2	Perennial Grass Establishment and Management	Complete	Complete	Complete	Published in PSSEL; Partially published in NSE
3	Harvesting Perennial Grasses for Bioenergy	3 Lessons complete; Additional lessons under development	Complete	Complete	Published in PSSEL in preparation for NSE submittal
4	Transportation and Storage of Perennial Grasses Feedstocks for Bioenergy	Under development			
5	Integrating Bioenergy Production into Current Systems	Complete	Completed	In progress	
6	Balancing Energy Demand with Food, Feed and Fiber Needs	Complete	Complete	Complete	
7	Developing a New Supply Chain for Biofuels: Contracting for Dedicated Bioenergy Crops	Complete	Complete	In progress	
8	Biofuels Policy: How Does Policy Affect the Market for Biofuels?	Draft complete; In process of conversion to on-line format			
9	Enterprise Budgeting for Producing Bioenergy Feedstocks	Rough draft complete; additional revision being made			
10	Genetics and Breeding of Perennial Grasses for Biofuel Production	Complete	In progress		
11	Introduction to Biofuel: Perennial Grasses as a	Complete	In progress		

Feedstock			
12	Perennial Grass Seed: Protection, Certification and Production	Complete	In progress
13	Preprocessing Herbaceous Feedstocks for Bioenergy	Under development	
14	Biochemical Conversion of Bioenergy Feedstocks	Under development	
15	Thermochemical Conversion of Bioenergy Feedstocks	Under development	

¹Plant & Soil Sciences E-Library administered by the University of Nebraska-Lincoln

²Natural Sciences Education (Peer-viewed journal)

Subtask 2A: Training Undergraduates via Internship Program

1. Planned Activities

- Continue to promote the undergraduate internship program and encourage application submissions through the March 9, 2014 application deadline.
- Centrally vet and rank applications based on the letters of interest, academic achievement, previous research experience, and letters of recommendation.
- Pool of likely candidates will be given to faculty hosts for review during the week of March 17, 2014 with selections and rankings of students requested from faculty by March 24.
- Highly ranked students, as indicated by faculty hosts, will be phone interviewed the weeks of March 24 and March 31, 2014.
- First offers to students beginning March 31, 2014 second offers to students beginning April 7 with cohort (14 students) finalized on April 15.
- Arrange travel for accepted students.
- Secure housing for students who will be placed with faculty mentors at partner institutions.

2. Actual Accomplishments

- Robust promotion of the program yielded a pool of 76 highly qualified applications on the March 9, 2014 deadline.

- Central vetting and ranking of the applications completed on March 14, 2014.
- Pool of likely candidates packaged and given to faculty hosts for review on March 17, 2014 selection decisions provided back on or before March 24.
- 22 student phone interviews with Raj Raman took place the weeks of May 24, March 31, and April 7, 2014.
- First offers extended the week of March 31, 2014 second offers extended the week of April 7, cohort of 16 students finalized on April 21.
- The 2014 CenUSA Bioenergy Internship cohort consists of 16 students – Iowa State University placements (5 male, 3 female), University of Nebraska-Lincoln placements (2 male, 2 female), Purdue University placements (2 male), University of Minnesota placement (1 female), ADM industry placement (1 female).
- All non-selected candidates notified on April 25, 2014 as was publicized on the website.

3. Explanation of Variance

For the first time in the three-year history of the CenUSA Bioenergy Undergraduate Internship Program, we have placed a student in an industry-based setting at ADM in Decatur, Illinois. This student, a female undergraduate majoring in Biosystems Engineering from the University of Florida, will be mentored by Tom Binder and members of his team.

With the late addition of one research project added to our list of internship placement opportunities, we needed some additional time to promote this new opportunity. Therefore our cohort was finalized on April 21, 2014 rather than the originally projected date of April 15.

4. Plans for Next Quarter

- Finalize all logistics; student travel, lodging at Iowa State University and all four partner institutions (University of Minnesota, University of Nebraska – Lincoln, Purdue University, and ADM), and administration of stipends.
- Provide mentor training using a 15-minute video (created by Raj Raman). Will share link with the internship mentors (faculty/grad student/post doc) in mid-May, followed by a combined face-to-face (for ISU-based mentors) and virtual (via WebEx for partners) meeting to clarify any questions and concerns.
- Launch the program on May 28, 2014 with the arrival of the students. Run the orientation at Iowa State from May 29 – June 1, send students to appropriate lab placements for start date on June 2, schedule weekly meetings (June 5 – July 24) with student interns to

discuss progress, face-to-face for ISU students and virtual (via WebEx) for partner-placement students.

5. Publications, Presentations, and Proposals Submitted

None to report in this period.

Subtask 2B – Training Graduate Students via Intensive Program

1. Planned Activities

None. This is a PY4 activity, and forward planning will begin in summer 2014.

2. Actual Accomplishments

N/A

3. Explanation of Variance

N/A

4. Plans for Next Quarter

N/A

5. Publications, Presentations, and Proposals Submitted

N/A

Subtask 2C –Subtask 2C – Training Graduate Students via Monthly Research Webinar

1. Planned Activities

Organize and deliver research webinars

- February 28, 2014 – Objective 6: Markets and Distribution
- March 29, 2014 – Objective 7: Health and Safety

2. Actual Accomplishments

Held Objective 6: Markets and Distribution research webinar on February 28, 2014, *Competition for Land Use: Why would the rational producer grow switchgrass for biofuel?* (Keri Jacobson).

3. Explanation of Variance

None.

4. Plans for Next Quarter

Considering the heavy load we have with educational programming (16 undergraduate research interns) from May 28 – August 2, 2014, we are holding off on any CenUSA research seminars until the co-project directors meeting scheduled on August 30, 2014.

Since we have completed seminars on Objectives 1-6, we will pick up in August with Objective 7.

5. Publications, Presentations, and Proposals Submitted

None to report.

OBJECTIVE 9. EXTENSION AND OUTREACH

The Outreach and Extension Objective serves as CenUSA's link to the larger community of agricultural and horticultural producers and the public-at-large. The team delivers science-based knowledge and informal education programs linked to CenUSA Objectives 1-7.

The following teams conduct the Outreach and Extension Objective's work:

■ Extension Staff Training/eXtension Team

This team concentrates on creating and delivering professional development activities for Extension educators and agricultural and horticultural industry leaders, with special emphasis on materials development (videos, publications, web posts, etc.).

■ Producer Research Plots/Perennial Grass Team

This team covers the areas of:

- ✓ Production, harvest, storage, transportation;
- ✓ Social and community impacts;
- ✓ Producer and general public awareness of perennial crops and Biochar agriculture;
- ✓ Certified Crop Advisor training.

■ Economics and Decision Tools Team

The Economics and Decision Tools Team focuses on the development of crop enterprise decision support tools to analyze the economic possibilities associated with converting acreage from existing conventional crops to energy biomass feedstock crops.

- **Health and Safety Team**

This team integrates its work with the Producer Research Plots/Perennial Grass and the Public Awareness/Horticulture/eXtension 4-H and Youth teams (See Objective 7. Health and Safety).

- **Public Awareness/Horticulture/eXtension/4-H and Youth Team**

This team focuses on two separate areas:

- **Youth Development.** The emphasis is on developing a series of experiential programs for youth that introduce the topics of biofuels production, carbon and nutrient cycling, and biochar as a soil amendment.
- **Broader Public Education/Master Gardener.** These programs acquaint the non-farm community with biofuels and biochar through a series of outreach activities using the Master Gardener volunteer model as the means of introducing the topics to the public.

- **Evaluation/Administration Team**

This team coordinates CenUSA's extensive extension and outreach activities. The team is also charged with developing evaluation mechanisms for assessing learning and behavior change resulting from extension and outreach activities, compiling evaluation results and preparing reports, and coordination of team meetings.

1. Extension Staff Training/eXtension Team

a. Planned Activities

- ✓ We finished entomology video and the plant pathology video.
- ✓ We hosted two webinars related to economics topics.
- ✓ We finished the paper *Reducing Hypoxia in the Gulf: An Alternative Approach*.
- ✓ We prepared the fact sheet *Commercialization Opportunities of Biochar*.
- ✓ We continued to assist with the planning of the *National Extension, Energy and Environment Conference*, which will be held at Iowa State University September 23-25, 2014.
- ✓ We prepared the February e-newsletter BLADES, and started production of the April e-newsletter and continued the expansion of CenUSA's social media channels.

