Northeast Woody/Warm-season Biomass Consortium

NEWBio

Quarterly Progress Report
For August - December 2012

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www.newbio.psu.edu
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Notice

This quarterly report was prepared by Penn State University and NEWBio research, extension and education partners from Cornell University, Delaware State University, Drexel University, Ohio State University, Rutgers University, SUNY College of Environmental Science and Forestry, University of Maine, University of Vermont, West Virginia University, USDA Eastern Regional Research Center, US DOE Idaho National Laboratory and US DOE Oak Ridge National Laboratory. This work was supported by Agriculture and Food Research Initiative Competitive Grant No. 2012-68005-19703 from the United States Department of Agriculture National Institute of Food and Agriculture (“USDA-NIFA”).
NEWBio Objectives

I. Understand the values, legacies, and motivations that drive perceptions and decisions about land management and business development for biomass energy systems to overcome barriers to development of perennial feedstocks.

II. Generate price-supply curves, facility siting and forward contracting tools to provide entrepreneur and investor confidence in biomass feedstock supply.

III. Develop and deploy as industry standards sustainable production practices for perennial grasses and short rotation woody crops to improve yield 25% and reduce costs by 20%.

IV. Commercialize the current pipeline of improved willow (Salix spp) and switchgrass varieties and develop genomic tools to accelerate breeding for marginal land.

V. Develop harvest, transport, storage and preprocessing systems that increase feedstock value as biomass moves through the supply chain toward advanced biofuel refineries.

VI. Create a culture of safety in the biomass production, transport and preprocessing sectors that addresses machinery hazards and environmental risks to protect workers.

VII. Transform standards of practice for biomass value chains to greatly improve carbon paybacks, net energy yields, soil and water quality, and other ecosystem services.

VIII. Deploy safe, efficient and integrated supply chains in four demonstration regions, each providing 500 to 1000 tons/day of high-quality low-cost sustainable biomass.

IX. Create learning communities of farmers, entrepreneurs, employees and investors informed about the best practices and emerging technologies in their bioenergy interest areas.

X. Provide business support services to generate at least 100 supply contracts and support over 50 new supply chain businesses to harvest, transport and preprocess biomass from short rotation woody crops and warm-season grasses.

XI. Educate students, citizens, landowners and policymakers to increase public understanding of biomass alternatives, including the social, economic, and environmental impacts of sustainable bioenergy systems in the Northeast.

XII. Create a culture of opportunity to support corporate commitments for two commercial-scale advanced biofuels facilities and encourage many more such commitments in the Northeast.
Project Administration

Project Organization and Governance Accomplishments

The NEWBio project has ten Northeast universities and three federal research laboratories participating in its research, extension, and education activities. NEWBio also counts 29 industry and agency partners as supporters for the five-year effort. Project oversight for this large and diverse collaborative effort rests with the Leadership Team, headed by Project Director Tom Richard at Penn State and Associate Director Tim Volk at SUNY-ESF. They are joined by thrust co-leaders Larry Smart at Cornell (Feedstock Improvement) and Jingxin Wang at West Virginia University (Harvest, Preprocessing and Logistics). Additional contributions to management will come from external program evaluators Laura Lindenfeld and Jessica Leahy (both from the University of Maine) and NEWBio’s External Advisory Board (see listing in Appendix B).

Faculty from core partner universities serve as co-leaders for NEWBio’s technical and integrative thrusts, and participate in monthly leadership/management conference calls. Barbara Kinne (Penn State Institutes of Energy and the Environment) provides day-to-day programmatic and administrative support to the management team, coordinates NEWBio’s reporting and evaluation efforts, and is the general point of contact for all project participants.

• Project Progress
  The NEWBio project team met on Penn State University’s University Park campus on August 20-21, 2012 for its first annual retreat, an opportunity for the 68 participants to connect with one another. These face-to-face meetings included break-outs for the project’s technical and integrative thrusts, an evening poster session, tours of Penn State’s agricultural research farms, and a round-robin “speed-dating” session where Thrusts were able to quickly learn each member’s research area and discuss key points of interaction.

