



# cenusa bioenergy

Annual Progress Report

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

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## 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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- Copies of this report are available for download at the CenUSA Bioenergy website (<http://www.cenusa.iastate.edu/ResourceLibraryItems>)

## *Executive Summary – CenUSA Bioenergy – Revised<sup>1</sup>*

The North Central US is one of the most agriculturally productive areas in the world. However, intensive crop production on land within this region that is not well suited to row crop production has impaired soil and water quality and led to loss of productivity. Growing dedicated biomass crops on land that is unsuitable or marginal for row crop production would mitigate these problems and provide additional ecosystem services without adversely affecting food production. This integrated and multidisciplinary research, education and outreach project focuses on growing herbaceous perennials for fuel production that provide potentially high biomass production and ecosystem services. A regional system for producing fuels from these biofeedstocks based on pyrolytic conversion is being evaluated. Objectives of the project are to: 1) develop cultivars and hybrids of perennial grasses optimized for bioenergy production, 2) develop sustainable production systems that optimize perennial biomass yields and ecosystem services, 3) develop flexible, efficient, and sustainable logistics systems, 4) identify and characterize sustainable bioenergy systems to achieve social, economic, and environmental goals and understand socioeconomic and environmental consequences of perennial bioenergy systems, 5) identify germplasm characteristics amenable to pyrolytic conversion and evaluate performance of pyrolytic biofuels, 6) evaluate policy, market, and contract mechanisms to facilitate broad adoption by farmers, 7) develop procedures for managing risks and protecting health for each component of the biofuel production chain, 8) provide interdisciplinary education and engagement opportunities for undergraduate and graduate students, and 9) develop outreach programs for all stakeholders of the bioenergy system.

The first year of the project, described in the following report, was characterized by intensive activity within and among the objective teams as they established research, education and extension activities that can be built upon in subsequent years. Throughout the year objective team leaders met monthly to discuss progress and exchange information with each other. The composition of the leadership team (co-project directors) and collaborations is highly diverse representing a network of eight institutions— Iowa State University, Purdue University; University of Wisconsin, Madison; University of Minnesota, Twin Cities; University of Nebraska, Lincoln; University of Illinois, Champaign; University of Vermont-Burlington; and the USDA's Agricultural Research Service and several research disciplines including plant breeding and genetics, crop ecology and management, ecology, systems modeling, economics, biological systems engineering, mechanical engineering and education and extension. The frequent meeting of objective team leaders provides an opportunity for interaction that leads to better understanding of whole system that is being evaluating and ultimately leads to the emergence of transdisciplinary outcomes.

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<sup>1</sup> The Executive Summary was revised February 20, 2013 to reflect feedback received from USDA-NIFA's *AFRI Sustainable Bioenergy Program* staff.

The year was not without challenges as a severe drought affected most of the region. This especially impacted those objective areas that were initiating field experiments (1, 2, & 3) and demonstration trials (9). However, despite setbacks at some locations, each of these objective teams was able to meet their goals and milestones for the year. The adverse weather actually increased interaction among the various teams and locations as they exchanged information about the progress of their experiments and how to mitigate the negative effects of the drought. We will have to wait until next spring before it will be possible to fully assess the impact of the drought on stand survival, but early indications are that most new plantings will survive and be useful in subsequent years.

Each of the nine CenUSA objectives has shown satisfactory progress towards meeting the project's first year timelines and deliverables schedules as detailed in the complete annual report. Highlights for the year include:

- **Feedstock Development.** Perennial grass yield trials planted at 13 locations (Illinois, Iowa, Michigan, Minnesota, Nebraska, Ohio, Pennsylvania, South Dakota, and Wisconsin).
- **Sustainable Feedstock Production Systems.** Seed factor analysis plots established in Iowa, Illinois, Indiana, Minnesota, and Nebraska.
- **Feedstock Logistics. Methods of baling grass and straw were assessed.** The bale accumulation method reduced fuel expenditures by 0.04 gal/ton DM.
- **System Performance Metrics, Data Collection, Modeling, Analysis and Tools.** The group acquired and tested the Environmental Policy Impact Climate model to estimate soil erosion losses, nitrogen and phosphorus movement, and soil carbon sequestration.
- **Feedstock Conversion and Refining.** Laboratory research has investigated the chemistry of a diverse group of biochars and has focused on quantifying inorganic and organic sources of alkalinity in fast pyrolysis char (red-oak and corn stover) and cellulose slow pyrolysis char.
- **Markets and Distribution.** The team has started to collect switchgrass trial data for CenUSA relevant states and has submitted a proposal to the USDA to establish an MOU that permits access to micro-level CRP data. Co-Project Director Dermot Hayes is engaged in interactions with industry to model the use of feedstocks as a fuel source for fast pyrolysis. The proposed business model involves a distributed model of fast pyrolysis that provides as byproducts biochar and bio-oil. Biochar would be sold as a soil amendment, and bio-oil would be sold for use as home-heating oil. Collaborators include soil scientists, and chemical and mechanical engineers.

- **Health & Safety.** The major duties and responsibilities of the Managing Risks in Producing Feedstocks task have been preliminarily identified. The team collaborated with Extension and Outreach Objective colleagues to create a *Master Gardener Biochar Safety Sheet*.
- **Education.** Eleven undergraduate students were successfully placed at CenUSA partner institutions from June 13 – July 31, 2012.
- **Extension and Outreach.** Extension and outreach activities reached over 3,700 persons. This includes 2426 Master Gardener volunteers reached through face-to face or electronic means; 1056 producers, 257 extension specialists; and 160 members of the public.

The activities of each of these teams were reviewed by and received guidance from an Advisory Board representing multiple segments of the agribusiness industry. The team is led by Tom Binder, President of Research, Archer Daniels Midland, and consists of fourteen members. The Board has been an excellent advisor to our researchers, having participated in our initial kickoff meeting in August 2011 and subsequently offering significant feedback after being introduced to our research plans. They also participated in this year's Annual Meeting and provided feedback and recommendations to the team at the meeting and in a subsequent report that was carefully reviewed by all team leaders and discussed at length in an online director's meeting.

**Meetings and Communications.** We held an initial kickoff meeting in Ames, Iowa in August 2011. At this well-attended meeting each objective was able to share its project plans with ample time for participants to share information. Given that nine objectives need to work collaboratively for the project goals to be realized, we believe that an annual meeting with significant time devoted to inter-objective question and answer periods will serve us well throughout the life of the project. We have also maintained important communications between our multi-state collaborators through monthly project leadership team meetings in a dedicated virtual meeting room. The Advisory Board chair attends monthly Co-Project Director meetings to offer input and maintain communications with the Board.

We have also established a website, [www.cenusa.iastate.edu](http://www.cenusa.iastate.edu), which allows us to share project information and educational and outreach materials with the interested public. The site serves as a repository of

### Planned Activities – Year 2

- **Feedstock Development.** The focus is on continuing the perennial forage breeding program.
- **Sustainable Feedstock Production Systems.** Monitor growth of newly established perennial system and factor plots and intervene as necessary to aid establishment.
- **Feedstock Logistics.** Continue to study biomass handling and drying rate characteristics.

- **System Performance Metrics, Data Collection, Modeling, Analysis and Tools.** Continue to adapt models to best represent data generated from field trials and other data sources.
- **Feedstock Conversion and Refining.** Continue field plot studies quantifying the impact of biochar on soil quality and carbon sequestration.
- **Markets and Distribution.** Continue to collect and analyze switchgrass trial data.
- **Health & Safety.** Conduct a baseline assessment of expected worker exposures for identified hazardous aerosols.
- **Education.** Iowa State University will host the Native Perennial Grass Bioenergy internship program in the summer of 2013.
- **Extension and Outreach.** Continue development of online materials, education modules and educational articles. Complete the establishment of the CenUSA Peer Network.

#### **Planned Activities – Year 2**

- **December 2012 Workshop - Roadmap to Commercialize Thermochemical Biofuels Processing in the Midwest**

CenUSA Project Director Ken Moore and Co-Project Directors Jill Euken and Robert Brown have organized the workshop *Roadmap to Commercialize Thermochemical Biofuels Processing in the Midwest* to be held December 11-12, 2012. A CenUSA Executive team meeting will follow the workshop (December 12 and 13). Both meetings will be held in Ames, Iowa.

Experts attending an Iowa State University workshop will create a roadmap to commercialize thermochemical processing of biofuels and bio-products. The workshop goals include defining the optimal biomass feedstocks for thermochemical processing and identifying commercial pathways for the technologies in the Midwest. Representatives of ten companies working to commercialize thermochemical processing of biomass are planning to attend the workshop. Each will describe their company's technologies, goals, desired type of feedstock, and amount of biomass needed for commercial operation.

Other attendees will include researchers and experts from the CenUSA project, representatives from producers of first-generation biofuels, agricultural crop growers associations, and government officials. A panel of experts on plant breeding and agronomy will describe how different agricultural approaches can be used to optimize the yield of biomass feedstocks while minimizing undesirable components such as ash, nitrogen, and moisture. Experts from Iowa State University and the U.S. Department of Agriculture and the Department of Energy will also discuss non-fuel products such as heating oil, biochar, and

bioasphalt that can be made by thermochemically processing biomass. Representatives from the producers group will describe their organizations, past projects, and criteria for new projects.

Meeting sponsors include CenUSA Bioenergy, the Iowa State University Bioeconomy Institute, the Iowa Energy Center, USDA Central-East Regional Biomass Research Center, and the Iowa EPSCoR Project.

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

### **2012 Annual Progress Report: August 1, 2011 – July 31, 2012**

#### **PROJECT ADMINISTRATION**

##### **1. Project Organization and Governance Accomplishments**

CenUSA Bioenergy (“CenUSA”) Project Director Ken Moore leads the overall research effort. Chief Operating Officer Anne Kinzel and Financial Manager Val Evans handle all CenUSA project administration and business affairs, including project coordination, communication, and data sharing among institutions across the states. Kinzel is responsible for the day-to-day project management and the planning and preparation of reports, meetings, data management, and maintenance of the project’s public face. Evans is responsible for all project financial activities, including the development and implementation of administrative policies and procedures to ensure effective financial operation and oversight of the project.

##### **a. Project Progress**

Each of the nine CenUSA objectives is showing satisfactory progress towards meeting the project’s first year timelines and deliverables schedules (See Exhibit 1. CenUSA Bioenergy Timelines and Deliverables).

##### **b. Advisory Board**

The Advisory Board consists of 12 members representing all links in the supply chain including biomass cultivar development and seed production and marketing, crop production, transportation, storage, conversion, marketing, environmental impacts, safety, and education are now represented on the Advisory Board (See Exhibit 2. CenUSA Bioenergy Advisory Board Roster). During 2012, two producers, Ben Steffen from Nebraska and John Weis from Minnesota joined the Board, as did Lavon Schiltz, the Executive Director of the Nevada Economic Development Council in Nevada, Iowa. Ms. Schiltz represents the interests of rural communities and rural economic development.



The Advisory Board has been significantly involved in the project throughout 2012. Almost the entire Advisory Board attended the CenUSA kickoff meeting held in Ames, Iowa in August 2011. Subsequent to the meeting the Advisory Board, the Advisory Board presented the CenUSA research team with its impressions and reaction to the information presented. (See Exhibit 3: Advisory Board Reactions to Project Introductions – August 2011). In addition, Tom Binder, President of Research at ADM attends the monthly Co-Project director (virtual) meetings.

**c. Coordination, Collaboration, and Communication**

- **Executive Team Meetings.** The nine objective leaders meet monthly with Ken Moore, Anne Kinzel and Val Evans 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 an Advisory Board presence during these important project gatherings.
- **Objective and Team Meetings.** All nine CenUSA Objectives participate in scheduled meetings using the CenUSA Adobe Connect meeting room or in face-to-face meetings.
- **2012 Annual Summit.** The 2012 Annual Summit will be held August 7-9, 2012 in Lincoln, Nebraska (See Exhibit 4. 2012 Annual Meeting Agenda). Ken Vogel, Supervisory Research Geneticist at the USDA Agricultural Research Service-Northern Plains and leader of the CenUSA *Germplasm to Harvest* research group, will host the 2012 Summit. We have prepared an evaluation for participants so that we may use the information in planning the 2013 annual meeting (See Exhibit 5. 2012 Annual Meeting Evaluation).

We anticipate that over eighty persons will attend the summit, including nice out of the 12 members of the Advisory Board. Eleven graduate students and post-docs will be attending as well as six employees of the USDA-ARS (See Exhibit 6. Meeting Participation Roster).

The 2013 Annual Summit will be held at Purdue University (West Lafayette, Indiana) and will be hosted by CenUSA Objective 2 (Sustainable Feedstock Production Systems) Co-Project Director Jeff Volenec.

- **Communication Platforms.** CenUSA continues to focus on internal and external communication needs. We have created the CenUSA Bioenergy website ([www.cenusa.iastate.edu](http://www.cenusa.iastate.edu)) to serve both the needs of project collaborators and the interested public at-large. The website is divided into a private and password

protected internal space and a publicly accessible external space. We have two primary website goals:

1. Serve the needs of the CenUSA research team by providing a repository of information that can be easily shared across project objectives, and
2. Allow the interested public maximum access to this taxpayer funded research effort.

We use the website to broadly disseminate reports, learning modules, articles, and webinars. We also use the site to promote CenUSA events and activities such as educational meetings, webinars, media events, eXtension bioenergy learning modules, field days, and networking opportunities.

CenUSA also maintains a Twitter account (@CenUSAbioenergy). We use this platform to quickly distribute information regarding CenUSA events, publications, and relevant developments in the fields of biofuels and bioenergy.

CenUSA uses three separate websites to distribute project webinars: a YouTube Channel (<http://www.youtube.com/user/CenusaBioenergy>), a Vimeo Channel (VIMEO) (<http://www.vimeo.com/user/CenusaBioenergy>), and the CenUSA website. While not originally planning on having this many video sites, we have learned that certain employers place restrictions on the types of video sites that employees can access. We have been advised that this combination of sites will make our materials broadly accessible.

Project photos are shared via a Flickr.com site (CenUSA Bioenergy).

- **Project Flyer and White Paper.** During the fourth quarter CenUSA completed and distributed two significant printed pieces, the *CenUSA Bioenergy Informational Flyer* (See Exhibit 7. Informational Flyer) and the CenUSA Bioenergy 2012 White Paper *Fueling the Future with Energy Crops: Energy Title Recommendations for 2012 Farm Bill* (See Exhibit 8. 2012 Farm Bill White Paper). Both documents have been widely shared and well received. Project Director Ken Moore shared both the informational flyer and the white paper at the 3<sup>rd</sup> Pan American Congress of Plants and Bioenergy held in Champaign, Illinois July 15-18, 2012.

CenUSA also produced a “trading card” as part of Iowa State University’s Bioeconomy Institute Trading Card series (See Exhibit 9. for CenUSA Trading Card). The card provides a summary description of the project and a QR code directing readers to the CenUSA website and is used for distribution at public events. We



anticipate the cards will be especially popular in Objective 9's Master Gardener and Youth Master Gardener projects.

- **Public Events (Administrative Staff).** CenUSA staff attended the 2012 Farm Progress Hay Expo in Boone, Iowa (June 20 & 21, 2012) and described project goals to multi-state attendees.

Project Director Ken Moore gave a presentation and paper for the 3<sup>rd</sup> Pan American Congress of Plants and Bioenergy that will be held in Champaign, Illinois (July 15-18,



2012).