- ✓ We developed eXtension BIO pages for CenUSA collaborators. These pages will rotate with others' bios on the <http://www.extension.org/>, and the eXtension Farm Energy Home Page: http://www.extension.org/ag_energy.
- ✓ We developed publications(s) on:
 - *Economics of Switchgrass*, authored by CenUSA collaborator Richard Perrin (University of Nebraska-Lincoln), and
 - Biochar research.
- ✓ We published *Storage of two Perennial Grasses as Biomass Feedstocks* by CenUSA CoPd Kevin Shinnars (University of Wisconsin, Madison).
- ✓ We continued maintaining the eXtension index: *Resources from CenUSA – Sustainable Production and Distribution of Bioenergy for the Central USA*, to include All CenUSA resources.
- ✓ We facilitated monthly Bioenergy CAPS extension calls, and represented CenUSA at these teleconferences.
- ✓ We used eXtension Farm Energy social media sites to broadcast information from CenUSA

b. Actual Accomplishments

- ✓ We reached 3629 persons this quarter with our project videos and webinars (Vimeo – 109, YouTube = 865, Facebook = 597). 2903 of the contacts were men; 726 of the contacts were women.
- ✓ The entomology video was finished and posted to our Vimeo and YouTube channels.
- ✓ We completed a first cut of the plant pathology video, and we are working with the content expert and video editor to fill in the identified gaps.
- ✓ We produced two webinars:
 - *Switchgrass Economics in the North Central Region of the USA*. CenUSA collaborator Richard Perrin hosted the webinar, which was broadcast February 19, 2014.
 - *Competition for Land Use: Why would the rational producer grow switchgrass for biofuel?* CenUSA CoPd Keri Jacobs hosted this webinar on April 29, 2014.

- ✓ We maintained the *eXtension Index: Resources from CenUSA - Sustainable Production and Distribution of Bioenergy for the Central USA* (<http://www.extension.org/pages/68136>).
- ✓ We developed an *Ask an Expert* system to answer public's questions on the CenUSA website <https://ask.extension.org/groups/1848/ask>.
- ✓ We developed a format for eXtension Bio pages for CenUSA collaborators. These pages will rotate with others' bios on the <http://www.extension.org/>, and the eXt Farm Energy Home Page (http://www.extension.org/ag_energy).
- ✓ Videos and webinars currently in development include:
 - *Economics of Switchgrass*, authored by CenUSA collaborator Richard Perrin and eXtension specialist Susan Harlow.
 - *Storage of Biomass*, authored by CenUSA CoPd Kevin Shinnars.
 - *Biochar Science Review*.
- ✓ We facilitated Bioenergy CAPs extension calls, and represented CenUSA at these meetings.
 - *Bioenergy CAP Commercialization* - March 18, 2014
- ✓ We posted CenUSA events on eXtension Farm Energy Facebook and Twitter and eXtension Learn Sites.
- ✓ Google Analytics provided these viewing statistics on CenUSA articles/fact sheets on the eXtension Farm Energy Site (Feb. 1 –April 30, 2014):
 - We recorded 1,183 pageviews representing 640 users⁵ 74% of these were new sessions; there was an average of 1.6 pages/ visit.² The bounce rate is 82% and average time on page is 3:36 minutes. Compared to last quarter, usage is steadily increasing – page views are up by 32% and users are up 15%.
 - Traffic sources are: 1) search engines (64%); 2) direct traffic (23%); and 3) referring sites (13%). There was a slight increase in direct and referring sites, which indicates that our communication and marketing efforts are effective.

² Pageviews are the total number of pages that visitors looked at during their time on the site.

- The top 10 states accessing CenUSA articles were Pennsylvania, Wisconsin, Michigan, Iowa, Minnesota, Illinois, Nebraska, New York, Texas, and California; with use from throughout the US and world.
- ✓ **Continuing Impact of the CenUSA Vimeo Channel.** During this quarter, the 30 CenUSA videos archived on Vimeo have had 248 plays.³ The 30 videos also had 2,138 loads; 1,685 of those loads came from CenUSA videos embedded on non-CenUSA web sites or pages.⁴ The embedded videos were played 66 times. CenUSA videos were downloaded 15 times.⁵
- ✓ **Continuing Impact of the CenUSA YouTube Channel.** CenUSA videos are also posted on YouTube. CenUSA YouTube videos were viewed 895 times between February 1, 2014 and April 30, 2014. 576 views were from the United States. Demographic analytics indicate an overall 73% male/27% female audience to date. Within the US, YouTube is also able to collect age range information. The reported ages of the CenUSA YouTube US are: 25-34 years (3%), 35-44 years (10%), 45-54 (27%), 55-64 (57%), and 65+ years (2%). The remaining 319 views did not have demographic associated with them.
 - YouTube also provides data related to how users view videos. 93% of the videos were viewed on their associated YouTube watch page (each video has a unique “watch page”), while 5.4% of videos were viewed from embedded copies on another site. Users found CenUSA videos through various avenues, which are referred to as “traffic sources.” Our top 4 traffic sources are: YouTube search, direct links, YouTube suggestions, and referrals from other web sites. 38% of our views came from users searching directly in YouTube. Views from mobile apps or from direct traffic (links in an e-mail or copying/pasting the direct URL) account for 20% of video views. The YouTube suggestion feature accounted for 17% of our views. Finally, referrals from outside YouTube (Google search or access through external web sites) account for 12% of video views.
- ✓ **CenUSA Web Site, Facebook, Twitter.** The goal of the communications team is to expand outreach using social media and other communications outlets.
 - The CenUSA web site had 1,257 visitors this quarter. These visitors logged a total of 7,271 pageviews during 2,142 sessions. A session qualifies as the entire time a

³ “Plays” are defined as users who viewed the video on the CenUSA Vimeo site, or on a web site that embedded a CenUSA video.

⁴ When a video is “loaded”, people see the video, but they do not click “play”.

⁵ A “download” means the video was saved to a hard drive (generally, viewers will use the download feature because they have limited Internet connectivity, which does not allow for live streaming of a video. Once the video is downloaded, it is available on to watch at the user's convenience.

user is actively engaging with the site. If activity ceases for an extended period of time, and the user returns, a new session is started.

- Twitter traffic consists of followers who subscribe to the CenUSA Twitter account (@CenUSABioenergy) and “follow” our tweets (announcements). Followers can “favorite” a tweet, or retweet it to share with their own followers. They can also “mention” CenUSA by tagging CenUSA’s Twitter account in their own tweets. During this quarter CenUSA tweets were retweeted a total of 86 times. Followers tagged CenUSA tweets as a favorite 33 times, and mentioned us 113 times. CenUSA also has 278 followers currently, up from 244 last quarter.
- By the end of April, CenUSA’s Facebook page had 142 likes, up from 93 the previous quarter. After current posts were made this quarter, our total reach included 583 individuals, with a single post reaching 699 individuals on April 22n, 2014. Our highest engagement this quarter resulted in 106 engagements in a single day after posting a video, photos, and a bioenergy quiz. The quiz received the most interactions, reaching 699 individuals, and initiating 29 engagements with Facebook users.
- ✓ **BLADES Newsletter.** The BLADES newsletter is the newest addition to our online outreach efforts. We created a CenUSA Communications Team in January 2014, and the team has released two newsletters this quarter, one in February and one in April. BLADES features stories related to CenUSA research activities, and other happenings in the world of perennial grass energy, including the industry sector. In February 2014, BLADES was sent to 474 individuals, only 3 of whom opted out from receiving the newsletter. Of the 474 individuals who received the newsletter, 182 (39.8%) of recipients opened the newsletter, and 42 (23.1%) clicked on a story. In April, an additional 38 people subscribed to BLADES, growing our list of recipients to 509. Of the 509 April BLADES, only 3 opted out of the e-mail list. In April, 183 (37.3%) individuals opened BLADES and 62 (33.9%) clicked on a story. Our numbers of opened newsletters and stories clicked are higher than the newsletter “industry” average for the education sector.

c. Explanation of Variance

Additional contracts added by our video expert have delayed the plant pathology related video. For the publication *Storage of Two Perennial Grasses as Biomass Feedstocks*, we are waiting for second review to be completed. Review for the Hypoxia article is taking longer than expected; the article it is still with the final reviewer.

d. Plans for Next Quarter.

- ✓ Host webinar May 23rd featuring work done by Dr. Susan Rupp with Dr. Rob Mitchell and Dr. Ken Vogel in relation to perennial grass production practices for bioenergy and wildlife habitat.
- ✓ Finish the plant pathology video featuring Dr. Gary Yuen.
- ✓ Gather footage for biochar videos at the annual meeting in Minnesota.
- ✓ Make the CenUSA Bioenergy open online, non-credit course available to the public.
- ✓ Develop eXtension Bio pages for CenUSA collaborators. These pages will rotate with others' bios on the eXtension Farm Energy Home Page.
- ✓ Publish fact sheets and research summaries:
 - *Economics of Switchgrass*, Perrin
 - *Biochar Science Review*, Laird
 - *Storage of Two Perennial Grasses as Biomass Feedstocks*, Shinnars
 - *Management Practices Impact Greenhouse Gas Emissions in the Harvest of Corn Stover for Biofuels*, Jin
 - *Switchgrass Nutrients* – Mitchell, Sawyer, Rosen
- ✓ Begin developing publications (tentative topics & authors)
 - *Land Competition*, Keri Jacobs
 - *Pyrolysis*, Keri Boutang
- ✓ Continue maintenance of index: Resources from CenUSA - Sustainable Production and Distribution of Bioenergy for the Central USA to include ALL CenUSA resources.
- ✓ Facilitate monthly Bioenergy CAPs extension calls, and represent CenUSA.
- ✓ Use eXtension Farm Energy Social Media sites to broadcast information from CenUSA.
- ✓ Publish BLADES Newsletter in June. Send newsletter to e-mail list in Constant Contact (currently 509 recipients)

e. Publications, Presentations, Proposals Submitted

None submitted this quarter

Producer Research Plots/Perennial Grass Team

a. Planned Activities

✓ Indiana

Host a CenUSA session for Indiana Small Farms Conference.

