



cenusa bioenergy

Annual Progress Report

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

October 2012

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

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

Quarterly Report: August 1, 2012 – October 30, 2012

PROJECT ADMINISTRATION

1. Project Organization and Governance Accomplishments

CenUSA Bioenergy (“CenUSA”) Project Director Ken Moore continues to lead the overall research effort. Chief Operating Officer Anne Kinzel and Financial Manager Val Evans handle project administration and business affairs, including all aspects of CenUSA operations, including coordination, communication, and data sharing among institutions across the states. In addition, 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 timelines and deliverables schedules.

b. Featured Activities

- **CenUSA Annual Meeting**

The 2012 Annual Meeting was held August 7-9, 2012 in Lincoln, Nebraska (See Exhibit 1. 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, hosted the meeting.

Over 80 people attended the meeting, including nine of 12 Advisory Board members. In addition, eleven graduate students and post-docs were able to attend as well as six employees of the USDA-ARS.

Each of the nine research objective research teams provided progress reports to update CenUSA colleagues and to respond to questions from colleagues, the CenUSA Advisory Board and from NIFA attendees Mark Poth and William Goldner. As had been the case in the 2011 Annual Meeting, Advisory Board members participated actively in the meeting and provided valuable feedback to the participants.

One entire day was spent touring the Feedstock Development objective's regional evaluation sites near Mead, Nebraska. There was also time for each of the research objectives to meet and discuss Year 2 activities and to make further plans for Year 2 and beyond.

Participants completed a meeting evaluation that will be used in planning the 2013 annual meeting (See Exhibit 2. 2012 Annual Meeting Evaluation).

- **American Society of Agronomy, Crop Science Society of America and Soil Science Society of America International Annual Meeting, October 21-24 Cincinnati, Ohio**

CenUSA Project Director Ken Moore, CenUSA Co-Project Directors Stuart Birrell, Robert C. Brown, Michael Casler, Dermot J. Hayes, Mark Hanna, Jason Hill, Cathy Kling, Keri Jacobs, David Laird, Robert Mitchell, Patrick Murphy, Raj Raman, Kevin Shinnars, Kenneth Vogel⁸ and Jeffrey Volenec and CenUSA COO Anne Kinzel attended the "Sustainable Production and Distribution of Bioenergy for the Central USA: An Agro-Ecosystem Approach to Sustainable Biofuels Production Via the Pyrolysis-Biochar Platform meeting held in conjunction with the ASA, CSSA and SSSA International Annual Meeting in Cincinnati, Ohio. Ken Moore provided an update on the CenUSA project.

- **Workshop: Roadmap to Commercialize Thermochemical Biofuels and Bio-Products Processing in the Midwest.**

CenUSA CoProject Directors Robert C. Brown and Jill Euken have collaborated with Project Director Ken Moore and Project COO Anne Kinzel and the Iowa State University Bioeconomy Institute to create the workshop *Roadmap to Commercialize Thermochemical Biofuels and Bio-Processing in the Midwest*. The event will be held December 11-12, 2012 at the Iowa State University Scheman Center in Ames, Iowa. CenUSA, the ISU Bioeconomy Institute, the USDA Central-East Regional Biomass Research Center, Iowa NSF EPSCoR (grant number EPS-1101284 from NSF), and the Iowa Energy Center will sponsor the event.

Program Focus – Optimal Feedstocks and Commercial Pathways. The workshop is intended to bring together and help foster relationships among researchers, industry, and agricultural producers in the Midwest as they work together to create a roadmap to commercialize thermochemical processing of biofuels and bio-products (See Exhibit 3. Proposed Agenda. Workshop: Roadmap to Commercialize Thermochemical Biofuels and Bio-Products Processing in the Midwest).

Specific goals include defining the optimal biomass feedstocks for thermochemical processing and identifying commercial pathways for the technologies in the Midwest. Representatives of leading companies working to commercialize thermochemical processing of biomass are attending the workshop. Each will describe their company's technologies, goals, desired type of feedstock, and amount of biomass needed for commercial operation.

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 and the USDA 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.

✓ **Proposed Sessions**

Sustainability Challenges to Biofuels – Byron Johnson, P66

Thermochemical Conversion Technologies 101 – Robert Brown, CenUSA & ISU

Impacts of Facility Scale and Location on Thermochemical Biorefinery Costs – Mark Wright, ISU

Preparing the Midwest to Supply biomass Feedstocks for Thermochemical Processing – Ken Moore, CenUSA & ISU

Non-fuel Products from Thermochemical Processing: Heating Oil, Biochar as a Soil Amendment, and Bioasphalt – Prasad Gupte, DOE, David Laird, CenUSA & ISU, and Chris Williams, ISU)

✓ **Proposed Panels**

Ideal Feedstock Characteristics for Thermochemical Processing of Biomass

Optimizing Plant Breeding, Agronomy, and Logistics for Thermochemical Processing

Establishing Linkages Between Thermochemical Biorefiners and Midwest Biomass Feedstock Suppliers

✓ **Invited Industry Participants**

Archer Daniels Midland

BP

Chevron	KiOR
Frontier Labs	P66
Gas Technology Institute (GTI)	Renmatix
ICM	Honeywell UOP
	Virent

Other attendees include researchers and representatives from producers of first-generation biofuels, agricultural crop growers associations (Ag Ventures Alliance, IDEA, Iowa Corn Growers, Iowa Farm Bureau, KAAPA, Lincolnway Energy, Stine Seeds, Tall Corn Ethanol, West Central Coop) and government officials, and experts from the CenUSA project (Birrell, R.C. Brown, S. Brown, Casler, Euken, Hayes, Mitchell, Moore, Raman, Schmer, Vogel, & Volenec), and members of the CenUSA Advisory Board (Bennett, Binder, Mellage, Schiltz and Weis).

- **CenUSA Planning & Collaboration Meeting – December 12-13, 2012**

Immediately following the Roadmap Workshop the CenUSA executive team will meet in Ames to discuss commercialization and transdisciplinary opportunities for the CenUSA project. This meeting will provide Co-Project directors with the opportunity to engage in additional research planning and share information from fall 2012 harvest activities. (See Exhibit 4. Proposed Planning and Collaboration Meeting Agenda).

c. **Advisory Board**

The Advisory Board continues to provide valuable feedback and advice to the research team. The Advisory Board was a strong presence at the August 2012 annual meeting, as nine of the 12 members were able to attend the meeting. The Board members provided extensive feedback to each of the Objective teams. At the conclusion of the meeting Board members provided their observations and opinions regarding the project's accomplishments to date. (See Exhibit 5. Reactions to 2012 Annual Meeting – August 2012: CenUSA Bioenergy Project Advisory Board Grouped Comments)

New Board Member. By late summer 2012, board member Ben Steffen, an agricultural producer from Nebraska, was no longer able to participate on the board and recruitment was reopened. In September 2012, Bryan Mellage joined the Advisory Board. Mr. Mellage is a producer and agricultural implement dealer from Auburn, Nebraska with over 30 years experience in the agriculture and implement industries. Mr. Mellage has a very strong interest in biofuel and biomass energy farming.

2. Coordination, Collaboration, and Communication

- **Executive Team Meetings.** The Co-Project directors representing each of the nine objectives continue to 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 is an Advisory Board presence during these important project gatherings. Beginning in January 2013, the Education Objective has scheduled its *CenUSA Research Seminar Series* to coincide with the monthly Co-Project director meeting. The Research Seminars will be held in the CenUSA Adobe Connect meeting room from 3:10-4PM Central Time between January and July 2013.

Each seminar will focus on the work of a CenUSA objective. The seminar format will begin with a 15-minute talk by a project Objective Co-project director and will be followed by a 15-minute talk by one of the graduate students involved in the work of the objective. The seminar will conclude with 20 minutes of question and answer time.

Table 1. 2013 Seminar Topic Schedule	
January 25	Objective 1 - Feedstock Development
February 22	Objective 2 - Sustainable Feedstock Production Systems
March 29	Objective 3- Feedstock Logistics
April 26	Objective 4 - System Performance Metrics, Data Collection, Modeling, Analysis and Tools
May 31	Objective 5 - Feedstock Conversion and Refining: Thermo-chemical Conversion of Biomass to Bio-fuels
June 28	Objective 6 - Markets and Distribution
July 26	Objective 7 - Health & Safety

- **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.
- **2013 Annual Summit.** The advance planning for the 2013 annual summit is complete. The meeting will be held July 30 - August 2, 2013 in West Lafayette, Indiana. Jeff Volenec, Professor in the Department of Agronomy at Purdue University and Co-Project Director of CenUSA's Sustainable Feedstock Production Systems Objective, will host the 2013 CenUSA Summit.

- **Communication Platforms.** CenUSA continues to focus on expanding the quality and sophistication of the CenUSA website (www.cenusa.iastate.edu) and other social media opportunities.

The website continues to expand content for both internal and external project stakeholders (industry professionals, agricultural and horticultural producers, educators, agency personnel, community leaders, extension educators, and the general public). The website continues to be used broadly to disseminate reports, learning modules, articles, and webinars. We also use the website to promote CenUSA events and activities such as educational meetings, webinars, media events, eXtension bioenergy learning modules, field days, and networking opportunities. We have been able to secure further assistance within the Iowa State University community to add additional features to the website which will be deployed in the second quarter (November 2012 – January 2013).

We have used a Twitter account (@CenUSAbioenergy) to provide project updates, and disseminate information regarding the availability of CenUSA publications. We have been able to generate a strong core of followers within the biofuels community.

Our project webinars and videos are disseminated in three separate sites: 1) via the CenUSA website, 2) via a “YouTube Channel” (www.youtube.com/user/CenusaBioenergy); and via a Vimeo site (<https://vimeo.com/cenusabioenergy>) to provide an additional outlet to view CenUSA webinars and videos. We now have a complement of 13 videos available on the two websites. (See Exhibit 6. CenUSA Video/Webinar List)

- **Financial Matters.** The Administrative Team continues to monitor all project budgets and subcontracts to ensure adherence to all sponsor budgeting rules and requirements.
- **Program Matters.** We will continue to focus on project coordination, communication, meetings and data sharing across Objectives, and on reaching the revised timelines milestones.
- **Upcoming Public Events (Administrative Presence).** CenUSA will share a booth with the Iowa State University Bioeconomy Institute at the 2013 *Iowa Renewable Fuels Summit and Trade Show* which will be held in Des Moines, Iowa (January 30, 2013).

3. Publications, Presentation, Proposals Submitted

We prepared a new CenUSA brochure that focuses on thermochemical conversion (See Exhibit 7. The Biomass to Energy Challenge).

GERMPLASM TO HARVEST

Objective 1. Feedstock Development

Feedstock Development focuses on developing perennial grass cultivars and hybrids that can be used on marginal cropland in the Central United States for the production of biomass for energy. In 2012, the focus is on the establishment of new breeding and evaluation trials.

1. Planned Activities

- 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.
- 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 diseased crown and root tissue of switchgrass.
- Initial biomass mineral composition data will be collected on a standard set of switchgrass samples representing specific biomass types and harvest maturities.
- Composition analyses: we will hire and train a technician to carry out analyses of additional expected project samples.

- Initial analyses on switchgrass biomass standards completed for composition and pyrolysis tests.
- In the pyrolysis research, TGA Instrument's *Specialty Library* will be used 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. These variables will be correlated to full composition data when available.
- Continue analyses work, including the statistical analyses, 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 set developed for comprehensive analyses and initial NIRS scans of samples completed.

2. Actual Accomplishments

- **Stand evaluations of multi-location yield tests.** (M. Casler, K. Vogel, & Cooperators). Thirty-nine trials were planted in May 2012 and three resulted in failed stands, one for each of the three species. Of the 36 successfully established trials, 13 experienced some loss in the number of cultivars, due to seed dormancy problems (See Objective 1, Table 1). Of these 13 trials without the full complement of cultivars, three belonged to switchgrass, eight to big bluestem, and two to indiangrass. The full complement of cultivars successfully established at nine locations for switchgrass, four locations for big bluestem, and 10 locations for indiangrass. Big bluestem took the hardest hit during establishment, but eight of 13 trials resulted in successful establishment of 10 cultivars (all except Bonanza and Sunnyview). Six locations had significant annual grassy weed issues that will not allow for a final determination of stands until spring green-up in 2013. At that time, we will make a final determination of which trials will move forward for data collection. Overall, the establishment of these trials of three different species in which 46 different cultivars or experimental strains being tested can be considered to be a success since 44 cultivars or experimental strains were at a minimum of 10 locations each. This was a major accomplishment considering the drought conditions that existed in the region during most of the growing season.

Because the seedlots used in the study came from different breeding programs and commercial seed companies and hence had germination and seed dormancy or hard seed tests conducted by different laboratories, all the seed lots were sent to the *Nebraska Crop Improvement Association* and the Nebraska Department of Agriculture's *Seed Testing Laboratory* (a joint laboratory) for germination tests without a pre-chill treatment and a pre-chill treatment to break dormancy. Some of the seed lots had significant amounts of

seed dormancy. The results from the seed tests will be used with the stand information obtained in the spring of 2013 to quantify the effect of germination percentages and seed dormancy on stand establishment.

- **Establishment and maintenance of switchgrass, big bluestem, and indiangrass breeding nurseries.** (K. Vogel & M. Casler) All planned nurseries were successfully established and maintained. Again, this was a major accomplishment considering the drought conditions that existed in the region during most of the growing season. All selection nurseries will be ready for data collection in 2013.
- **Biomass yield harvests were made on a family basis for all selection nurseries established in 2011.** (K. Vogel & M. Casler) All harvests were completed as scheduled by breeding programs at Lincoln and Madison during the late summer and autumn of 2012. Samples were collected for biomass analyses. Heading date and height information was collected on specific nurseries being used in molecular marker research.
- **Seed will be harvested from specific polycross nurseries and increase fields for use in additional testing and increase.** (K. Vogel). Seed was harvested as scheduled from irrigated seed increase nurseries as planned and several non-irrigated switchgrass nurseries. Because of severe drought conditions, no seed was harvested from five non-irrigated indiangrass polycross nurseries and four non-irrigated big bluestem polycross nurseries. Seed had been harvested from these nurseries in previous years and was used in the yield trials and the breeding nurseries. The intent of the 2012 seed harvests was to replenish seed supplies of the experimental strains for potential use in seed increase for potential cultivar releases based on the yield test results. The lack of seed harvest in 2012 did not affect the research in progress. Plans are in progress to develop portable irrigation systems for use on the grass seed isolations if the current drought persists.

Insects will be monitored biweekly through the end of September. (Tiffany Heng-Moss and staff at UNL) Sampling was initiated to identify and monitor potential arthropod pest and natural enemies associated with switchgrass and other bioenergy grasses. Samples were collected every two weeks from May through September using pitfall traps and yellow sticky traps from switchgrass, big bluestem, and Indiangrass nurseries. Samples are being processed to identify potential pests and beneficial arthropods and characterize their seasonal abundance.

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Table 2. Summary of stands in multi-location yield tests.