**Photo 1. CenUSA Outside Event Display**

- **Financial Matters.** The Administrative Team has sent amended subcontracts covering the period August 1, 2012 through July 31, 2013. To date all subcontracts with the exception of the University of Illinois, Champaign have been fully executed. We anticipate no problems in obtaining the final version of that two subcontract.

- **Program Matters.** We will concentrate on project coordination, communication, meetings and data sharing across Objectives, and on reaching the revised timelines milestones. We will especially focus on the dissemination of research results from CenUSA's first year (August 2011-July 2012).

## 2. Publications, Presentation, Proposals Submitted

An abstract describing the project titled *Sustainable production and distribution of bioenergy for the Central USA* was published in the Proceedings of the 3<sup>rd</sup> Pan American Congress on Plants and Bioenergy.

## 3. Annual Report Organization

Previously, CenUSA submitted quarterly reports for the first three quarter of 2012. Each of these reports is available to the public via the CenUSA website (See <http://www.cenusa.iastate.edu/ResourceLibraryItems> and Exhibit 10. 2012 CenUSA Q 1 & 2 Reports and Exhibit 11. 2012 CenUSA Q 3 Report). This annual report primarily covers events that have taken place during the period May 1 to July 31, 2012. Where needed for clarity of reporting we will address events that have taken place throughout 2012.

We have also provided an executive summary for each of the CenUSA objectives.

## Germplasm to Harvest Research Group

Ken Vogel, Supervisory Research Geneticist at the USDA Agricultural Research Service (Northern Plains) leads the Germplasm to Harvest research group.<sup>2</sup>

The **Germplasm to Harvest** group focuses on four project objectives:

- Feedstock Development
- Sustainable Feedstock Productions Systems
- Feedstock Logistics
- System Performance Metrics, Data Collection, Modeling, Analysis and Tools.

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<sup>2</sup> Ken Vogel: (402) 472-1564 / Ken.Vogel@ars.usda.gov

## ***Executive Summary – Feedstock Development***

The Feedstock Development objective 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 2012, the research team has concentrated on the establishment of new switchgrass breeding and evaluation trials.

### **Co-Project Directors**

- Ken Vogel, USDA Agricultural Research Service - Northern Plains.  
Ken.Vogel@ars.usda.gov / (402) 472-1564
- Mike Casler, U.S. Dairy Forage Research Center. michael.casler@ars.usda.gov / (608) 890-0065

### **Accomplishments – Year 1**

Switchgrass, big bluestem, and indiangrass yield trials planted at 13 locations in Illinois, Iowa, Michigan, Minnesota, Nebraska, Ohio, Pennsylvania, South Dakota, and Wisconsin. Energy grass half-sib family selection nurseries have been established at the University of Nebraska's Agricultural Research and Development Center near Mead, Nebraska.

Sampling has been initiated to identify and monitor potential arthropod pest and natural enemies associated with switchgrass and other bioenergy grasses. In screening studies, yellow sugarcane aphids and greenbugs were identified as two potential pests of switchgrass. Initial evaluations of field experiments in early June 2012 yielded fungi known to be pathogenic on switchgrass or pathogenic on grasses in general.

A set of switchgrass standard samples has been sent researchers conducting composition and pyrolysis analyses.

### **Planned Activities – Year 2**

A primary focus is on continuing the perennial forage breeding program that started in Project Year 1:

- Phase 1: Germplasm acquisition and evaluation: Evaluate forage yields, quality and other traits
- Phase 2: Recurrent selection breeding program: Evaluate forage yields, quality and other traits
- Phase 3: Regional small plot trials: Harvest trials
- Phase 4: Field scale or grazing trials of advanced lines: Field or grazing trial production harvests

## **Objective 1. Feedstock Development<sup>3</sup>**

The Feedstock Development objective 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 2012, the research team has concentrated on the establishment of new switchgrass breeding and evaluation trials.

### **1. Planned Activities**

- Switchgrass, big bluestem, and indiangrass yield tests planted at all locations.
- Switchgrass, big bluestem, and indiangrass selection nurseries and breeder seed increase nurseries transplanted to field nurseries.
- Stand and survival notes taken on all switchgrass selection nurseries established in 2011. Heading and other notes completed.
- Nurseries monitored for insects and other arthropods. Initial evaluations of selected switchgrass strains and other bioenergy grasses for susceptibility/resistance to aphids.
- Nurseries monitored for plant pathogens.
- Switchgrass, big bluestem, and indiangrass sample sets assembled for analyses by CenUSA collaborator Bruce Dien (ARS Peoria) and for initial pyrolysis work by CenUSA collaborator Akwasi Boateng (ARS-Wyndmoor).
- Select method for analyzing for carbohydrates and set up instrument.
- Initiate pyrolysis research on selected sets of switchgrass biomass samples.

### **2. Actual Accomplishments (May 1, 2012 – July 20, 2012)**

- Switchgrass, big bluestem, and indiangrass yield trials planted at 13 locations by CenUSA collaborators and cooperators. Included in the trials are 22 switchgrass entries (7 cultivars and 15 experimental strains), 12 big bluestem entries (7 cultivars and 5 experimental strains), and 12 indiangrass entries (6 cultivars and 6 experimental strains). Trial locations and cooperators are listed in Table 1. Initial stand information will be collected in 2012.
- Two switchgrass, one big bluestem, and five indiangrass half-sib family selection nurseries were established at the University of Nebraska's Agricultural Research and Development Center near Mead, Nebraska using greenhouse grown seedlings (Table 2).

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<sup>3</sup> Date of report: July 20, 2012.

Over ten thousand plants were transplanted to establish these nurseries. A big bluestem seed increase nursery was also transplanted.

<b>Table 1. CenUSA Yield test locations and cooperators</b>			
Location	Collaborator	Funding source	HZ <sup>4</sup>
Arlington, WI	Michael Casler	Casler	4a
Prairie du Sac, WI	Michael Casler	Casler	4a
Marshfield, WI	Michael Casler	Casler	4b
Grand Rapids, MN	Russ Mathison	Casler-SCA	3b
Chatham, MI	Doo-Hong Min	Casler-SCA	4b
Urbana, IL	DK Lee	Casler-SCA	5b
Wooster, OH	Mark Sulc	Casler-SCA	5b
West Lafayette, IN	Keith Johnson	CENUSA	5b
State College, PA	Paul Adler	CRIS	6a
Mead, NE	Ken Vogel	Vogel	5a
Brookings, SD	Arvid Boe	Vogel-SCA	4a
Ames, IA	Ken Moore	CENUSA	5a
Columbia, MO	Rob Kallenbach	Vogel-SCA	5b

- Four switchgrass selection nurseries established in 2011 at the ARDC for this project were managed for biomass production (Table 2).
- Four switchgrass half-sib family selection nurseries were established at the University of Wisconsin Arlington Agricultural Research Station in 2012. These nurseries included ~15,000 plants to be used for genomic selection for increased biomass yield.
- Data collection was initiated in two switchgrass half-sib family selection nurseries were established at the University of Wisconsin Arlington Agricultural Research Station in 2011. Phenotypic and genotypic data from these two nurseries will form the initial training population for genomic selection.

<sup>4</sup> HZ = USDA Plant Hardiness Zone. See <http://planthardiness.ars.usda.gov/PHZMWeb/>.

**Table 2. CenUSA Selection, crossing, and seed increase nurseries established in 2012 and status of nurseries established in 2011 for CenUSA research by the Lincoln, NE and Madison, WI breeding programs.**

Species	Experiment	Population Description	Nursery type	Status
<b>Switchgrass</b>	PV-1201-2103	Kanlow N2 winter survivor C2 Sel. Nurs.	Lowland, tetraploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings.
	PV-1202-2103	NE 2010 8X HYLD-HDMD C1 Sel. Nursery	Upland octaploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings
	PV-1103-70	KxS HP1 NET02 C3 selection nursery.  Duplicate nursery in WI.	Low-upland tetraploid hybrid pop. Half-sib family selection nursery	Established in 2011. Stands, disease, yield & quality data in 2012.
	PV-1104-70	Summer Late Mat. HYLD C3 selection	Upland tetraploid half-sib family selection nursery.	Established in 2011. Stands, disease, yield & quality data in 2012.
	PV-1107-70	SWAG1 – Genome wide Selection in WS4U Switchgrass.  Duplicate of nursery in WI.	Northern tetraploid half-sib family genomic selection nursery	Established in 2011. Stands, head date, yield & quality data in 2012.
	PV-1105-70	CIR C5 selection nursery	HZ 6 upland, octaploid half-sib family selection nursery	Established in 2011. Stands, yield & quality data in 2012.
<b>Big Bluestem</b>	AG-1213-2103	MW5B C2 selection nursery.	Plant hardiness zone (HZ) 5B Midwest germplasm half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings
	AG-1214-2103	MW5B C1 seed increase nursery.	Seed increase nursery for next generation of testing.	Established in 2012 using greenhouse grown seedlings
<b>Indiangrass</b>	SN-1207-2013	Oto C3 HYLD-HDMD C5 Sel. Nursery	Central Plains & western MW HZ 5/6 half-sib family selection nursery.	Established in 2012 using greenhouse grown seedlings
	SN-1208-2103	NE 54 HYLD-HDMD C4 Sel. Nurs.	Central Plains HZ 5 half-sib family sel. Nursery.	Established in 2012 using greenhouse grown seedlings



**Table 2. CenUSA Selection, crossing, and seed increase nurseries established in 2012 and status of nurseries established in 2011 for CenUSA research by the Lincoln, NE and Madison, WI breeding programs.**

Species	Experiment	Population Description	Nursery type	Status
	SN-1209-2103	HoltxOto Early HYLD-HDMD C4 Sel. Nurs.	Central Plains & western MW HZ 4 half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings
	SN-1210-2103	SN HZ 4 C2 Sel. Nurs.	Midwest HZ 4 germplasm in half-sib family selection nursery.	Established in 2012 using greenhouse grown seedlings
	SN-1211-2103	SN HZ 5 C2 Sel. Nurs.	Midwest HZ 4 germplasm in half-sib family selection nursery.	Established in 2012 using greenhouse grown seedlings.
<b>Madison, Wisconsin</b>				
Switchgrass	SWAG3	WS10L selection nursery.	Lowland, tetraploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings.
Switchgrass	SWAG3	WS11L-OK selection nursery.	Lowland, tetraploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings.
Switchgrass	SWAG3	WS11L-IL selection nursery.	Lowland, tetraploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings.
Switchgrass	SWAG3	WS11L-NJ selection nursery.	Lowland, tetraploid half-sib family selection nursery	Established in 2012 using greenhouse grown seedlings.
Switchgrass	SWAG1	WS4U-C2 selection nursery.  Duplicate of nursery in NE.	Northern tetraploid half-sib family genomic selection nursery	Established in 2011. Stands, head date, yield & quality data in 2012.
Switchgrass	SWAG2	KxS HP1 NET02 C3 selection nursery.  Duplicate nursery in NE.	Low-upland tetraploid hybrid pop. Half-sib family selection nursery	Established in 2011. Stands, disease, yield & quality data in 2012.

- CenUSA Collaborator Tiffany Heng-Moss and her staff (UNL) initiated sampling to identify and monitor potential arthropod pest and natural enemies associated with switchgrass and other bioenergy grasses. Samples are collected every two weeks throughout the growing season using pitfall traps and yellow sticky traps from switchgrass, big bluestem, and indiangrass nurseries. Potential pests are being

characterized as those arthropods capable of causing injury or serving as an arthropod vector.

- In a series of screening studies, yellow sugarcane aphids and greenbugs were identified as two potential pests of switchgrass. Four switchgrass populations (Kanlow, Summer, K x S, and S x K) were evaluated for resistance and compared with the primary host plants for these aphids (barley – sugarcane aphid, sorghum – greenbug). All four switchgrasses were less susceptible to yellow sugarcane aphid and greenbug feeding when compared with barley and sorghum. Additionally, significant differences were observed in resistance ratings among the four switchgrass populations, with Kanlow consistently exhibiting the lowest damage ratings and Summer the highest. Screening evaluations with Russian wheat aphid and bird cherry-oat aphid indicate that switchgrass is not a suitable feeding and/or reproductive hosts for these two aphids.
- Initial evaluations of field experiments (selection nurseries) by plant pathologists (CenUSA Collaborator Gary Yuen and staff, UNL) in early June 2012 yielded fungi known to be pathogenic on switchgrass or pathogenic on grasses in general, including *Alternaria alternata*, *Bipolaris sorokiniana*, *Curvularia geniculata*, and *Phyllosticta* sp. In addition, numerous strains of yet unidentified fungi and bacteria were isolated. Rating of select experiments for severity of leaf spot, virus, and other diseases was initiated. Leaf spot ratings in two experiments (PV-1103-70 and PV-1105-70) revealed leaf spots to be limited to older growth in the lower canopy, with new growth exhibiting little or no symptoms of leaf spot. Subsiding of leaf spot since the beginning of June was likely due to high temperatures and low precipitation favoring switchgrass growth while restricting growth of pathogens. Little to no leaf spot symptoms in new growth were observed in other experiments as well. Rust was notably absent from the plantings. Little to no leaf spot symptoms in new growth were observed in other experiments as well. Rust was notably absent from the plantings. In five experiments (PV-1103-70, PV-1104-70, PV-1105-70, PV-1107-70, and PV-0910-2102N) rated for virus disease, marked differences in virus symptom severity were observed among half-sib family plots and within families.
- A set of switchgrass standard samples was sent to researchers conducting composition (Bruce Dien) and pyrolysis analyses (Akwasi Boateng; Robert Brown, ISU). Samples of other species are being compiled and selected for additional work.
- Bruce Dien has selected compositional analysis protocols. High-Performance Anion Exchange Chromatography with Pulsed Amperometric Detection (HPAE-PAD) was selected for measurement of biomass carbohydrates. A muffle oven has also been set up and is in use for ash and Klason lignin analysis. A Leco nitrogen analyzer will also be used.



- Selected condensable gases compounds (28) and non-condensable gases (8) for non-catalytic and catalytic pyrolysis over HZSM5 were quantified for pyrolysis of 12 switchgrass genotypes (Sarath et al., Bioresource Technology 102:9579-9585) known to differ in lignin and other composition factors using methods developed on the py-GC/MS by Boateng and staff (ARS-Wyndmoor). Char yields (wt.%) were determined using the CDS Pyroprobe and the ash content of the biomass was determined by complete combustion at 900 °C utilizing TGA. Overall mass balance of solid, liquid and gaseous pyrolysis products was completed using the above results. Total liquid (condensable gas) yield was determined by difference after measuring the char and gas (CO, CO<sub>2</sub>, CH<sub>4</sub>, and C<sub>2</sub>-C<sub>4</sub> hydrocarbons) yields. An initial ANOVA was conducted to determine statistically significant differences within the results. The complete data set has been forwarded back to ARS-Lincoln (Gautam Sarath & Ken Vogel) for more advanced statistical analyses.
- Initiated the analyses of the thermal decomposition properties of Cave-in-Rock and Kanlow switchgrass samples harvested at different levels of maturity (Boateng & staff). Completed TGA experiments of switchgrass samples at 700 °C. Used the data generated to perform kinetic analysis using Specialty Library software to calculate the average kinetic parameters (e.g. activation energy, pre-exponential factor).
- Five additional Cave-in-Rock and Kanlow switchgrass samples were studied by py-GC/MS in a manner similar to that described in item 1 (Boateng & staff). Samples were pyrolyzed at various temperatures (450, 550, 650 °C) with 6 repetitions for each sample for condensable and non-condensable gases. Performed CHNS/O analysis for each sample. Conducted statistical analysis (ANOVA) on NCG data and identified statistically significant differences in the production of individual pyrolysis products due to changing pyrolysis temperature and sample type.