✓ Iowa.

- Hold a teleconference with other states to discuss plans for our 2014 demonstration plots.
- Burn off the Winborn plots.
- Apply N rate treatments to the demonstration plots.

✓ Minnesota

- Burn the Elko plots after snow melt.

✓ Nebraska.

- Initiate land payments to cooperating landowners
- Purchase a mower to cut alleys in plots.
- Participate in the CenUSA multi-state conference call to discuss research/demonstration plot activities for the coming months.
- Purchase a small Gandy fertilizer spreader.
- Burn the first year biomass off the CenUSA plot located near Milford Nebraska.
- Develop an agenda and secured speakers for field days at each site in August 2014.

b. Actual Accomplishments

✓ Indiana

Host a CenUSA session for Indiana Small Farms Conference.

✓ Iowa

- We held a teleconference with other states to discuss plans for our 2014 demonstration plots.
- We burned off the Winborn plots (April 26, 2014).

✓ **Minnesota**

None

✓ **Nebraska**

- We initiated land payments to cooperating landowners.
- We purchased a mower to cut alleys in plots.
- We participated in the CenUSA multi-state conference call to discuss research/demonstration plot activities for the coming months.
- We purchased a small Gandy fertilizer spreader.
- We developed an agenda and secured speakers for field days at each site in August 2014.

c. Explanation of Variance

✓ **Indiana**

Host a CenUSA session for Indiana Small Farms Conference.

✓ **Iowa**

- Weather has delayed application of N treatments.
- Burning on the Winborn plots was done to improve weed control and remove biomass from the past year.

✓ **Minnesota**

The Elko plots burn has been delayed due to excessive rain and/or excessive wind.

✓ **Nebraska**

Excessive wind and dry conditions did not allow for burning of biomass from CenUSA plots.

d. Plans for Next Quarter

- ✓ Indiana
 - We will participate in the *Heating the Midwest* conference, Green Bay, Wisconsin.
- ✓ Iowa
 - Apply N rate treatments to the demonstration plots.
 - Evaluate grass stands.
- ✓ Minnesota
 - Burn of the Elko plots.
 - Apply N fertilizer in late May 2014.
 - We may need to do a small amount of overseeding in some bare spots lost to erosion during last year's heavy rains at the Lamberton plots.
 - As necessary, we will treat weeds in grass plots using 2,4-D.
 - VOM observations will begin in July.
 - Participate in the *Organic Crops Field Day* on July 16, 2014.
 - Participate in the *University on the Prairie*, a three-day educational event for high school students.
- ✓ Nebraska

We will:

 - Apply agronomic treatments to both CenUSA biomass research/demonstration sites.
 - Secure vendors for August field days.
 - Work on the development and implementation of a marketing plan for the field days.
 - Develop storyboards for the Field Days.
 - Develop participant evaluation instrument.
 - Continue to collect biomass samples from the field plots.

e. Publications, Presentations, Proposals Submitted

None.

2. Economics and Decision Tools**a. Planned Activities**

- Provide seminar in southeast Iowa about perennial grasses for bioenergy.
- Host webinar on costs of producing switchgrass.
- Start work on a watershed surface water phosphorus reduction planning tool spreadsheet like the nitrogen spreadsheet.
- Continue work on perennial crop enterprise budget calculator/decision tool.
- Publish article in the *Journal of Soil and Water Conservation* on the nitrogen tool.

b. Actual Accomplishments

- We hosted a seminar in southeast Iowa about perennial grasses for bioenergy. 155 people attended, 115 male and 43 female.
- We prepared and hosted a webinar on production economics for switchgrass.
- We began work on the phosphorus tool.
- We published in the *Journal of Soil and Water Conservation* on the nitrogen tool. A second article was submitted to the *Agronomy Journal* and is under review.
- We prepared a draft framework for the perennial crop enterprise budget calculator/decision tool. CenUSA Objective 2 collaborator Emily Heaton reviewed the draft; it is currently being updated based on Emily's comments.

c. Explanation of Variance

None

d. Plans for Next Quarter

- Spring field days will be held at the ISU Southeast Research Farm in Crawfordsville, Iowa where a switchgrass plot has been established. Demonstrations of the plot, as well as the economics of establishing switchgrass will be discussed.
- Complete an article and prepare an extension presentation on switchgrass economics.

- Continue work on the phosphorus tool and the budget website.
- Take the framework from the draft budget and apply it for (at least) a couple varieties of grasses. Obtain reviews from CenUSA researchers (Mitchell and Perrin) to fully align the budget estimates with CenUSA research results.

e. Publications, Presentations, Proposals Submitted

None.

3. Health and Safety

See Health and Safety Objective report, above.

4. Public Awareness/Horticulture/eXtension/4-H and Youth Team

a. Youth Development

✓ **Planned Activities**

○ **Indiana**

- Pilot test grade school curriculum (grades 3-5).
- Draft text for exhibit for Trafalgar (state FFA center).
- Prepare and plan for summer science workshops.
- Plan and schedule summer activities at Trafalgar.

○ **Iowa**

- Host training session for adult leaders to share Biorenewables “C6” Youth STEM education materials.
- Recruit summer interns to develop C6 i-Pad App, i-Book, and classroom and informal education teaching guides for C6.
- Schedule and host meetings for CenUSA C6 interns with experts from Agronomy, Engineering, Sociology and Economics.
- Plan educational programs for CenUSA Bioenergy summer camp outreach programs to be held in Waterloo, Iowa in cooperation with Waterloo school district and Black Hawk County School district; the Iowa 4-H Youth Conference; and the Iowa 4-H STEM Camp.

✓ **Actual Accomplishments**

○ **Indiana**

- Pilot testing is in progress, and will continue through May at Indiana elementary school. Program includes raised bed gardens with biochar.
- Text for display is complete; review and editing is in progress.
- Hosted visits to Purdue campus by elementary students. Students participated in presentations, viewed display, and hands-on activities.
- Planning is underway for summer science workshops.
- Held planning meetings for Trafalgar program.
- Held CenUSA Purdue Extension budget meetings.

○ **Iowa**

- Hosted training session for adult leaders to share Biorenewables “C6” Youth STEM education materials (8 adult white females attended)
- We recruited summer interns to develop C6 i-Pad App, i-Book, and classroom and informal education teaching guides for C6.
- We scheduled and hosted three meetings for CenUSA C6 interns with experts from Agronomy, Engineering, Sociology and Economics.
- We planned educational programs for CenUSA Bioenergy summer camp outreach programs to be held in Waterloo, Iowa in cooperation with Waterloo school district and Black Hawk County School district; the Iowa 4-H Youth Conference; and the Iowa 4-H STEM Camp.

✓ **Explanation of Variance**

None

✓ **Plans for Next Quarter**

○ **Indiana**

- Execute science workshops.
- Execute Trafalgar activities.

- Continue pilot test of elementary curriculum.
- Finalize and install display at Trafalgar.
- Continue development and editing of online modules.
- **Iowa**
 - Mentor the CenUSA interns who will be working on the i-Pad App, i-Book, and teaching guidelines, preparation of plans to host sessions to pilot the materials at summer camps.
 - Schedule and facilitate additional meetings with technical experts as appropriate.
- ✓ **Publications, Presentations, Proposals Submitted**
 - **Indiana**
 - Submitted two abstracts to Extension Energy and Environment (E3) conference call.
 - **Iowa**
 - Submitted six abstracts to Extension Energy and Environment (E3) conference call.

5. Broader Public Education/Master Gardener Program

a. Planned Activities

- **Iowa**
 - Telephone conference with Minnesota group.
 - Order test plot seeds and plants.
 - Presentation on biochar utilization as soil amendment for State Women's Club Convention held in Fort Dodge, Iowa on April 25, 2014.
- **Minnesota**
 - Give presentation to Hennepin county Extension Master Gardeners to include the CenUSA overview, the product biochar and information regarding the demonstration gardens in Minnesota; recruit EMG volunteers for demonstration

gardens via avenues that reach all Twin Cities Metro Extension Master Gardener groups.

- Contract with grower to start demonstration garden seeds.
- Update applications, position descriptions and procedures for volunteers.
- Update garden design.
- Schedule demonstration garden leader team meeting in March.
- Develop a display for *Anoka County Extension Master Gardeners Home Landscaping and Garden Fair* event on April 12, 2014. Prepare a presentation (one of the concurrent sessions) for the event about CenUSA biochar project.
- Get results from Kurt Spokas (USDA-ARS biochar expert) regarding tissue tests made on select 2013 garden plants to determine effects from biochar.
- Determine new site for CenUSA Master Garden demonstration garden at Fond du Lac Tribal Community Center. We need to move from the original site due to logistical issues. Order biochar from Royal Oak for new site.

b. Actual Accomplishments

- **Iowa**

- Participated in telephone conference with the Minnesota group.
- Ordered test plot seeds and plants.
- Delivered presentation on biochar utilization as a soil amendment for State Women's Club Convention. 65 white women participated.