Location	Switchgrass establishment	Switchgrass cultivars	Big bluestem establishment	Big bluestem cultivars	Indiangrass establishment	Indiangrass cultivars
Ames, IA	Satisfactory	22	Moderate	12	Moderate	12
Arlington, WI	Excellent	22	Satisfactory	10	Satisfactory	12
Brookings, SD	Moderate	22	Moderate	12	Moderate	12
Chatham, MI	Satisfactory	22	Unsatisfactory	7	Moderate	9
Columbia, MO	Moderate	22	Moderate	12	Moderate	12
Grand Rapids, MN	Moderate	14	Moderate	8	Moderate	12
Marshfield, WI	Satisfactory	22	Satisfactory	10	Satisfactory	12
Mead, NE	Satisfactory	22	Moderate	10	Satisfactory	12
So. Charleston, OH	Unsatisfactory	0	Moderate	12	Moderate	12
Spooner, WI	Excellent	22	Satisfactory	10	Satisfactory	12
State College, PA	Satisfactory	20	Moderate	8	Unsatisfactory	5
Urbana, IL	Satisfactory	22	Satisfactory	10	Satisfactory	12
West Lafayette, IN	Moderate	16	Unsatisfactory	5	Moderate	9
Number of Cultivars Planted		22		12		12

- **A series of greenhouse insect screening evaluations will be conducted on switchgrass, big bluestem, and indiagrass cultivars.** (Tiffany Heng-Moss and staff at UNL) The greenhouse screening evaluations were initiated as planned and are underway 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 & begin conducting statistical analyses of disease severity data.** (G. Yuen, UNL) Methods for rating virus and leaf spot disease severity were developed and used to evaluate plants in several switchgrass spaced-planted breeding nurseries. Virus ratings were collected on every plant in four switchgrass breeding nurseries and a large genetic study. Leaf spot ratings were made on two switchgrass breeding nurseries. All data has been entered into databases and is ready for statistical analyses.
- **Initiate testing of fungal and bacteria stains isolated from diseased leaves for pathogenicity on switchgrass.** (Gary Yuen, UNL). Research is in progress. There were major disease problems on four big bluestem selection nurseries (Objective 1, Figure 1).

This is the most severe disease problem that Ken Vogel has seen on big bluestem. It is believed that drought stress imposed on the plants enabled the plant pathogens to overcome the plant's resistance to the pathogens. Plants in the nursery were scored for disease severity and half-sib families were harvested for biomass yield to document the combined effect of drought and diseases on biomass yields in comparison to the two previous years. This unexpected disease problem illustrates the need for plant disease work on perennial grasses grown for bioenergy. Potential sources of resistance were identified.

- **Initiate work on isolating fungi from diseased crown and root tissue of switchgrass.** Research is in progress.

Figure 1. Effect of drought and diseases on big bluestem biomass yields

ARS Bamboo C2 big bluestem, UNL ARDC, September 10, 2010.



ARS Bamboo C2 big bluestem, UNL ARDC, September 27, 2012.



- **Initial biomass mineral composition data will be collected on a standard set of switchgrass samples representing specific biomass types and harvest maturities.** Five switchgrass standard samples have been developed that will be used to develop baseline data on mineral element composition of biomass. The five samples represent both lowland and upland switchgrass harvested at different maturity stages. The bulk samples have been subdivided into multiple replicate sub-samples. The replicated sub-samples are ready to be sent to commercial analytical laboratories that use different technologies for determining mineral concentration. The information will be used to determine the variation that exists within and among laboratories for mineral composition determinations and to determine the extent of variation among methods across laboratories. This baseline information is needed to identify the best methods to be used by the researchers on this project and the biofuels industry for measuring mineral concentration of perennial grass biomass and identify potential laboratory problem areas.

- **Composition analyses - Hire technician to carry out analyses of additional expected project samples; develop laboratory capabilities to conduct analyses.** (Bruce Dien, ARS-Peoria). The appropriate analytical equipment required to carry out cell wall analysis and other chemical analyses was obtained and configured for the analyses and a technician has been hired to perform the analyses.
- **Initial analyses on switchgrass biomass standards completed for composition and pyrolysis tests.** We found significant differences in condensable gas composition between pyrolyzed samples. Non-catalytic pyrolysis produced statistically significant differences in yields of acids, KAA, aromatics, nitrogens, and phenols, while catalytic pyrolysis produced significant differences only in yield of sugars. Analysis using an outside model developed by Aaron Saathoff (ARS Lincoln) found differences between samples in Guaiacol, Syringol, and some lignin-derived compounds. Additional research is in progress.
- **Pyrolysis research. TGA Instrument's *Specialty Library* will be used to perform kinetic analyses of switchgrass samples.** (A. Boateng) Kinetic analysis was performed on TGA results from switchgrass samples. From this analysis, the only switchgrass biomass property that correlated with significant differences in kinetic properties was harvesting time. Additional research is in progress.
- **Continue analyses on the relationship between pyrolysis products and composition of biomass from switchgrass genotypes known to differ genetically for biomass composition.** Laboratory analyses are complete. Final statistical comparisons are in progress. Initial results indicate switchgrass genotypes (from populations developed by generations of divergent breeding for biomass digestibility) that were significantly different in biomass composition, differed in pyrolysis product yields. These findings are the result of cooperative work between A. Boateng and ARS-Lincoln staff.
- **Big bluestem and indiangrass sample set developed for comprehensive analyses and initial NIRS scans of samples completed.** Several thousand-plant samples have been reviewed for both species and samples are in the process of being selected for additional NIRS work prior to samples being sent to B. Dien and A. Boateng for composition and pyrolysis analyses. This work is slightly behind schedule because a laboratory technician had to be replaced. The position will be open for recruitment in the near future and when filled, it is expected the work will be back on schedule within a few months.

3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule with the exception noted above regarding the hiring of a new laboratory technician.

4. Plans for Next Quarter

- Biomass samples collected during the summer and autumn 2012 will be dried, ground, and scanned for their NIRS spectral profiles. Selected samples will be selected for laboratory analyses by ARS-Lincoln, comprehensive compositional analyses by B. Dien (ARS-Peoria) and pyrolysis by A. Boateng (ARS-Wyndmoor) will be initiated.
- Clonal pieces of switchgrass plants will be moved from the field to the greenhouse for intermating during the winter months (K. Vogel, Lincoln).
- Seed harvested during the autumn of 2012 will be cleaned and tested. Seed of one experimental strain will be made available for seed producers pending official cultivar release (K. Vogel, Lincoln, M. Casler, Madison).
- Plant Canada milkvetch seedlings in the greenhouse for four breeding populations for potential use in different Midwest Plant Adaptation Regions. Plant seedling for Partridge Pea selection nurseries. (K. Vogel, Lincoln).
- Insect sampling plans will be developed for the summer of 2013. (T. Heng-Moss, Vogel, Mitchell, & Casler). Continue identification of insects collected in 2012.
- Complete statistical analyses of 2012 virus ratings of switchgrass genotypes (Yuen, Vogel).
- Continue to screen selected switchgrass, big bluestem, and Indiangrass cultivars and experimental strains for their susceptibility to greenbugs and sugarcane aphids (T. Heng-Moss, UNL).
- Compositional analyses. Complete training of technician in plant cell wall compositional analysis and initiate full laboratory composition analyses capacity (B. Dien, ARS-Peoria).
- Continue py-GC/MS and TGA experiments and associated statistical analysis on 2012 sample sets of switchgrass. Prepare for initial analyses of big bluestem, and indiangrass samples.
- Initial draft of manuscript on effect of genetic differences in biomass composition of 12 divergent switchgrass genotypes on pyrolysis products completed for review.

5. Publications, Presentations, and Proposals Submitted

- B S. Dien, P.J. O'Bryan, Michael D. Casler, Mi. A. Cott, H.G. Jung, J.F.S. Lamb, R.B. Mitchell, G. Sarath, and K. Vogel. "Variation in Composition and Yields Among Populations of Alfalfa Stems, Reed Canarygrass, and Switchgrass for Biochemical

Conversion to Sugars and Ethanol,” ACS Abstract, New Orleans, Louisiana, April 7 - 11, 2013.

- Robert B. Mitchell, Kenneth P. Vogel, and Marty R. Schmer. “2012 Switchgrass (*Panicum virgatum*) for biofuel production.” <http://www.extension.org/pages/26635/switchgrass-panicum-virgatum-for-biofuel-production>, July 24, 2012.
- Vogel, Kenneth P., and Robert. B. Mitchell. “Training on the breeding, establishment, and management of perennial grasses for bioenergy.” Presentation, University of Nebraska Crop Management and Diagnostic Clinic. (August 30, 2012). Note: Forty-five farmers, certified crop consultants, professional agronomists, and farm management consultants attended the field clinic. See Extension and Outreach report for impact.

Objective 2. Sustainable Feedstock Production Systems

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

1. Planned Activities

- 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 use control measures as necessary.
- Harvest plots for biomass (where it makes sense to do so) at/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 greenhouse gas 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.

2. Actual Accomplishments

- **Iowa State University**

- ✓ **Armstrong Farm.** The corn crop was harvested and population assessments were done on perennial treatments; switchgrass establishment was very poor due to abnormal drought. Annual surface soil samples were collected from each plot. Laboratory work is in progress to analyze soil cores for aggregate stability, bulk density, and moisture retention. Particle size distribution of bulk soil samples has been completed.
- ✓ **Agronomy and Ag Engineering Farm.** Additional biochar at the rate of 5.4 tons per acre was applied to existing plots. Total rate of biochar on those plots is now 13.6 tons per acre.

- **USDA-ARS, Madison.**

Biomass yield, soil samples, and biomass-quality samples were collected at two locations in Wisconsin in 2012 (Arlington and Marshfield, HZ4 and HZ3, respectively). Harvest stages and dates were: anthesis (mid-August) and killing frost (mid-October). The third and fourth harvest treatments (early winter and post-winter) will be made in late November 2012 and early April 2013.

- **University of Minnesota - Factor analysis plots, Becker, MN.**

- ✓ Monitored growth and weed pressure of newly established plots throughout the growing season. Growth was slow due to loamy sand soil with low organic matter. We ceased irrigation in late July and less than 1.5" of rain was received in August and September. Did not apply herbicide.
- ✓ Conducted stand frequency analysis. Some plots may need reseeding in 2013, particularly the low-diversity mix, which had the lowest stand frequency of the protocol grasses.

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- ✓ Harvested factor analysis plots on October 30, 2012 using Carter harvester and biomass was weighed wet in the field (Figure 3). Two subsamples (0.25m x 0.25m) were collected from each subplot, stored in plastic bags under cool conditions and weighed in the laboratory. We conducted a visual estimate of grass/weed content for each subsample. Subsamples are drying and will be processed for dry matter and nutrient analysis.



Figure 2. Bioenergy Switchgrass, Sept. 11, 2012



Figure 3. "Shawnee" at Harvest, Oct. 30, 2012

- **University of Illinois**

- ✓ **Factor Analysis Plots.** The factor analysis plots at the University of Illinois bioenergy research farm at Urbana had poor establishment due to severe drought from May through August and weed pressure during late summer. However, many seedlings were observed and a decision to replant will be based on stand counts in spring 2013. Feedstocks included were low diversity mix (big bluestem, indiagrass, and sideoats grama), 'Shawnee' and bioenergy switchgrass, prairie cordgrass, and a mixture of prairie cordgrass with big bluestem and Miscanthus.
- ✓ **Comparison Field Trial.** Feedstocks included in the comparison field trial at the University of Illinois were four different prairie cordgrass accessions, *Miscanthus x giganteus*, a big bluestem local ecotype, and 'Kanlow' switchgrass. Light interception and height data were measured on a weekly basis on these plots from March through November of 2012. The plots were harvested on November 15, 2012. Biomass yield and chemical compositions will be compared among the tested populations in response to the wet marginal land situation where they were grown.

- **Purdue University**

Factor Analysis Plots and Research. Findings/observations include:

- ✓ **Southern Purdue Agricultural Center.** The Southern Purdue Agricultural Center (SEPAC) is located near Butlerville, Indiana. The SEPAC plots were harvested October 29, 2012. Perennials at this site include the biomass switchgrass, a mixture comprised of equal amounts of big bluestem and indiangrass, and *Miscanthus x g.* all seeded in 2011. Yield data is not yet available, but observations indicate that all three perennial systems survived the drought/heat of 2012, but have relatively low yields. Biomass sorghums at this site and grew much better than maize (control) at every N rate. Although data is not yet available, maize yields were negligible (e.g., 6 plants/4 row plot) while all sorghums established and grew surprising well considering the limited rainfall and high summer temperatures (see Figure 5 below).



Figure 4. 2012 Big Bluestem Harvest
Photoperiod sensitive sorghum

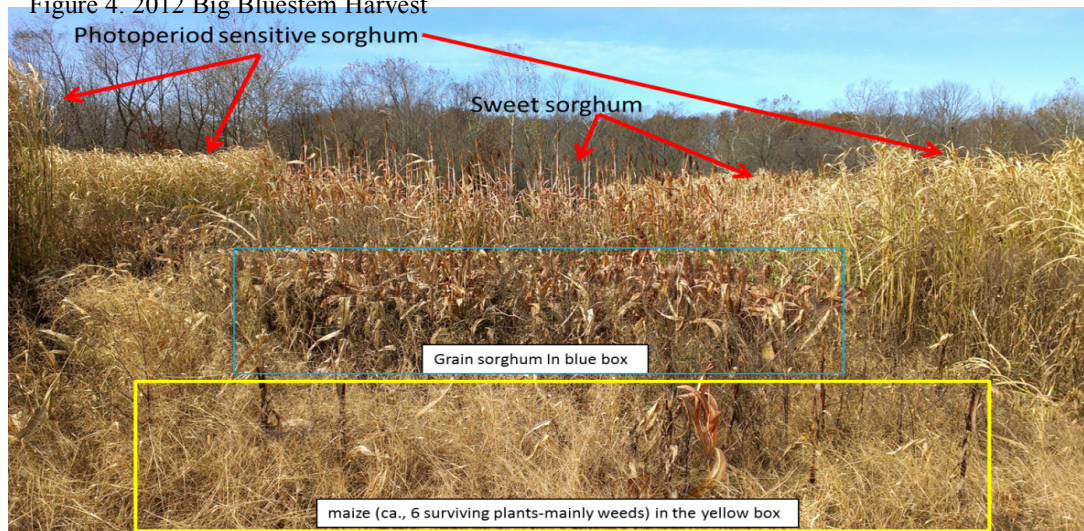


Figure 5. Southern Purdue Agriculture Center Plantings

- ✓ **Northeast Purdue Agricultural Center (NEPAC).** Plots at this location performed slightly better than at SEPAC because of one or two timely rain events that mitigated some, but not all of the drought effects. Large visual differences in agronomic performance between maize (poor) and the biomass sorghums were apparent. The perennial biomass systems (seeded in 2011) survived the drought but yields will be low because of lack of moisture. These plots are scheduled for harvest during the week of November 5 to 9, 2012.
- ✓ **Throckmorton Purdue Agricultural Center (TPAC).** Like SEPAC and NEPAC, large differences in dry matter yield were observed among the biomass sorghums and maize. About half of the maize plants in each plot died during the drought, and those that survived had much reduced growth. The annual biomass systems were harvested the week of October 15-19, 2012 and data are currently being analyzed. The perennial **biomass** systems established in 2011 also survived at this location; however, we anticipate low biomass yields because of drought and heat stress. This location also has N, P, and K fertility as management factors applied to pre-established stands of both switchgrass (two studies) and *Miscanthus x g*. Fertilizer effects on biomass yield are not visually apparent. This is not surprising since extreme drought and high temperature stress generally overrides any positive effects of fertility. Analysis of fiber, P, K, and N from the 2011 harvest of these fertility factor-analysis plots was completed. We will harvest all perennial plots at this location on November 1, 2012 and data analysis will commence shortly thereafter.

System Analysis Plots. Findings include:

- ✓ Drought also reduced growth of plants in the systems analysis plots, with large reductions in maize growth visually apparent (see Figures 6, 7 and 8, below).

Maize grain and stover yields (control system) are anticipated to be reduced by approximately 50 percent. Sorghum appears to have tolerated the heat/drought better than maize, and it resumed growth in mid-August (see center photo above). The unfertilized native prairie system survived well, but yield will be reduced by drought. Both the switchgrass and *Miscanthus x g* tolerated the drought and we anticipate reasonable biomass yields from these systems despite the drought and heat stress. Greenhouse gas measurements on these plots continued throughout the growing season. Weeds and insects were controlled as needed using best management practices. These plots were harvested for biomass the week of October 29-November 2, 2012.