### **3. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

### **4. Plans for Next Quarter**

- Initial stand counts will be made on switchgrass, big bluestem, and indiangrass yield tests planted in the spring of 2012.
- Switchgrass, big bluestem, and indiangrass selection nurseries and breeder seed increase nurseries transplanted to field nurseries in 2012 will be maintained. No year 1 data will be collected.

- Biomass yield harvests will be made on a family basis for all selection nurseries established in 2011. Samples will be collected from all family plots for quality analyses. Heading and other data collection will be completed.
- Seed will be harvested from specific polycross nurseries and increase fields for use in additional testing.
- Insects will be monitored biweekly through the end of September 2012.
- A series of greenhouse screening evaluations will be carried out to evaluate selected switchgrass, big bluestem, and indiangrass cultivars and experimental strains for their susceptibility to greenbugs and sugarcane aphids.
- Initiate work on identifying virus species causing severe symptoms on some plants in the field and begin conducting statistical analyses of disease severity data.
- Initiate testing of fungal and bacteria stains isolated from diseased leaves for pathogenicity on switchgrass.
- Initiate work on isolating fungi from switchgrass diseased crown and root tissue.
- Initial biomass mineral composition data will be collected on a standard set of switchgrass samples representing specific biomass types and harvest maturities.
- We will hire and train a technician to carry out analyses of additional expected project samples.
- Initial analyses on switchgrass biomass standards will be completed for composition and pyrolysis tests.
- In the pyrolysis research, we will use TGA Instrument's Specialty Library to perform kinetic analyses of the switchgrass samples and determine the average activation energy, pre-exponential factor and order of reaction for each sample based on TGA results. We will correlate to full composition data when available.
- Continue analysis work, including the statistical analysis, of the relationship between pyrolysis products and composition of biomass from switchgrass genotypes known to differ genetically for biomass composition and for biomass of different cultivars harvested at different maturity stages.
- Big bluestem and indiangrass sample sets will be developed for comprehensive analyses and initial NIRS scans of samples will be completed.

## 5. Publications, Presentations, and Proposals Submitted

- Sandra Schaeffer, Frederick Baxendale, Tiffany Heng-Moss, Ransom Sitz, Gautam Sarath, Robert Mitchell, and Robert Shearman, “Characterization of the Arthropod Community Associated with Switchgrass (Poales: Poaceae) in Nebraska,” *Journal of the Kansas Entomological Society* 84(2) (2011): 87-104.
- Ken Vogel. “Biofuels and the Environment: Environmental Assessment Endpoints for Feedstock Production” (Invited presentation on perennial grasses at Environmental Protection Agency workshop, November 29, 2011).
- Ken Vogel. “Biomass Biofuel Policy, Switchgrass Genetics, and Next Generation Bioenergy Varieties” (Invited workshop sessions at the CenUSA Bioenergy Switchgrass Field Day at the University of Nebraska’s Agricultural Research and Development Center, Ithaca, Nebraska, March 2012). Also gave training session on conversion technologies. Workshop was a professional development field day for extension educators, state agencies, federal agencies, and others. Presentation was video taped for future webinars by University of Nebraska and Iowa State University staff for use by CenUSA Bioenergy, March 20, 2012).
- Ken Vogel. Invited briefing on the use of perennial grasses for bioenergy for the 2012 CenUSA Bioenergy summer 2012 internship program, Iowa State University. June 11, 2012.
- Kyle Koch, Jeff Bradshaw, and Tiffany Heng-Moss. “Evaluation of Switchgrass for Resistance to the Yellow Sugarcane Aphid, *Sipha flava* (Forbes).” (First place prize in the student poster competition Entomological Society of America Annual Meeting, Reno, Nevada, 2011)
- Kyle Koch, Rachael Fithian, Jeff Bradshaw, and Tiffany Heng-Moss. “Evaluation of switchgrass for resistance to potential aphid pests.” (First place prize in the student oral competition North Central Branch Entomological Society of America Annual Meeting, Lincoln, Nebraska, 2012.

## ***Executive Summary - Sustainable Feedstock Production Systems***

This CenUSA Bioenergy 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 goal is to produce a quantitative assessment of the net energy balance of candidate systems and optimize perennial feedstock production and ecosystem services on marginally productive cropland while maintaining food production on prime land.

### **Co-Project Directors**

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- David Laird, Iowa State University. [dalaird@iastate.edu](mailto:dalaird@iastate.edu) / (515) 294-1581

### **Accomplishments – Year 1**

Seed factor analysis plots have been established in Iowa, Illinois, Indiana, Minnesota, and Nebraska. Soil samples have been secured and analyzed. Plots have fertilized based on soil test recommendations. Weed competition has been monitored and necessary control measures implemented. Where possible, environmental measurements have started, including greenhouse gas (GHG) measurements.

The group sponsored two CenUSA undergraduate interns who were actively involved in research activities during the summer of 2012.

### **Planned Activities – Year 2**

- Monitor growth of newly established perennial system and factor plots and intervene as necessary with management tools to aid establishment.
- Continue to monitor weed pressure and establishment and use control measures as necessary.
- Continue soils analysis for nutrients and carbon.
- Where possible, install necessary equipment and begin environmental measurements, including GHG concentrations.
- Analyze tissues for cellulose, hemicellulose, lignin, ash, and other constituents.
- Harvest plots for biomass at or near the killing frost for each location, and calculate yields.
- Conduct statistical analysis of data.
- Prepare annual reports of data for GHG emissions, biomass production, surface soil, and management.
- Continue to improve biophysical models.

## Objective 2. Sustainable Feedstock Production Systems<sup>5</sup>

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. In Project Year 1 this team focused on establishment of new test plots.

### 1. Planned Activities

- Establish Factor Analysis plots. Where necessary identify location-specific candidate feedstocks and seed plots.
- Secure and analyze soil samples. Fertilize according to soil test recommendations.
- Establish systems analysis plots where appropriate.
- Use best management practices for establishing these biomass species.
- Collect data on existing trials relevant to CenUSA goals and objectives.

### 2. Actual Accomplishments

- **Iowa State University**
  - ✓ **Seed Factor Analysis plots.** Monitor establishment and weed competition, and use control measures as necessary.
  - ✓ **Seed Systems Analysis Plots in IA.** Seed annual systems, fertilize, apply weed control measures, and other agronomic practices as necessary. Where possible, install necessary equipment and begin environmental measurements, including greenhouse gas (GHG) measures.
  - ✓ Analysis of 1.2 m soil cores from system plots is continuing.
- **University of Minnesota**
  - ✓ **Location.** Identified Factor Analysis (FA) plot site at U of MN Sand Plain Research Farm (SPRF) in Becker, Minnesota, on excessively drained Hubbard loamy sand. The

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<sup>5</sup> Date of report: July 25, 2012.

field has been used primarily for bulk rye, although a detailed analysis of cropping history will be compiled at a later date. FA plot layout was designed to accommodate field dimensions and meet study objectives. Sub-subplots are 6 x 15 ft. (1.8 x 4.6 m) each.

- ✓ **Soil:** Prior to identifying this field for the FA plots, a rye crop was planted the previous fall and 50 lbs. N per acre was applied in late March. However, an astonishing 13.2 inches of rain (more than twice the climatological average) fell between N application and planting.

In late April 2012, the immature rye was killed with glyphosate. Results from the April 10 soil cores (0-6", averaged over the plot) were as follows:

- Bray P: 25 ppm
- Ammonium acetate extractable K: 54 ppm
- Organic matter: 1.4%
- pH: 6.4

The field was fertilized based on test results (P and K), chisel plowed, cultivated and packed prior to seeding. A second round of soil cores (0-2 ft. for nitrate-N analysis) was collected at planting, May 31, 2012. We are awaiting results of those tests.

- ✓ **Feedstocks.** In addition to the required feedstocks, we used three location-specific feedstocks to square the plots and better facilitate a robust experimental design within our space. We have a total of 210 sub-subplots. The location-specific feedstocks are as follows:
  - F4: High-diversity polyculture (MN-adapted CRP mix)
  - F5: "Sunburst" switchgrass
  - F6: Low diversity grass mix (F3) plus native legumes (purple prairie clover, Canada milk vetch, showy tick trefoil).
- ✓ **Establishment.** Planting was scheduled for mid-May, but poor weather, followed by equipment problems, delayed planting until May 31, 2012. Seeding was accomplished using a small plot drill with the exception of the low-diversity mix (F3 and F6), which was too fluffy for the drill. The grasses on the F3 and F6 plots were hand seeded and the legumes on the F6 plots were drilled. The first wet period, starting 10 days after planting (4.3 inches within 10 days), was followed by a prolonged dry period. The first irrigation was June 22, 2012 (0.4 inches), as grasses

were just emerging. Due to excessively drained soils, excessive heat and dry weather patterns, irrigation will continue as needed to ensure establishment. Plots are being monitored and photographed at near-weekly intervals. To date, no weed control has been warranted.

- **University of Illinois**

- ✓ Establish new Factor Analysis plots on wet marginal land (Land Capability Class 5W) with 3 standard feedstocks: 'Shawnee' switchgrass, bioenergy switchgrass and low diversity mixture (big bluestem, indiangrass and sideoats gramma) and 3 local feedstocks: 'Savoy' prairie cordgrass, *Miscanthus x giganteus* and mixture ('Savoy' and '17-101' big bluestem). The selected site has been abandoned for 5 years due to frequent spring flooding. Factor analysis plots were established on the fallow ground. The site was prepared using a disk harrow and packed with a cultipacker before seeding. The plots were seeded at 30 PLS/ft<sup>2</sup> seeding rate using a no-till drill with 7.5 inch row spacing in May 17, 2012 with leaving the space for miscanthus for later transplanting. A pre-emergent application of 1 quart of atrazine (Bicep) plus 8 oz. of quinclorac (Paramount®) per acre was applied to the plots containing switchgrass, prairie cordgrass and prairie cordgrass mixture. The plots containing the mixture of big bluestem, indiangrass, and sideoats gramma grass were sprayed with 4 oz. of imazapic (Plateau®) per acre the next day of seeding. *Miscanthus* plugs were planted on June 6, 2012. The plots were mowed to control the weeds on June 20 then sprayed with 2-4-D at the rate of 2 quarts per acre on June 26, 2012 to control broadleaf weeds.
- ✓ For the comparison trial, the light interception measurements were taken on a weekly basis with AccuPAR LP-80 Ceptometer (Decagon Devices, Inc. 2365 NE Hopkins Ct. Pullman, WA 99163 - USA.) Two spots were selected in each plot and the light measurements were taken for outside and under the canopy to determine the light intercepted by grasses in each plot. Height measurements were also taken on a weekly basis to determine the growth rate.
- ✓ Maintained plots and collected data from the existing comparison trial established in 2010 with the objective of evaluating yield and overall performance of four accessions of prairie cordgrass 'PC-17-104', 'PC-17-109', 'PC-46-102', and 'PC-20-107' with *Miscanthus x giganteus*, Illinois local big bluestem, and 'Kanlow' switchgrass on a marginally-productive land because of poor drainage.

- **Purdue University**

- ✓ Establish Factor Analysis plots/research. This included:



- Seeding the biomass sorghums and maize plots and fertilizing with 0 to 150 kg/ha N at three locations.
- Fertilize 80 switchgrass plots previously fertilized with 0 to 75 kg P/ha (four rates) and 0 to 400 kg K/ha (five rates) with 75 kg/ha N in order to explore the interaction of K and P on biomass production and composition.
- Fertilized 16 large plots established on a site with contrasting soil test P and K with four N rates (0 to 150 kg N/ha) in order to evaluate an N x P x K interaction for biomass yield and composition.
- Fertilized *Miscanthus x g* established on a site with low soil test P and K with 0 to 150 kg N/ha (4 rates, 50 kg/ha increments) and either 400 kg K/ha and 75 kg P/ha or no P and K fertilizer. As in subsection 3 above, our goal is to determine the N x P/K interaction for biomass yield and composition for this species.
- Switchgrass and the native prairie seeded in 2011 were reseeded at one location because of stand failure.
- GHG measurements began on a subset of the Factor Analysis plots at Throckmorton Purdue Ag Center 25 km from the Purdue campus.
- Weed control and plot maintenance activities were implemented on all Factor Analysis plots.
- ✓ Systems Analysis Plots.
  - Perennial biomass plots (*Miscanthus*, switchgrass) were fertilized with 75 kg N/ha. For a comparison, the native prairie plots were left unfertilized.
  - Dual-purpose biomass sorghum, maize with and without stover removal, and the soybean-maize rotation plots (control) were established using best management practices.
  - GHG measurements on these plots started at time of N fertilization.
  - Weeds and insects are being controlled using best management practices.
- **USDA-ARS, Lincoln**
  - ✓ Established Factor Analysis plots. This included:



- Seeded a replicated field trial of ‘Shawnee’ switchgrass, an experimental strain of Bioenergy switchgrass, a low diversity mixture, an experimental strain of Bioenergy big bluestem, and a big bluestem mixture on May 17 and 18, 2012.
  - Sprayed FA plots on May 30, 2012 for weed control.
  - Stand frequencies were collected on July 6, 2012.
    - Shawnee switchgrass – 65%
    - Bioenergy switchgrass – 52%
    - Big bluestem – 49%
    - Bioenergy big bluestem – 32%
    - Low diversity mix – 42%
  - Stand frequencies were lower than System Analysis plots, likely due to later planting.
  - Good weed control to date.
  - Severe drought has stressed the plantings.
- ✓ System Analysis Plots. Continued management activities following planting in April 2012.
- Pre-emergent application of appropriate herbicides on 9 and 10 May.
    - Big bluestem & Low diversity mix – 4 oz. of Plateau
    - Switchgrass – 8 oz. of Paramount + 1 qt. of atrazine
    - Sprayed with 1 qt. of 2,4-D in July to control broadleaf weeds
  - Soil samples were collected on June 14 , 2012 by split plot.
  - Stand frequencies were collected on July 9, 2012.
    - Bioenergy switchgrass – 84%
    - Big bluestem – 68%
    - Low diversity mix – 60%
  - No fertilizer or irrigation was applied.

- Although severe drought has stressed the plantings, excellent stands exist.
- ✓ Sponsored two CenUSA student interns, Chris Anderson and Kirsten Paff. They have become actively involved in the research activities of the CenUSA project and have traveled to numerous research and demonstration sites in Nebraska.

### **3. Explanation of Variance**

No variance has been experienced at any location and accomplishments are on schedule.

### **4. Plans for Next Quarter**

- Monitor growth of newly established perennial system and factor plots. At some locations photo-document establishment and growth on a near-weekly basis.
- Continue to monitor the weed pressure and establishment and use control measures as necessary.
- Harvest plots for biomass (where it makes sense to do so) at or near the killing frost for each location, and subsample biomass for compositional analysis.
- Continue soils analysis. Some soil samples will be analyzed for nitrate levels to a depth of 60 cm.
- Design and test GHG monitoring system for new system plots
- At some locations continue to maintain and collect the light interception and height measurements for the comparison trial.
- Initiate 2012 research on the Systems Analysis plots in Indiana, Iowa, and Nebraska. Seed perennial Systems Analysis Plots in Iowa. Seed annual systems, fertilize, apply weed control measures, and other agronomic practices as necessary. Where possible, install necessary equipment and begin environmental measurements, including GHG concentrations.