  NEWBio held three leadership team teleconferences, four leadership-management team teleconferences, twelve thrust team teleconferences, and three All Hands teleseminars this period. As the following pages will show, activities are underway and demonstrating satisfactory progress during this start-up period.

• Project (Task) Timelines
  Using the proposed project task and timeline (as seen in Appendix A) as a baseline, each thrust populated a matrix with tasks and sub-tasks to benchmark work planned, data needed, data outputs, and corresponding milestones over NEWBio’s anticipated five-year
span. These timelines are in progress and will be shared in future progress reports when completed.

- **Advisory Board**
  NEWBio’s Advisory Board attended the first annual retreat in August, and received invitations to participate in monthly All Hands teleseminars. Helen Cummisky joined the board in October as the representative from American Refining Group, Inc. The Advisory Board will be involved in the proposal review process for NEWBio’s first round of Seed Grant funding next quarter.

- **Communication Platforms**
  NEWBio uses an internal website to maintain project contact listings, announce and schedule meetings, share materials and work collaboratively within and across the eight teams. Our public website (www.newbio.psu.edu) went live the day Secretary Vilsack announced the NEWBio award. Upcoming events are listed here, along with educational and employment opportunities and project news. Plans for next quarter include the development of a newsletter for listserve distribution. An RSS feed is under consideration.

- **Post-USDA Award Media Attention**
  The announcement of the NEWBio AFRI CAP award by USDA Secretary Tom Vilsack on October 16, 2012 prompted a number of news articles and interviews for the NEWBio team.
    - USDA Announces Nation’s Sixth Regional Biofuels System, Meant to Spur Innovation and Job Creation in the Northeast: Pennsylvania State University Awarded $10M to Develop Next-Generation Biofuels (October 16, 2012)
    - $10M Grant will fund research into biofuel-based economic development (October 16, 2012)
      http://live.psu.edu/story/62023

NEWBio was featured on "The Allegheny Front", a regional Appalachian radio show. The show aired at various times throughout the northern Appalachian region. "Bringing
Biofuels to the Northeast” featured NEWBio team members Calvin Ernst, Mike Jacobson, and Brian Richards.

The December 2012 issue of Ethanol Producer Magazine carried an announcement of the NEWBio award.

A December 24, 2012 article by Associated Press environmental reporter Mary Esch was widely distributed throughout the Northeast and elsewhere, including Bloomberg Businessweek (http://www.businessweek.com/ap/2012-12-23/energy-from-willows-comes-of-age-in-upstate-ny)

- Financial Matters

Niki Page and Christy Shaw-Godinez, both with Penn State’s Strategic Interdisciplinary Research Office (SIRO), provide oversight and monitoring of NEWBio’s day-to-day financial operations. NEWBio’s budget structure allots resources to 12 partner universities and national research labs and 13 thrust co-leaders located at Penn State, and to separate administrative and seed grant budgets. Accomplishments for this reporting period include the set-up of all budgets and formal completion of all sub-contracts.

There is one budget redistribution to note for this reporting period. NEWBio’s administrative budget transferred $28,341 to the Kemanian budget (Sustainability Systems Thrust) for supplies and purchased services associated with new biomass feedstock plantings.

The Leadership and Management teams developed guidelines for the receipt and review of proposals for the initial round of Seed Grant funding. Each thrust will be eligible to submit one or more proposals for this first year’s Seed Grants. $20,000 has been allocated from the USDA-NIFA budget for non-Penn State seed projects and a similar amount is available from Penn State’s match account for seed projects at Penn State. Connectivity to and between thrusts will be important considerations in the evaluation of seed grant proposals.

Plans for Next Quarter

- The Seed Grant request for proposal will be released early in the quarter. The NEWBio External Advisory Board will be asked to participate in the review of proposals and make recommendations to Project Director Richard. Richard will consult with the USDA Program Manager to make a selection.
• NEWBio will host a booth at the annual Pennsylvania Farm Show from January 4-12, 2013.
• Planning will move forward for NEWBio’s second annual retreat, scheduled for August 16-17, 2013 on Penn State’s University Park campus.
• A full slate of team meetings are scheduled for January through May 2013 for the leadership, management and All Hands teleseminars.