Figure 6. Maize and Miscanthus x g



Figure 7. Maize, Sorghum, Prairie



Figure 8. Miscanthus x g and Switchgrass

- **USDA-ARS, Lincoln**

- ✓ **Factor Analysis Plots.** The Factor Analysis plots at the University of Nebraska Agricultural Research and Development Center (ARDC) near Mead, NE will not be harvested in 2012 due to drought. Feedstocks at this site include ‘Shawnee’ and bioenergy switchgrass, bioenergy big bluestem, a low diversity mixture comprised of big bluestem, indiangrass, and sideoats grama, and a bioenergy mixture all seeded in 2012. All stands are well established and exceed minimum stand frequency requirements. Additional stand frequency data will be collected in spring 2013.
- ✓ **Systems Analysis Plots.** Drought reduced plant growth and yield in the systems analysis plots. However, maize grain yield averaged 102 bushels/acre for the three control system replicates, even though April through August precipitation was more than 9 in. below the long-term average. A target of 50 percent of the stover was removed from each replicate and averaged 1.44 tons/acre. A winter triticale cover crop was planted on half of each replicate on September 18, 2012 and acceptable stands have established (see photos below).



Figure 9. Maize Stover Removal



Figure 10. Triticale Cover Crop

- ✓ In the perennial feedstock fields, stands are excellent and averaged 84 percent for bioenergy switchgrass, 68 percent for big bluestem, and 60 percent for the low diversity mixture (see photos below). Weeds were managed as needed using best management practices. Insects were sampled in these plots through September 2012. These fields were not harvested for biomass due to drought, but two 3 ft. x 25 ft. strips will be harvested from each feedstock replicate at 30-d intervals throughout the dormant season (weather permitting) to determine harvestable dry matter loss over

time. Yield estimates for the baseline harvest in October were 3.4 tons/acre for bioenergy switchgrass, 1.2 tons/acre for big bluestem, and 1.9 tons/acre for the low diversity mixture. These harvest strips will be georeferenced using GPS located and the effects of harvest during drought will be evaluated.



Figure 11. Switchgrass



Figure 12. Big Bluestem



Figure 13. Low Diversity Mix

3. Explanation of Variance

Drought caused poor stand establishment for perennial feedstocks at some locations. We will develop a contingency plan for replanting where needed.

4. Plans for Next Quarter

- Continue sampling biomass plots where feasible.
- Process harvested biomass samples for compositional analysis.

- Acquire soil samples following the completion of biomass harvests and analyze annual soil fertility samples for pH, electrical conductivity, and major nutrients.
- Assess stand frequencies in plots and fields in response to the drought.
- Begin summarizing and analyzing biomass yield data.
- Begin laboratory analysis of biomass samples.
- Ongoing baseline soil profile analysis will continue with measurements of bulk density, water retention, and aggregate stability via dry sieving.

5. Publications, Presentations, and Proposals Submitted

- Anderson, E., T. Voigt, & D.K. Lee. "Salt tolerance in *Panicum virgatum* and *Spartina pectinata*." Abstract 198-4. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati Ohio, October 21-24, 2012.
<http://scisoc.confex.com/scisoc/2012am/webprogram/Paper73607.html>.
- Burks, J., S.M. Brouder, & J.J. Volenec. "Seasonal accumulation and partitioning of carbon- and nitrogen-containing compounds in perennial bioenergy crops." Abstract 99-4. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati Ohio, October 21-24, 2012.
<http://scisoc.confex.com/scisoc/2012am/webprogram/Paper72902.html>.
- Dierking, R., J.J. Volenec, & S.M. Brouder. 2012. "The potential of maize and sorghum biomass grown on marginal sites." Abstract 247-5. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati Ohio, October 21-24, 2012. <http://scisoc.confex.com/scisoc/2012am/webprogram/Paper72548.html>.
- Dowd, P.F., G. Sarath, Mitchell, R.B., A.J. Saathoff, & K.P. Vogel. 2012. "Insect resistance of a full sib family of tetraploid switchgrass (*Panicum virgatum* L.) with varying lignin levels." Genetic Resources and Crop Evolution. (Online DOI 10.1007/s10722-012-9893-8).
- Follett, R.F., K.P. Vogel, G. Varvel, Mitchell, R.B., & J. Kimble. 2012. Soil carbon sequestration by maize and switchgrass grown as bioenergy crops. Bioenergy Research. DOI 10.1007/s12155-012-9198-y.
- Laird, David. "Sustainable Integrated Bioenergy-Agronomic Systems." Presentation, 4th Annual Biofuels: Science & Sustainability Tour, Iowa State University, BioCentury Research Farm, August 14, 2012.

- David Laird. “Biochar: Presentation for Master Gardeners.” Iowa State University, Ames Iowa, August 25, 2012.
- David Laird. Contribution of Soil Biochar Applications to Sustainable Bioenergy Feedstock Production. Poster, New Technology Expo to Reduce Nutrient Flux to Water Resources, Iowa State University, BioCentury Research Farm, September 12, 2012.
- David Laird. “Potential of Biochar to Increase Resiliency of Agriculture.” Presentation, Iowa State University Bioeconomy Institute, Ames Iowa, September 17, 2012. Note: The presentation was for representatives from the Farm Bureau.
- David Laird. “The Biochar Frontier.” Seminar, Purdue University, West Lafayette Indiana, October 1, 2012.
- David Laird, Natalia Rogovska, Pierce Fleming, Douglas Karlen & Samuel Rathke. 2012. Biochar Mitigation of Allelopathy Induced Yield Loss in Continuous Maize. Abstract 74-Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati, Ohio, October 21-24, 2012.
- M. Long, M., J.J. Volenec, & S. M. Brouder. Nitrogen impacts on the yield and cell wall composition of contrasting sorghum lines used for biomass. Abstract 383-8. Inter. Meeting of the Amer. Soc. Agron. Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati, Ohio, October 21-24, 2012.
- Rob Mitchell, and Kenneth P. Vogel. “Field Day, Management of Perennial Grasses for Bioenergy.” University of Nebraska Crop Management and Diagnostic Clinic, University of Nebraska ARDC, Ithaca, Nebraska, August 30, 2012. Note: Hosted a field day for 45 professional agronomists on the breeding, establishment,
- Mitchell, R., Vogel, K.P., Uden, D.R. 2012. “The feasibility of switchgrass for biofuel production.” *Biofuels Journal*. 3:47-59.
- Rob Mitchell & Marty Schmer. “Switchgrass harvest and storage,” in *Switchgrass: A valuable biomass crop for energy (Green Energy and Technology)*, ed. A. Monti. 113-127: London Springer-Verlag, 2012.
- Rob Mitchell, R., K.P. Vogel, K.J. Moore, & M.R. Schmer. 2012. Location effect on switchgrass biomass loss and feedstock quality during storage. Abstract 198-3. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati, Ohio, October 21-24, 2012.
- Ken Moore, S.J. Birrell, R.C. Brown, M. Casler, J.E. Euken, D.J. Hayes, M. Hanna, J.D. Hill, C.L. Kling, K.L. Jacobs, D.A. Laird, R. Mitchell, P.T. Murphy, R. Raman, C.V.

Schwab, K.J. Shinnars, K.P. Vogel, & J.J. Volenec. 2012. Sustainable production and distribution of bioenergy for the Central USA: An agro-ecosystem approach to sustainable biofuels production via the pyrolysis-biochar platform (USDA-NIFA AFRI CAP, Project #2010-05073). Abstract 26-3. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati, Ohio, October 21-24, 2012. <http://scisoc.confex.com/scisoc/2012am/webprogram/Paper74539.html>

- A. Parrish, D.K. Lee & T. Voigt. 2012. Fertilizer and harvest timing effects on *Miscanthus x giganteus* and *Panicum virgatum*. Abstract 247-10. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati Ohio, October 21-24 2012. <http://scisoc.confex.com/scisoc/2012am/webprogram/Paper73205.html>
- S. Thapa, A. Parrish, J. Guo, T. Voigt, & D.K. Lee. Evaluation of prairie cordgrass (*Spartina pectinata* L.) for abiotic stress tolerance and sustainable biomass production in marginal land. The 3rd Pan America Congress. Champaign, Illinois, July 16-18, 2012.
- E. Trybula, I. Chaubey, J. Frankenberger, S.M. Brouder, & J.J. Volenec. Quantifying ecohydrologic impacts of perennial rhizomatous grasses on tile discharge, a plot level comparison of continuous corn, mixed prairie, upland switchgrass, and *Miscanthus x giganteus*. Abstract 297-9. Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer. Cincinnati, Ohio, October 21-24, 2012. <http://scisoc.confex.com/scisoc/2012am/webprogram/Paper75175.html>
- P. Woodson, S.M. Brouder & J.J. Volenec. 2013. Field-scale K and P fluxes in the bioenergy crop switchgrass: Theoretical energy yields and management implications. J. Plant Nutr. Soil Sci. (in press).

Objective 3. 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.

1. Planned Activities

University of Wisconsin-Madison

Research activities planned during the late summer and early fall of 2012 included:

- Time and motion study of bale handling logistics;
- Field drying studies;
- Initiation of a bale storage study; and
- Quantification of the energy required to size-reduce perennial grasses by various means.
- Outreach activities included beginning production of a video and accompanying fact sheets concerning best harvesting practices.

Iowa State University

Research activities planned during the late summer and early fall of 2012 included:

- Determination of potential perennial biomass supply based on NASS data on cropland use and percent of marginal soils, and subsequent supply radius required.
- Integration of potential biomass perennial supply into a field harvest and logistics cost model, including the effect of producer demographics on harvest, storage and transportation costs.
- Analysis of harvest supply chain costs for multi-source cellulosic feedstock, including perennial grasses.

2. Actual Accomplishments

University of Wisconsin-Madison

- We harvested several fields using a round baler where bales were either randomly distributed or strategically accumulated in one field location as if the baler were equipped with a bale accumulator. Three CRP fields planted to either switchgrass or native grasses were used. Bales were loaded onto trailers by an experienced operator using front-end loaders and bale handling logistics quantified by time, distance traversed, and fuel use per bale. Overall, accumulation and strategic bale placement reduced time to load bales by 38 percent and total travel distance in the field by 40 percent. Although strategic bale handling did reduce total fuel required to handle bales, the specific fuel required to handle bales was small compared to that required for baling and transport.

We investigated two techniques to further enhance the drying rate of switchgrass: intensive conditioning and wide-swath drying. Intensive conditioning involved mechanisms to hard crush the stem accompanied by shear forces to disrupt the waxy epidermis of the stem. Wide-swath drying involved a post-cutting tedding operation that distributed the crop across the full cut-width. Although not consistent across all studies,

intensive conditioning generally was more effective than wide-swath drying at improving switchgrass drying rate. The combination of intensive conditioning and wide-swath drying consistently resulted in the greatest drying rate compared to the control treatment. This combination produced switchgrass moisture contents well below 15 percent (w.b.) in three separate studies.

We have begun to quantify the energy required to size-reduce perennial grasses either at the time of harvest or post-storage. Three size-reduction mechanisms were used: round baler with pre-cutter; forage harvester; and tub grinder. Using a pre-cutter on a baler increased bale density by 0 to 10 percent and increased specific fuel consumption by 10 percent to 23 percent with an average of 17 percent. A wide particle-size distribution resulted from use of the baler pre-cutter. Size-reduction by chopping with a forage harvester or by tub-grinding produced similar particle-size and mass throughputs. However, baling followed by post-storage tub grinding required more than twice the specific energy compared to chopping with a forage harvester.

Bales formed during the studies above were used in a storage study that will be conducted over the next six months. Four treatments were considered in this dry bale study, including indoor and outdoor storage and bales wrapped in plastic film (either individually or in a tube).

Finally, working with cooperators in CenUSA's *Outreach and Extension* objective (Objective 9), we took professional video of harvesting operations to begin production of an educational video on best harvesting practices. Fact Sheets will be developed to support the video.

Iowa State University

- NASS data on cropland use and percent of marginal soils have been integrated into a field harvest and logistics cost model. The model has been utilized on different case studies to determine the effect on changing the marginal row crop land in perennial grasses, and the subsequent effect this has on the supply radius for bio-refineries of different sizes. In general, the case studies show that the supply radius with the addition of perennial grasses replacing row crops on marginal land (dual feedstock supply), is similar to the supply radius for a single feedstock supply (row crop residues) with relatively high removal rates, and much less than the supply radius for a row crop residues with more conservative and sustainable removal rates.

A Monte Carlo simulation for analysis and optimization of field harvest and logistics costs based on producer demographics has been developed. As expected the optimum machinery set varies by producer size and feedstock harvest and logistics costs are decreased with increasing producer size. This Monte Carlo optimization is in the process

of being integrated into the field harvest and logistics cost model. The Monte Carlo simulation provides the ability for stochastic cost analysis and sensitivity analysis.

Analysis of harvest supply chain costs for multi-source cellulosic feedstock, including perennial grasses, and the subsequent effect the supply radius costs for bio-refineries of different sizes, is continuing, but has not been completed.

3. Explanation of Variance

University of Wisconsin-Madison

No variance has been experienced –we accomplished all that we had planned during this project period.

Iowa State University

No significant variance has been experienced –we accomplished all that we had planned during this project period. The only issue that has slightly delayed work has been the recruitment of graduate students. Additional personnel started in the middle of the first quarter (August – October 2012).

4. Plans for Next Quarter

University of Wisconsin-Madison

Now that our fall harvest period is complete we plan to:

- Analyze the collected data from the fall 2012 harvest;
- Manage our bale storage study;
- Begin design and fabrication on machines to combine cutting/intensive conditioning/tedding into a single operation; and
- Continue to collect post-storage size-reduction energy requirements of bales, but now using bales removed from storage during the winter months.

Iowa State University

Now that our fall harvest period is complete we plan to:

- Continue the development and integration of the Monte Carlo simulation into the field harvest and logistics cost model;
- Continue the development of laboratory scale equipment to study unit operations in the harvest, storage and transportation of perennial grasses; and

- Collaborate with CenUSA CoPds in Nebraska (Objective 2 - Sustainable Feedstock Production Systems) to collect machine performance and logistics data for large-scale harvest and transportation of perennial grasses.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

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

This objective 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. Planned Activities

Iowa State University

- Our first two broad tasks 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.

University of Minnesota

- Planned activities for this quarter included 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), and the initiation of Task 3 (Integrate physical and economic models to create spatially-explicit simulation models representing a wide variety of biomass production options).

2. Actual Accomplishments

Iowa State University

- We have acquired and are testing the most recent version of the Environmental Policy Impact Climate (EPIC) model. The model 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 N₂

(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).

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.

A major component of the ISU-Center for Agricultural and Rural Development modeling work in this objective involves the improvement of SWAT models for the Upper Mississippi River Basin and the Ohio Tennessee River Basin with USGS 12-digit subwatersheds. This effort is also supported by a National Science Foundation grant. During the first year of the 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. Initial calibrations of the model are complete.

University of Minnesota

- Our major accomplishment this quarter was finishing our comparison of U.S. federal agency bioenergy feedstock production scenarios for achieving Renewable Fuel Standard (RFS2) biofuel volumes. Major discrepancies among agency projections of future biomass availability were identified, as were underlying reasons for them. This work has been submitted to a journal for publication.

Other ongoing projects include continued work on yield trial data to understand yield gaps in production, compiling production cost and return data for switchgrass, exploring different biodiversity models for use in our InVEST modeling, and writing of scripts to automate the modeling of biomass production placement on the landscape.

3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

4. Plans for Next Quarter

Iowa State University

Continue work on the first two tasks:

- 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.

University of Minnesota

- Next quarter will include continued work on Tasks 1, 2, and 3, as well as continued work ahead of schedule on Task 4 (Evaluate the life cycle environmental consequences of various bioenergy landscapes).