### **5. Publications, Presentations, and Proposals Submitted**

- Mitchell, Rob. 2012. “Grasslands for bioenergy, Nebraska Range Short Course” (Invited presentation to University of Nebraska and Chadron State College, Chadron, Nebraska, June 20, 2012).
- Volenec, Jeff. “Biomass research at Purdue University” (Presentation to North Central Regional Research Committee 31,” Bloomington, Minnesota, June 19-21, 2012).

- Volenec, Jeff, Sylvie Brouder, Indrajeet Chaubey, and Benjamin Gramig. 2012. “Integrating bioenergy crops into the landscape. Biomass 2012: Confronting challenges, creating opportunities. Sustaining the commitment to bioenergy” U.S. DOE, Washington, DC., July 10-11, 2012).
- Woodson, P., S.M. Brouder and J.J. Volenec. “Field-scale K and P fluxes in the bioenergy crop switchgrass: Theoretical energy yields and management implications.” J. Plant Nutrition and Soil Science (2012.submitted).

## ***Executive Summary - Feedstock Logistics***

The Feedstock Logistics Objective focuses on developing systems and strategies to enable sustainable and economic harvests, 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.

### **Co-Project Directors**

- Stuart Birrell, Iowa State University. sbirrell@mail.iastate.edu / (515) 294-2874
- Kevin Shinnars, University of Wisconsin-Madison kjshinne@wisc.edu / (608) 263-0756

### **Accomplishments – Year 1**

Several fields of grass and straw were round baled, and bales were either randomly distributed or strategically accumulated in one field location as if the baler were equipped with a bale accumulator. An experienced operator loaded bales onto trailers and bale handling was quantified by time, distance traversed, and fuel use per bale. We found that accumulating bales reduced fuel expenditures by 0.04 gal/ton DM. Accumulating bales had greater impact on bale handling expenditures when only one operator was used for both bale handling and trailer positioning. When a second person was available to strategically move the trailer in the field during loading, bale accumulation resulted in far less savings.

We have instrumented a tractor to measure Power Take Off (pto) power and total fuel use so that we can begin quantifying the energy required to size-reduce reed canarygrass and switchgrass bales. A conventional tub grinder has been rented and different size screens procured. We will begin these tests in late-July, 2012.

### **Planned Activities – Year 2**

- Work will continue on time and motion studies of bale handling and quantifying bale processor energy requirements.
- Continue research focused on improving the drying rate of perennial grasses.
- Develop standardized modules of compacted biomass that has been size reduced at harvest – and compare with the Idaho National Lab PDU system.
- Quantify the storage characteristics of the standardized biomass modules.
- Supply materials to cooperators to evaluate conversion efficiency and biochar quality.

### **Objective 3. Feedstock Logistics<sup>6</sup>**

The Feedstock Logistics Objective focuses on developing systems and strategies to enable sustainable and economic harvests, 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.

#### **1. Planned Activities**

Several activities were planned during the early summer period. We conducted a preliminary time and motion study of bale handling logistics and continued preparation for a study that quantifies the energy required to size-reduce reed canarygrass and switchgrass bales.

#### **2. Actual Accomplishments**

Several fields of grass and straw were round baled, and bales were either randomly distributed or strategically accumulated in one field location as if the baler were equipped with a bale accumulator. An experienced operator loaded bales onto trailers and bale handling was quantified by time, distance traversed, and fuel use per bale. Randomly distributed bales required 66 s per bale requiring 900 ft. travel per ton of Dry Matter (DM). Accumulated bale placement required 48 s per bale and 574 ft. travel per bale. Accumulating bales reduced fuel expenditures by 0.04 gal/ton DM. Accumulating bales had greater impact on bale handling expenditures when only one operator was used for both bale handling and trailer positioning. When a second person was available to strategically move the trailer in the field during loading, bale accumulation resulted in far less savings.

We have instrumented a tractor to measure Power Take Off (pto) power and total fuel use so that we can begin quantifying the energy required to size-reduce reed canarygrass and switchgrass bales. A conventional tub grinder has been rented and different size screens procured. We will begin these tests in late-July, 2012.

We have arranged for an additional 15-acre field of switchgrass in southwest Wisconsin to conduct additional harvest tests in late summer.

#### **3. Explanation of Variance**

There were no variances – we have accomplished all that we had planned for the spring harvest.

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<sup>6</sup> Date of report: July 19, 2012.

#### **4. Plans for Next Quarter**

Work will continue on time and motion studies of bale handling and quantifying energy requirements of bale processors. In August 2012, we will begin research concerning improving the drying rate of perennial grasses.

#### **5. Publications, Presentations, and Proposals Submitted**

None to report this period.

## ***Executive Summary - System Performance Metrics, Data Collection, Modeling, Analysis and Tools***

This research team focuses on providing 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.

### **Co-Project Directors**

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- Cathy Kling, Iowa State University. ckling@iastate.edu / (515) 294-5767

### **Accomplishments – Year 1**

We have acquired and are testing the Environmental Policy Impact Climate (EPIC) model, which is a field-scale environmental model that can be used for estimating soil erosion losses, nitrogen and phosphorus movement, and soil carbon sequestration.

We completed the draft of a policy brief that assesses the potential for cellulosic feedstocks to reduce the frequency and magnitude of flood events in the Raccoon River Watershed (Iowa). A manuscript based on this paper is now completed and under review at a journal.

A major component of our modeling work involves the improvement of SWAT models for the Upper Mississippi River Basin and the Ohio Tennessee River Basin with USGS 12-digit subwatersheds. We have made significant progress in developing the model and populating it with data. Our modeling structure will provide the ability to perform enhanced scenarios including greatly refined targeting scenarios to study placement of switchgrass and other biofuel crops in the landscape to evaluate the water quality and carbon effects at the landscape level.

We have performed initial simulations with the Agro-IBIS model. We have begun compiling data on yield gaps to reflect differences between plot trial and farm scale production. We are also gathering data on carbon storage under herbaceous bioenergy cropping systems. We are nearly finished compiling production costs and returns for current annual and forage crops.

### **Planned Activities – Year 2**

- Continue to adapt models to best represent data generated from field trials and other data sources.
- Continue to adapt existing economic land-use models to best represent cropping system production costs and returns.
- Integrate physical and economic models to create spatially-explicit simulation models representing a wide variety of biomass production options.
- Evaluate the lifecycle environmental consequences of various bioenergy landscapes.

#### Objective 4. System Performance Metrics, Data Collection, Modeling, Analysis and Tools

This research team focuses on providing 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.

##### 1. Iowa State University (ISU)<sup>7</sup>

###### a. Planned Activities (ISU)

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.

###### b. Actual Accomplishments (ISU)

- ***Environmental Policy Impact Climate Model (EPIC)***. We have acquired and are testing the most recent version of the *Environmental Policy Impact Climate* (EPIC) model, which is a field-scale environmental model that can be used for estimating soil erosion losses, nitrogen and phosphorus movement, and soil carbon sequestration. An improved version of EPIC0810 is adopted here to account for emission estimates of two important greenhouse gases: nitrous oxide gas and N<sub>2</sub> (dinitrogen gas). This version of EPIC operates with daily climatic inputs, but the denitrification computations are performed on an hourly time step using inputs from the soil organic submodel. This version of EPIC also contains the improved soil carbon cycling functions developed by Izaurralde et al. (2006).
- **Draft Policy Brief**. We completed the draft of a policy brief that provides an **assessment** of the potential for cellulosic feedstocks to reduce the frequency and magnitude of flood events in the Raccoon River Watershed in Iowa. We use a watershed **based** hydrologic model to represent changes in water movement under different land uses in the watershed. First, we develop a baseline scenario of flood risk based on the current land use and typical weather patterns. We then simulate the effects of varying levels of increased perennials on the landscape under the same weather patterns and compare the change in stream flows and water quality to the baseline scenario. A manuscript based on this paper is now completed and under review at a journal.

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<sup>7</sup> Date of report: July 17, 2012 (Catherine L. Kling, Iowa State University).



A major component of the ISU-CARD modeling work in this objective involves the improvement of SWAT models for the Upper Mississippi River Basin (UMRB) and the Ohio Tennessee River Basin (ORTB) with USGS 12-digit subwatersheds. This effort is also supported by a National Science Foundation grant. During the first year of the CenUSA project, significant progress in developing the model and populating it with data has been achieved. There is now a much denser subwatershed delineation; e.g., 5,279 12-digit subwatersheds versus 131 8-digit subwatersheds for the UMRB. This modeling structure will provide the ability to perform enhanced scenarios including greatly refined targeting scenarios to study placement of switchgrass and other biofuel crops in the landscape to evaluate the water quality and carbon effects at the landscape level.

**c. Explanation of Variance (ISU)**

No variance has been experienced and accomplishments are on schedule.

**d. Plans for Next Quarter (ISU)**

We will continue work on the first two tasks:

- **Task 1.** Adapt existing biophysical models to best represent field trials and other data and
- **Task 2. Adapt** existing economic land-use models to best represent cropping system production costs and returns.

With respect to the second task, the current phase of model development involves incorporation of key land use and stream system management parameters into the UMRB and ORTB modeling systems. The effects of subsurface tile drains will be incorporated into the UMRB and ORTB models based on the spatial dataset compiled by the *World Resources Institute* and as described in the on-line report *Assessing U.S. Farm Drainage: Can GIS Lead to Better Estimates of Subsurface Drainage Extent?*<sup>8</sup> Subsurface tile drains are key conduits of nitrate within UMRB and ORTB cropping/soil systems and thus must be accounted for in the modeling system. These data are assembled at a county level and will first be aggregated to the 8-digit watershed level and then disassembled to the 12-digit subwatershed level. Tillage practices will be imputed to cropped areas within both of the study regions based on the tillage data assembled by the *United States Geological Survey*.<sup>9</sup> These data are currently available at the 8-digit watershed level and will have to be disassembled to the 12-digit subwatershed level.

<sup>8</sup> The report is available on-line at [http://pdf.wri.org/assessing\\_farm\\_drainage.pdf](http://pdf.wri.org/assessing_farm_drainage.pdf).

<sup>9</sup> The data is described at <http://pubs.usgs.gov/ds/ds573/>.

Fertilizer and manure nutrient application rates will be based on the nutrient balance data assembled by the *International Plant Nutrition Institute* (IPNI) in their NuGIS database.<sup>10</sup> Specific crop fertilizer and manure nitrogen and phosphorus application rates will be estimated from these data, which are available at the 8-digit watershed level. The nutrient application rates determined at the 8-digit watershed level will be used directly for the cropped areas within the 12-digit subwatersheds. Additional development work will focus on the incorporation of other conservation practices (besides tillage), point sources on stream segments, and reservoirs on main river stems and tributaries.

#### e. Publications, Presentations, and Proposals Submitted (ISU)

- Kling, Catherine 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 to the *University of Iowa Hydraulics Laboratory, Iowa City, Iowa* available at <http://www.card.iastate.edu/environment/presentations.aspx>
- González-Ramírez, Jimena, Kling, Catherine L. and Valcu, Adriana. “An Overview of Carbon Offsets from Agriculture” forthcoming in the *Annual Review of Resource Economics* Vol. 4, October 2012. Review in advance available at <http://www.annualreviews.org.proxy.lib.iastate.edu:2048/doi/abs/10.1146/annurev-resource-083110-120016>.

## 2. University of Minnesota (UMN)<sup>11</sup>

#### a. Planned Activities (UMN)

Planned activities for fourth quarter of 2012 include continued work on Task 1 (Adapt existing biophysical models to best represent data generated from field trials and other data sources) and Task 2 (Adapt existing economic land-use models to best represent cropping system production costs and returns).

#### b. Actual Accomplishments (UMN)

We report continued progress on both Tasks 1 and 2.

- **Task 1.** (Adapt existing biophysical models to best represent field trials and other data) For Task 1 we have performed initial simulations with the Agro-IBIS model. We have begun compiling data on yield gaps to reflect differences between plot trial

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<sup>10</sup> The database is available at <http://www.ipni.net/nugis>.

<sup>11</sup> Date of report: July 28, 2012 (Jason Hill, University of Minnesota).

and farm scale production. We are also gathering data on carbon storage under herbaceous bioenergy cropping systems.

- **Task 2.** (Adapt existing economic land-use models to best represent cropping system production costs and returns) For Task 2 we are nearly finished compiling production costs and returns for current annual and forage crops. We are beginning to develop domain-wide enterprise budgets for bioenergy crops.
- **Task 4.** (Evaluate the life cycle environmental consequences of various bioenergy landscapes) We have also begun work early on Task 4 by outlining material and energy flows along biomass production, conversion, and fuel combustion stages.

**c. Explanation of Variance (UMN)**

No variance has been experienced and accomplishments are on schedule.

**d. Plans for Next Quarter (UMN)**

Next quarter will include continued work on Tasks 1, 2, and 4, and the beginning of Task 3 (Integrate physical and economic models to create spatially-explicit simulation models representing a wide variety of biomass production options).

**e. Publications, Presentations, and Proposals Submitted (UMN)**

- Sun, J. “Agro-IBIS Crop Simulation over the Mississippi River Basin” (Presentation at the Agro-IBIS User’s Group Meeting, Ames, IA, May 4, 2012).
- Anderson-Teixeira, K. J., P. K. Snyder, T. E. Twine, S. V. Cuadra, M. H. Costa, E. H. DeLucia. 2012. “Climate regulation services of natural and agricultural ecoregions of the Americas”, *Nature Climate Change*, doi:10.1038/nclimate1346.

## POST-HARVEST RESEARCH GROUP

Robert Brown, Director of Iowa State University's bio economy Institute leads the post harvest research group.<sup>12</sup>

The Post-Harvest group focuses on three project objectives:

- Feedstock Conversion/Refining
- Markets and Distribution

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<sup>12</sup> Robert Brown: rcbrown3@iastate.edu / (515) 294-7934

- Health and Safety

## ***Executive Summary - 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:

- Perform technoeconomic analysis of converting grass crops into fuel via pyrolysis.
- Preparing and characterizing Biochar for agronomic evaluations.

### **Co-Project Director**

- Robert Brown, Iowa State University. [rcbrown3@iastate.edu](mailto:rcbrown3@iastate.edu)/ (515) 294-7934

### **Accomplishments – Year 1**

Laboratory research has investigated the chemistry of a diverse group of biochars and has focused on quantifying inorganic and organic sources of alkalinity in red-oak fast pyrolysis char, corn stover fast pyrolysis char and cellulose slow pyrolysis char. We have established 16 new large-scale (0.3 5 4ha) in October 2011 with controls (0Mg/ha) and biochar (24Mg/ha) treatments at the ISU Armstrong Research and Demonstration Farm in Pottawattamie County, Iowa. Time zero soil samples have been loosely collected for these plots and are being analyzed to quantify the initial soil organic carbon stocks and other soil quality parameters.

### **Planned Activities – Year 2**

Field plot studies quantifying the impact of biochar on soil quality and carbon sequestration are on-going. The suitability of Biochar as a soil amendment and carbon sequestration agent is being addressed in three sets of long-term Biochar field trials, in coordination with the Sustainable Feedstock Production Systems objective.

- Continue to prepare and characterize Biochar at the ISU at the unique ISU pyrolysis pilot plant and py products characterization lab.
- Perform techno-economic analysis (TEA) of converting grass crops into fuel via pyrolysis.

## **Objective 5. Feedstock Conversion and Refining: Thermo-chemical Conversion of Biomass to Bio-fuels<sup>13</sup>**

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; and
- Preparing and characterizing Biochar for agronomic evaluations.