- **Minnesota**

- Lynne Hagen presented an overview of the CenUSA project, including a discussion about Biochar, and the Biochar Research Gardens, to an audience of 180 Extension Master Gardeners from Hennepin County in February 2014 for the purpose of recruiting volunteers. Sixteen people requested additional information about biochar and four volunteered to be added to the team in 2014.
- Seeds were ordered for the biochar gardens and arrangements were made with a local grower to start some of the plants for the four gardens in Minnesota

- Volunteer applications, position descriptions and procedures for volunteers have been updated.
- The garden design will be similar to prior years; an adjustment will be made to accommodate the need for rotation on solanaceae crops.
- A biochar garden team leader meeting was held on April 1, 2014. A discussion took place on successes from the prior years and improvements to be made in 2014.
- Lynne Hagen and the two co-leaders on the biochar garden project in Andover (Dave Knapp and Jeff Stahmann) co-presented an overview of the biochar project during one of the concurrent sessions for the Extension Master Gardener Program's Home Landscaping and Garden Fair event in Anaoka County on April 12, 2014. Fifteen people attended the presentation. Ten of the 15 people completed an evaluation after the presentation. An additional non-staffed biochar exhibit was on display for this event where there were approximately 200 people in attendance.

c. Explanation of Variance

- **Iowa**

None

- **Minnesota**

Kurt Spokas did not have the tissue test results available at the time of this report.

d. Plans for Next Quarter

- **Iowa**

- Hold a meeting to plan "planting parties" for Master Gardeners at each test plot site.
- Develop reporting tools to teach proper data collection and reporting.

- **Minnesota**

- Finalize garden rotation design.
- Install interpretative signage and plant labels.
- Coordinate individual crop teams for each site.

- Procure biochar for the relocation of the Cloquet site.
- Plant four gardens and schedule maintenance at each one.
- Collect data on plants at designated times.

e. Publications, Presentations, Proposals Submitted

- **Minnesota**

- 2014 data collection instructions.
- Plant data worksheets.
- Agenda from team leader meeting.
- Evaluation of biochar presentation.

6. Evaluation and Administration

a. Planned Activities

- Develop generic field day survey.
- Complete survey analysis and summaries of outreach activities and events.
- Continue working with the C6 game team to develop educational materials targeting K12 youth.
- Plan and host a meeting with Vermeer Company leaders to develop the plans and budget for the new Vermeer perennial grass demonstration plots at their Global Headquarters in Pella, Iowa.
- Continue planning for the National Extension Energy and Environment Conference to be held September 23-25, 2014.
- Develop a plan for beef feedlot demonstration project with CenUSA switchgrass feedstocks (recruit beef feedlot Extension specialists, feedlot, etc.) for the demonstration, secure feedstuffs for the trial.
- Develop job descriptions for three CenUSA Extension interns for summer 2014; recruit applicants, etc.
- Meet with each of the CenUSA Extension teams to facilitate planning and coordination between teams.

- Provide input for CenUSA communications leader and interns.
- Prepare reports.

b. Actual Accomplishments

- Developed generic field day survey.
- Completed survey analysis and summaries of outreach activities and events.
- Continued working with the C6 game team to develop educational materials targeting K12 youth.
- Planned and hosted introductory planning meeting with equipment manufacturer Vermeer to develop strategy for perennial grass demonstration plots for outreach to industry leaders interested in bioenergy crops.
- Wrote four summary reports.
 - *Using Biochar in Gardens – 2013 Minnesota State Fair, Survey Results*. (See Exhibit 3)
 - *Integrated Agricultural Landscapes for Profit & Risk Management, Survey Results* (See Exhibit 4)
 - *CenUSA October 2013 Bioenergy Field Day Evaluation Results* (See Exhibit 5)
 - *Establishing and Managing Perennial Grasses for Bioenergy, Survey Results* (See Exhibit 6).
- Continued planning for the Extension Energy and Environment (E3) conference, see: <http://www.2014e3.org/>.
 - Developed and released “*Call for Innovations.*”
 - Recruited Extension staff to submit abstracts.
 - Worked with conference planning committee to develop conference agenda (<http://www.2014e3.org/agenda/>).
- Managed conference planning committee to review and select presenters from the abstracts that were received (see attached list of selections) (See Exhibit 6).
 - Recruited plenary speakers.

- Recruited people to provide tours for the conference.
- Planned logistics (meeting rooms, tours, etc.), see: <http://www.2014e3.org/tours/>
- Developed outreach banner for outcome/impact display for CenUSA annual meeting
- Worked with CenUSA Extension Producer Education team to produce a literature review in preparation for developing 1) a “science review” publication that summarizes the current state of biochar research, and 2) an article targeting public audiences that describes the status of the current biochar economy (where it is being used now) and what the emerging markets look like.
- Developed the plan for beef feedlot demonstration project with CenUSA switchgrass feedstocks (recruit beef feedlot Extension specialists, feedlot, etc.) for the demonstration, secure feedstuffs for the trial.
- Developed job descriptions for three CenUSA Extension interns for summer 2014; recruit applicants, etc.
- Met with each of the CenUSA Extension teams to facilitate planning and coordination between Objectives.
- Provided input for CenUSA communications leader and interns.
- Prepared reports.

c. Explanation of Variance

None

d. Plans for Next Quarter

- Continue administrative and evaluation activities as described above
- Participate in 2014 CenUSA Annual Meeting
- Mentor CenUSA summer interns
- **Publications, Presentations, Proposals Submitted**

None this quarter.

CenUSA Press List (April 30, 2014)

University Contacts

ISU: Bioeconomy Institute	Bob Mills
ISU: CALS Communications Service	Brian Meyer
ISU: University Relations	Fred Love
Minnesota: CFANS	Becky Beyers
Minnesota: Institute on the Environment	Todd Reubold
Purdue: Ag Communication Service	Keith Robinson
Purdue: Ag Communication Service	Beth Forbes
UNL: University Communications	Steve Smith
Vermont: University Communications	Josh Brown
Wisconsin: CALS	Bob Mitchell

Press

AgProfessional	Rich Keller
AgriNews	James Henry
AgriView	Jane Fyksen
Ames Tribune	Michael Crumb
Biomass Magazine	Erin Voegelé
Delta Farm Press	Forrest Laws
Des Moines Register	Donnelle Eller
Environment & Energy Publishing	Amanda Peterka
Environmental Leader	Jessica Lyons Hardcastle
Farm Journal	Charlene Finck
Farm News	Larry Kershner
Farm Progress Publications	Willy Vogt
Farm Show Magazine	Mark Newhall
Feedstuffs	Kristen Bakker
Hay & Forage Grower	Fae Holin
Iowa Farmer Today	Tim Hoskins
Iowa State Daily (Student Paper)	Caitlin Deaver
Journal Star- Lincoln, Neb.	Dave Bundy
Midwest Energy News	Dan Haugen
Milwaukee Journal Sentinel	Rick Barrett
Minneapolis Star Tribune	David Shaffer
Minnesota Farm Guide	Mark Conlon
Minnesota Daily (Student Paper)	Emma Nelson

Momentum
Progressive Farmer
Renewable Energy Focus
Successful Farming
The Badger Herald (Student Paper)
The Country Today
The Farmer
The Progressive Farmer
Wall Street Journal
Wallaces Farmer
Wisconsin State Farmer
World Watch Institute

RADIO

Minnesota Farm Network
WHO Radio

MISC

Farm Bureau Spokesman

Mary Hoff
Gregg Hillyer
Reginald Tucker
Betsy Freese

Jim Massey
Paula Mohr
Dan Miller
Kelsey Gee
Rod Swoboda
Carla Gunst
Sophie Wenzlau

Emery Kleven
Van Harden

Dirck Steimel

Dr. Keri Jacobs Webinar ""Competition for land use: Why would the rational producer grow switchgrass for biofuel?"

Exhibit 2



To continue receiving free educational webinars, we need your feedback to document the value of these programs. Please take 3 minutes to complete this survey. It is completely voluntary and anonymous. You may skip questions you are not comfortable answering and withdraw from participating at any time. Your responses will not be linked directly to you by name as all data will be combined. There is no risk involved in responding to this survey. Thank you for your input.

1. How much has your understanding of the costs and benefits of switchgrass production (including monetary and non-monetary) increased as a result of today's webinar?

- None
- Some
- A lot

2. How much has your understanding of advancements needed to make producing switchgrass for bioenergy feasible increased as a result of today's webinar?