Publications, Presentations, Proposals Submitted

Research Presentations


Dr. Richard has organized a trip to visit the Sustainable Bioenergy Coordinated Agricultural Projects (CAPs) led by Washington State University and the University of Washington in January 2013 that will include a presentation on the NEWBio project.
Thrust 1: Human Systems in the Northeast Regional Bioeconomy

Human Systems focuses on understanding the values, legacies, and motivations that drive perceptions and decisions about land management and business development for biomass energy systems. Goals are to identify and describe the knowledge, attitudes, risk perceptions, ownership motivations and behaviors of local landowners and to determine perceived barriers and willingness to engage in production. Human Systems will test the effectiveness of communication techniques in encouraging landowners to participate in the market and evaluate opportunities and challenges for consolidating bioenergy crop management across multiple land parcels. We will also generate price-supply curves, facility siting and forward contracting tools to provide entrepreneur and investor confidence in biomass feedstock supply.

Task 1.1: Understanding social and economic constraints
Task 1.1.1: Economic availability

1. Planned Activities
   - Finalize research methodology:
     - Identify and map factors defining marginal lands.
     - Conduct comparative economic analysis for conventional food crops and energy crops on identified marginal lands.
     - Conduct Sensitivity Analysis for energy crops with respect to economic effect of marginal land using POLYSYS.
   - Conduct supply chain cost analysis of energy crops on marginal lands.

2. Accomplishments
   ✓ Met with Project Director on November 28 to discuss economic analysis.
   ✓ Developed draft research proposal.
     - Review underway of publications for marginal land.
     - Identified three general factors defining marginal land.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Develop methods for refining NE yield and production budgets.
   - Develop methods for defining and incorporating marginal lands.
     - Collect spatial data for demonstration sites
     - Define detailed factors of marginal lands.
Task 1.1.2: Social Acceptability

1. Planned Activities
   - Gather background socio-demographic data on case study communities.
   - Scope potential media sources about social acceptability of biomass.
   - Summarize supply chain management report.
   - Coordinate PhD and Post-Doctoral position descriptions to be hired for social acceptability work.
   - Continue to define and delineate specific tasks for social acceptability research.

2. Accomplishments
   - Began initial assembly and synthesis of data.
   - Produced a short summary of media sources for potential content analysis of media sources.
   - Completed summary report on supply chain management.
   - Posted PhD position description for research assistantship for SUNY ESF Environmental and Natural Resources Policy Program.
   - Continued research tasks definition.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Analyze background data on case study sites.
   - Begin media content analysis.
   - Recruit and fill PhD position.

Task 1.2: Assess demonstration sites as they pursue scale-up of biomass crop production and supply chain infrastructure

1. Planned Activities
   - Begin to scope site selection.
   - Gather background socio-demographic data on case study communities.
2. Accomplishments
   ✓ Data are being gathered and synthesized.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Narrow site selection choices.
   • Select PhD students and Post-docs for assignment to this task

Thrust 1: Publications, Presentations and Proposals Submitted

Research Presentations
Thrust 2: Feedstock Improvement for Perennial Energy Crops

Feedstock Improvement will optimize low input perennial feedstock crops (shrub willow and perennial grasses) that research has shown to be the best suited for Northeast climates and marginal soils. Our goal is to deliver cultivars with improved performance and expanded range on marginal lands.

Task 2.1: Breeding of non-invasive triploid hybrids of willow displaying hybrid vigor

1. Planned Activities
   - Execute recurrent selection program for tetraploid species; Identify potential collaborators in Asia to share Salix miyabeana.
   - Execute recurrent selection program for diploid species – Identify potential collaborators in Asia to share Salix koriyanagi, S. gracilistyla, and other species.
   - Develop new triploid progeny.

2. Accomplishments
   ✓ In October 2012, Larry Smart visited potential collaborators at Kangwon National University in Chuncheon, South Korea and at the Korea Forest Research Institute in Suwon, South Korea. Both of those institutions have collections of Salix native to South Korea, including Salix koriyanagi and S. gracilistyla that they will be willing to share through a clonal exchange. In November, Smart hosted a visit by willow breeders from the Jiangsu Academy of Forestry located near Nanjing, China and discussed a similar clone exchange including Salix suchowensis, which has recently been sequenced by researchers at Nanjing Forestry University. Plans were initiated for controlled pollinations in January 2013 to produce new triploid progeny.