### **1. Planned Activities**

Evaluate the Bohem titration method for characterizing the acid-base chemistry of biochar surfaces.

### **2. Actual Accomplishments**

Laboratory research investigating the chemistry of a diverse group of biochars has focused on quantifying inorganic and organic sources of alkalinity in red-oak fast pyrolysis char, corn stover fast pyrolysis char and cellulose slow pyrolysis char. Field plot studies quantifying the impact of biochar on soil quality and carbon sequestration are on-going.

- Major accomplishments during the reporting period include evidence that Bohem titrations, which are widely used with activated carbons, are problematic for quantification of the pKa distributions of reactive organic functional groups on the surfaces of biochar due to the presence of inorganic alkalies in biochars and the leaching of soluble organic compounds from biochars during equilibrations with Bohem reactants. Total alkalinity of cellulose, corn stover and red oak biochars were 0.23, 0.26, and 1.43 meq/g, respectively, and found to vary widely in proportions of organic functional groups, carbonates and other inorganic alkalis contributing to total alkalinity. The results indicate that the liming value (calcium carbonate equivalent) of most biochars will be relatively low, ranging from 1 to 7% that of pure CaCO<sub>3</sub>.

### **3. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

### **4. Plans for Next Quarter**

Evaluate water sorption isotherms of diverse biochars.

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<sup>13</sup> Date of report: July 31, 2012.

## **5. Publications, Presentations, and Proposals Submitted**

- Catherine Brewer, Eric Hall, Jeff Rudisill, Klaus Schmidt-Rohr, David Laird, Robert C. Brown. “Effect of Oxygen in Slow Pyrolysis Reaction Atmosphere on Biochar Properties” (Presentation to 2012 U.S. Biochar Initiative Conference, Rohnert Park, California, July 30, 2012).
- Rivka B. Fidel, David A. Laird, and Michael L. Thompson. “Evaluation of three modified Boehm titration methods for use with biochars” (2012 U.S. Biochar Initiative Conference, Rohnert Park, California, July 30, 2012).



## ***Executive Summary - Markets and Distribution***

The Markets and Distribution objective recognizes that a comprehensive strategy to address 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.

### **Co-Project Directors**

- Dermott Hayes, Iowa State University. [dhayes@iastate.edu](mailto:dhayes@iastate.edu) / (515) 294-6185
- Keri Jacobs, Iowa State University. [kljacobs@mail.iastate.edu](mailto:kljacobs@mail.iastate.edu) / (515) 294-6780

### **Accomplishments – Year 1**

- We have begun to collect switchgrass trial data for CenUSA relevant states. We have submitted a proposal to the USDA to establish a memorandum of understanding that permits access to micro-level CRP data for signups 27 through 40 (recent general and continuous signups).

### **Planned Activities – Year 2**

- We have begun to collect switchgrass trial data for CenUSA relevant states. We expect this will continue into the next quarter. We will also continue to:
  - ✓ Pursue access to the necessary CRP data.
  - ✓ Work with other CenUSA objectives to develop a usable definition for marginal land.
  - ✓ Analyze switchgrass trial data.
  - ✓ Synthesize and distribute findings from our research intern's work.
- To identify the barriers and drivers of implementation of the biomass production system, we will participate in an Integrated Crop Management extension series in November 2012. A collaborative effort with CenUSA Extension and Outreach colleagues will allow our team to gather information from producers and stakeholders that will be used to inform our modeling efforts and the policy and market mechanisms necessary to make the system viable. Information will be gathered via a CenUSA developed survey at the ICM event.

## Objective 6 Markets and Distribution<sup>14</sup>

The Markets and Distribution objective recognizes that a comprehensive strategy to address 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 – Iowa State University

The team had three planned activities for the fourth quarter of 2012: 1) begin to assess and formalize the “barriers and drivers of implementation” of the biomass production system; 2) continue collection of switchgrass trial data; and 3) contact the USDA to obtain updated micro-level CRP data.

### 2. Actual Accomplishments

Each of our planned activities has been further advanced in the fourth quarter, and we continue to make progress on our Year 1 and Year 2 planned tasks (Tasks 1 and 2).

- With a goal of identifying the barriers and drivers of implementation of the biomass production system, our team has arranged to participate in an Integrated Crop Management (ICM) extension series during November 2012. A collaborative effort with CenUSA colleagues Jill Euken, Chad Hart, Sorrel Brown, and other project participants in Objective 9 (Extension and Outreach) will allow our team to gather information from producers and stakeholders that will be used to inform our modeling efforts and the policy and market mechanisms necessary to make the system viable. We will seek input from collaborators and scientists from nearly all other objective teams to accomplish this. Information will be gathered via survey at the ICM.
- Team member Richard Perrin is collecting switchgrass trial data from states relevant to our study. We expect this will continue into the next quarter.
- Our team submitted a proposal to the USDA to establish a memorandum of understanding that permits access to micro-level CRP data for signups 27 through 40

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<sup>14</sup> Date of report: July 21, 2012

(recent general and continuous signups). These data include parcel-specific information on a type of marginal land that may be used in the project's system. Specific information will be used to develop expectations of switchgrass biomass cost estimates, yields, and expected production penalty of switchgrass relative to competing crops. Our team anticipates a delay of several months before these data will be available to us, if the USDA is able to make them available.

- Objective 6 CoProject Directors Dermot Hayes and Keri Jacobs are hosting a CenUSA undergraduate research intern this summer. The intern, Katherine Manz has chemistry training, therefore, we have asked her to identify each step in the bioenergy production system – for both corn stover and switchgrass – to compare the net energy requirements of each. Our goal is to use this information to develop efficiency comparisons between corn stover and switchgrass systems.

### **3. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

### **4. Plans for Next Quarter – Iowa State University**

During the first of year 2 (August – October 2012) our team will: 1) continue to pursue access to the necessary CRP data; 2) work with other CenUSA objectives to develop a usable definition for marginal land; 3) analyze switchgrass trial data; 4) synthesize and distribute findings from our research intern's work; and 5) develop the survey instrument to be administered during the ICM.

### **5. Publications, Presentations, and Proposals Submitted**

A MOU proposal was submitted to the USDA (described above).

## ***Executive Summary - Health & 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.

### **Co-Project Directors**

- Mark Hanna, Iowa State University. hmhanna@iastate.edu / (515) 294-0468
- Chuck Schwab, Iowa State University. cvschwab@iastate.edu / (515) 294-4131

### **Accomplishments – Year 1**

The major duties and responsibilities for the task *Managing Risks in Producing Feedstocks* have been preliminarily identified. A safety instruction publication has been developed for the Extension and Outreach objective's Master Garden program. The publication *Master Gardeners' safety precautions for handling, applying, and storing biochar* was distributed to Master Gardener program volunteers to provide information about the safety precautions to use when handling, applying, and storing of biochar. The Health and Safety team participated in the CenUSA eight-week internship program by hosting Ms. Chrysantha Smith from Sweet Briar College. Ms. Smith's internship was focused on applying a risk analysis of the various tasks associated with establishing biomaterials of cornstover, switchgrass, and miscanthus. Preliminary findings indicate miscanthus could involve lower risk mostly based on the task associated with establishing miscanthus and properties of how often those tasks must be performed over a 10 year period.

### **Planned Activities – Year 2**

- Conduct a baseline assessment of expected worker exposures for identified hazardous aerosols.
- Prepare a refined decision tool in health and safety issues related to making recommendations for protective actions in biomass production.

## **Objective 7 Health & Safety<sup>15</sup>**

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 Objective 7 team addresses two key elements in the biofuel feedstock supply chain:

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

### **2. Task 1 – Managing Risks in Producing Feedstocks**

#### **a. Planned Activities**

Objective 7 CoProject Directors Mark Hanna and Charles Schwab will host a CenUSA intern during the summer of 2012.

#### **b. Actual Accomplishments**

- Schwab and Hanna participated in the CenUSA eight-week internship program by hosting Ms. Chrysantha Smith from Sweet Briar College. Ms. Smith's internship was focused on applying a risk analysis of the various tasks associated with establishing biomaterials of cornstover, switchgrass, and miscanthus. Preliminary findings indicate miscanthus could involve lower risk mostly based on the task associated with establishing miscanthus and properties of how often those tasks must be performed over a 10 year period.

#### **c. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

#### **d. Plans for Next Quarter**

Additions to the preliminarily identified listing of duties and responsibilities will occur and refinement and details will begin to be added to this listing.

#### **e. Publications, Presentations, and Proposals Submitted**

None.

### **3. Task 2 – Assessing Primary Dust Exposure**

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<sup>15</sup> Report submitted July 31, 2012.

**a. Planned Activities**

This activity is scheduled during Project Year 2 but initial locations where dust exposures are possible are being identified from Task 1, above.

**b. Actual Accomplishments**

Not applicable.

**c. Explanation of Variance**

Not applicable.

**d. Plans for Next Quarter**

We will continue to identify any potential locations of dust exposure while producing the listing of duties and responsibilities associated with producing feedstocks.

**e. Publications, Presentations, and Proposals Submitted**

None to report this period.

**EDUCATION, OUTREACH AND EXTENSION RESEARCH GROUP**

Jill Euken, Brown, Deputy Director of Iowa State University's Bio Economy Institute leads the Education, Outreach and Extension Research Group.<sup>16</sup>

The group focuses on two project objectives:

- Education
- Extension and Outreach

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<sup>16</sup> Jill Euken: jeuken@iastate.edu / (515) 294-6286

## ***Executive Summary - 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, and
- To provide interdisciplinary training and engagement opportunities for undergraduate and graduate students.

### **Co-Project Directors**

- Patrick Murphy, Purdue University. ptmurphy@purdue.edu / (765) 494-1175
- Raj Raman, Iowa State University. rajraman@iastate.edu / (515) 294-0465

### **Accomplishments – Year 1**

Eleven undergraduate students were placed at CenUSA partner institutions Iowa State University (5 interns); University of Nebraska, Lincoln (2 interns); Purdue University (2 interns); USDA Eastern Regional Research Center (2 interns) from June 13 – July 31, 2012. The Co-Project Directors held weekly meetings (live and virtual) with the interns to discuss project research experiences. All students returned to Iowa State University to present at the ISU-wide undergraduate research poster session on August 3, 2012. CenUSA Co-Project Directors from the Feedstock Development, Feedstock Logistics, and Health and Safety Objectives gave presentations to the interns.

The Perennial Grass Physiology, Growth, and Development and the Perennial Grass Establishment and Management modules have been completed and are under internal review.

### **Planned Activities – Year 2**

The Perennial Grass Harvest Management, Harvesting Systems for Bioenergy Grasses Storage Systems for Bioenergy Grasses, Markets and Distribution and Overview of Logistics for Producing Bioenergy Feedstocks modules are in development.

Iowa State University will host the *Native Perennial Grass Bioenergy* internship program in the summer of 2013. The program has a targeted enrollment of 50 students (35 graduate/15 undergraduate students) selected from CenUSA partner institutions.

Graduate students from partner institutions will come to study and discuss sustainable production and distribution of bioenergy derived from perennial biomass sources during a two-week intensive program to be held in June 2013. Objective leaders and key affiliates will be asked to present lectures (on site or virtual).

A seminar series of up to six seminars will highlight student research by *requiring students to explain how their research fits into the broader goals of the project*. CenUSA Co-Project Directors will organize the series. The goal is for the graduate students and interns involved to develop a transdisciplinary perspective and approaches to problem solving.



## Objective 8 Education<sup>17</sup>

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, and
- To provide interdisciplinary training and engagement opportunities for undergraduate and graduate students.

Subtask 1 is curriculum development. Subtask 2A involves training undergraduate students via an 8-week summer internship program modeled on the highly successful NSF REU (research experience for undergraduates) program.

Subtask 2B involves training graduate students via a two week summer intensive program modeled on a highly successful industry sponsored intensive

### Subtask 1: Curriculum Development

#### 1. Planned Activities – Curriculum Development

- Determine the topics for the remaining 10 modules
- Complete content outlines and begin conversion to web-based format for the following modules:
  - ✓ Harvesting systems for bioenergy grasses
  - ✓ Storage systems for bioenergy grasses
  - ✓ Logistics modeling of feedstock production systems: field to factory
  - ✓ Perennial Grass Establishment and Fertility Management
- Complete draft content outlines for two modules in the markets and distribution area

#### 2. Actual Accomplishments – Curriculum Development

Four additional topics in the markets and distribution area were determined. Topics for remaining modules will be determined at a future date based on need.

- **Module 1. Perennial Grass Physiology, Growth, and Development** (lead author CenUSA collaborator John Guretzky) status of components:

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<sup>17</sup> Date of report: July of 16, 2012.

- ✓ “Harvesting Seed Structure/Seedling Emergence” activity has been completed and is under internal review
- ✓ “Tiller Structure” text based lesson has been completed and is under internal review and includes these pieces:
  - “Leaf and Tiller Growth” PowerPoint Voice Over in done in Camtasia
  - “Mean Stage Count Calculation Demonstration” video done in Camtasia
  - Auto-graded Module Quiz
- **Module 2. Perennial Grass Establishment and Management** (lead author John Guretzky) status of components:
  - ✓ “Pure Live Seed Calculation” video: first cut created by CenUSA collaborator Amy Kohmetscher is currently under review by John Guretzky.
  - ✓ “Soil Fertility Lesson” text has been written and we are compiling photos we have copyright permissions to use.
  - ✓ “Establishment Grid Usage” video raw field-based footage has been captured. We will share completed video with Objective 9 – Extension and Outreach.
  - ✓ Materials borrowed from CenUSA Extension efforts include Rob Mitchell’s webinar presentation, drill calibration demo, and drill overview video from the March 20, 2012 field day.
- **Module 3. Perennial Grass Harvest Management** (lead authors CenUSA Objective 8 CoProject Director Patrick Murphy and graduate student Iman Beheshti Tabar) status of components:
  - ✓ The “Mowing and Conditioning” content second draft has been completed and is ready to be placed into an activity. We are securing copyrights for critical animations and photos; Patrick Murphy and Iman Beheshti Tabar will also take original photos at a farm equipment expo.
  - ✓ The “Raking and Baling” content first draft is being edited and put into storyboard format.
- **Module 4. Storage Management** (lead authors Patrick Murphy and Iman Beheshti Tabar) status of components:
  - ✓ Preliminary draft outline completed.

- **Modules 5 and 6 – Markets & Distribution Modules** (lead authors Nicole Olynk and Corrine Alexander) status of components:
  - ✓ Preliminary draft outlines of first two Markets & Distribution modules are complete.

### 3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

### 4. Plans for Next Quarter

- **Module 1. Perennial Grass Physiology, Growth, and Development**
  - ✓ Seed Structure and Seedling Emergence activity will be made publically available and submitted to the *Journal of Natural Resources and Life Sciences Education (JNRLSE)* for peer review.
  - ✓ Tiller Structure text based lesson will be made publically available and submitted to the *Journal of Natural Resources and Life Sciences Education* for peer review.
- **Module 2. Perennial Grass Establishment and Management**
  - ✓ Complete components and submit to internal review at *JNRLSE*.
- **Module 3. Harvesting Systems for Bioenergy Grasses**
  - ✓ Complete components and submit to internal review at *JNRLSE*.
- **Module 4. Storage Systems for Bioenergy Grasses**
  1. Complete components and submit to internal review
- **Modules 5 and 6. Markets & Distribution Modules** (lead authors Nicole Olynk and Corrine Alexander).
  - ✓ Complete content outlines and begin activity development with Amy Kohmetscher.
- **Module 7. Overview of Logistics for Producing Bioenergy Feedstocks** (lead authors Patrick Murphy and Iman Beheshti Tabar).
  - ✓ Complete content outline.