- None
- Some
- A lot

3. As a producer, if a biomass market was available to you, please indicate reasons you would transition land you operate into switchgrass production Check all that apply (Non producers, please mark "not applicable")

- Improved economic return on investment compared to annual row crops
- Improved water quality

Improved soil conservation

To meet landlord/farm management firm expectations

Not applicable

Other (please specify)

4. Please select the range of acres you influence

0

1 – 50 acres

51 – 500 acres

501 – 1000 acres

More than 1,000 acres

5. Please select the number of people you will reach with this information.

0

1 – 10

11 – 50

51 – 100

101 - 500

6. What is your primary occupation?

Higher education

Extension educator

Industry

Agricultural producer

Certified Crop Advisor

Governmental agency

Other (please describe)

Done

Powered by **SurveyMonkey**
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Using Biochar in Gardens: 2013 Minnesota State Fair Survey Results

Sorrel Brown, PhD
Iowa State University Extension
sorrel@iastate.edu
Guang Han, Graduate Student
Dept of Agricultural Education & Studies



University of Minnesota Extension Master Gardener volunteers presented fairgoers with information about biochar and its benefits when used in home gardens. Participant responses (n=55) indicated the following:

Exhibit 3

Awareness of Biochar:

- 54.5% of respondents had heard about biochar before attending the Minnesota State Fair.
- The three most common sources of information were:
 - a) Master Gardeners
 - b) Internet
 - c) Minnesota State Fair

Knowledge gained:

- 31% of respondents indicated they were a lot more informed about the benefits of biochar after listening to Extension educators at the Fair.
- 47.3% indicated they were somewhat informed afterwards.
- 16.4% indicated they were a little more informed afterwards.
- 3.6% indicated they knew the same as before.

Intentions:

- 42% indicated they would be very likely to use biochar in their gardens.
- 49% indicated they would be somewhat likely to use it.
- There is a moderately positive correlation between how people are informed about the benefits of biochar in their gardens and their likelihood of using it.

In summary, education about biochar at the 2013 Minnesota State Fair strengthened people's awareness of biochar and increased their knowledge about using biochar in home gardens. After learning about the benefits of biochar, most people indicated they intend to use it. Results also show that the likelihood of people using biochar can be increased if they are better informed about how to use it. Thus, developing multiple methods of teaching and communicating about biochar is more likely to reach more of the public.

For more information, contact:

Julie Weisenhorn
University of Minnesota Extension
weise019@umn.edu

This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

... and justice for all

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Integrated Agricultural Landscapes for Profit & Risk Management Survey Results

Sorrel Brown, PhD
Iowa State University Extension
sorrel@iastate.edu
Guang Han, Graduate Student
Dept of Agricultural Education & Studies



Exhibit 4

CenUSA Outreach and Extension educators conducted an educational session about integrated agricultural landscapes for profit and risk management at the 2013 Integrated Crop Management Conference in December. Participant responses (n=46) indicated the following:

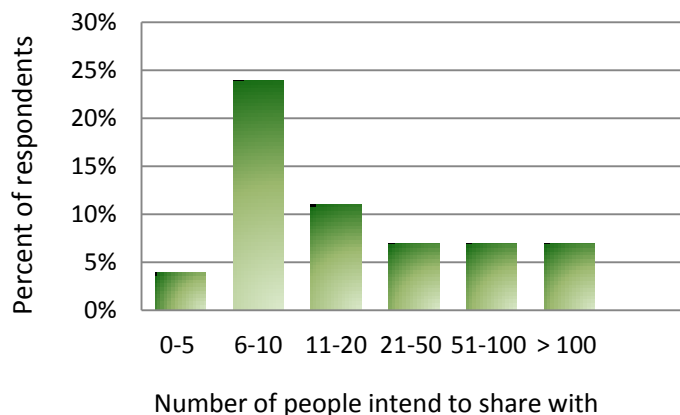
Knowledge gained:

- Knowledge about “resources available from CenUSA bioenergy CAP” was significantly increased.
- Knowledge about “soil constraints for corn stover harvest” was significantly increased.
- Knowledge about “using yield maps to make bioenergy crop decisions” was significantly increased.
- Knowledge about “economic opportunities for integrating dedicated energy crops in the landscape” was significantly increased.

Ranked value of topics:

- 1) Variable biomass harvest
- 2) Marketing information
- 3) Economic benefit
- 4) Using yield maps on making decisions

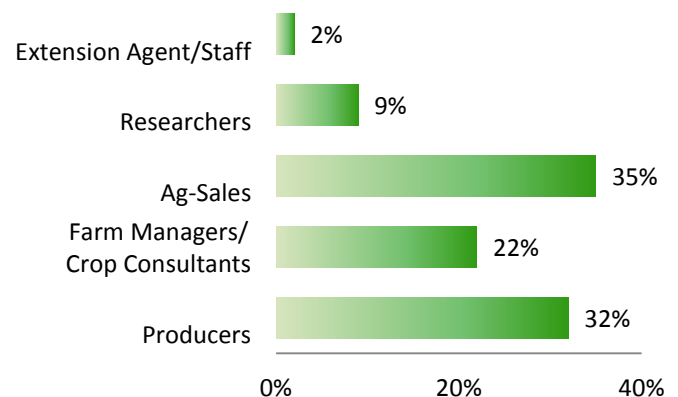
Respondents' intention to share information:



Intentions:

- 56% want to learn more about integrated agricultural landscapes for their own farming practice.
- 12% would consider adopting an integrated agricultural landscape system.
- 8% will share what they learned and discuss future decisions with families and friends.
- 8% will wait for the marketing evolution.

Occupation:



In summary, the educational session on integrated agricultural landscapes increased participants' knowledge of available resources, soil constraints for corn stover harvest, yield maps, and economic opportunities.

Respondents are more interested in biomass harvest, marketing information, and economic benefit.

Most respondents want to learn more about integrated agricultural landscapes. A small proportion intend to adopt integrated agricultural landscapes. Most respondents are willing to share the information they learned from this workshop with others.

This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

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CENUSA October 2013 Bioenergy Field Day Evaluation Results

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Dept of Agricultural Education & Studies



Exhibit 5

CenUSA Outreach and Extension educators held a field day October, 2013 that focused on perennial grass production for bioenergy. Participants (n=21) were surveyed to determine the knowledge they gained from the educational presentations during the field day.

Awareness:

Most respondents (76%) had not heard about specific environmental implications of bioenergy perennial grass production before attending the session; 24% had heard about them before.

Decision-making:

More than half of the respondents (52%) indicated the session they had attended at the field day had some influence on their choosing species for bioenergy production; 19% reported a lot of influence; 19% reported a little influence; only 10% reported no influence at all. Species mentioned were switchgrass, *Miscanthus* and sorghum.

Value:

More than half of the respondents (57%) indicated it was very easy to recognize how genetic improvement in bioenergy grass varieties influences production after attending the field day; 29% indicated it was somewhat easy; 14% indicated it was not easy.

Summary:

Before the educational field day about bioenergy crops, most participants did not understand the environmental implications of perennial grasses grown for bioenergy. What was learned at the field day made a strong impact on respondents' decisions regarding the crop species to choose for bioenergy production. In addition, most participants' knowledge about how genetic improvement influences production was increased.

For more information, contact:

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This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

... and justice for all

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Establishing and Managing Perennial Grasses for Bioenergy Survey Results

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Guang Han, Graduate Student
Dept of Agricultural Education & Studies



CenUSA Outreach and Extension educators conducted an educational session about establishing and managing perennial grass for bioenergy at the 2013 Integrated Crop Management Conference in December. Participant responses (n=37) indicated the following:

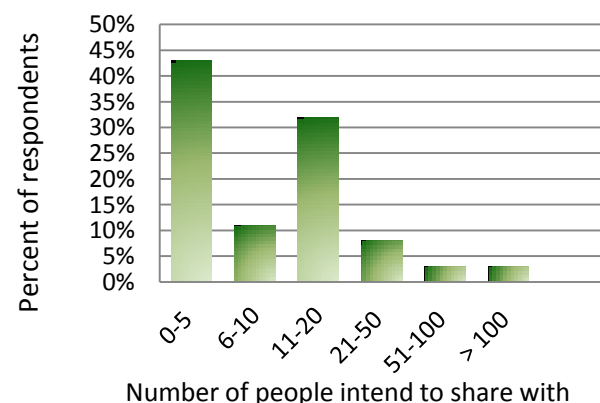
Knowledge gained:

- Knowledge about “how quickly perennial grasses can be established” was significantly increased.
- Knowledge about “the management requirements for perennial grasses for bioenergy” was significantly increased.
- Knowledge about “the yield potential of perennial grasses” was significantly increased.
- Knowledge about “the feasibility of perennial grasses for bioenergy” was significantly increased.

Ranked value of topics:

- 1) Techniques for establishing perennial grasses
- 2) Future and feasibility of perennial grass production
- 3) Yield
- 4) Profitability of perennial grasses compared to corn/soybean

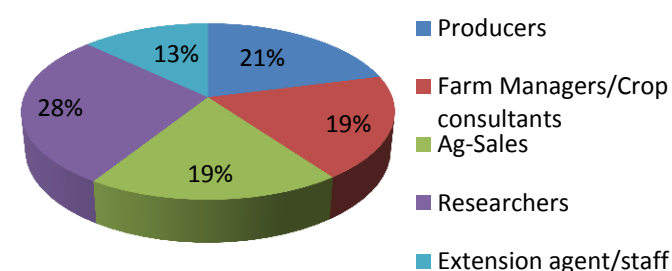
Respondents' intentions to share information:



Intentions:

- 57% want to learn more about perennial grasses production for their own farming practice.
- 29% will consider adopting perennial grass production.
- 14% will share the information and discuss future decisions with families and friends.