5. Publications, Presentations, and Proposals Submitted

- Hill, Jason. "Ethanol: Fact is Stranger than Fiction." Lecture, ASABE Minnesota Section Fall 2012 Meeting, St. Paul, MN, October 2012.
- Rabotyagov, Sergey, Adriana Valcu, & Catherine L. Kling. "Reversing the Property Rights: Practice-Based Approaches for Controlling Agricultural Nonpoint-Source Water Pollution When Emissions Aggregate Nonlinearly." Presentation, Global Environmental Challenges: The Role of China Shanghai, China, December 12-13, 2012.
- Kling, Catherine L. National Science Foundation, "Climate and Human Dynamics as Amplifiers of Natural Change: A Framework for Vulnerability Assessment and Mitigation Planning, (Principal Investigator), 2012-2016, \$480,000.
- Kling, Catherine L. "Markets and Regulation: Alternative or Complements." Presentation, 2012 Agricultural Outlook Forum, USDA, Washington DC, February 2012. <http://www.card.iastate.edu/environment/presentations.aspx>.
- 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." Center for Agricultural Research and Development, Iowa State University, Ames, Iowa <http://www.card.iastate.edu/environment/presentations.aspx>
- Gonzalez-Ramirez, J., Adriana Valcu & Catherine L. Kling. "An Overview of Carbon Offsets from Agriculture." *Annual Review of Resource Economics* 4 (2012): 145-160.

POST-HARVEST

Objective 5. Feedstock Conversion and Refining: Thermochemical Conversion of Biomass to Biofuels

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.

Sub-objective 1. Perform Technoeconomic Analysis

1. Planned Activities

Identify project graduate student and develop plan for process modeling.

2. Actual Accomplishments

A PhD student in Mechanical Engineering has been identified. This student has a year of experience developing and modifying process models in Chemstations Chemcad® and AspenPlus®. A background literature review has begun.

3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

4. Plans for Next Quarter

Conduct preliminary literature search to develop plan for process modeling assumptions. We will determine the most appropriate modeling program and begin model development.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

Sub-objective 2. Prepare and characterize biochar

Identify project graduate student and develop plan for process modeling.

1. Planned Activities

Evaluate water sorption isotherms on diverse biochars.

2. Actual Accomplishments

Water vapor adsorption and desorption isotherms were determined for 14 biochars prepared from corn stover and alfalfa meal at temperatures ranging from 300 to 600 °C. The data set includes equilibrium water contents at six different relative humidities ranging between 11 to 98 percent RH.

3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

4. Plans for Next Quarter

Laboratory work to analyze the anion exchange capacity of biochars that have aging in aqueous solutions under oxidizing conditions.

5. Publications, Presentations, and Proposals Submitted

Michael Lawrinenko & David Laird. 2012. "Anion exchange capacity of biochar." Abstract 80-20 Inter. Meeting of the Amer. Soc. Agron.-Crop Sci. Soc. of Amer.-Soil Sci. Soc. of Amer.. Cincinnati, Ohio, October 21-24 2012.

Objective 6. Markets and Distribution

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

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

1. Planned Activities

Our team anticipated a total of five activities for the first quarter of the second year of the project:

- Continue to pursue access to farm-level recent 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; and
- Develop the survey instrument to be administered during ISU's Integrated Crop Management (ICM) Conference.

2. Actual Accomplishments

Each of our planned activities for Q1 Y2 has been addressed in some manner. Brief explanations for each are provided here.

- **Pursuit of Access to Farm-level Recent CRP Data.** Our team proposed to the USDA that a memorandum of understanding (MOU) be established to permit access to micro-level CRP data for signups 27 through 40 (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. Parcel 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. There has been no advancement of this activity during this quarter due to anticipated delays in data access allowance.
- **Marginal land definition.** We continue to explore placement scenarios for switchgrass on the landscape in collaboration with researchers and scientists in the CenUSA *System Performance Metrics* objective (Objective 4). These scenarios consider land quality attributes that fall within definitions of marginal land. Most recently, we have considered the attribute ranges of CRP lands.
- **Switchgrass Trial Data.** CenUSA Collaborator Richard Perrin is collecting switchgrass trial data from states relevant to our study. We expect this will continue into the next quarter.
- **Undergraduate Intern.** CenUSA Objective 6 CO-Project Directors Dermot Hayes and Keri Jacobs hosted an undergraduate research intern during the summer. The intern did research to understand the energy requirements of corn stover and switchgrass. The

research was presented at a summer undergraduate research symposium at ISU and also at CenUSA's annual meeting in Lincoln, NE, August 7-9, 2012.

Development of ISU's ICM Conference Survey Instrument. To better identify the barriers and drivers of implementation of the biomass production system, our team has arranged to participate in Iowa State University's Integrated Crop Management (ICM) extension series to be held November 28—29, 2012. We will engage in a collaborative effort with fellow CenUSA researchers Jill Euken, Chad Hart, Sorrel Brown, and Rob Mitchell to 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. The session will provide landowners and farm managers with information about the expected costs, returns, and production details of planting switchgrass on the landscape. A survey will be administered to gain feedback from session participants that will assist us in fully responding to our objective of studying and quantifying the production and location-specific barriers and drivers of implementation of the entire system from producers of feedstock, producer groups and their stakeholders, and from biofuel producers.

3. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

4. Collaborative Efforts.

Our team engaged in numerous collaborative efforts –within CenUSA and with industry partners, during the quarter.

Collaboration and interaction among the CenUSA program areas includes:

- Jacobs worked with CenUSA colleagues Jason Hill, Cathy Kling, and other collaborators in the *Markets and Distribution* objective (Objective 4) to model placement of switchgrass on the landscape. Hill's and Kling's objective have expertise in such modeling, and Jacobs possesses information related to CRP that is useful in their efforts. Jacobs recently traveled to the University of Minnesota for a meeting with Jason Hill and his team to develop a plan going forward. The meeting was useful for Jacobs to understand the capability of Hill's team's modeling efforts and to understand their data needs so that Jacobs may help with those needs.
- In preparing for the 2012 ISU ICM Conference and the CenUSA Bioenergy Symposium to be delivered at the conference, Jacobs collaborated with researchers and scientists from CenUSA Objectives 1 (*Feedstock Development*), 2 (*Sustainable Feedstock Production Systems*), and 9 (*Extension and Outreach*), including CenUSA colleagues David Laird, Rob Mitchell, Jill Euken, Chad Hart, and Sorrel Brown. The ICM presentation will address the economics of a system of perennial grasses and administer a survey to gauge participants' thoughts on the likely barriers and drivers of implementation.

Collaboration with industry and business model development:

- Co-Project Director Dermot Hayes indicates:

I am part of a group that is interacting with Du Pont, Deere and Stine seeds on a project to model the use of feedstocks as a fuel source for fast pyrolysis. The fast pyrolysis system would be distributed and would provide a char byproduct. The group includes soil scientists, chemical engineers and mechanical engineers. This project has now evolved to the point where we have begun to construct a business model. The model involves the sale of bio-oil for use in furnaces for heat. Used in this manner the bio-oil will qualify for credit as a cellulosic biofuel. The char will be sold as a soil amendment to improve water holding capacity and ion exchange on eroded land or thin soils. Initial results suggest that the product has the potential to permanently improve soil quality.

I am also working with an economist at Indiana University to model the aggregate supply curve for switchgrass, wheat straw and corn stover. The results suggest that corn stover will supply enough biomass to meet the cellulosic fuel mandates before any of the other possible sources become economical.

5. Plans for Next Quarter

During the second quarter year 2 (Q2 Y2), our team will work towards accomplishing the following:

- Deliver a session at the 2012 ICM CenUSA Bioenergy Symposium, titled, *Understanding the economics of a system of perennial grasses for bioenergy in the central U.S.* (Jacobs).
- Report the findings of the survey administered during the ICM event (Jacobs).
- Continue to push forward on the goal of accessing farm-level CRP data (Jacobs).
- Interact with industry (Du Pont, Deere, and Stine Seeds) on a project to model the use of feedstocks as a fuel source for fast pyrolysis. The business model involves a distributed system of fast pyrolysis that provides as byproducts char and bio-oil. Char will be sold as a soil amendment, and bio-oil will be sold for use in furnaces for heat. The group includes soil scientists, chemical engineers and mechanical engineers (Hayes).

- Model the aggregate supply curve for switchgrass, wheat straw, and corn stover (Hayes).

6. Publications, Presentations, and Proposals Submitted

None.

Objective 7. 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.

1. Task 1 – Managing Risks in Producing Feedstocks

a. Planned Activities

The team expanded the collection of the various duties and responsibilities associated with producing feedstocks to be used in risk assessments for hazards. The development of the procedural process for identifying, analyzing, and grouping tasks was continued. The team also began the collection of various injury data sources to be used in the analysis of frequency and severity of agricultural injuries associated with task of producing feedstocks.

b. Actual Accomplishments

More items have been added to the list of identified duties and responsibilities for determining the risk involved. Refinement in the group methodology is being considered because of the different types of individual tasks connected with duties and responsibilities associated with producing feedstocks. First examination of preliminary injury data sources to be used in the risk assessment was conducted and a change in the procedure of measuring the risk might be needed because of available data.

c. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Plans for Next Quarter

Refinement of the accumulated listing of duties and responsibilities will continue. Risk assessment protocol for handling the evaluation of the various tasks will continue. The continued evaluation of the various injury data sources that links available injury data to identified tasks will move toward completion.

e. Publications, Presentations, and Proposals Submitted

Previous publication submitted: Schwab, C. V., and M. Hanna. “Master Gardeners’ safety precautions for handling, applying, and storing biochar.” CenUSA Bioenergy 2012 Publication. ISU University Extension and Outreach, Ames, IA 50011.

2. Task 2 – Assessing Primary Dust Exposure

a. Planned Activities

Initial locations where dust exposures are starting to be identified and those identified from Task 1 above are being included.

b. Actual Accomplishments

Several initial locations for dust exposures were logged and several more were explored in the first quarter of project year 2.

c. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Plans for Next Quarter

We will continue to find more potential locations of dust exposure. Appropriate monitoring equipment will be identified and obtained to conduct the pilot study. Approvals and procedures will be established.

e. Publications, Presentations, and Proposals Submitted

None to report this period.

OUTREACH AND EXTENSION

Objective 8. Education

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

- To develop a shared bioenergy curriculum core for the Central Region, and

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

Subtask 1 focuses on 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 2-week summer intensive program modeled on a highly successful industry sponsored intensive program in biorenewables the team led in 2009.

Subtask 1: Curriculum Development

1. Planned Activities

- **Module 1. Perennial Grass Physiology, Growth, and Development**
 - ✓ **Seed Structure/Seedling Emergence Activity.** Make 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.
- **Module 2. Perennial Grass Establishment and Management**
 - ✓ Complete components and submit to internal review/*JNRLSE*.
- **Module 3. Harvesting Systems for Bioenergy Grasses**
 - ✓ Complete components and submit to internal review/*JNRLSE*.
- **Module 4. Storage Systems for Bioenergy Grasses**
 - ✓ Complete outline of module content.
- **Modules 5 and 6. Markets & Distribution Modules** (lead authors Nicole Olynk and Corrine Alexander)
 - ✓ Complete content outlines and begin development of activities with Amy Kohmetscher.

2. Actual Accomplishments

- Identified specific evaluation goals and developed initial tools for evaluating modules in off-line environments (Evaluation lead: Gwen Nugent)

- Attended workshop on Americans with Disabilities Act compliance of on-line materials. We will adapt new practices that improve accessibility of module activities for differently-abled students.
- **Module 1. Perennial Grass Physiology, Growth, and Development.** Status of components (Lead author John Guretzky):
 - ✓ **Seed Structure/Seedling Emergence** activity. Reviewed and evaluated by students in UNL *Forage Crop and Range Management* course.
 - ✓ **Tiller Structure Text-based Lesson.** Reviewed and evaluated by students in UNL *Forage Crop and Range Management* course.
- **Module 2. Perennial Grass Establishment and Management.** Status of components (Lead author John Guretzky):
 - ✓ Completed lessons on drill calibration and establishment grid usage.
 - ✓ Pure Live Seed lesson reviewed and evaluated by students in UNL *Forage Crop and Range Management* course.
- **Module 3. Perennial Grass Harvest Management.** Status of components (Lead authors Pat Murphy and Iman Beheshti Tabar):
 - ✓ Added content related to winowing and baling equipment.
 - ✓ Added animations demonstrating mower-conditioning and baling from equipment manufacturers with copyright permission.
 - ✓ Students reviewed and evaluated module in Purdue Crop Production Equipment course.
- **Module 4. Storage Management.** Status of components (Lead authors Pat Murphy and Iman Beheshti Tabar):
 - ✓ Completed outline of module content.
- **Module 5. Integrating Bioenergy Production into Current Systems.** Status of components (Lead author Nicole Olynk):
 - ✓ Completed development of content in PowerPoint.
- **Module 6. Markets & Distribution Module.** Status of components (Lead author Corrine Alexander):

- ✓ Completed outline of module content.

- **Module 7. Introduction to Perennial Grasses as a Bioenergy Feedstock.** Status of components (Lead author John Guretzky):

- ✓ Converted CenUSA Co-Project Director Ken Vogel's webinar into lesson.

3. Explanation of Variance

Not applicable.

4. Plans for Next Quarter

- **Module 2. Perennial Grass Establishment and Management**

- ✓ Complete internal review and submit to *JNRLSE* for peer review.

- **Module 3. Perennial Grass Harvest Management**

- ✓ Complete internal review and submit to *JNRLSE* for peer review.

- **Module 4. Storage Management**

- ✓ Develop module content in PowerPoint and begin module development activities with Amy Kohmetscher.

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

- ✓ Complete module development activities with Amy Kohmetscher.

- **Module 6. Markets & Distribution Module**

- ✓ Complete development of content in PowerPoint and begin module development activities with Amy Kohmetscher.

- **Module 7. Introduction to Perennial Grasses as a Bioenergy Feedstock**

- ✓ Complete outline of remaining content.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

Subtask 2A: Training Undergraduates via Internship Program

1. Planned Activities

- 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 program.
- All student interns will travel to Mead, Nebraska, to visit the University of Nebraska's Agricultural Research and Development Center (ARDC). Field plots tours will showcase all aspects of management, production, sustainability, breeding, and basic biology research. Rob Mitchell and Ken Vogel will lead the demonstrations and tours with help from other CenUSA team members.
- 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 research projects conducted by 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 paths 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 on 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.

2. Actual Accomplishments

- Interns at partner institutions returned to Iowa State University for program conclusion.
- Interns visited the University of Nebraska's Agricultural Research and Development Center (ARDC) and participated in tours.
- Interns participated in the ISU university-wide undergraduate research poster session and reception.
- Interns completed post-program survey.

- All internship-relevant payments processed except for one with a partner institution where there's been a delay in getting the bill from their housing department.
- Soliciting faculty hosts for the summer 2013 program.

3. Explanation of Variance

Not applicable.

4. Plans for Next Quarter

- Finish solicitation of projects from faculty.
- Determine distribution of students to sites, that is, determine the number of slots for each participating lab.
- Promote the undergraduate internship program and encourage application submissions, working with lists of underrepresented minority students generated by ISU graduate college, and through job-posting boards at regional institutions.
- Migrate program website to primary CenUSA host, rather than independent site (ISU ABE) used for inaugural year.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

Subtask 2B – Training Graduate Students via Intensive Program

1. Planned Activities

- 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 Intensive Program for graduate students.
- Contact CenUSA faculty members and secure their involvement and participation.

2. Actual Accomplishments

- Met with CenUSA Project Director and key Objective leaders to determine when to conduct the Intensive Program – established that this should occur in second week of June 2013 at the ISU campus.
- Created a detailed draft schedule for inaugural Intensive Program for graduate students.

- Contacted CenUSA faculty members. Well over half have made commitments of time; some have indicated concerns about scope of their portion, and we have adjusted schedule accordingly.

3. Explanation of Variance

Not applicable.

4. Plans for Next Quarter

- Get tentative headcount from entire program.
- Finalize schedule.
- Get clear learning objectives for each day of content from program lead.
- Line up housing and facilities for program.

5. Publications, Presentations, and Proposals Submitted

None to report this period.

Objective 9. 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. The team delivers science-based knowledge and informal education programs linked to CenUSA Objectives 1-7.

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

■ Extension Staff Training/eXtension Team

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

■ 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; and
- ✓ Certified Crop Advisor training.

- **Economics and Decision Tools Team**

This team focuses on the development of crop enterprise decision support tools to analyze the economic possibilities associated with converting acreage from existing uses to energy biomass feedstock crops.