### 5. Publications, Presentations, and Proposals Submitted

None to report this period.

## Subtask 2A: Training Undergraduates via Internship Program

### 1. Planned Activities

- Finalize all logistics (travel and accommodations) related to the students' arrival at Iowa State University for the two-day orientation on June 11 and 12, 2012. Also finalize logistics for student's travel and accommodations/subsistence for partner institution placements as well as their return for the close of the program. Process all student travel at the close of the program.

**Table 3. 2012 Cenusa Bioenergy Internship Cohort**

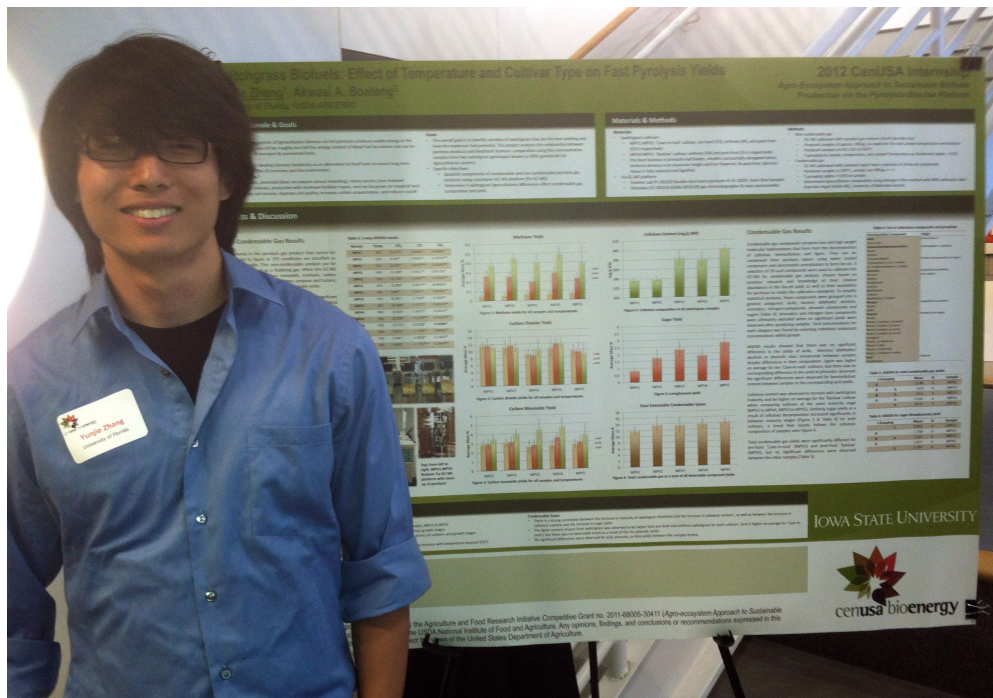
First Name	Last Name	Gender	Home Institution		Placement Location
Shelley	Koehn	F	Purdue	Murphy	Purdue
Kirsten	Paff	F	Purdue	Jin	Nebraska
Nicholas	Jayne	M	Purdue	Chaubey	Purdue
Benjamin	Meier	M	Iowa State	R. Brown	Iowa State
Jerrad	Kaiser	M	Missouri	Birrell	Iowa State
Ethan	Liebswager	M	North Dakota State	Laird	Iowa State
Chrysantha	Smith	F	Sweet Briar College	Schwab Hanna	Iowa State
Katherine	Manz	F	Rensselaer Polytechnic	Hayes	Iowa State
Chris	Anderson	M	University of Idaho	Mitchell Schmer	Nebraska
Kelsey	Downey	F	Michigan State	Boateng	ERRC Wyndmoor
Yunjie	Zhang	M	University of Florida	Boateng	ERRC Wyndmoor

- Provide mentor training using 15-minute video created by CenUSA Objective 8 CoProject Director Raj Raman. The video will be shared via link with the internship student mentors (graduate student/postdoc) in mid-May, followed by a combined face-to-face (for ISU-based mentors) and virtual meeting (via Adobe Connect for partners) to clarify any questions.

- Conduct orientation that provides an overview and expectations of the program, lab safety training, and lectures by program objective leaders.
- Students with placements at partner institutions will attend orientation at Iowa State University and will then depart for host lab placements.
- Schedule weekly meetings with student interns to discuss progress, face-to-face for ISU students and virtual meetings (via Adobe Connect) for partner-placed students.
- Organize several field experiences and professional development seminars and workshops.

## 2. Actual Accomplishments

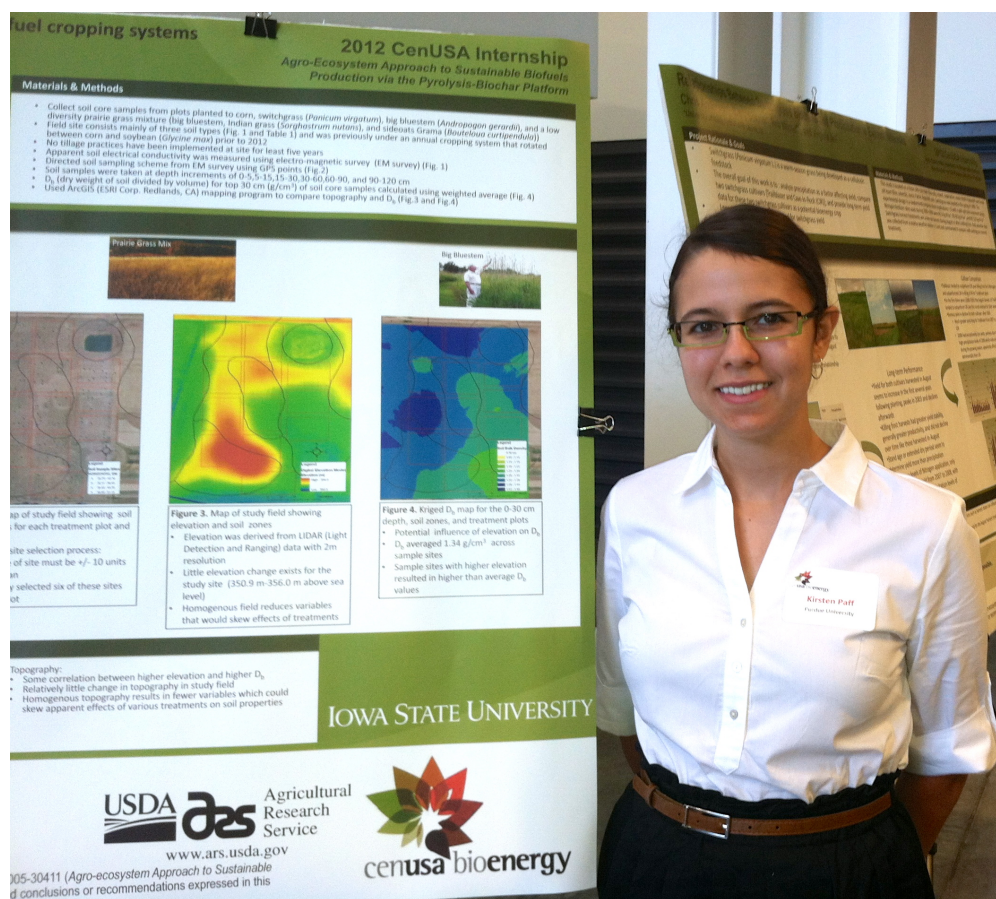
- Finalized all logistics (travel and accommodations) related to the student's arrival at Iowa State University for the two-day orientation on June 11 and 12, 2012. Also finalized logistics for student's travel and accommodations/subsistence for partner institution placements as well as their return to Iowa State University for the close of the program. Purchased and processed all student travel (for those traveling by air) at the close of the program.
- Provided mentor training using 15-minute video CenUSA Objective 8 CoProject Director Raj Raman. Video shared via link with the internship student mentors (faculty and graduate student/postdoc) in mid-May 2012.
- Conducted orientation that included an overview and expectations of the program, lab safety training provided by Iowa State University's *Environmental Health & Safety* personnel, lab research documentation training provided by a graduate student, an energy overview lecture by Raj Raman, and research presentations by several of CenUSA objective leaders (Ken Vogel, Stuart Birrell and Charles Schwab).
- Iowa State University's *Research Institute for Studies in Education* (RISE) administered a pre-program survey to assess students. Provided a baseline for program evaluation.
- Students placed at partner institutions University of Nebraska, Lincoln working with Dr. Virginia Jin and Dr. Rob Mitchell; Purdue University working with Dr. Patrick Murphy and Dr. Indrajeet Chaubey; USDA Eastern Regional Research Center working with Dr. Akwasi Boateng) departed Iowa State University on June 12 to begin their host lab placements on June 13 – July 31, 2012.



**Photo 2. 2012 CenUSA Intern Yunjie Zhang**

- Scheduled weekly meetings (Wednesday, June 20 – Wednesday, August 1) with student interns to discuss progress and research poster content, face-to-face for ISU students and virtual (via WebEx) for partner-placed students.
- Interns placed at Iowa State University participated in a full-day workshop on June 14, 2012 on *Bioethics in Research* conducted by Dr. Clark Wolf, director of Iowa State University's Bioethics Institute. This workshop included a presentation as well as engaging case study exercises.
- Interns placed at Iowa State University toured a *Renewable Energy Group, Inc.* biodiesel refinery in Newton, Iowa on June 22, 2012 as well as Iowa State's *BioCentury Research Farm* on June 29, 2012.
- The ISU-based interns participated in a team-building canoe trip on the Des Moines River on Saturday, June 23, 2012.
- All the CenUSA Bioenergy interns attended a presentation by Raj Raman on July 18 on *Applying to and Getting into Graduate School*, face-to-face for ISU-based students and virtual (via WebEx) for partner-placed students.





**Photo 3. 2012 CenUSA Kirsten Paff**

### 3. Explanation of Variance

The mentor training video (created by Raj Raman) was shared via link with the internship student mentors (faculty/grad student/postdoc) in mid-May 2012 however time constraints did not permit for a follow up face-to-face (for ISU-based mentors) and virtual (via Adobe Connect for partners) meeting.

### 4. Plans for Next Quarter

- On August 1, 2012, the six students placed at partner institutions (Purdue University, University of Nebraska, Lincoln, and the USDA Eastern Regional Research Center in Wyndmoor, Pennsylvania) will return to Iowa State University for the conclusion of the 2012 program.



- On August 2, 2012, all 11-student interns will travel to Mead, Nebraska, to visit the University of Nebraska's *Agricultural Research and Development Center* (ARDC). Field plot tours will showcase all aspects of management, production, sustainability, breeding, and basic biology research. CenUSA Objective 1 CoProject Directors Rob Mitchell and Ken Vogel will lead the demonstrations and tours with help from other CenUSA team members.
- On August 3, 2012 all CenUSA student interns will participate in the ISU university-wide undergraduate research poster session and reception. This poster session, the culminating event of the *CenUSA Bioenergy Internship Program*, will include all undergraduate research interns who have participated in summer research internships at Iowa State University. This event will showcase over 100 students.
- All students will complete a post-program survey conducted by Iowa State University's Research Institute for Studies in Education (RISE). The purpose of this assessment is to (1) assess the program's activities; (2) evaluate immediate program successes and challenges; (3) promote continued interest in the program by alumni after they complete their research experience; and (4) track the career participation of our graduates.
- Finalize and process all payments related to the internship program. Coordinate with Purdue University to insure all relevant payments for students placed using Purdue funds were accomplished.
- Make a plan for student placements and begin soliciting faculty hosts for the summer 2013 program.
- Create a calendar and content outline for the summer 2013 program.

## **5. Publications, Presentations, and Proposals Submitted**

None to report this period.

### **Subtask 2B – Training Graduate Students via Intensive Program**

#### **1. Planned Activities**

None. This is a Project Year 2 activity, and forward planning will begin in summer 2012.

#### **2. Actual Accomplishments**

Rough outline of 2013 Intensive Program has been created. The program outline has been tailored to balance the breadth of research within each program objective area.

#### **3. Explanation of Variance**

Not applicable.

#### **4. Plans for Next Quarter**

- Meet with CenUSA project director and key objective leaders to determine when to conduct the Intensive Program (e.g., early summer or in conjunction with the annual meeting in August 2013).
- Create detailed schedule for inaugural graduate student intensive program.
- Contact CenUSA faculty members and secure their 2013 involvement and participation.

#### **5. Publications, Presentations, and Proposals Submitted**

None to report this period.

## ***Executive Summary - Extension and Outreach***

The Extension and Outreach objective serves as CenUSA's link to the larger community of agricultural and horticultural producers and to the public-at-large.

### **Co-Project Directors**

- **Jill Euken**, Iowa State University. [jeuken@iastate.edu](mailto:jeuken@iastate.edu) / (515) 294-6286
- **Sorrel Brown**, Iowa State University. [sorrel@iastate.edu](mailto:sorrel@iastate.edu) / (515) 294-8802

### **Accomplishments – Year 1**

A field day for Extension educators was held in March 2012 in Mead, Nebraska. The presentations were live webcasted and six field day webinars were recorded for dissemination on CenUSA's website, VIMEO and YouTube channels, and on the *eXtension Farm Energy* website. *Education Module 1- Perennial Grass Physiology, Growth, and Development* is under internal review for distribution in Year 2. The Educator Peer Network's goals and mission have been established. CenUSA Post Harvest Coordinator Robert Brown presented "The Thermochemical Option" as part of the University of Nebraska and eXtension Farm Bioenergy's *Friday Webinar Series* (May 25, 2012). The webinar is available on CenUSA internet sites.

Producer research plots have been established in Indiana, Nebraska, Minnesota, and Iowa. Networks have been initiated with Master Gardener programs in Iowa and Minnesota and Ag teachers and the FFA organization in Indiana. Master Gardener demonstration gardens have been planted in Iowa and Minnesota. Minnesota Master Gardener volunteers have been trained on the safe use of Biochar. Contact was made with 451 Master Gardeners at the 2012 Upper Midwest Master Gardener Conference (July 2012). CenUSA personnel conducted a special Biochar informational session at the Midwest conference.

CenUSA Extension and Outreach activities reached 3,792 persons during the project's first year. This number includes 2426 Master Gardener volunteers reached through face-to face or electronic means; 1056 producers, 257 extension specialists; 160 members of the public; and 53 Master Gardener Volunteers for Youth and youth in the Youth Master Gardener Pilot program.

A complete set of project evaluation materials has been developed.

### **Planned Activities – Year 2**

- Continue development of online materials
- Complete the establishment of the CenUSA Peer Network
- Complete four Education Modules and market the materials to Extension educators
- Peer review and publish four Switchgrass articles through eXtension collaboration
- Continue to monitor and develop producer research plots
- Finalize youth development materials and hold the 4-H Science Workshop (June 2013)

## Objective 9 Extension and Outreach<sup>18</sup>

The Extension and Outreach objective serves as CenUSA's link to the larger community of agricultural and horticultural producers and to the public-at-large. CenUSA's Extension objective focuses on four primary goals:

- Developing awareness of biochar and bioenergy materials for extension educators, industry leaders, farmers and the general public.
- Increasing knowledge and awareness of the benefits of perennial and biochar agriculture and horticulture
- Establishing and utilizing a "citizen science" program to share "Best Management Practices" for perennial grass and biochar agriculture and the horticulture industry
- Stimulating adoption of perennial grass production, pyrolytic conversion of biomass to biofuels, and utilization of biochar as a soil amendment by Agricultural producers and Extension personnel.