Occupation:



In summary, the educational session on establishing and managing perennial grasses for bioenergy increased participants' knowledge on

- establishment and management requirements,
- yield potential, and
- feasibility of perennial grasses.

Respondents were more interested in

- techniques of establishment,
- yield potentials, and
- the future and feasibility of production.

Most respondents want to learn more about producing perennial grasses for bioenergy. A small proportion intend to try planting perennial grasses. Most respondents were willing to share information they learned from this workshop with others.

For more information on perennial grasses, contact:

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University of Nebraska-Lincoln East Campus
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This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

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2014 Extension Energy and Environment Summit Program Abstracts
Regional demonstration site activities enliven NEWBio's knowledge-to-action extension model

The knowledge-to-action model for extension within NEWBio (Northeast Woody and Warm-season Biomass Consortium) is necessarily multifaceted, involving not just a combination of bioenergy feedstocks but also a combination of industry and federal entities partnering with multiple academic institutions. Highly integrated programs like these require innovative outreach strategies for maximum efficacy over broad geographic and disciplinary scales. In NEWBio, this is achieved through knowledge building within regional demonstration sites that serve as foci for the entire Northeast region and are selected due to strong producer and/or industry presence as well as farmer/landowner/business-owner interest and potential for industry expansion. Key features at these sites are interpretive bioenergy crop plantings whose management activities are highlighted in field tours and workshops. This type of experiential learning offers potential producers a detailed understanding of bioenergy crop dynamics, helping them feel more comfortable taking on a “new” crop yet untried on their land, and reciprocally informs the project as a whole about the highest-impact leverage points for local landowners—namely, accessible (often non-energy) markets and fuller land utilization. With support from experts and specialists in the field, county extension agents help connect the larger vision of this broad-scale program to the local interests of landowners through these programs as well as interactive learning tools like budget modeling, technical short course workshops, and more traditional forms of outreach like fact sheets and “ask an expert” platforms. To extend the high level of engagement achieved in this process, NEWBio focuses on accessibility of new technology for new crops by connecting interested landowners to existing industry infrastructure, alternative biomass markets, and biomass business/supply chain models and by subsidizing rental costs in an equipment sharing program for hybrid willow planting and harvesting. These interactive learning tools and focused demonstration site activities elevate an information-delivery model of extension to an action- and experience-based form of engagement, allowing NEWBio's extension team to deliver quality programming with staying power within a finite time scale and with a limited budget.

Presenter: Sarah Wurzbacher

Penn State Cooperative Extension (NEWBio Consortium)

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Sarah Wurzbacher is a Penn State extension educator based in Crawford County, PA, who holds degrees in environmental science and forestry. Sarah works within NEWBio, or the Northeast Woody and Warm Season Biomass Consortium, a multi-state, USDA-funded initiative dedicated to expanding agricultural biomass energy in the Northeastern

US. This initiative focuses on switchgrass, giant miscanthus, and shrub willow as dedicated energy crops.

Extension and Outreach Activities in Support of the The Southeast Partnership for Integrated Biomass Supply Systems (IBSS)

The Southeast Partnership for Integrated Biomass Supply Systems (IBSS) demonstrates real-world solutions towards economically and environmentally sustainable production and conversion of biomass-to-biofuel in the southeast United States (SE US). This Partnership is helping to meet the USDA goal of producing almost 50% of the next generation of biofuels in the SE US, while supporting robust and innovative research, education and extension activities. The goal of the Extension, Education and Outreach Effort (E2O) is to provide creditable, impactful, and integrated programs and communication tools that result in a well-trained workforce, and landowners, stakeholders and policy makers with the knowledge necessary to thoughtfully enable a biofuels industry. This presentation will highlight a number of products, activities and programs undertaken by a dedicated group of agriculture and forestry Extension, education and outreach professionals over the last several years. Examples include updates on eXtension, webinars, fact sheets, tours, demonstration plots, clientele assessment and perceptions studies, and integration with other efforts in the region.

Presenter: **William Hubbard**

CES – Southern Region (UGA)

4-402 Warnell School of Forestry & Natural Resources, The University of Georgia
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Daytime: (706)542-7813 Mobile: (706)340-5070

Dr. William G. Hubbard is a Southern Regional Extension Forester, The University of Georgia. Dr. Hubbard has served as the Regional Forester for the Extension Service-Southern Region since 1993. This is a liaison to thirteen 1862 University Land Grant University and the Southern Region of the U.S. Forest Service. His work involves using new and traditional technologies in regional educational programming and enhanced communication and coordination of information and activities across states and agencies in the areas of forestry and natural resource management. He previously held several teaching, research and Extension positions at the University of Florida in Gainesville.

* * * *

Assessing the Interests, Needs, and Concerns of Stakeholders Regarding Sustainable Bioenergy Initiatives

Across the, biofuel and bioenergy initiatives are paving the way for homegrown energy and bioproducts using sustainable and renewable biomass. In the Pacific Northwest (PNW), our project Advanced Hardwood Biofuels Northwest (AHB) is researching and

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developing a supply chain using sustainably grown hybrid poplar to produce bioproducts and transportation fuels. For AHB and other bioenergy initiatives to be successful, the needs, concerns, and interests of stakeholders across the supply chain must be addressed.

As part of our outreach efforts, the AHB Extension Team has identified seven key stakeholders essential for the success of hardwood biofuel and bioproduct industries in the PNW. To further understand how we can support stakeholder needs, we are surveying three stakeholder groups: extension professionals, environmental professionals, and landowners. Our goal is to understand the perceptions, needs, and concerns of these professionals and landowners regarding biofuels, especially hybrid poplar as a feedstock. These assessments will assist us in determining how to best inform stakeholders on issues relevant to these new industries and use their input in addressing barriers to industry developments.

At the E3 Summit, we will discuss how the initial survey results are being used to guide biofuel extension and outreach activities that will assist in educating concerned stakeholders and landowners in supporting emerging biofuel and bioproduct industries. We will share our experience in producing outreach materials and events tailored for these diverse stakeholders. Session attendees will be able to apply our findings and experiences to inform stakeholders involved with their own energy and environment extension programs.

Presenter: Patricia Townsend

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patricia.townsend@wsu.edu
Daytime: (425)741-9963

Patricia Townsend is a Regional Extension Specialist and Educator at Washington State University (WSU). She is part of a team from WSU that provides outreach and Extension for Advanced Hardwood Biofuels Northwest. Before joining WSU, Patricia completed her Ph. D at the University of Washington (UW) working on tropical forest restoration and conservation in Costa Rica. During this time she worked closely with landowners and local conservation practitioners to find realistic solutions to land degradation and planning for climate change. While at UW, Patricia also worked on the environmental impacts of biofuel feedstocks. Currently, she is happy to be providing outreach to build a sustainable biofuel system in the Pacific Northwest.

* * * *

Biomass: Demonstration to Symposium

Success and not-so-successful efforts to education the public about biomass energy opportunities will be shared. The impact of the portable biomass gasification unit demonstrated at various field days and other activities over a four year period will be

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shared. The engineering and end-use adoption effort has been in collaboration with the agronomic and production side of grass based biomass education efforts. Participants will also gain insight into the limitation and drawbacks of our efforts. Also, the presentation will share the reasons behind a move from grass based to a woody biomass focus for the Tri-state Heating with Woody Biomass Symposium. Woody biomass may be the “low hanging fruit” to get biomass for heat started in some areas. As this effort continues, part of the focus will need to be on developing the end-users knowledge to make informed decisions about biomass utilization.

Presenter: **Stanley (Jay) Solomon**

University of Illinois Extension

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Stanley Solomon is a University of Illinois Extension Energy and Environmental Stewardship Educator. He has 22 years of extension experience, including Missouri and Illinois. Solomon brings an agricultural engineering focus to his work with livestock, crop production, environmental issues, and renewable energy. He work includes engineering review of grass biomass pelleting issues, demonstration gasification unit, and biomass heating systems. Solomon's extension education focus has been on raising awareness, demonstrating viability, and encouraging early adoption of emerging renewable technology on a local basis. He is a founding member of the Illinois Biomass Working Group.

* * * *

Miscanthus Production in Northeast Ohio: Biofuel & BioProducts for the Future

This presentation will provide details on how *Miscanthus x giganteus* is helping to grow the Biofuel & BioProduct industry in Northeast, Ohio. Through the BioMass Crop Assistance Program (BCAP) over 4,000 acres have been planted by Aloterra Energy (and cooperating farmers) in northeast Ohio since 2010. During this session, participants will learn more about the production of miscanthus and how it is being used both as a biofuel and bioproduct. Learn how this grass is being converted into heating pellets, construction materials, disposable tableware and even toilet paper. Information will be also shared on how OSU Extension is helping to conduct research and author Extension publications for use by the industry.

Presenter: **David Marrison**

Ohio State University Extension

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David Marrison is an Associate Professor & Extension Educator for OSU Extension in Ashtabula County, Ohio. Mr. Marrison works with wide diversity of agricultural crops and livestock as part of his Extension Outreach. Included in this is work with Miscanthus as over 4,000 acres is planted of this biofuel grass is planted in Northeast Ohio.