3. Explanation of Variance
   A source of tetraploid Salix miyabeana has not yet been identified. Since this species is native to Japan and is banned for import through normal APHIS procedures, we will need to make arrangements for import through the USDA Plant Materials Import Center.

4. Plans for Next Quarter
   - Accomplish controlled pollinations of Salix to improve diploids and tetraploids and to generate novel triploid hybrids.
Task 2.2: Genetic basis for pest and disease resistance in willow and perennial grasses

1. Planned Activities
   - Survey *Salix* germplasm collection for susceptibility to potato leafhopper.
   - Survey *Salix* germplasm collection for susceptibility to rust.
   - If insects and diseases present – half sib family breeding nurseries and existing switchgrass trials will be evaluated.
   - Identify switchgrass plants with resistance to diseases and/or insects.

2. Accomplishments
   ✓ The 2012 growing season was characterized by early and heavy populations and feeding pressure from potato leafhopper (*Empoasca fabea*). We scored our germplasm collection, several yield trials, and progeny families for damage symptoms from potato leafhoppers. In contrast, due to dry weather, especially in June and July, there was virtually no rust observed on willow. Surveys were completed, but there was very little infection observed. In 2012, we had our most severe infestation of switchgrass gall midge to date. Plants in newly established seed production nurseries were the most susceptible to midge damage. All plants were rated for severity of midge damage. Differences were observed including some plants with no apparent damage over multiple replications. We also scored breeding nurseries and replicated cultivar trials of switchgrass for tolerance to anthracnose disease. No damage from stem borer insects were observed this year and there were no significant outbreaks of rust this year.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Prepare manuscript describing sensitivity and resistance patterns for potato leafhopper on willow.
   - Summarize switchgrass insect and disease data. Compare insects and diseases at Cornell and Rutgers.
   - Cornell will process switchgrass seed from breeding program and determine entries for a fungicide trial to be established at Rutgers in 2013.
   - Rutgers will establish a replicated trial with and without fungicide treatments to determine the impact of disease incidence on biomass yield of switchgrass.
Task 2.3: Breeding and selection of cultivars adapted for Northeast conditions

1. Planned Activities
   - Evaluate willow germplasm and select parents based on vigor on soil conditions that are limiting to growth in the Northeast - Establish common garden trial of *S. purpurea* on low pH soil and ag soil
   - From breeding nurseries at Rutgers and Cornell, harvest seed from each plant in each nursery
   - Thresh harvested seed

2. Accomplishments
   ✓ Trials were established (using NE Sun Grant funds) to accomplish common garden germplasm evaluation and for association mapping in Morgantown, WV, Geneva, NY, and Portland, NY. Survival was assessed and plans were made to replant dead cuttings. Rutgers and Cornell harvested seed from experimental switchgrass selections in seed production nurseries, then threshed and weighed seed in preparation for 2013 plantings.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Coppice the *S. purpurea* trials and make cuttings for spring replanting. Start switchgrass seeds in greenhouse for nursery establishment on a high-clay, poorly drained site, early to mid-March.

Task 2.4: Breeding and selection of willow and switchgrass yields on reclaimed mine land

1. Planned Activities
   - Establish willow trial on reclaimed mine land in WV (NE Sun Grant funds).
   - Fall site preparation (herbicide application) of reclaimed strip mine land site in PA.
2. Accomplishments

✓ A yield trial with 24 genotypes was established on a reclaimed strip mine site in Morgantown, WV in 2012, dead cuttings were replanted, and survival was assessed at the end of the growing season.

3. Explanation of Variance

Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter

• Coppice the willow trial and prepare cuttings for spring replanting.
• Prepare cuttings for spring planting on mineland site in PA.
• Spring site preparation on mineland site in PA, including incorporation of organic amendment.
• Determine the half-sib switchgrass families (harvested and threshed as part of task 2.3) that will be planted in PA mine lands, and start seeds in greenhouse, early to mid-February. We plan to establish 150 half-sib families in this experiment.