Extension and Outreach group was responsible for CenUSA primary public contact responsibilities. AS shown in Table 4, below CenUSA has been successful in meeting its first year outreach obligations.

Table 4. 2012 Education & Outreach Contacts	
Extension Personnel	257
Agricultural Producers	1056
Horticultural Industry	2426
Youth 4H/Master Gardeners	53
<b>Total Reached*</b>	<b>3792</b>
* A total of 969 males and 1156 were identified recorded by collaborators who tabulated attendance by gender.	

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

- **Extension Staff Training/eXtension Team**

This team concentrates on creating and promoting professional development activities for Extension educators and agricultural and horticultural industry leaders.

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<sup>18</sup> Date of report: July 31, 2012.

#### ■ **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**

This team will focus 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 (Objective 7).

#### ■ **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.
- **Broader Public Education/Master Gardener Program** – The goal is to acquaint the non-farm community with biofuels and biochar through a series of outreach activities using the highly successful 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.



**Photo 4. Purdue Youth Development Activity, Summer 2012**

## **Extension Staff Training/eXtension Team**

### **1. Planned Activities**

- Develop learning objectives and outline for learning modules, webinars and articles.
  - ✓ Finish Module 1 (CenUSA Collaborator John Guretzky), submit materials for peer-review publication in the *Journal of Natural Resources and Life Sciences Education* and begin Module 2.
  - ✓ Assist Patrick Murphy and Objective 8 (Education) in developing education modules.
- Prepare video clips and content, edit and design modules; convert materials to on-line format; prepare articles and develop FAQs.
  - ✓ Finish harvest video and complete peer-review, adding closed captioning and posting to CenUSA site.
  - ✓ Finish planter calibration demonstration video – complete peer-review, add closed captioning and posting to CenUSA site.
  - ✓ Finish planting video – complete peer-review, add closed captioning and posting to CenUSA site.

### **2. Actual Accomplishments**



- Develop learning objectives and outline for learning modules, webinars and articles. Currently, four eXtension Articles are in development.
  - ✓ Logistics. Written by CenUSA Collaborator Amy Kohmetscher using information provided by Objective 3 CoProject Director Stuart Birrell. Sent to John Hay and Stuart Birrell for internal review.
  - ✓ Switchgrass Stand Establishment. The module is ready for review.
  - ✓ Switchgrass Weed Control. The first draft is complete (CenUSA Objective 2 CoProject Director Rob Mitchell, ARS/UN and Susan Harlow, UVM).
  - ✓ Switchgrass Fertility Management. The first draft is complete (Rob Mitchell, ARS/UN and Susan Harlow, UVM).
- Prepare video clips and content, edit and design modules; convert materials to on-line format; prepare articles and develop FAQs.
  - ✓ **Video platform/hosting.** Currently videos are disseminated via the CenUSA site without an embedded player. After testing with industry contacts, Vimeo.com (VIMEO) seems like a suitable platform that most users should be able to open at the work place. VIMEO will allow for more reliable play back, and will not force users to download the file. This should help deliver content to producers and distance learners in rural communities with slower internet connections. We will continue to use the CenUSA site and our YouTube Channel as well, however VIMEO will serve as the “primary video distribution channel.
  - ✓ A VIMEO channel for CenUSA has been established at <http://www.vimeo.com/user/CenusaBioenergy>
  - ✓ Videos (using the VIMEO uploads) will be embedded on the eXtension Farm Energy media site (<http://farmenergymedia.extension.org/videos>, search on keyword “cenusa”. This site provides a related page for additional information, transcript, and linked resources.
  - ✓ Switchgrass harvest, baling. Internal peer-review is complete; closed captioning has been added, and the video has been posted to the CenUSA site/You Tube Channel [http://www.youtube.com/watch?v=\\_RcJBURXwKc&feature=youtube](http://www.youtube.com/watch?v=_RcJBURXwKc&feature=youtube)
  - ✓ **Planter Calibration.** Internal peer-review done, closed captioning added, posted to the CenUSA site/You Tube Channel (<http://www.youtube.com/watch?v=izBHivo5xfw&feature=context-cha>) and the



- CenUSA VIMEO channel. The full webinar version has also been posted to [http://www.youtube.com/watch?v=7TPLfWLkd\\_U&feature=plcp](http://www.youtube.com/watch?v=7TPLfWLkd_U&feature=plcp).
- ✓ Planting and Weed Management. The draft version is complete and has been internally reviewed. Final edits are underway. It has been due to critical weed management components.
  - **Partnering with CenUSA Education Module Development**
    - ✓ **Education Module 1. Perennial Grass Physiology, Growth, and Development** (Lead author John Guretzky). Status of components:
      - **Seed Structure and Seedling Emergence Activity.** The activity is complete and is under internal review.
      - **Tiller Structure Text-based Lesson.** The activity is complete and under internal review and includes these pieces:
        - Leaf and Tiller Growth PowerPoint Over done in Camtasia
        - Mean State Count Calculation Demonstration Video done in Camtasia
      - **Auto-graded Module Quiz.**
        - Module 1 materials were shared with extension team to help develop extension materials based on this package
    - ✓ **Education Module 2. Perennial Grass Establishment and Management** (lead author John Guretzky). Status of components:
      - **Pure Live Seed Calculation Video.** First cut created by Amy Kohmetscher, currently under review by John Guretzky.
      - **Soil Fertility Lesson.** Text written, compiling photos we have copyright permissions to use.
      - **Establishment Grid Usage Video.** Raw field-based footage captured. Will share completed video with Objective 9
      - Materials borrowed from Extension CenUSA efforts include Rob Mitchell's webinar presentation, drill calibration demo, and drill overview video from March 20, 2012 Switchgrass Establishment Field Day (Mead, Nebraska).
    - ✓ **Education Module 3. Perennial Grass Harvest Management** (lead authors Pat Murphy and Iman Beheshti Tabar). Status of components:

- “Mowing and Conditioning” content second draft is complete and ready to be placed into an activity. We are securing copyrights for critical animations and photos. Tabar and Murphy will also shoot original photos at a farm equipment show.
  - “Raking and Baling” content first draft being is currently edited and put into storyboard format.
- ✓ **Education Module 4. Storage Management** (lead authors Patrick Murphy and Iman Beheshti Tabar). Tabar is compiling storage activity content.
- ✓ **Review Protocol Development.** The “Google Doc” format did not work as smoothly as we had envisioned. We are currently testing another format using Survey Monkey. The form under development can be viewed at <http://www.surveymonkey.com/s/3D2TMWT>.
- **Develop marketing materials to encourage Extension educators to participate in the on-line learning.**
  - ✓ **Educator Peer Network Site.** The goals, mission and FAQs have been developed for the Online Peer Network.
    - We are drafting survey questions to learn what tools could be offered in an online network that would be most useful to participating Extension educators.
    - Discussion is continuing on the most effective and interactive platform to use, learning towards the Extension Community of Participation (CoP).
- **Conduct webinar for each learning module.**
  - ✓ CenUSA Objective 5 CoProject Director Robert Brown gave the presentation “The Thermochemical Option” on May 25, 2012, through the University of Nebraska and eXtension Farm Bioenergy’s *Friday Webinar Series*.
- **Secure and upload images to CoP Flickr sites.** eXtension Farm Energy CoP has been building a media site, now in beta mode. See <http://farmenergymedia.extension.org/> for sharing various types of multimedia resources. This will enhance the effectiveness of image sharing by CenUSA participants. This may also change how the CoP Flickr site is used.

### 3. Explanation of Variance

- **Personnel Changes.** An outreach specialist at the University of Wisconsin (Pam Porter) was hired on May 1, 2012, to coordinate development of extension learning modules.

- **Method Change.** Rather than design static learning modules, we have decided to deliver more timely, flexible and interactive learning modules. We are exploring delivery of these materials through the online peer network site, but are not convinced this site can enable as much interaction as we would like.
- We have begun work on year 2 video deliverables, beginning with the combined “planting and weed management” video. The video and webinar work has gone extremely well, so we will be looking to add enhanced video features to year 2 videos. Also, with time allotted to this project, we’ve been able to do significant work with the education team and Amy Kohmetscher has provided assistance to writing the online eXtension materials.
- **Image Sharing.** As noted above, the eXtension Farm Energy CoP has been building a media site, <http://farmenergymedia.extension.org/>. As this may change how the CoP Flickr site is used, we have postponed engaging the CenUSA specialists in providing image contributions.

#### 4. Plans for Next Quarter

- Develop learning objectives and outline for learning modules.
  - Prepare video clips and content, edit and design modules; convert materials to on-line format; prepare articles and develop FAQs.
- ✓ **Videos**
- **Planting and Weed Management.** The video is complete, with added effects and has been submitted for internal review. We will make final edits, add captioning and post to VIMEO.
  - Check with Ken Vogel, Rob Mitchel and John Hay about recording August 18, 2012, field presentation as the material will be from March’s *Switchgrass Establishment* event.
  - Identify topic(s) for video or interactive online activity in insect management and/or plant pathology
  - Upload all finished video and webinar to VIMEO or YouTube and embed onto <http://farmenergymedia.extension.org/videos> site.
- ✓ **Partnering with Education Team**
- **Education Module 1. Perennial Grass Physiology, Growth, and Development**

- **Seed Structure and Seedling Emergence Activity.** Make the materials publically available and submit to *Journal of Natural Resources and Life Sciences Education* (JNRLSE ) for peer review.
- **Tiller Structure Text-based Lesson.** Make publically available and submit to JNRLSE for peer review.
- **Education Module 2. Perennial Grass Establishment and Management.** Complete components and submit to internal review and eventually to JNRLSE.
- **Education Module 3. Perennial Grass Harvest Management.** Complete components and submit to internal review/JNRLSE.
- **Education Module 4. Storage Management.** Complete components and submit to internal review.
- **Education Modules 5 and 6.** Work with Corrine Alexander and Nicole Olynk to develop their modules.
- ✓ **eXtension Articles**
  - Peer review and publish four Switchgrass articles.
  - Four articles for Year 2 deliverables: Biomass harvest and storage systems, and economics of feedstock production systems.
  - Identify exact topics.
  - Outline article contents and engage authors.
  - Draft first article and begin peer review process.
- ✓ **Develop marketing materials to encourage Extension educators to participate in the on-line learning module.**
  - Design and hold first quarterly meeting for Sustainable Bioenergy Peer Network.
  - Review survey results to identify what type of information and what type of delivery tools would be most useful to participating Extension educators.
  - Secure platform and begin populating site with content for online peer network.
  - Edit eXtension materials.
  - Explore funding for in-person annual Extension Educator training to be held Spring 2013. ISU has expressed an interest in hosting the meeting in Ames, Iowa.

- ✓ **Conduct webinar for each learning module**
  - Contact CenUSA researchers for content they can deliver via webinars.
  - Identify CenUSA researchers for first quarterly On-Line Peer Network meeting.
  - Conduct one webinar for each learning module.
- ✓ **Develop and Activate “Ask an Expert” feature on CoProject Directors: Develop topics for “Ask an Expert” feature on eXtension, and recruit CenUSA specialists to fill the roles.**
- ✓ **Develop and administer assessments and evaluations.**
  - Secure and upload images to extension Farm Energy media site(s).

## **5. Publications, Presentations, and Proposals Submitted**

See above.

### **Producer Research Plots/Perennial Grass Team**

#### **1. Planned Activities**

- Minnesota, Iowa, Nebraska and Indiana: Identify locations for demonstration plot(s) in each state; create plot layout to accommodate space limitations.
- Conduct soil analyses at each site, fertilize as necessary (P and K); prep fields for planting.
- Plant plots; document germination and establishment; observe climate using nearby stations.

#### **2. Actual Accomplishments**

- **Indiana.** Producer plot with Jeremy and Jerry Sweeten.
  - ✓ Demonstration site located 3 miles southwest of Roann, Indiana.
    - **May 21, 2012.** The field was sprayed with Roundup.
    - **May 24, 2012.** Plots were no-till drilled into soybean stubble and winter annual weed residue.
    - **June 11, 2012.** Pre-emergent herbicides were applied to plot areas with 10 foot unsprayed strip left in each plot.

Significant rainfall did not occur for the first six weeks after planting.

Significant rainfall occurred at the site in the middle of July, however no grass seedlings have emerged at this time.

- ✓ Demonstration site at Throckmorton Purdue Agricultural Center (TPAC). Site located 5 miles south of Lafayette, Indiana.

- **April 12, 2012.** The field was sprayed with Roundup and 2,4-D.
- **May 17, 2012.** Plots were no-till drilled into soybean stubble and winter annual weed residue.
- **June 7, 2012.** Pre-emergent herbicides were applied to plot areas with 10 foot unsprayed strip left in each plot .
- **July 24, 2012.** Plots mowed to control weeds (i.e., velvetleaf and manestall).

Significant rainfall did not occur for the first four weeks after planting.

Approximately two inches of rainfall has occurred on the plots since planting.

Grass seedlings began to emerge around July 9 and continue to emerge slowly.

- **Nebraska.** Producer plot with Ben and Paula Sue Steffen Farm, 71263 637<sup>th</sup> Ave, Humboldt, NE 68376 was established this quarter.
  - ✓ **April 26, 2012.** Seedlings were drilled no-till into soybean stubble.
  - ✓ **April 26, 2012.** – The entire area sprayed with Roundup herbicide.
  - ✓ **April 26, 2012.** Pre-emergence herbicides applied to the plot areas. A check strip was left through the length of the plots.
  - ✓ **June 13, 2012.** Plots were mowed to control pigweed.

The subsoil conditions at planting time were significantly less than field capacity. A total of 1.7” of precipitation occurred from April 26 – June 14, 2012. So far the switchgrass and low diversity mix has been coming very slowly and in some of the plot areas no seedlings have emerged. The area of the state where the plot is located is classified as under moderate drought conditions.

- **Minnesota.** The plot was planted on June 13, 2012, rather than in mid-May, due to poor weather and equipment problems). On June 14, 2012, the day after planting, torrential rains washed out much of the site, leaving the field in terrible condition. The two closest weather stations reported 4.37 inches/3.49 inches of rain, respectively. Three days later (June 17-18, 2012), the site received another downpour (3.54/3.65 inches). Rainfall rates



during both of these events exceeded one inch per hour. The resulting soil erosion at the site was extreme (see photos below). One full rep was completely lost and the low diversity plot in the second rep sustained heavy losses. A small section of the low diversity plot, approximately 30 ft. x 90 ft., remains relatively intact. One plot each of Shawnee and bioenergy switchgrass remained largely intact.



**Photo 5. Minnesota Site Erosion**

Given the serious erosion, combined with the risk of planting too late and losing the grasses to winterkill, the Minnesota team chose to remediate and stabilize the soil with a cover crop rather than reseeding the grasses.

When the field was dry enough to work (June 28-29, 2012), the Minnesota team brought in equipment to move soil from the downslope deposition area to fill the most severe washouts, then re-dragged the most heavily damaged areas to prep for planting, and seeded a fast-growing cover crop (oats) combined with a locally-adapted CRP mix.

Currently, the Minnesota team is making weekly trips to the site to monitor the germination and growth in the remaining plots. The site has received very little precipitation (0.02 inches) since planting.



- **Iowa.** Producer plot with Phil Winborn, 2550 500th St SW, Kalona, IA was established in this quarter.
  - ✓ April 2012. Roundup was sprayed for burn down weed control.
  - ✓ May 11, 2012. Seedlings were drilled no-till into soybean stubble.
  - ✓ May 14, 2012. Pre-emergence herbicides were applied to the plot areas (20% of each plot left untreated).
  - ✓ July 7, 2012. Plots were mowed to control water hemp.