* * * *

Building on Solid Ground: Providing Renewable Energy Project Development Support

To invest or not to invest? That is quite literally the multi-million dollar question facing many farmers across the nation in regard to renewable energy technologies. With rising energy costs, increased focus on nutrient management issues, and the possibility of increased renewable energy portfolio standards, turning on-farm wastes into valuable resources is an attractive option for many farms. However one must ask; is it worth the cost and risks of start-up? When evaluating this question, it is important that agriculturalists have decision support tools that are up-to-date, scientifically valid, economically sound, and (most importantly) affordable to use. Since 2009 Michigan State University researchers have been developing a number of free-to-use decision support tools that allow farmers and other business owners to assess the potential energy and economic value of available biomass for renewable energy project development. This presentation will seek to provide farmers and extension agents with a set of tools to critically evaluate the feasibility of on-farm renewable energy projects, and highlight additional resources that are available for furthering their renewable energy goals. The program will also incorporate recent and future upgrades to these MSU resources including GIS mapping integration with utility databases and the use of an economic decision support model to provide preliminary pro-forma analysis of renewable energy projects.

Presenter: Jason Smith

Michigan State University

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smith840@msu.edu

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Jason Smith is a graduate research assistant in Michigan State University's Biosystems and Agricultural Engineering program. Mr. Smith is a former researcher at MSU's Anaerobic Digestion Research and Education Center (ADREC), where he performed applied engineering research and worked with farmers to help optimize their anaerobic digestion operations. Mr. Smith has also worked as a renewable energy engineer for Tetra Tech Inc. where he performed numerous renewable energy feasibility studies for farms, municipalities, and small businesses. Mr. Smith is currently pursuing his masters degree in Biological Systems Engineering at MSU.

The Impact Of Ethanol Fuels on Small Non Road and Legacy Engines

Much of the discussion regarding ethanol containing fuels is on late model road vehicles. But there are two other classes of engines that use ethanol containing fuels. Small non-road engines, such as those found in lawn mowers, line trimmers, chainsaws and other small horsepower engines; and legacy engines found in old tractors and cars. Both of these classes of engines can utilize ethanol containing fuels, but deserve some special consideration as ethanol containing fuels are consumed. This presentation will touch on the areas of consideration that owners of small non road and legacy engines should consider.

Presenter: **Edwin Brokesh**

Biological and Agricultural Engineering Dept.
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Ed Brokesh is an Extension Specialist working on biofuels and biomass collection logistics in the Biological and Ag. Engineering Department at Kansas State University. Ed joined the K-State BAE Department following a 24 year career in industry as a senior design engineer working in the livestock, grain handling and ATV industries. He is a licensed Professional Engineer in the state of Kansas and holds MBA and BS Ag. Engineering degrees from Kansas State University.

* * * *

Farm Energy Management

Energy expenditures for Iowa agriculture are about one billion dollars annually. An outreach program on farm energy management and efficiency for crop and livestock farmers has been underway for five years. Twenty-four bulletins on a series of targeted topics including field operations, grain drying, livestock confinement, farm shop, and general energy literacy are available. Web site visits have increased to over 800 per month. An annual training webinar is hosted for Extension staff, energy service providers, and farmers. Additional programming is done through summer field days, winter meetings. and state and national farm press. Current projects include on-farm energy measurements.

Presenter: **Mark Hanna**

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Dr. H. Mark Hanna is an Extension Agricultural Engineer with Iowa State University. Hanna's main focus is sustainable agricultural systems, including chemical application, energy consumption, tillage/planting and harvest. His research focus has been on developing ways for field equipment to enhance productivity and environmental stewardship as machinery interacts with crops and soils. His research is accompanied by field days, conferences and additional outreach activities within the industry.

* * * *

How Biofuels Change Gasoline: Consumer Fuel Literacy

Ethanol fuel blends are ubiquitous yet many people quote misconceptions about how ethanol impacts engines and driving. Any future of higher blends will be aided by an educated consumer who understands how ethanol impacts their vehicles. This presentation will give a basic scientific background of gasoline quality characteristics and how ethanol impacts these characteristics. Ethanol has both positive and negative impacts on fuel. You will leave this session more confident in your ability to discuss the facts with people who dislike ethanol or who have been told ethanol is bad. If time permits this presentation will also include how biodiesel changes diesel fuel.

Presenter: **F. John Hay**

University of Nebraska – Lincoln Extension

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Lincoln, NE 68583-0726

jhay2@unl.edu

Daytime: (402)472-0408 Mobile: (402)992-0947

F. John Hay is an Extension Educator focused on Energy and Biofuels issues. John has a BS in Agronomy from University of Nebraska Lincoln and an MS in Agronomy from Texas A&M University. His extension efforts have recently focused on bioenergy crops for Nebraska, Fuel literacy, and youth curriculum development related to biofuels and renewable energy. John and his wife Brooke and daughter Liatrix live in Palmyra, NE.

* * * *

Engaging Extension Volunteers in Research

Citizen science through volunteer involvement can result in great benefits to a research project, but also present some unique challenges. Extension Master Gardeners (EMGs) provide a unique bridge between research and the public. The volunteers are educated in horticulture by Extension and considered part of the University community and interpreting and communicating application of research to the public. Volunteers self-select for research projects and demonstrate a genuine interest in the research effort. The "Sustainable Production and Distribution of Bioenergy for the Central USA" project is a five-year, multistate USDA NIFA Bioenergy CAP-supported grant focused on

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biofuels and bioenergy. The project trains and deploys EMG volunteers in the Extension and Outreach objective. Over the past three years, teams of EMGs have been observing and recording plant performance data in home-style demonstration gardens treated with biochar. Their objective: to help answer the question “Is biochar beneficial for soil in home gardens?” and determine biochar’s future potential as a readily-available, retail product for the home gardener. .

This presentation will highlight best practices for involving and working with volunteers in a citizen science project, and will share “lessons learned: re: educating volunteers about the project; teaching volunteers proper techniques and processes; developing leadership and teams at research sites to promote self-management; and motivating and communicating with volunteers throughout the study.

Presenter: Julie Weisenhorn

University of Minnesota / Extension

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Daytime: (952)239-6608 Mobile: (952)239-6608

Julie Weisenhorn is a collaborator for the Extension/Outreach objective for “Sustainable Production and Distribution of Bioenergy for the Central USA”, a five-year, multistate USDA NIFA Bioenergy CAP-supported grant focused on biofuels and bioenergy.

Weisenhorn oversees the involvement of U of MN Extension Master Gardener volunteers observing and recording data about plant performance in an effort to determine if biochar benefits home garden soils. Weisenhorn holds master’s degrees in communications and horticulture from the University of Minnesota where she taught landscape design (2002-2007) and served as Extension Master Gardener state director (2007-2013). Weisenhorn is currently an extension educator, specializing in horticulture education, landscaping and plant selection.

* * * *

C6: A Sustainability Educational Game

[C6 Sustainability Game] is a 2D simulation game, to be published online via web browser and mobile application. The game will have an accompanying iBook providing supportive content for the science, economics, engineering, agricultural practices, and sociological implications of a bio-based economy. Players interact with the land, Farmville-style, deciding when and where to implement sustainability technology. Gameplay takes place over a series of rounds (years), at the end of which players are able to see their cumulative effects on the farm, community, and environment. Players should come away with a better understanding of sustainability technology and its real-world applications. The game is a novel and engaging way to teach students about sustainability practices using accurate demonstrations of sustainability technology and its effects. The game has the potential for later expansion into further topics.

Presenter: Jay Staker

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Jay Staker, Associate Director, Iowa Space Grant Consortium, is an Iowa State University Extension Youth STEM specialist serving the K-12 audience.

* * * *

Sharing research-based biofuel knowledge via the web

A team of university and industry partners, led by the LSU AgCenter, is studying the production of biomass for conversion to biofuels and bioenergy using existing refinery infrastructure. This project, funded by USDA-NIFA Award No. 2011-69005-30515, focuses on development of feedstocks of energycane and sweet sorghum – crops unfamiliar to Louisiana producers – to provide feedstock material to be processed in a biochemicals pilot plant that opened at the AgCenter's Audubon Sugar Institute in 2013. Surveys identified roadblocks that include convincing growers and landowners to consider production of unfamiliar crops, absence of extension agents familiar with biofuel production, and a shortage of coordinated programs to train a biofuel workforce. To help overcome these roadblocks, the LSU AgCenter launched a website in late 2013 where information regarding production, conversion technologies, economics and business, education and extension is housed.

The website contains videos, image galleries, fact sheets, a short course series, as well as audio files. A series of seminars about cultural practices will be recorded using either the Cisco TelePresence Content Server (TCS) or a Mediasite Video Streaming Server, and uploaded to the site. Both platforms allow for playback on-demand. The Mediasite server also allows for playback on mobile devices.

An interactive page of equipment located in the pilot plant was built using HTML5 and JQuery. On this page, users can roll their mouse over each piece of equipment and a brief text explanation will appear to explain the function of each piece of equipment.