- **Health and Safety Team**

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

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

This team focuses on two separate areas:

- **Youth Development** – The emphasis is on developing a series of experiential programs for youth that introduce the topics of biofuels production, carbon and nutrient cycling and biochar as a soil amendment.
- **Broader Public Education/Master Gardener 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.

1. Extension Staff Training/eXtension Team

a. Planned Activities

- Provided three presentations at *Crop Management Diagnostic Clinics* in Nebraska.
- Development, review, posting and publication of Extension publications related to switchgrass establishment, switchgrass weed control, switchgrass nutrient management, and optimizing harvests of perennial grasses.
- Establish eXtension Farm Energy Image gallery.

b. Actual Accomplishments

- **Public Presentations.** Gave three presentations (60 crop consultants, extension educators and producers) at *Crop Management Diagnostic Clinics* in Nebraska.
- **Fact Sheets.** Switchgrass Establishment (Fact Sheet 1.1) has been drafted and is in final review; Switchgrass Weed Control (Fact Sheet 2.1) has been drafted and is in review; Switchgrass Nutrient Management (Fact Sheet 2.2) has been drafted and is in review; Optimizing Harvest of Perennial Grass (Fact Sheet 3.1) has been drafted and is in review.
- **Video Productions.** “Optimizing Harvest of Perennial Grass” has been produced and is being edited.
- Extension Farm Energy Image gallery completed and tested, now ready for image uploading by CenUSA collaborators (<http://farmenergymedia.extension.org/images>).

c. Explanation of Variance

Not applicable.

d. Plans for Next Quarter

- **Public Presentations.** Three presentations are scheduled for a large farm machinery show related to bioenergy/biofuels/switchgrass to be held in Nebraska.
- **Fact Sheets.** We will continue to work on fact sheets and video listed in the “Actual Accomplishments” section, above.

e. Publications, Presentations, and Proposals Submitted

- Deanna Namuth-Covert, Ashu Guru, Michael Fairchild, Amy Kohmetscher, Deanna Leingang, Carol Speth, Jamie Sherman, Don Lee, Martha Mamo, Mary Brakke, John Guretzky, and Patrick Murphy. “Learning Object Repository Becomes of Age – Reflecting on 13 Years of Faculty Development and Technology Applications.” Presentation, 18th Annual Sloan International Conference on Online Learning: University of Nebraska-Lincoln, Montana State University, University of Minnesota and Purdue University, October 12, 2012.
- Gave three presentations for 60 crop consultants, extension educators, and producers at the Crop Management Diagnostic Clinics. CenUSA Extension and Outreach collaborator Keith Glewen was responsible for planning the event. Co-presenters were CenUSA Co-Project Directors Rob Mitchell and Ken Vogel.

2. Producer Research Plots/Perennial Grass Team

a. Planned Activities

- *Switchgrass for Bioenergy Crop Clinic* at University of Nebraska
- Evaluation of on-farm perennial grass demonstrations in Iowa, Nebraska, Minnesota, and Indiana.
- Perennial Grass Field Day at the Phil Winborn family farm (Kalona, IA)

b. Actual Accomplishments

- Held a One-day *Switchgrass for Bioenergy Crop Clinic* at the University of Nebraska attended by 34 crop consultants and producers from Nebraska, Minnesota, Missouri, Kansas, and South Dakota. The producers reported farming a total of 28,710 acres and the attending consultants described impacting 966,671 acres.
 - ✓ 83 percent of participants reported major or significant improvements in their understanding of potential fuel yields from perennial grasses (gal/ton).
 - ✓ 72 percent of participants reported major or significant improvement in their understanding of switchgrass basic agronomic practices.
 - ✓ 72 percent of participants reported major or significant improvements in their understanding of land types on which switchgrass and other perennial grasses have economic potential as bioenergy crops.
 - ✓ 62 percent of participants reported major or significant improvement in their understanding of the potential for genetic improvements in switchgrass for bioenergy.
 - ✓ 65 percent of participants reported major or significant improvement in their understanding of biomass storage requirements.
 - ✓ 59 percent of participants reported major or significant improvement in their understanding of environmental benefits of growing perennial grasses as bioenergy crops.
 - ✓ 45 percent of participants reported they would expand and/or modify what they are already recommending regarding switchgrass and other perennial bioenergy grasses if a biomass biorefinery is built in their area, as a result of their attendance at the crop clinic.

- ✓ 48 percent of participants reported they would and/or modify their recommendations regarding perennial warm-season grasses for hay or pasture to spread production risks as a result of the crop clinic.
- Field days at on-farm demonstration plots in Iowa and Minnesota were cancelled due to poor establishment of switchgrass in 2012 (result of early torrential rains and summer drought).
- Deployed “grid method” to evaluate stand establishment of switchgrass prior to frost to determine what rescue treatments of the plots would be required in Indiana, Iowa, Nebraska, and Minnesota in 2013.
- Developed the concept for the CenUSA bioenergy exhibit and worked through several edits to the exhibit.

c. Explanation of Variance

Planned field days were cancelled in Iowa and Minnesota due to poor establishment of the project demonstration plots.

d. Plans for Next Quarter

- Recruit farmers for second set of on-farm demonstration plots to be established in Indiana, Iowa, Nebraska, and Minnesota in the spring of 2013.
- Meet with Minnesota Corn Growers to discuss CenUSA project objectives and challenges associated with switchgrass establishment on marginal lands.
- Plan for field days to be held in June 2013 in Indiana and Iowa.
- Work with Purdue Exhibit Center to continue development of CenUSA Bioenergy Grass exhibit.

b. Publications, Presentations, and Proposals Submitted

None to report.

3. Economics and Decision Tools Team

a. Planned Activities

- **Iowa Team.** Identify and develop sessions regarding perennial bioenergy grass economics and producer interest for the *Iowa Integrated Crop Management (ICM) Clinic*.

- **Minnesota Team.** Developing spreadsheet of overall costs/gallon relative to conventional gasoline.

b. Actual Accomplishments

- **Iowa Team.** “CenUSA mini series” entitled *Sustainable Bioenergy Symposium* with presentations by four CenUSA researchers/extension leaders will be offered at the ISU ICM Clinic. See: <http://www.aep.iastate.edu/icm/workshops.html#cenusa>.
- **Minnesota Team.** (MN) Developing spreadsheet of overall costs/gallon relative to conventional gasoline.

c. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Plans for Next Quarter

- **Iowa and Nebraska.** CenUSA information will be incorporated into Extension winter meetings
- **Minnesota.** Awareness talk or paper on the spreadsheet of overall costs/gallon relative to conventional gasoline.
- **Indiana.** Indiana Biomass Energy Working Group meeting to be held January 8, 2013 in which the topic of discussion will be the research and market emergence for Aviation Biofuels. Speakers will include not only CenUSA project faculty, but also policy experts, and aviation industry professionals.
- **Indiana.** Hosting Indiana Small Farms Conference March 1 - 2, 2013, in which there will be a session devoted to CenUSA and utilization of marginal crop and grasslands for biofuel energy crop production.

e. Publications, Presentations, and Proposals Submitted

None to report this period.

4. Health and Safety

a. Planned Activities

None this quarter.

b. Actual Accomplishments

None this quarter.

c. Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Plans for Next Quarter

None for the next quarter.

e. Publications, Presentations, and Proposals Submitted

None for the next quarter.

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

5.A – Youth Development

a. Youth Development – Planned Activities

- **Indiana.** Ordering and gathering supplies and curricular materials for 3rd grade, 8th grade, and Indiana high school classrooms interested in learning about biochar in the classroom through plant and soil science.
- **Indiana.** Generate six to seven counties interested in implementing education program in 3rd grade classrooms all around Indiana.
- **Indiana.** Two 8th grade science classrooms in an urban Lafayette, Indiana junior high school interested in biochar-related classroom activities, moving forward with one (implementation will be in November 2013), another will move forward as soon as supplies are gathered. A high school classroom in urban Indianapolis, Indiana with extremely at-risk youth is interested in implementing biochar-related science education.

b. Youth Development – Actual Accomplishments

- **Indiana.** Began educating 8th grade youth about biochar and soil chemistry at Indiana urban junior high school.
- **Indiana.** Introduced the concepts of pyrolysis and the products of biogas, bio-oil, and biochar.
- **Indiana.** Also introduced the concept of increasing the carbon content of soils to potentially increase yields in crops, as well as the carbon sequestration potential of biochar.

- **Indiana.** Began ordering and gathering supplies and curricular materials for 3rd grade, 8th grade, and high school classrooms for interested parties.
- **Indiana.** Confirmed participation of urban high school with at-risk youth in Indianapolis.
- **Indiana.** Reviewing draft of ISU developed Biochar educational curriculum. Reviewing for safety, effectiveness and appropriateness of approach.

c. Youth Development – Explanation of Variance

- **Indiana.** Emphasis in Indiana was on recruitment this quarter rather than curriculum review. This was due to the CenUSA graduate student having the opportunity to teach in an 8th grade classroom once a week as part of an academic professional development course.
- **Indiana.** Space constraints in classrooms required the evaluation of multiple options for plant light setups crucial to growing plants in the classroom.
- **Indiana.** Undergraduate worker situation has yet to be resolved. We are working on finding a reliable individual.

d. Youth Development – Plans for Next Quarter

- **Indiana.** Hold Junior Master Gardener training with focus on how existing activities can be adapted to include discussions of biochar and biofuels.
- **Indiana.** Pilot test evaluation instruments for education programs to assess their validity and reliability.
- **Indiana.** Implementation of plant and soil science lessons focused on biochar in two 8th grade urban junior high school classrooms.
- **Indiana.** Implementation of plant and soil science lessons in an urban high school classroom with at-risk youth.
- **Indiana.** Implementation of plant and soil science lessons in 3rd grade classrooms across Indiana with the assistance of Purdue Extension Educators.
- **Iowa.** Recruit 4-H groups to partner with Master Gardeners for spring planting of biochar demonstrations based on the developed K-12 curriculum and adapted for use in a non-formal setting. Promote with K-12 formal educations as well.

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

None to report this period.

5.B – Broader Public education/Master Gardener Program

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

- **Iowa and Minnesota.** Collect yield and quality data from biochar demonstration gardens.
- **Minnesota.** Host display at Northern Threshing Show.

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

- **Iowa and Minnesota.** Data has been collected and is in process of being analyzed.
- **Minnesota.** Display at Northern Threshing Show.

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

No variance has been experienced and accomplishments are on schedule.

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

- Establish initial Master Gardener biochar demonstration gardens. All sites are on schedule for planting.
- **Minnesota.** Evaluation will be created and sent to Master Gardener volunteers involved in biochar gardens in 2012 to get their feedback from this first year's experience.
- **Iowa and Minnesota.** Assessments will be made on the data collection over the next 2 months. Master Gardener volunteer recruitment of 2013 will take place in January-February, 2013.
- **Iowa and Minnesota.** Assessments will be made from the fall 2012 soil tests.
- **Minnesota.** Julie Weisenhorn will be meeting with a new Master Gardener group from the Fond du Lac Tribal community on November 27, 2012 to establish a new biochar research plot in an existing community garden that will replicate the three plots already located in the Twin Cities. The soil at this site has low pH and is a mixture of sand and rocks. A soil test will be taken before amending the site in the spring.

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

- Byers, Becky. “Biochar, Bio-benefits?” Solutions, *University of Minnesota College of Food, Agricultural and Natural Resource Sciences* (Fall 2012).
<http://www.cfans.umn.edu/Solutions/Fall2012/Biochar/index.htm>.

6. Evaluation/ Administration Team

a. Evaluation/ Administration Team – Planned Activities

- Hold breakout session on evaluation tools at CenUSA annual meeting for CenUSA Extension Team members.
- Review CenUSA Extension evaluation protocols and instruments developed by CenUSA Extension team member Sorrel Brown, and ask for feedback.
- Revise protocols and instruments based on feedback.
Revise evaluation instruments based on feedback.
- Write final CenUSA Extension components for CenUSA quarterly reports and the 2013 annual report.
- Negotiate and finalize Year 2 Extension budgets.
- Participate in CenUSA Extension team meetings/webinars.
- Plan CenUSA workshop to address weakness identified by USDA program managers. Workshop will include representatives of thermochemical conversion companies, producer groups, elected officials and economic development professionals, CenUSA team members and advisory board members.

b. Evaluation/ Administration Team – Actual Accomplishments

- Evaluation protocols and instruments were reviewed at the annual meeting; adjustments were made, meetings held with individual and groups of CenUSA Extension team members to plan evaluation for 2013 programs.
- Reports were prepared.
- A workshop, **Roadmap to Commercialize Thermochemical Biofuels and Bio-Products Processing in the Midwest**, has been planned for December 11-13, 2012.

c. Evaluation/Administration Team – Explanation of Variance

No variance has been experienced and accomplishments are on schedule.

d. Evaluation/ Administration Team – Plans for Next Quarter

- Continue development and analysis of evaluations for CenUSA workshops.
- Continue to work with Extension teams to plan, develop, and implement CenUSA Extension programs.
- Host workshop **Roadmap to Commercialize Thermochemical Biofuels and Bio-Products Processing in the Midwest**, December 11-13, 2012.

e. Evaluation/ Administration Team – Publications, Presentations, and Proposals Submitted

- None to report this period.

Agenda for the CenUSA Annual Summit

(Lincoln, NE, August 7-9, 2012)

Date	Time	Agenda Item	Location
Aug. 7	0730-0900	Open meeting, review agenda, introductions. (Continental Breakfast @ 7:30)	Lincoln Downtown Holiday Inn
	0900-0915	Load bus or buses for research tour	UNL Ag. Research. Development Ctr. (ARDC)
	1000-1200	Research Tour - Obj. 1 & Obj. 2	ARDC
	1200-1300	ARDC Research Discussion	ARDC Lunch
	1300-1500	ARDC Tour cont. Report & discussion – Objectives 1, 2, 7, & 8.	ARDC
	1500-1600	Return to Lincoln	
	1600-1800	Year 1 Accomplishment Reports Obj. 1 & 2 (Non-Lincoln sites), Obj. 3 & 4.	Lincoln Downtown Holiday Inn
	1830-2030	Group Dinner	Green Gateau, Lincoln
Aug. 8			
	0730-0800	USDA- NIFA comments (Continental Breakfast @ 7:30)	Lincoln Downtown Holiday Inn
	0800-0945	Report & discussion – Objectives 5 & 6	
	0945-1015	Break	Refreshments
	1015-1230	Report & discussion – Objectives 7, 8 & 9	
	1230-1330	Lunch Break	Lincoln Downtown Holiday Inn
	1330-1430	Advisory Board – Questions & Comments	
	1430-1445	Break	Refreshments
	1445-1800	Year 2 Planning by Objective/ Objective integration. (Start with O-6 Keri Jacobs)	
	Free evening	Many restaurants in area (>25 within easy walking distance).	Local restaurants
Aug. 9			
	0730-1000	Year 2 Planning by Objective and Objective integration. (Continental Breakfast @ 7:30)	Lincoln Downtown Holiday Inn
	1000-1015	Break	Refreshments
	1015-1200	Continue planning including administrative planning	
	1200	Adjourn	
	1300-xxxx	Individual team meetings as arranged.	