So far the switchgrass has been coming very slowly. The mixed native grasses have shown up in one of the two reps. After planting, no rainfall was recorded for 3 weeks. In the two months since planting total rainfall has been less than 3 inches with only 2 dates of rainfall exceeding 0.3 inches.

### 3. Explanation of Variance

**Minnesota.** Torrential rainfall leading to serious erosion, as explained above. Our intent is to replant the damaged plots in the spring of 2013 by killing the oat/CRP stands with glyphosate and reseeding with a no-till drill.

### 4. Plans for Next Quarter

- **Nebraska.** The plan is to continue monitoring the growth and development of the sparse stand of seedlings that have germinated and emerged. Mowing of weeds may be needed to reduce stress on grass seedlings.
- **Iowa.** A field day has been tentatively scheduled for September depending on the continuing drought and grass establishment.
- **Minnesota:** Photo-document establishment and growth on weekly basis; plots will be monitored for weeds and sprayed and/or mowed accordingly. Anticipate first killing frost will occur in October (Q4 2012), after which Minnesota team will sample and harvest plots.

### 5. Publications, Presentations, and Proposals Submitted

None this quarter.

## Economics and Decision Tools Team

### 1. Planned Activities

Nothing planned this quarter.

## **2. Actual Accomplishments**

Nothing planned this quarter.

## **3. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

## **4. Plans for Next Quarter**

No planned activity is scheduled in in Project Years 1 and 2. The Team is available to assist other Objectives and Teams as needed throughout the first two project years.

## **5. Publications, Presentations, and Proposals Submitted**

None to report this period.

### **Health and Safety Team**

#### **1. Planned Activities**

See Objective 7, above.

#### **2. Actual Accomplishments**

See Objective 7, above.

#### **3. Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

#### **4. Plans for Next Quarter**

Additions to the preliminarily identified listing of duties and responsibilities will occur and refinement and details will begin to be added to this listing. See Objective 7, above.

#### **5. Publications, Presentations, and Proposals Submitted**

None.

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

#### **3.A – Youth Development**

##### **a. Youth Development – Planned Activities**

- Develop educational materials and lessons for you (4-H) and adults to work with youth (volunteers, 4-H, and Master Gardeners).
- Identify locations to implement the Master Gardner biochar demonstration gardens.
- Develop local partnerships to implement and test the lessons and the biochar garden project with youth.
- Identify school and community site for the classroom demonstration project.

#### **b. Youth Development – Actual Accomplishments**

- Develop educational materials and lessons for youth (4-H) and adults to work with youth (volunteers, 4-H, and Master Gardeners).
  - ✓ Four fact sheets, of the eight planned, are near completion (*Bioenergy Production; Biochar Use; Carbon Cycle; and Biomass Feedstock Production*).
  - ✓ An initial set of learning activities were piloted during this quarter at Purdue track “PINE” (*Plants, Insects, Natural Resources and the Environment*) and will be further expanded and developed in fall and spring 2012-2013.
  - ✓ During 4-H Science Workshops, youth were surveyed for level of interest, potential ideas and activities they would like to learn about. Twenty youth participated in several activities—including a tour of agronomy demonstration and research plots for biomass crops (Murphy/Johnson plots), planting of biomass grasses to take home (switchgrass, bluestem, and Indian grass), and a role-playing, inquiry-based activity. This activity had the youth assume the roles of county-based energy production planning teams and assess diverse areas around the state in order to determine the best biorenewable energy production sources.
  - ✓ Planning is underway for summer of 2013 to create and host a Biorenewables science workshop for high school youth (it will become a new workshop “track” for existing 4-H Science Workshops at Purdue).
  - ✓ CenUSA’s Purdue Extension group is developing an exhibit to be used at events, activities, fairs, demonstrations together with CenUSA collaborators Chad Martin, Patrick Murphy, and Keith Johnson.
- Identify locations to implement the Master Gardner biochar demonstration gardens
  - ✓ Locations for two demonstration gardens have been identified.
  - ✓ Purdue perennial grass demonstration plots have been established.

- Develop local partnerships to implement and test the lessons and the biochar garden project with youth.
  - ✓ Networks have been established through 4-H and Master Gardener programs; preliminary partnerships have been confirmed in both the northern and southern part of state (Indiana).
  - ✓ Networks have been established with Ag teachers and the FFA organization.

**c. Youth Development – Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

**d. Youth Development – Plans for Next Quarter**

- Finish, finalize and publish fact sheets.
- Edit, develop and pilot expanded activities for youth programming including school demonstration gardens for biochar use and development of 4-H curricula.
- Continue plans for Biorenewables 4-H Science Workshop track (for June 2013).
- Finalize school/community collaborators for the gardening activities.
  - ✓ Fact Sheets to be used with Youth audiences, along with activities.
    - Biofuels Production
    - Carbon and Life on Earth
    - What Is Biochar?
    - Biomass Feedstocks Production
  - ✓ Publicity brochure for 2013 Biorenewables 4-H Science Workshop.
  - ✓ 2012 4-H PINES Science Workshop interest survey.

**e. Youth Development – Publications, Presentations, and Proposals Submitted**

None to report this period.

**3.B – Broader Public education/Master Gardener Program**

**a. Broader Public Education/Master Gardener Program – Planned Activities**

- Establish initial biochar demonstration gardens and signage. Coordinate planting demonstration sites.
- **Minnesota.** Staff and faculty to present at 2012 *Upper Midwest Master Gardener Conference*. The Arboretum exhibition is underway.
- A team meeting is scheduled for July 22-23, 2012 in Minnesota.
- Build connections to the National Junior Master Gardener program and Extension Master Gardeners.
- Develop supporting educational materials for educating volunteers, teaching materials for the volunteers to use, and social media for engaging Master Gardeners (MG) volunteers.
- **Evaluation.** Develop and use in-person and online assessment tools to measure youth and adult knowledge gained and potential behavior changes related to biochar.
- Collect names and email address of participants in events and online activities.

**b. Broader Public Education/Master Gardener Program – Actual Accomplishments**

- Establish initial biochar demonstration gardens and signage. Coordinate planting demonstration sites (See Exhibit 12. Garden Design).
  - ✓ Demonstration gardens established and planted.
  - ✓ Signage posted – control, treatments 1 & 2; plants labeled.
  - ✓ Volunteers began collecting and recording data June 25th. A few key points:
    - A majority of potatoes rotted from the wet spring.
    - There was poor germination in beans; they were replanted at all sites.
    - **Problems:** Japanese beetles at St. Paul campus site; poison ivy at Andover site; aster yellows at all three sites. Nutrient deficiency symptoms at Andover site (sandy soil).
    - Cucumbers and peppers are being harvested.
    - Lettuce has been removed and measured.





**Photo 6. Minnesota Master Gardener Biochar Garden**

- Build connections to the National Junior Master Gardener program and Extension Master Gardeners
  - ✓ This is developing as CenUSA Collaborator Karen Jeannette becomes more involved in the program. See attached overview about the Extension Master Gardener social media (See Exhibit 13. Master Gardener Social Media Report).
- Develop supporting educational materials for volunteers; teaching materials for the volunteers to use; and social media for engaging Master Gardeners (MG) volunteers. Post materials post on-line. Complete teaching materials for MGs to use for educational programs.
  - ✓ Approximately 30 the University of Minnesota Master Gardeners participated in the online 1-hour training around the Biochar Project. (See <https://connect.extension.iastate.edu/p8ed31qx4wk/> to view the training).



**Photo 7. Master Gardener Gathering Data**

- ✓ CenUSA Collaborator Lynne Hagen has completed a tabletop display for use at county fairs and state fair (See Exhibit 14. Master Gardener Tabletop Display).
- ✓ We are beginning to monitor Twitter and other social networks for biochar discussions. A January 2012 transcript of a Twitter @Gardenchat has been downloaded and is being analyzed for public perceptions of biochar. An additional spreadsheet has been created to capture possible biochar FAQs the public is asking. We hope to work with CenUSA researchers and educators to create, edit, and review FAQs that we can share with Extension Master Gardeners and the general public via social media and other educational functions.
- ✓ Volunteers have been asked to submit their questions about biochar to help staff create an FAQ sheet.
- **Evaluation.** Develop and use in-person and online assessment tools to measure youth and adult knowledge gained and potential behavior changes related to biochar; Collect names and email address of participants in events and online activities.



- ✓ We collected names and contact information from 451 Master Gardeners who attended the 2012 Upper Midwest Conference, including 13 who attended the biochar session on July 21, 2012. When asked, approximately 60% had heard of biochar, but only one person knew anything about it. A conference survey due out by July 27, 2012.
- ✓ We collected names and contact information from 30 Master Gardeners volunteering on the biochar project; Master Gardeners at Biochar session reported most had heard of biochar, but only one person knew anything about it.

**c. Broader Public Education/Master Gardener Program – Explanation of Variance**

- The team meeting scheduled for July 22-23, 2012 in Minnesota cancelled due to unforeseen family emergency.
- **Building connections to the National Junior Master Gardener program.** We have not pursued this at this point due to in favor of concentrating on the work surrounding the establishment of sites and MG training.

**d. Broader Public Education/Master Gardener Program – Plans for Next Quarter**

- Weisenhorn is scheduled to make presentations at the 2012 Minnesota State Fair in the Horticulture Building at “The Dirt” stage.
- Minnesota’s role in the project will be featured in the fall 2012 issue of *Solutions* (<http://www.cfans.umn.edu/Solutions/>), a publication of the University of Minnesota’s College of Food, Agriculture, and Natural Resource Sciences (CFANS).
- Our group will make a presentation at the CenUSA annual meeting in Lincoln (August 7-9, 2012).
- **Increased activity around social media options.** In the next two months, we anticipate we will lead Master Gardeners through blog training so they can share what they are learning through the Extension Master Gardener Blog. Plans to start blogging about the progress of the trial gardens are underway. We will continue to work with other partners on the CenUSA project to identify other products and engagement opportunities.
- We anticipate having increased opportunities to evaluate peoples’ knowledge and potential behavioral change associated with biochar through upcoming county fair(s) and the Minnesota state fair.

- The Anoka County Fair and Minnesota State Fair booths will include a biochar display with volunteers talking with people about biochar. We will also have examples of pepper plants in containers with biochar added (Control Treatment #1, Treatment #2).

**e. Broader Public Education/Master Gardener Program – Publications, Presentations, and Proposals Submitted**

- Staff and faculty will give presentations at the 2012 Upper Midwest Master Gardener Conference (July 19-21, <http://hennepinmastergardeners.org/events/upper-midwest-master-gardener-conference/>); The Arboretum exhibition is underway.
- CenUSA Collaborator Lynne Hagen and University of Minnesota researcher Kurt Spokas presented a session at the 2012 Upper Midwest Master Gardener Conference, 7/21; 13 Master Gardeners attended.
- Informal presentation at MN Landscape Arboretum to grounds crew and staff in association with Dirt-O-Rama4.
  - ✓ 40 people in two groups; Hagen and Weisenhorn presented informally to one group apiece. When asked if they had heard about biochar, approximately 40% indicated by a show of hands that they had heard about biochar; approximately 20% claimed to know anything about biochar before the presentation.
- Approximately 30 U of Minnesota Master Gardeners participated in the online 1-hour training around the Biochar Project. Link to recorded webinar: <https://connect.extension.iastate.edu/p8ed31qx4wk/>.
- Lynne Hagen has completed A Tabletop display completed by for use at county fairs and state fair (See Exhibit 14).
- Control and treatment signage for sites (attached).
- Master Gardener Biochar Information sheet (See Exhibit 15. Biochar Safety Sheet).
- Dirt-O-Rama Biochar Information sheet (See Exhibit 16. Master Gardener Dirt-o-Rama Fact Sheet).

**Evaluation/Administration Team**

**1. Evaluation/Administration Team – Planned Activities**

The CenUSA Evaluation Coordinator (Sorrel Brown) has planned and developed evaluation protocols and tools to document both knowledge gained and behavioral changes of participants in CenUSA Extension and Outreach activities.

## **2. Evaluation/Administration Team – Actual Accomplishments**

Appropriate educational outreach events were identified and evaluation tools were developed to capture data.

- Participants who attended the biochar sessions at the Integrated Crop Management Conference (December 2011) were electronically surveyed for the level of awareness and perceptions regarding biochar as a production agriculture commodity in the Midwest (See Exhibit 17. ICM Evaluation Report Biochar Survey).
- Participants who attended a biomass program (March 2012) were surveyed to determine their increase in knowledge regarding biochar marketing, production, and government support (See Exhibit 18. Switchgrass Establishment Training Survey Results).

The participants in the switchgrass establishment training workshop reported they increased their knowledge of switchgrass and other perennial grasses as bioenergy crops, learned about technologies to convert biomass to biofuels, grasped the challenges of biomass harvest, and understood plant adaptation requirements to produced perennial grasses.

Evaluation of participants at all these events documented the intended effect of acquainting them with the basics of successfully producing biomass from perennials and use of biochar as a soil amendment was reached. As many participants served in informal educational roles, there is an expectation they will circulate the information among farmers they interact with.

## **3. Evaluation/Administration Team – Explanation of Variance**

No variance has been experienced and accomplishments are on schedule.

## **4. Evaluation/Administration Team – Plans for Next Quarter**

At the CenUSA 2012 annual meeting, Sorrel Brown will review evaluation efforts and results to date, go over the evaluation tip sheets, respond to questions and continue to provide support for future evaluation efforts.

## **5. Evaluation/Administration Team – Publications, Presentations, and Proposals Submitted**

The Evaluation Coordinator produced three analytical summaries of the surveys described in the “Accomplishments” section, above.

An evaluation presentation given by the evaluation coordinator, Sorrel Brown, at the first annual meeting for all project collaborators (Sept 2011) introduced the importance of evaluation in documenting changes that will result from outreach efforts in promoting the awareness of and stimulating production of perennials, and the use of biochar as a garden soil amendment. Various evaluation techniques were reviewed, including their feasibility given the constraints of planned team activities (cell phone polling, printed and electronic surveys, webinar polling). Emphasis was placed on how the public benefits from individuals who are willing to allocate some of their marginal land to plant perennial grasses suitable for biofuel production. Through this approach, it may be easier to generate public interest in biofuels and helps to link project efforts to a bigger picture.

The Evaluation Coordinator participated in the *NIFA Sustainable Bioenergy & Bioproducts* meeting that included all NIFA–CAP grant recipients (Washington, D.C., October 2011). She helped form a network of all participants who are responsible for evaluation for their grants to promote sharing and expertise via email.

The project Evaluation Coordinator produced several evaluation tip sheets to help all project teams understand evaluation protocol and better plan and execute their evaluations. Those include:

- *Evaluation Requirements for CenUSA Colleagues* (See Exhibit 19).
- *Human Subjects Review Protocol for Extension and Outreach Education* (See Exhibit 20).
- *Interviewing an Audience for Feedback on Biochar* (See Exhibit 21).
- *Value of Introductions for Outreach Surveys* (See Exhibit 22).
- *Retrospective Pre-then-Post Survey Format* (See Exhibit 23).
- *Asking the Right Demographic Questions* (See Exhibit 24).

The Evaluation Coordinator also participated in virtual meetings (Adobe Connect system) and teleconference sessions with several of the Objective 9 teams and was available for clarification on evaluation issues.

**EXHIBITS 1-24 ARE AVAILABLE AS A SEPARATE DOCUMENT IN THE CD**



*"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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... and justice for all

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