* * * *

Google Analytics is being used to measure and analyze traffic to the website.

Attending this presentation will give participants knowledge about different platforms and tools to use when building websites, as well as knowledge of a website where these platforms and tools are being utilized.

Presenter: **Denise Attaway**
LSU AgCentet

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Denise Attaway is an assistant communications specialist for the LSU AgCenter in Baton Rouge. She is currently working on the Sustainable Bioproducts Initiative, which is a project designed to study the regular production of biomass, from energycane and sweet sorghum, for economically viable conversion to biofuels and bioenergy using existing refinery infrastructure. Attaway holds a bachelor's degree in journalism and a master's degree in technical writing from Louisiana Tech University. She holds a doctorate in human resource education from Louisiana State University.

* * * *

Using eXtension Farm Energy: Collaboration & Outreach

Do you use eXtension: to connect with your colleagues? ...for your own professional development? ..to publish your resources and research? Do you have an eXtension ID, but don't know why? This speed session will provide a short tour of eXtension's various sites and opportunities; discussion will focus on participants' experience and tips for using eXtension to your advantage.

The eXtension Farm Energy (aka Sustainable Ag Energy) Community of Practice (CoP) has ~240 members from across the US, with a mission to provide timely, practical and sustainable energy information for agricultural producers and service providers. The CoP, through its members (you!), provides resources to suit varied learning styles and time availability: live webinars, in depth curriculum modules, articles and fact sheets, FAQs, videos, images, Ask an Expert and social media posts.

Six years in the making, eXtension Farm Energy resources and programming delve deeply into the following topics: Anaerobic Digestion and Biogas; Biodiesel; Biomass; Efficiency and Conservation; Feedstocks and Energy Crops; Bioenergy Logistics & Processing; Sustainability Dimensions; Solar Energy; and Wind Power.

eXtension Farm Energy collaborates with a number of projects. For example, 2 of the NIFA Bioenergy CAP Projects, CenUSA and NEWBio, share their collective knowledge and integrate it into the body of Extension resources. These projects involve 194 collaborators, 15 States, 16 Universities, 8 Federal and 8 Industry Partners. Their growing resource base assists bioenergy stakeholders and the public to make choices and overcome obstacles to entering the bioenergy supply chain.

Future Plans: Further build on our existing resources, projects and programming: focusing on increasing the local use of CoP resources; expanding the depth and breadth of our resources to include topics like bioenergy economics and findings from

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conversion technology research; increasing dynamic & interactive content; establishing new collaborations and project partners. Please join us and share the wealth!

Presenter: **Susan Hawkins**

eXtension – University of Vermont

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Sue Hawkins has coordinated the eXtension Farm Energy Community of Practice since 1988. She works for University of Vermont Extension. In her previous life chapter, she was an integrated crop management consultant for Vermont dairy farms.

* * * *

The Impact Of Yield And Machine Usage on Costs Associated with Biomass Harvest

The consideration of costs associated with biomass harvesting have been one dimensional. The discussion has been that there is one cost that can be found out for harvesting biomass and that it applies across all yield levels and operation sizes. This presentation will look at how yield and machine usage impact biomass harvesting costs and thereby may impact the interest some producers may have in harvesting biomass.

Presenter: **Edwin Brokesh**

Biological and Agricultural Engineering Department

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Ed Brokesh is an Extension Specialist working on biofuels and biomass collection logistics in the Biological and Ag. Engineering Department at Kansas State University. Ed joined the K-State BAE Department following a 24 year career in industry as a senior design engineer working in the livestock, grain handling and ATV industries. He is a licensed Professional Engineer in the state of Kansas and holds MBA and BS Ag. Engineering degrees from Kansas State University.

* * * *

Cross-Discipline Energy Programming and the New Tennessee Extension Strategic Plan

Extension programs too often are placed into the silos of Agriculture and Natural Resources (ANR), Community Economic Development (CED), Family and Consumer Sciences (FCS) or 4-H Youth Development. But, by their nature, energy conservation, efficiency and alternatives educational programs cross all demographics and program

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area boundaries. The University of Tennessee Extension has developed Strategic Plans under the ANR/CED and FCS program areas, creating a framework for program planning, evaluation and reporting that is intended to aid in developing priority programs and fewer, but better impact statements. Traditionally, agents and specialists select priority programs and report through the program areas – ANR/CED, FCS or 4-H – as they are identified by their appointments. The UT Extension Energy Working Group is developing a model for cross-discipline program planning, delivery and reporting in a multiple strategic plan environment. Some of the current efforts include:

- A new 'UT Extension Energy Center' web portal to provide easy access to research-based energy information from all disciplines
- Energy monitoring and efficiency improvements research/demonstration projects
- Multidisciplinary in-service and other programs
- A coordinated program evaluation and reporting program

Presenter: **Tim Prather**

University of Tennessee Extension

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The presenters represent Tennessee Extension's three program areas: ANR/CED, FCS and 4-H Youth Development, and are members of the Extension Energy Working Group and UT Extension Energy Center.

* * * *

Renewable Energy in Extension: Societal and Developmental Synergies and Conflicts

The Energy Information Administration projects that national renewable energy consumption for electric power and heat generation will increase by 6% in 2014. Renewable energy expertise, training, and programming will ensure that Cooperative Extension is at the forefront of solving the nation's energy challenges. Connecting renewables to traditional Extension foci will 1) reinforce Extension's role of disseminating research-based and unbiased information to the public; 2) illuminate Extension's energy role among federal and state entities; and 3) bolster Extension's relevancy in the 21st century.

This session will present the research findings from a renewables-focused survey distributed at the 2013 National Extension Energy Summit (n=41), focus group interviews at the 2013 Extension Sustainability Summit (n=25), combined with a statewide energy needs assessment to be conducted in the late spring of 2014. Participants will learn how to best implement and communicate renewable energy programs to Extension clientele based on the benefits and barriers identified in the national survey, focus groups, and state needs assessment.

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Presenters: **Blake Thomas and Roslynn Brain**

Utah State University Extension Sustainability

USU Department of Environment & Society

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Daytime: (434)989-9098

Blake Thomas, MS Candidate – Renewable Energy Research Assistant, Utah State University Extension Sustainability. Blake's research examines Extension's role and needs regarding renewable energy projects in Utah. He has conducted national Extension-focused renewable energy surveys, presented research findings in four states, and has published four peer-reviewed articles on energy and sustainability topics.

Roslynn Brain, PhD – Assistant Professor, Sustainable Communities Extension Specialist in the Department of Environment and Society, College of Natural Resources at Utah State University. Roslynn uses conservation theory, communication techniques, and social marketing tools to foster community-based pro-environmental behaviors.

* * * *

Value Capture and De-risking Through Public/Private Biomass Projects

The challenges of funding biomass energy projects with prevailing capital market conditions and policy uncertainty often requires innovative approaches to maximize capture of economic benefits and manage risks. Public/private collaborations are one arena that offers enhanced monetization of incentives, improved project credit-worthiness and flexibility in asset ownership for biomass project developers. Municipal sponsored projects can provide communities with multiple benefits and provide developers critical de-risking attributes. Not only are energy dollars staying closer to home, but increased investment may provide improved performance from existing infrastructure (e.g. municipal utilities, wastewater and solid waste), employment opportunities and a strengthened tax base. However, these often complex and capital intensive projects require careful consideration of all of the elements found in a successful energy project.

Presenter: **Timothy Baye**

University of Wisconsin-Extension

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Tim Baye is a Professor of Business Development and State Energy Specialist with the University of Wisconsin-Extension. His research and educational programs serve

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renewable energy executives, professionals and policy leaders. Baye has also served as CEO of Lafayette BioAg, LLC a renewable energy technology and project development firm. He has 30 years experience in industrial renewable energy projects, primarily biomass and biogas, in both executive and advisory capacities. Baye holds a senior position with ReCon Associates, an energy industry management consulting and professional development firm. ReCon's clients include: North American and international renewable energy, agri-business and manufacturing companies, the Open Society Institute, U.S.DOE, USDA, U.S.AID & World Bank.

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Sustainable Agricultural Land Tenure and Farm Transitions

Ed Cox is a staff attorney for the Drake University Agricultural Law Center. Ed's principle work revolves around the nexus between land tenure, sustainability, and beginning farmers. As part of the Law Center's Sustainable Agricultural Land Tenure (SALT) Initiative, Ed has authored numerous journal articles, published "The Landowner's Guide to Sustainable Farm Leasing," developed SustainableFarmLease.org, and filmed and edited several mini-documentaries. Ed also works on resources relating to new farmer policy and legal issues in direct farm marketing. He serves as the Chair of the Farmer Veteran Coalition of Iowa and on the board of FarmCommons. Ed received a B.S. from Missouri State University and his J.D. from Drake University Law School with a Certificate in Food and Agricultural Law.

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"Our vision is to create a regional system for producing advanced transportation fuels derived from perennial grasses grown on land that is either unsuitable or marginal for row crop production. In addition to producing advanced biofuels, the proposed system will improve the sustainability of existing cropping systems by reducing agricultural runoff of nutrients and soil and increasing carbon sequestration."

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This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the National Institute of Food and Agriculture.

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