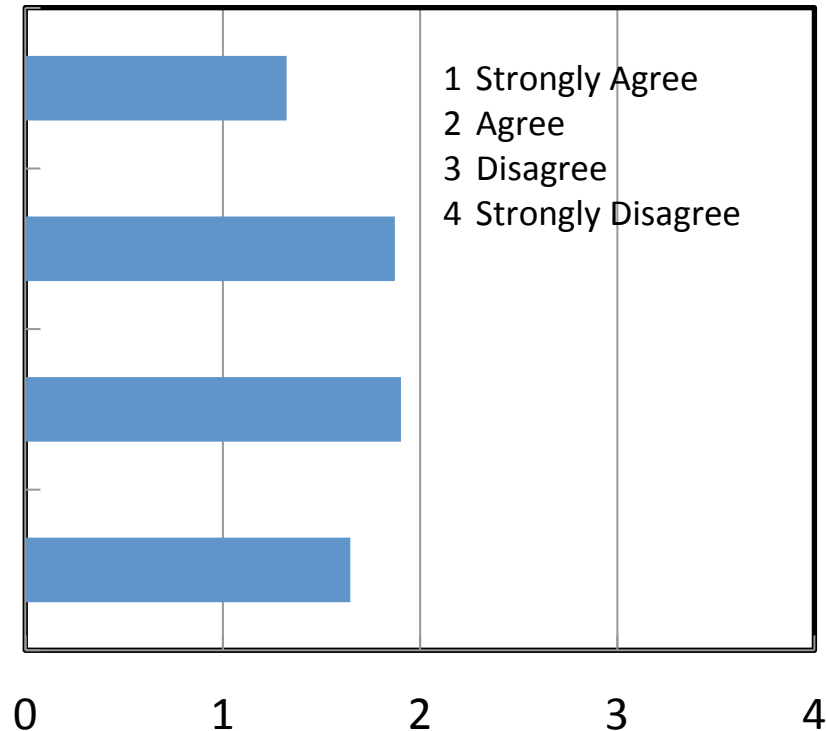
2012 Annual Meeting Evaluation

The field tours were valuable in helping me better understand Objectives 1&2.

There was enough time to network with project colleagues.

The meeting format was conducive to learning what other teams were doing.

The meeting covered all the project objectives clearly.



2012 Annual Meeting Evaluation

What did you get out of last year's Bioenergy annual meeting that helped your team accomplish its objectives for the first year?

- Outline of all objectives. Timeline very helpful. People contact to know who knows what. Technical overview of topics.
- Understanding the require scope of work.
- What other teams are doing.
- Met everyone and got to learn who was doing what.
- Networking with other CenUSA members. Gaining understanding of general challenges and goals for each objective.
- Face to face planning time is more valuable than phone meetings.
- Coordination of team members and the project as a whole.
- Interaction with other teams useful to understand scope of project.
- A lot of the benefits were simply the opportunities to get together and discuss. Much easier than all the email. Create more of a team approach.
- Field tours nice but not essential to this understanding. Opportunity cost time. Coordination. Communication.
- Meeting with objective team members.

2012 Annual Meeting Evaluation

What barriers have you encountered in reaching your team's objectives for the 1st year?

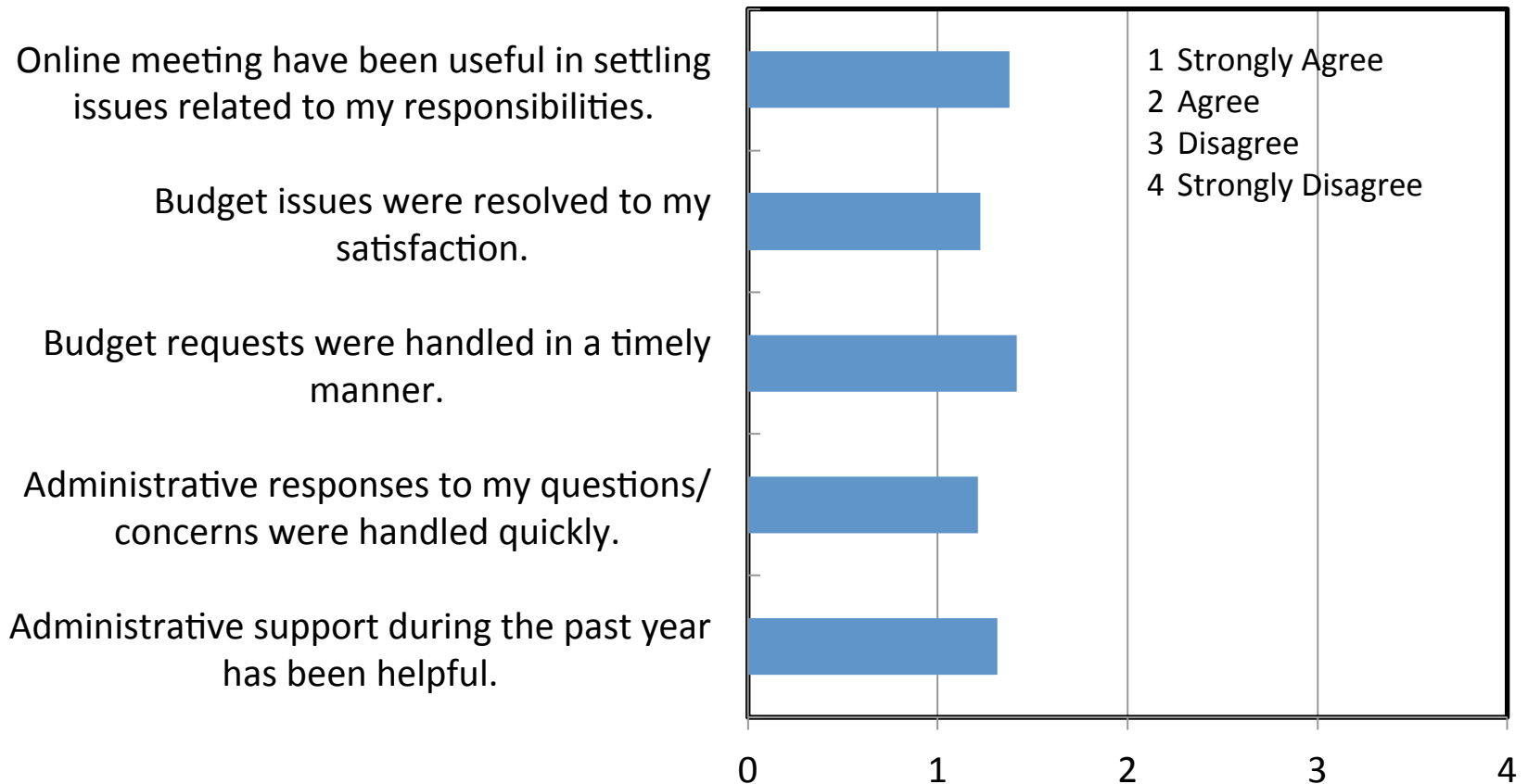
- Personal changes. Staff hired to do project resigned and time lag getting up to speed with new staff.
- Communication. It might help to have a point person at each institution for objective 9 since there are so many people.
- Graduate student recruitment.
- Weather-hurt student establishment.
- Getting people going on projects.
- Some of our team members still seem unclear as to their roles and tasks; consequently they are far behind on their pieces.
- Internal fund transfer; drought.
- Time constraints.
- Data availability.
- Weather, FSA CRP rules.
- Weather.
- Our objective relies on others to produce material so we go a bit of a slow start, but we're catching up quickly now that everyone is moving.
- Time, Money, Rain

2012 Annual Meeting Evaluation

Additional Comments (Annual Meeting):

- Agenda changed from having two talks on Tuesday 4-6 to having four talks after slide sets were submitted. This made it hard to adjust talk lengths to the 30 minutes time slot.
- Advisory board candid comments are good. Keep up the positive acceptance of divergent understandings. We're scientists and so forth who know when we're being snowed so I appreciate the candid discussion.
- Shorter objective presentations. A lot of length reduced focus and didn't add much new information.
- Good meeting. Informative.
- If no graduate students/junior scientists attend next year, it would be great to have a little parallel programming that bring the students together to discuss their research amount themselves.
- I wonder if it would be good to have a formal poster session and to limit presentations to only leaders and guests.
- Improve slides! Learn proper use of laser pointers, monitor time limits on presentations. Have objective teams meet individually before the overall meeting.
- Continue keeping group activities shared.
- Next time maybe leave more time for groups to meet and work on details/plans.
- Good meeting seeing crop in test plots was good. Would like to see some actual applications in a whole farm setting.
- Some speakers gave way too much detail. Agenda was way too vague. No control over time structure. Last half day was a complete unknown. Tell us in advance what's expected. Some talks had really bad slides that were unreadable due to poor contrast and/or small fonts.
- The field day was very useful. It would be nice to make sure presentations stick to the timeline. Maybe improve breakfast offerings next year.

2012 Project Administration Evaluation



2012 Project Administration Evaluation

What might have project administration done during the past year that would have helped you meet your team's objectives for the 1st year?

- Keep up the good work.
- Nothing I can think of.
- Was ok.
- Quarterly newsletter.
- More communication on accomplishments and outreach to media about the positive work.
- I liked the monthly calls for updating; a written summary would be useful.
- Keep doing the same.
- Collaboration with ARS went well.
- No issues.
- I do not work directly with administration.
- Well done.
- Work my home institutions post-award office get its act straight.

2012 Project Administration Evaluation

What do you anticipate needing from administration for the coming year?

- Continued communication.
- Some as this past year.
- It is hard to know.
- Updates where we are at budget wise.
- Information.
- Reminder of quarterly report needs.
- Same as past.
- No major needs.
- No extra support.
- Over view of publications and delivery methods.
- Assistance translating material for extension audience. Research summaries, webinars, and fact sheet.
- I do not work directly with administration.
- Met my expectations.

2012 Project Administration Evaluation

Additional Comments (Administration):

- This is a very well-coordinated project. As a San Grant participant this meeting was much more informative.
- Perhaps more cross pollination of objectives with objective 8 & 9. It takes creativity, perhaps have subsets of people or objective 9 divide and conquer.
- How about a quarterly newsletter? Highlight one participant, highlight a couple of deliverables (tell the story not just day research) etc. Next year have session where each objective team meets with each of others individually around 10-15 minutes each to ensure cross fertilization of goals and deliverables.
- It would be helpful if at the end of objective reports there was a focused summary especially with the goal of extension.



IOWA STATE UNIVERSITY

Bioeconomy Institute



Roadmap to Commercialize Thermochemical Biofuels and Bio-products Processing in the Midwest Workshop

Dates: December 11-12, 2012

Sponsors: ISU Bioeconomy Institute, CenUSA Bioenergy, USDA Central-East Regional Biomass Research Center, Iowa EPSCoR, Iowa Energy Center*

Location: Scheman Center, Iowa State University

December 11		
Time	Subject	Presenter(s)
11:30 am	Registration and Lunch	
12:15 pm	Welcome	<ul style="list-style-type: none"> • Wendy Wintersteen, Iowa State University • Jonathan Wickert, Iowa State University • Ken Moore, Iowa State University
12:30 pm	Sustainability Challenges to Biofuels	Byron Johnson, P66
1:00 pm	Thermochemical Conversion Technologies 101	Robert Brown, Iowa State University
1:30 pm	Impacts of Facility Scale and Location on Thermochemical Biorefinery Costs	Mark Wright, Iowa State University
2:00	Break	
2:15 pm	Ideal Feedstock Characteristics for Thermochemical Processing of Biomass <ul style="list-style-type: none"> • Pyrolysis • Acetic Acid Pulping • Solvent Liquefaction • Catalytic Pyrolysis • Gasification • Pyrolysis • Pyrolysis • Aqueous Phase Reforming & Catalytic Processing • Solvent Liquefaction 	<ul style="list-style-type: none"> • Mark Hughes, P66 • Tom Binder, ADM • Michelle Young, Chevron • Magdalena Ramirez, KiOR • Bert Bennett, ICM • Terry Marker, GTI • Stanley Frey, UOP • Andrew Held, Virent • Manuk Colakyan, Renmatix
3:45 pm	Q and A	
4:00 pm	Break	
4:15 pm	CenUSA USDA NIFA Bioenergy CAP Project Preparing the Midwest to Supply biomass Feedstocks for Thermochemical Processing	Ken Moore, Iowa State University

4:45 pm	Optimizing Plant Breeding, Agronomy, and Logistics for Thermochemical Processing <ul style="list-style-type: none"> • Perennial Grass Genetics • Perennial Grass Storage and Agronomics • Environmental and Genetic Bioenergy Traits in Corn Stover • Corn Stover Genetics • Corn Stover Agronomics 	<ul style="list-style-type: none"> • Ken Vogel, USDA ARS, Lincoln, NE • Rob Mitchell, USDA ARS, Lincoln, NE • Kendall Lamkey, Iowa State University • Thomas Lubberstedt, Iowa State University • Marty Schmer, USDA ARS, Lincoln, NE
5:45 pm	Q and A	
6:15 pm	Adjourn to ISU BioCentury Research Farm	Transportation provided
6:30 pm	Dinner	
7:15 pm	Tour	<ul style="list-style-type: none"> • Andy Suby, ISU, Overview • Stuart Birrell, ISU, Logistics • Robert Brown, ISU, Thermo Processing
7:45 pm	Dessert Buffet and Discussion	
8:15 pm	Adjourn Transportation to Scheman Parking Lot	Shuttle to Hotel

December 12

Time	Subject	Presenter(s)
7:30 am	Breakfast	
8:00 am	Non-fuel Products from Thermochemical Processing <ul style="list-style-type: none"> • Heating Oil (30 min) • Biochar as a Soil Amendment (20 min) • Bioasphalt (20 min) 	<ul style="list-style-type: none"> • Prasad Gupte, DOE • David Laird, Iowa State University • Chris Williams, Iowa State University
9:15 am	Establishing Linkages Between Thermochemical Biorefiners and Midwest Biomass Feedstock Suppliers	<ul style="list-style-type: none"> • Brad Petersburg & Rusty Schmidt, Ag Ventures Alliance • Rod Backhaus & Howard Roe, Tall Corn Ethanol • Bill Couser, Lincolnway Energy • Paul Kenney, Kearney Area Ag Producers Alliance • Jeff Stroburg, West Central Coop • Rod Williamson, Iowa Corn Producer Assoc.
10:30 am	Q and A	
10:45 am	Break	
11:00 am	Assembling the Pieces to Commercialize Thermochemical Processing in the Midwest	All
12:00 pm	Lunch - Discussion Continues	
1:00 pm	Adjourn	

*Workshop support: Iowa State University Bioeconomy Institute; CenUSA Bioenergy, funded by USDA-Agriculture & Food Research Initiative Competitive Grant no. 2011-68005-30411 from USDA National Institute of Food & Agriculture ; Iowa EPSCoR, supported by the National Science Foundation under Grant Number EPS-1101284; & Iowa Energy Center. We also thank Ken Vogel, ARS for his assistance in developing this event.

CenUSA Planning & Collaboration Meeting

December 12 & 13, 2012

Ames, Iowa

Exhibit 4

December 12		Scheman Center
Time	Subject	Presenter(s)
1:15 pm	Welcome	Ken Moore, Iowa State University
1:30 pm	Lessons Learned from Industry Workshop <ul style="list-style-type: none"> Identify and discuss industry research needs. Record lists of needs and opportunities. 	Ken Moore, Iowa State University
3:00	Break	
3:20 pm	Transdisciplinary Opportunities Lead PI(s) Objectives 1-9 briefly describe: <ul style="list-style-type: none"> Overall 5 year project goals and project-to-date progress Identify project-to-date roadblocks Identify areas of changed thinking and new opportunities Identify potential collaboration opportunities with other project objectives 	<ul style="list-style-type: none"> Please note we will not be using any video presentations. Presentations should be no longer than 10 minutes per objectives.
5:00 pm	Adjourn for Dinner	Shuttle to Gateway Center
6:00 pm	Working Dinner	Gateway Conference Center
December 13		Gateway Conference Center
Time	Subject	Presenter(s)
7:30 am	Breakfast	Gateway Conference Center
8:00 am	Research Planning <ul style="list-style-type: none"> Use lists of needs and opportunities identified in "Lessons Learned from Workshop" and the Industry Workshop sessions to focus on specific industry needs and requirements. Review overall project plans for opportunities to enhance project outputs through expanded collaborative efforts. Develop plan outlines for each identified need or opportunity. 	Participants will split into into groups*: <ul style="list-style-type: none"> Germplasm to Harvest (Objectives 1-4) Post Harvest (Objectives 5-7) Objectives 8 & 9 can join either group and/or circulate
9:30 am	<ul style="list-style-type: none"> Research Planning Reports Germplasm to Harvest Post Harvest Education And Outreach & Extension 	Each group will provide an update from it's "Research Planning Session"
10:30 am	Adjourn	

*This workshop is made possible through the support of USDA-Agriculture and Food Research Initiative Competitive Grant no. 2011-68005-30411 from the USDA National Institute of Food and Agriculture (www.cenusa.iastate.edu)

Reactions to 2012 Annual Meeting – August 2012

CenUSA Bioenergy Project Advisory Board Grouped Comments

This meeting was very exciting and discussed the current developments and future plans. The weather this year has presented unusual challenges and in the end will help in the development of a much more robust program as long as solutions to its challenges are found. The field trip was an important component and I would encourage this at every meeting.