Thrust 2 Publications, Presentations, Proposals

Research Presentations


Smart, L.B. “Breeding shrub willow for improved yield and biofuels conversion efficiency”, Korea Forest Research Institute, Suwon, South Korea, Oct. 18, 2012. Invited department seminar.

Smart, L.B. “Breeding shrub willow as a sustainable feedstock crop for biofuel production”, International Symposium on Forest Environments and Low Carbon Green Growth, Thirtieth Anniversary Symposium of the College of Forest and Environmental Sciences, Kangwon National University, Chuncheon, South Korea, Oct. 18, 2012. Invited plenary speaker.


**Extension and Outreach Presentations**

Willowpedia Workshop “Farming Wood for Heat and Biofuels”, Geneva, NY, Dec. 18, 2012, Organized and hosted workshop with six invited speakers and 71 registered attendees, including harvesting equipment demonstration and tour of willow chip barn and boiler facility, 5 hours.

Agroforestry Field Day, USDA-NRCS Big Flats Plant Materials Center, Nov. 16, 2012. Field day tour stop at willow yield trial, spoke to ~50 attendees for 0.5 hours.

Sukkot Willow Dealers, Geneva, NY, Nov. 8, 2012 – field tour and survey of willow germplasm collection with Charlie Schwab and David Taplin, Jewish Sukkot willow stem dealers, for 2 hours.

Jiangsu Academy of Forestry Willow Researchers, Geneva and Fredonia, NY, Nov 1-3, 2012 – oral presentation, field tours, discussions, and planning of cooperative research and commercialization projects with three willow researchers for 18 hours.


Crawford County Farm Planning Meeting, Meadville, PA, Oct. 25, 2012 – discussion with Crawford County (PA) Supervisors, Ohio State Cooperative Extension, Penn State Cooperative Extension, and Cornell Cooperative Extension to plan demo plantings of perennial bioenergy crops on County Farm, discussion and field tour with group of 12 professionals for 2 hours.
Rondout Valley High School Educators, Geneva, NY, Sept. 21, 2012 – field tour, discussion and planning of educational outreach projects with four educators for 0.5 hours.

Ag Progress Days, Pennsylvania Furnace, PA, Aug. 14-15, 2012. Presented a display with Penn State collaborators on willow bioenergy crops and breeding in the Natural Resources Barn for two days. Interacted with ~200 attendees over the course of 12 hours. Also spoke on field tour of yield trial at the site, 0.5 hour each day with total of 40 attendees.

Perennial Biofeedstock Field Days, USDA-NRCS Big Flats Plant Materials Center, Aug. 10, 2012. Field day tour stop at willow yield trial, spoke to ~110 attendees for 0.5 hours.

Proposals Submitted
Thrust 3: Harvest, Preprocessing, and Logistics of Integrated Biomass Supply Chains

For perennial crop systems like willow, miscanthus and switchgrass, harvesting and transportation can account for 40 to 60 percent of the delivered cost of biomass. Preprocessing of biomass through drying, size reduction, storage and compaction can increase transportation efficiency, reduce delivered costs, and improve conversion efficiency. Cost reductions associated with biomass logistics, including harvest and collection, processing, transportation, and storage unit operations, are key to establishing a commercially-viable, sustainable biorefinery. Partly because logistics costs associated with low density, and unstable biomass are so high, much of the physically available supply is not available at delivered prices of $60-100/dry ton.

Task 3.1: Significantly reduce the harvesting cost per ton of biomass feedstocks from willow and perennial grasses

Task 3.1.1: Optimize the operation of the forage harvester

1. Planned Activities
   - Collect time-motion data from large scale willow harvest.

2. Accomplishments
   - Designed willow harvest protocols.
   - Collected data on 100+ acres of willow harvest in New York.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Continue to collect time-motion data from large-scale willow harvests.
   - Collect data on willow harvest outputs per acre.

Task 3.1.2: Detailed time and motion data collection and fuel use analysis

1. Planned Activities
   - Identify model parameters for biomass harvesting models.
   - Determine time and motion data collection procedures and experimental design.
2. **Accomplishments**
   - ✔ Identified key parameters for biomass harvesting models.
   - ✔ Developed preliminary time-motion data collection procedures for the forage harvester, tested it in the field and revised it based on field experience.
   - ✔ Developed experimental design.
   - ✔ Initiated large scale harvest of willow biomass crops as part of a project supported by USDOE and NYSERDA (NY State Energy Research and Development Authority). By the end of December over 130 acres of willow biomass crops had been harvested with a Case New Holland forage harvester fitted with a specialized cutting head. Time motion data and chip samples were collected during harvesting operations.