As a Board we offer the following comments for the project researchers to consider

Germplasm to Harvest

Feedstock Development

- **Feedstock Production Expectations.** Expectations are to reach 10-11 tons per acre production by **2020**. This is a very aggressive target and it will be good to see how productive the current varieties are in the various region test plots when we have a normal year I am very interested in better descriptions of the inputs that are required to achieve these types of yields. Intensive fertilizer, insecticide, and herbicide management is an entirely different picture than has been portrayed by a large contingent of bio energy crop proponents. Quantifying this will provide a much more realistic picture for both the government and farmers interested in exploring this technology. The program does appear to have good cooperation across research organizations and I hope to see major advances in the marker assisted breeding technology using the rapid typing by NIR. There is a real need to determine whether focusing entirely on a crop that has pyrolysis traits or one that is a compromise between fermentability and pyrolysis or even focusing on fermentability and developing pyrolysis technology that works with this. Outlining this path with initial markets that enable the other markets to develop large scale uses will be important in finding the correct **partners** for end product conversion. Based on the input from the USDA program monitor this will be an important aspect to strengthen the project.
- **Agreed.** Someone mentioned that it is about yield per input and they were very correct, with high inputs I think the yield goal can be realized, but we need cost factors. It may be difficult to combine fermentability and pyrolysis ability in the same genetics since fermentation likes sugars and cellulose and pyrolysis like lignin. I liked the idea of adding a pyrolysis system to existing fermentation facilities to take advantage of existing infrastructure.
- **Importance of Field Trips.** I think having a field trip is very important when showing progress and/or obstacles related to feedstock development. There is good cooperation and communication among the researches involved with this objective. I feel having input from potential end users will help this group determine what traits will bring the most economic benefit to the value chain.

- **Don't Forget Alternate Pathways.** Feedstock development needs to continue on path of providing the biomass and avoid getting locked into trying to maximize traits for a single conversion platform (pyrolysis, fermentation). This project will need to continue to focus on pyrolysis and byproduct (biochar) as the conversion platform used to test biomass products being developed, but should be cognizant of alternate pathways for conversion as well as potential feedstocks to be potentially used as livestock feed.

Biomass feedstocks that provide 8-11 tons per acre and are managed for annual biomass production are going to be incredibly different from today's perennial feedstock stands. Measures are carefully being taken to establish impacts on soil, water, carbon, plant health, and insect pests because there is not a current analog to pull information from. There will be challenges in Objective 4 in assuming what the wildlife benefits are, or are not, on these crops without specific information...because we don't have analogs for this type of perennial crop on marginal lands for wildlife either. This will be important for incorporating these perennial grasses into USDA conservation programs. We should encourage cooperation and coordination with Wildlife Biology faculty at cooperating institutions to attempt to address this need.

- **Identify all Traits.** While the initial project identified fast pyrolysis as the end conversion technology, I also heard when analyzing plant traits and how they would identify available sugars. Personally I believe we should be identifying all traits that may affect the various bioenergy technologies – boilers, gasify, pellets, pyrolysis, fermentation.... Crop selection may shift toward the pyrolysis hybrid for this project, but knowing the trait for other uses will be beneficial in the future.

Sustainable Feed Production Systems

- **Yields and Marginal Lands.** A key question is will yields translate to actual marginal land. This year really put this to the test and determining how to establish the crop on high sloping ground before erosion takes place will be important. You will be getting a great comparison of the different crop options out of this segment. I was impressed by the scenario modeling and would like to see this transferred to actual trials.
- Agreed. Yields and establishment on marginal lands will be problematic, that's why they are called marginal lands. I agree good modeling and trials are needed.
- I'm very interested to see how this project will impact the return on investment of marginal land. Additionally, I am curious to see if one of the potential products of this initiative (biochar) will have a positive impact on the productivity of marginal land.
- We have seen yield drops when new crops go to full-scale fields. It should be a priority to establish actual yield data information for the public. I would suggest a range (i.e. 7 to 12 T/A) so farms can make good decisions. Full-scale fields will have variable soil conditions let alone field to field in a county/state.

Feedstock Logistics

- This section is still looking at large scale production and will make sense if CRP land is totally converted to energy crops since there will be large fields converted. At the high yields per acre, I am not sure that some of the need for bale aggregation concerns will be realized. At the other end of the equation is if these crops are deployed mainly to meet long-term sustainability goals. This leads to a much different logistical issue of long strips of energy crops and small lots. Is this more compatible with combining stover and energy crop harvest? How would this be enabled? Is there a possibility of inducing senescence so that the producer can schedule harvest?
- **Introducing Senescence.** Agreed. When producers start driving all over bumpy CRP ground they will look for bale aggregation ability. While I would like to see strips of energy crops between strips of conventional crops that may be a hard sell to the producer. Being able to induce senescence would be a great advantage to minimize and hasten drying time.
- In order to reach our goal of producing large volumes of perennial biomass there will be a need for a very broad range in scales of production, ranging from large tracts of land to small lots and narrow long strips. I'm assuming that current baling technologies and equipment owned by many producers will be adequate to allow small-lot and narrow strip harvests to be managed by the grower and/or custom operators using their current equipment base. The area that I would like to see more development emphasis is for very large production systems. As someone who had the experience of working in the cotton industry (including custom harvesting), I'm encouraged by the presentation Stuart and Kevin gave showing large bulk baling systems and hope to see some progress in exploring these types of technologies for large land-tract production of perennial biomass.

I would also like to emphasize the importance of in-field size reduction ONLY to the point that optimizes in-field densification and transport economics. In reality, there is likely going to be numerous conversion technologies, each with their own size reduction requirements. For example, in some CHP applications, no additional size reduction below 6" to 12" minus will be required (some systems can use whole bales). In contrast, fast pyrolysis will need size reduction levels significantly greater than what is practical in field. It is also important to note that stationary size-reduction equipment can be more readily designed to meet strict sizing requirements generally for less capital and less energy than what would be necessary to incorporate into a mobile field operation.

- **Share Developments with Farm Community.** Currently, the logistics involved with handling and transporting of biomass is a major obstacle to the development of this industry. To keep farmers interested in this project, any logistical improvements need to be shared with the existing farm community. This is especially true for livestock producers who currently move hay, straw, corn stover, etc.

- **Converting CRP to Biomass.** I also believe converting CRP to biomass production should be an option. There should be some work on how to do this. I assume we would want to establish the new grass hybrids, which means we need to eliminate the standing CRP crops. How much will this cost? What is the process? Is there tillage involved? Will that impact GHG numbers?

I suggested to the harvest group they do some analysis of harvesting CRP acres to understand true cost to harvest on HEL/CRP type acres. Most of their numbers are from good hay/corn fields.

A year ago, I thought a larger bale size was part of the analysis. This would reduce the amount of bales and handling time in logistics. What happened to that idea?

In our support of other harvest trials, I continue to hear about “tagging” bales with pertinent data – date, harvest conditions, crop, field, owner.... I believe this will be important in feedstock management and perhaps required for chain of custody documentation. I know some large square balers have this option, can we create or are there available tagging devices for round bales or bulk storage modules?

System Performance Metrics, Data Collection, Modeling, Analysis and Tools

- **Modeling on a Large Scale.** There were some big picture models presented and movement towards models that are finely divided information. Long term this portion will have to model on a very local scale to determine what practices will have the largest impacts. Designing a model representing the environment in each region will help determine what practices make the most sense from an environmental and profit standpoint. Model farms such as this would be interesting and probably the easiest to translate to farmers trying to make decisions.
- Modeling on a local or regional scale is a plus.
- **Demonstrate an Attractive Model.** I have stated this a couple times, ROI is very important but not the only factor. Does the farm/land owner support bioenergy or rural development? I believe this fact will impact the ROI number. Will the landowner say yes to establish a biocrop at a lower ROI than the farm that does not support bioenergy?

I also agree that this crop will not be established on Quarter section fields – nor should it. The impact to establishment/maintenance, logistics when we establish the crop along watersheds and waterways will be substantial. It should be a priority to evaluate these extreme conditions. Providing a realistic model for the farmers will be important – this is not China where we can dictate what is planted, we must show an attractive model to be incorporated into today’s Midwest farms.

Post Harvest

Feedstock Conversion/Refining

- This area needs to find its role in having a commercial path at the end of the project. Will it need to start with stover and pull in energy crop producers or will it be so economical that energy crops will be deployed rapidly to feed it? Will it be catalytical pyrolysis or old style? What industry partners does it need on board? An important action item, if biochar is to be a major driver, will be to determine what is the composition of “good biochar” versus “bad”. Without this information out, as soon as possible, there is a real probability that a few bad experiences will keep people from ever being willing to use it.
- **Watch out for the “bad” biochar.** Adding to existing ethanol plants would be a big plus. We need to make sure only “good” biochar is released, cooked completely dry, I have seen some experiments with “bad” biochar, not cooked dry, that turned out very badly.
- The challenge to financing and commercially deploying a new technology is very significant, especially when considering the risks associated with very large scaling factors (going from laboratory to industrial), and the large capital requirements for both the new technology and their associated balance-of-plant installations. One important potential pathway that will likely be the most practical and cost effective, is to consider “bolting on” new conversion technologies to an existing industrial base. The benefit of this approach is that much of the existing infrastructure needed to support a new technology deployment is already in place. For example, there are over 170 first generation ethanol plants with offices, major utilities, skilled operators, transport infrastructure: roads, scale house, load out facility, rail yard, etc. already in place and paid for. Utilizing this existing infrastructure will greatly reduce capital requirements, in some cases saving up to 50% or more when compared to capital needed for greenfield developments.

In 5, 10 or more years, when natural gas prices once again become more prohibitive and our perennial biomass production potential builds momentum, the same biofuel industrial along with large agro-industrial food processors, etc. (distributed throughout the Midwest and US) will also likely be excellent first customers for locally produced perennial, energy crop and stover based biomass. Many of these potential biomass users can have an enormous impact on our agro-industry’s carbon footprint by first incorporating highly efficient, well developed, low risk CHP technologies that supply process steam and electrical power (there are a number of gasification technologies and numerous solid fuel boiler makers that can readily provide CHP solutions today). Once a CHP application is developed and operational, it will be much easier for the same operation to “bolt on” more advanced conversion technologies (after they have been thoroughly vetted and proven by other more courageous first adopters).

It is my recommendation and preference that the economic modeling team consider the bigger picture and include a large number of CHP conversions (with a biochar co-product)

followed by a much smaller, but important group deploying fast pyrolysis, bio-oil and biochar. It is my opinion that this approach will represent a more realistic deployment of new, more advanced technologies that convert biomass to liquid fuels and commodity chemicals.

Regarding the specifics and advantages of bolting on a 200 TPD fast pyrolysis unit to an existing 1st generation biofuel ethanol plant using ICM technology:

- An existing 50 or 100 MMgal/yr ethanol plant likely has enough room on their air permits to amend for added truck traffic, biomass processing and emissions from the pyrolysis heater.
- It may be possible to add the high-sugar bio-oil fraction from the pyrolysis stream as a feed additive to the DDGS. Or possibly setup a separate fermentation process to product more ethanol, which would have the benefit of using existing distillation equipment, tank farm, load out, etc.
- Rail facilities are on-site and available for shipping bio-oil to centralized upgrade plants.
- Non-condensable off-gasses and “still-hot” combustion products from the fast pyrolysis heater can be sent to existing thermal oxidizer (which plays an integral part of the plant’s process steam generation).
- Heat recovery from the fast pyrolysis unit (especially from the first higher temperature fractions) can be readily integrated into the ethanol process.
- When co-locating with CHP facility, the cost for feedstock handling and storage can be shared.
- When co-located with CHP facility, the integration of emissions control and heat recovery will be less expensive and less complicated due to likely close proximity of equipment.
- The co-located CHP system can also readily utilize off-spec feedstock not acceptable to advanced conversion technologies, making it a lot easier to build good relations with the many producers needed to supply a large biomass based operation, i.e. knowing they have a market for their “occasional” off-spec feedstocks.
- Non-condensable off-gasses and “still-hot” combustion products from the fast pyrolysis heater are much more readily integrated into a CHP process.
- In a CHP co-location scenario, the low value, high water fraction coming off the fast pyrolysis process can also be disposed of by using it as a means to control temperatures in the CHP’s combustion process (i.e. minimize thermal NO_x formation). This also allows the CHP process to capturing the minor heating value associated with the dilute, low

value organic components, while allowing the fast pyrolysis system to avoid waste water disposal issues or expensive recovery processes.

Regarding biochar standards, it should also be noted that the International Biochar Initiative has already developed Biochar Standards and Testing Guidelines. It is also important to note that there are many possible paths to high quality biochar that do not necessarily need to come from fast pyrolysis platforms. There are, in fact, low temperature gasification technologies capable of producing high quality biochars while simultaneously providing a CHP platform that can be readily integrated into existing and future agro- and bio-based industries.

- **Develop Specifications.** The development of specifications and standards for biochar and bio-oil will help with their acceptance for industrial uses. Input from potential end users will be needed early in the process to help develop these standards.
- **Is this project viable?** I also was interested in the discussion of a 1/10th scale model compared to current 25MGY (plus) cellulosic ethanol projects. Mobil units going to the bale storage yards to convert – very interesting and would like to see how big of an operation this would be. What would this look like – do you need power/water/covered area.... How are the end products handled (bio oil, biochar)?

I also thought about the delivery practice of a full-scale biorefinery – when a truck pulls onto the scale with 36 bales, how does the facility know what they are buying? There will likely be specifications established like moisture and ash content. Is there a device on the market that can sample the material and have analysis complete by the time the unloaded truck returns to the scale? This would be the expectation of the farmer at a grain elevator. I believe some of the cellulosic ethanol projects are working on this but have not seen a final product. The other option is for the bales to be tested prior to delivery – which seems like an extra cost to the purchaser.

The comments that Red Oak is the best; corn stover is the worst – if baled grass is only slightly better than stover, is this project viable? Can scale overcome production loss? Is there a pretreatment that can enhance grass/stover bio oil yield? [Van Roekel]

Markets and Distribution

- This group is most in need of input from the rest of the program so they can determine what the actual process might look like and get the economics determined. I was impressed with the variety of scenarios being looked at and hope that these can be sharpened as more information is developed.
 - Agreed.
- More input will be needed from end users and other industry partners.

Health and Safety

- The safety aspects are being developed and hopefully will be expanded to the entire process. At 8 tons per acre it will be difficult to actually see the landscape one is driving over.
- Agreed. Farming is dangerous, farming on HEL and marginal land is even more dangerous. Commercial operators, gypsy farmers, are not necessarily safer. Best and safest practices need to be identified through the entire operation, planting to fuel.
- Any newly developed safety best practices should be shared with existing industry. Not only because it's the right thing to do, but this project can be credited with discovery

Education

- Education is a very important aspect especially to interest future generations in considering careers in this area. This has the largest potential to reach the US population in general. Developing materials for gardeners and farmers both on biochar and the benefits of bioenergy crop deployment is important and this looks like it is progressing well.
 - Agreed.
- As a small-to-midsized technology development and engineering company, ICM actively supports student intern opportunities, however, the vast majority go to family and friends of ICM employees. It is also important to note that the really exciting work in emerging biomass conversion technologies are not accessed by interns due to very significant IP issues. Engineering interns may work in area of project management or assist engineers in projects that are not associated with sensitive new technology developments. As a potential employer we are interested in how well students interact in an industrial internship setting, but just as important (and possibly more important), is learning about some of the exciting internship opportunities they may have had in academic research programs that focus on emerging biomass conversion technologies.

Outreach and Extension

- The Extension group is really making progress at determining what the outreach will need to be like. There was a lot of really great insight into what would make this happen and what farmers will need to know as well as their expectations.
 - Agreed.
- **A Demonstration Farm.** I mentioned this at the end of the meeting; I firmly believe a demonstration or model farm would be a wonderful way to include all of the 9 objectives into one facility. Showing best hybrids, establishment practices, crop maintenance, harvest/storage, economics, integrating with row crops, mapping/gps technology, water

quality, erosion control, wildlife impact, gardening, student education (K-PHD), farm and public education. It would need to look like a normal farm setting, managed like a farm with open income statements making typical farm decisions to reinforce the ROI of adding energy crops to the typical row crop farm. The exceptions would be a learning center and pathways for tours. You could show good vs. poor practices, rotate in new hybrids, management practices, harvest/storage techniques, mobile unit pyrolysis...allowing the public to see this is possible.

General Comments

- The *System Performance, Metrics, Data Collection, Modeling, Analysis and Tools; Markets and Distribution; and Education and Outreach* objectives are probably the most important ones for determining what needs to happen to make this a reality. They will need to have good communication with the other groups so that research that maximizes the positives and minimize the negatives is done rather than academic research. I was impressed with the idea of using precision farming to enable energy crop deployment with food crops in the modern farming world.
 - Agreed, but precision farming equipment is a long way from universal. [Weis]
- Real decision needs to be made on what initial markets will develop first and how to leverage this to the end game of liquid fuels.
 - This is a tough one and the reason stover will need to be in the mix. Placing a pyrolysis unit on an existing ethanol plant may be the best way.
- If pyrolysis is the end game, can a chemical treatment be applied to the biomass as it is harvested to stabilize it? Can this agent be either derived from the pyrolysis process or be a catalyst in the pyrolysis process such as acid?
 - Storage and stability are big concerns that need to be worked on.
- In general it seems that the right activities are being considered. I did not see the scenarios being modeled, but from Tom's comments my assumption is that the teams are modeling larger fields, all used for production.

I would like to suggest, as was done in previous comments from the advisory board, that the group attempt to model a scenario where these crops are produced in combination with traditional row crops. Where these crops are used in strips, for erosion control, as an alternative to or in combination with terraces, where the farmers would be able to generate some revenue that would complement the row crop revenue. In this scenario these crops could also be produced on headlands, and as buffer strips along waterways. This scenario is unique in the scale of the harvest equipment and the resulting density of the bales that would be produced, but maybe the farmers would have different revenue expectations under this scenario.

I also earlier suggested the possibility of using road ditches and medians for production. It still seems wrong to have mowing crews using inefficient mowers cutting grass in these areas, and then just leaving the grass lay. The grass grown on these lands is currently not managed very well, and is probably a cost to the DOT. This could be changed, and it could become an asset. I believe that specialized equipment could be developed to mow, bale and transport the materials from these areas, and that a significant number of acres are available. It would not be possible everywhere, but there are certainly large sections of land where this is a possibility. Maybe this topic is best left out of this exercise, but do you know if anyone is considering this?

- With the July meeting being my first introduction into the CenUSA project, I am hesitant to offer many comments. I come from the economic development community. My participation in projects usually occurs when the project has been proven and is moving to commercialization.

As I commented during our sessions, I believe that industry should be involved as soon as possible. Processes and projects may be good in theory but if the economics do not work then feasibility may be a moot point.

Questions I have are: Is the USDA open to changing the CRP rules? Could CRP contracts be modified to allow for the removal of at least part of the plant material for the production of bio-fuels? Could CRP payments continue until such time as the numbers pencil out to more profitability to the grower, i.e.: taking into account time spent on harvesting and maintenance? With increased cost involved in crop maintenance and harvesting, the producer would obviously have to realize a considerably greater payback then just an even replacement of CRP revenue.

Perhaps if we bring industrial representatives to the table, we also need to bring a varied group of producers into the discussion.

- Additional uses of these crops is reality. The more market opportunities for the crop, the faster farms will adapt. I have sent Rob Mitchell my contact on stover enhancement trials so he can investigate grass to cattle feed. I also feel the “chicken or the egg” debate is very real; if it takes 3 years to get full production of energy grass, I assume facility construction is 18 to 24 months – this means you will need full scale establishment prior to construction. I would assume this will make farms very nervous and tentative to sign any contract unless they have alternative uses or CRP options. The beauty of thermal process is you can have a variety of feedstocks – so will corn stover, wheat straw, soybean straw.... Be a real part of any facility plan? This can help defer some of the establishment time frame.

I forget who made the comment that planters and sprayers are equipped with mapping data and can shut off individual rows – I agree. My concern is the energy grass will be at full height at the time of corn/bean harvest – so what does the combine do when they reach a grass area (waterway/watershed)? Will they drive through it or have to reverse and go

around? Will they plant end rows around the grass areas? What is the impact of driving through the standing grass – will it stay down or pop back up for fall/winter harvest?

If harvest can be expanded to after frost to March/April – this is good. What impact does this have on quality? How does snow impact harvest/storage/quality?

CenUSA Video/Webinar List

CenUSA video and webinars are available on CenUSA dedicated YouTube and Vimeo sites.
(www.youtube.com/user/CenusaBioenergy / <https://vimeo.com/cenusbioenergy>)

CenUSA Bioenergy: Opportunities in Biofuel

Learn about the Cenusa Bioenergy and our project vision of creating a regional system for producing advanced transportation fuels derived from perennial grasses grown on marginal land in the Central USA. (4:01) <http://youtu.be/VrisN7RliRo>

2012 CenUSA Bioenergy Overview

Learn about Cenusa Bioenergy's vision of sustainable production and distribution of bioenergy derived from perennial grasses grown on marginal land in the Central USA. (3:11)
<http://youtu.be/NqxbF8-F8lc>

2012 CenUSA Bioenergy Farmer Focus

Farmer Kevin Ross describes to CenUSA Bioenergy why energy crops matter to farmers. (1:36)
<http://youtu.be/Ve8IwPMFcHg>

Drill Calibration Walk Through

CenUSA Bioenergy CoProject Director Rob Mitchell discusses the basic parts and adjustments of a drill for seeding perennial grasses. (4:59) <http://youtu.be/izBHivo5xfw>

Switchgrass Establishment, Weed Control, and Seed Quality

CenUSA Bioenergy CoProject Director Rob Mitchell discusses switchgrass establishment, weed control, and seed quality at the March 20, 2012, CenUSA-Extension Switchgrass Establishment Field Day held in Mead, Nebraska. (30:54) <http://youtu.be/7xVFMqBvCvQ>

Switchgrass Cost of Production

Marty Schmer, Agroecosystem Management Research Unit USDA-ARS, discusses "Switchgrass Cost of Production" at the CenUSA-Extension Switchgrass Establishment Field Day held Mar. 20, 2012 in Mead, Nebraska. (34:00) http://youtu.be/AsrWGhjr4_Y

Part One – Switchgrass and Perennial Grasses, Biomass and Biofuels

CenUSA Bioenergy CoProject Director Ken Vogel (USDA-ARS) discusses "Switchgrass and Perennial Grasses, Biomass and Biofuels" with attendees of the CenUSA-Extension Switchgrass Establishment Field Day held March 20, 2012, in Mead, Nebraska. (QuickTime Movie 38.8MB) (32:35) <http://youtu.be/N1FcOSbRkfM>

Part Two – Switchgrass and Perennial Grasses, Biomass and Biofuels

CenUSA Bioenergy CoProject Director Ken Vogel (USDA-ARS) continues the discussion "Switchgrass and Perennial Grasses, Biomass and Biofuels" with attendees of the CenUSA-Extension Switchgrass Establishment Field Day held March 20, 2012, in Mead, Nebraska (28:02) <http://youtu.be/QDkIHRGh6PI>

Dave Stock Industry Perspectives

CenUSA Bioenergy Advisory Board member David Stock, President of Stock See Farms, provides the industry perspective to attendees of the CenUSA-Extension Switchgrass Establishment Field Day held March 2012, in Mead, Nebraska. (23:01)

<http://youtu.be/xPjG44eyDOI>

No Till Drill Calibration Training Video

CenUSA Bioenergy CoProject Director Rob Mitchell discusses calibration of the Truax No Till Drill (Seeder) in this short video from the CenUSA-Extension Switchgrass Establishment Field Day (Mar 20, 2012) held in Mead, Nebraska. http://youtu.be/7TPLfWLkd_U

Harvesting Native Grass for Biofuel Production

CenUSA Bioenergy CoProject Director and USDA scientist Rob Mitchell discusses the potential of a native grass, switchgrass, for use in biofuel production. Mitchell discusses basic information about switchgrass, as well as demonstrating harvesting equipment used and techniques involved. (2:58) http://youtu.be/_RcJBURXwKc

Thermochemical Option: Thermochemical Conversion of Biomass to Fuel

Dr. Robert Brown is a foremost expert and author on biomass conversion processes. Dr. Brown is the director of the Iowa State University Bioeconomy Institute and a CenUSA Bioenergy Co-project director. This presentation focuses on using thermochemical processes for production of liquid biofuels. (31:29) <http://youtu.be/6dkV9OKw2F8>

Switchgrass and Bioenergy Crop Logistics

CenUSA Bioenergy CoProject Director Stuart Birrell discusses "Switchgrass and Bioenergy Crop Logistics" at the March 20, 2012 CenUSA Switchgrass Establishment Field Day in Mead, Nebraska. (36:44) <http://youtu.be/OGEd4KZOE2Q>



Sustainable Production and Distribution of Bioenergy for the Central USA



CenUSA Bioenergy Objectives

- **Feedstock Development**
- **Sustainable Production Systems**
- **Feedstock Logistics**
- **System Performance**
- **Feedstock Conversion**
- **Markets and Distribution**
- **Health and Safety**
- **Education**
- **Extension and Outreach**

The Biomass to Energy Challenge

Dependence on foreign oil. Greenhouse gas emissions. Overcoming the blend wall associated with the use of ethanol as fuel. Avoiding the food vs. fuel debate arising from the use of corn for biofuels production. Providing sufficient supply of biomass to biorefineries. These are serious challenges to the future of transportation fuels.

CenUSA addresses these challenges through fast pyrolysis of biomass and catalytic upgrading of the resulting bio-oil to produce drop-in fuels. Fast pyrolysis is the rapid thermal decomposition of organic material in the absence of oxygen. The products are a liquid known as bio-oil, a charcoal residue known as biochar, and a flammable liquid known as syngas. The bio-oil is a complex mixture of oxygenated organic compounds derived from the carbohydrate and lignin components of lignocellulosic biomass. Through the addition of hydrogen in the presence of catalysts, bio-oil can be upgraded to hydrocarbons that are indistinguishable from the molecules found in petroleum-derived gasoline, diesel, and aviation fuel. Because these hydrocarbons can be freely blended with traditional transportation fuels, they are sometimes known as “drop-in” biofuels. The biochar, rich in both carbon and mineral matter, can be incorporated into the soil to build fertility and sequester carbon from the atmosphere. The syngas can be used to heat the pyrolysis reactor.

Why Focus on Thermochemical Conversion?

Thermochemical approaches to biofuels production have several advantages over biological processing, including rapid reaction, similarities to existing petroleum refining technologies, and prospects for polygeneration of fuels, chemicals, and power.

Fast pyrolysis, in particular, has several unique advantages. It can be built at smaller scales, allowing distributed processing of bulky grass crops that would be difficult to bring to a centralized processing facility. The biochar product makes possible nutrient recycling and production of very low carbon fuels. Attractive economics suggest that pyrolytic biofuels may be commercialized earlier than biofuels produced by biological processes.

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Research Partners

Iowa State University

Purdue University

University of Illinois–Champaign

University of Minnesota–Twin Cities

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University of Vermont–Burlington

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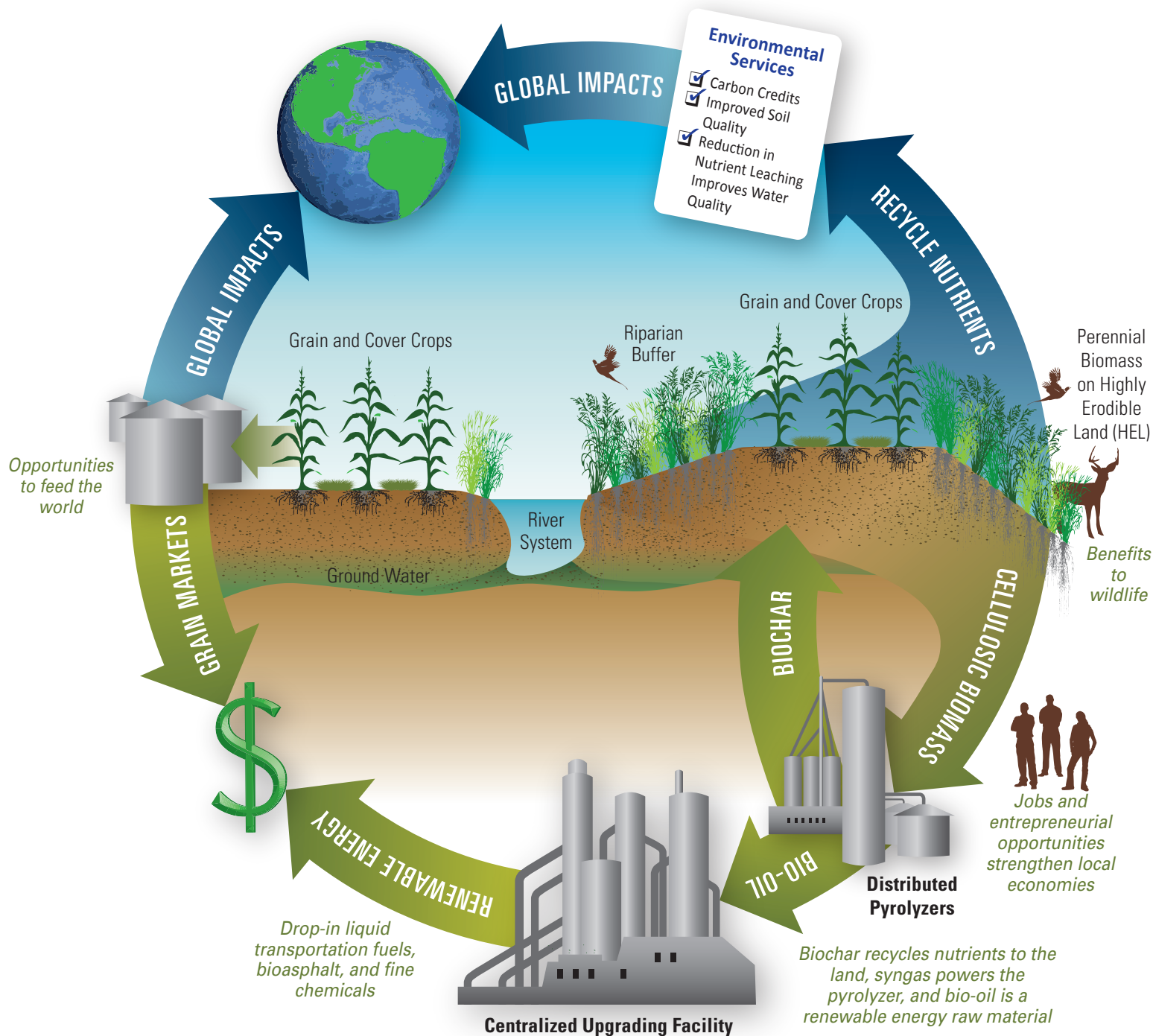
USDA ARS—Ames, Iowa;
Lincoln, Nebraska; Wyndmoor,
Pennsylvania; Madison, Wisconsin

The CenUSA Vision

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.

Duration

2011–2016



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



United States
Department of
Agriculture

National Institute
of Food and
Agriculture



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

... and justice for all

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