   *Large scale harvesting trials were conducted in December 2012 in central NY in collaboration with NEWBio partner Case New Holland and Mesa Reduction and Engineering. The harvester is a Case New Holland forage harvester fitted with a cutting head that was specifically designed to cut short rotation woody crops like willow.*

   Photo by D. Angell

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Refine data collection procedures for time-motion data of forage harvester.

   **Task 3.1.3:** Cost effective technologies for harvesting perennial grasses

1. **Planned Activities**
   - Produce case study on round baling switchgrass and on-farm densification.
2. **Accomplishments**
   - Designed switchgrass harvest protocols.
   - Collected time-motion data on switchgrass harvesting and baling.

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. Miscanthus harvesting will not be initiated until late winter/early spring 2013.

4. **Plans for Next Quarter**
   - Process data collected during field trials.

**Task 3.1.4: Optimize the operation of the perennial grass harvester**

1. **Planned Activities**
   - Conduct mechanical property tests for energy crops.

2. **Accomplishments**
   - Tested static properties of miscanthus plants collected in October and November 2012. Samples collected in January 2013 will be tested.
   - Tested static properties of switchgrass plants collected in Spring 2012.
   - Provided data for Life Cycle Analysis.

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Continue to examine the mechanical properties of energy crops.
   - Design and fabricate a test device for dynamic mechanical properties of miscanthus.

**Task 3.1.5: Feedstock Logistics, supply chain and modeling optimization**

1. **Planned Activities**
   - Identify and define base supply chain and supply chain nodes.
     - Define current parameters in logistics model that are relevant to field trials to inform those on production-related thrust of data valuable to our model.
o Compile list and description of modeling efforts to better understand capabilities and discuss integration opportunities.
o Discuss integration opportunities between the modeling efforts in the Harvest Logistics thrust as well as any production or conversion models within the NEWBio consortium.

2. Accomplishments
   ✓ Populated matrix consisting of model descriptions and key parameters.
   ✓ Used model matrix to begin to identify where integration efforts would provide the most value.
   ✓ Discussed with production-related thrusts about necessary data to be recorded during field trials to enable population of the models with more accurate.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Develop model for baseline supply chain
     o Develop additional modules as needed to comply with baseline system.
     o Incorporate additional parameters into model that were identified as key to assessing associated processes.
     o Incorporate field trial data where applicable to initialize processes in the model.

Task 3.2: Quantify the role of preprocessing for densification and storage on transportation efficacy and downstream fuel conversion

Task 3.2.1: Quantitative metrics of preprocessing parameters of biomass densification

1. Planned Activities
   • Develop survey of critical biomass characteristics in consultation with outside experts and stakeholders.
   • Survey stakeholders to prioritize biomass characteristics of round baling switchgrass and on-farm densification.

2. Accomplishments
   ✓ Developed a matrix of biomass characteristics that includes standard units of measurement and reasons for importance in biomass harvest, storage and downstream conversion protocols.
3. **Explanation of Variance**  
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**  
   No activities are planned for the next quarter.

**Task 3.2.2: Effects of preprocessing transportation and downstream fuel conversion**

1. **Planned Activities**  
   No activities planned for this quarter.

2. **Accomplishments**  
   No accomplishments to report for this quarter.

3. **Explanation of Variance**  
   No variance to report.

4. **Plans for Next Quarter**  
   No activities are planned for the next quarter.

**Task 3.2.3 Biomass densification**

1. **Planned Activities**
   - Plan biomass densification studies and analytical methods, and initiate densification studies for grasses and willow.
   - Develop survey of critical biomass characteristics in consultation with outside experts and stakeholders.
   - Survey stakeholders to prioritize biomass characteristics of round baling switchgrass and on-farm densification.

2. **Accomplishments**
   - Developed experimental design and analytical method protocols.

3. **Explanation of Variance**  
   Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter
   • Expand densification studies
   • Acquire biomass characteristics data

Task 3.3: Assess the storage requirements and effects of long term storage on the quality of willow and perennial grasses
Task 3.3.1: Storage system development and assessments for perennial grasses

1. Planned Activities
   • Plan and initiate long term storage studies for perennial grasses.

2. Accomplishments
   • Developed plans for long term storage studies of switchgrass and miscanthus.
   • Analyzed initial samples of switchgrass.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Expand long term storage studies for perennial grasses.

Task 3.3.2: Storage system development and assessments for willow

1. Planned Activities
   • Plan and initiate long term storage studies for willow.

2. Accomplishments
   ✓ Developed plans for a long term storage pile study of willow biomass chips.
   ✓ Created, tested and modified a chip pile sampling device.
   ✓ Tested and repaired temperature data loggers in preparation for a long term pile study.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter
   - Expand long term storage studies for willow.

Task 3.4: Techno-economic analysis, cost engineering, and life cycle analysis of
densification, storage preprocessing and biorefinery integration
Task 3.4.1: Develop an integrated supply chain model

1. Planned Activities
   - Identify and define base supply chain nodes.
     - Define current parameters in logistics model that are relevant to field trials to inform
       those on production related thrust on which data are valuable to our model.
     - Compile list and description of modeling efforts to better understand capabilities and
       discuss integration opportunities.
     - Discuss integration opportunities between the modeling efforts in the Harvest
       Logistics thrust as well as any production or conversion models within the NEWBio
       consortium.

2. Accomplishments
   ✓ Populated matrix consisting of model descriptions and key parameters.
   ✓ Used model matrix to begin to identify where integration efforts would provide the most
     value.
   ✓ Discussed with production-related thrusts data to be recorded during field trials to enable
     population of the models with more accurate data.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Develop model for baseline supply chain.
     - Develop additional modules as needed to comply with baseline system.
     - Incorporate additional parameters into model that were identified as key to assessing
       associated processes.
     - Incorporate field trial data where applicable to initialize processes in the model.
Task 3.4.2: Cost engineering models for satellite preprocessing and storage

1. Planned Activities
   • Identify suppliers of inputs for cost models and cost model schedule dates.

2. Accomplishments
   ✓ Key stakeholders were identified and model systems defined.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   No activities are planned for next quarter.

Task 3.4.3: Life Cycle analysis, techno-economic analysis, and model integration

1. Planned Activities
   • Conduct literature review of feedstock production LCAs.
   • Define temporal/spatial system boundaries for feedstocks and production processing routes.

2. Accomplishments
   ✓ Defined system boundaries for select feedstock (willow, switchgrass, and miscanthus) to energy end-products via pyrolysis, torrefaction, and pelletization intermediate steps.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Define LCI material balance model and begin data collection.
   • Acquire necessary data: output from feedstock supply chain and logistics model
   • Data will be collected for LCA and TEA model construction.
   • Initiate life cycle inventory (using SimaPro software) and techno-economic models.
   • Focus initial TEA models on engineering costs.
Thrust 3:   Publications, Presentations and Proposals Submitted

Refereed Publications


Research Presentations


Thrust 4: System Performance and Sustainability Metrics

Sustainability will assess the overall system performance and sustainability of biomass to biofuel systems through a combination of detailed measurements at willow and perennial grass experimental sites, regional simulations using benchmark scenarios, and integration of the techno-economic analysis (shared with thrust 3 - Harvest, Preprocessing, and Logistics). These activities provide information to assess sustainability following the criteria proposed by the Global Bioenergy Partnership: (1) the fuels life-cycle GHG emissions, (2) changes in soil quality, (3) emissions of non-GHG air pollutants, (4) impacts on water quality, (5) impacts on landscape biodiversity, (6) land use and land-use change related to energy feedstock production, and (7) rural and social development. Criterion (7) requires coordination with Thrust 1 – Human Systems. We also emphasize inclusion of so-called non-market ecosystem services that perennial systems may provide in the NE landscapes.

Task 4.1: Site- and crop-specific knowledge gaps

Task 4.1.1: Biomass production

1. Planned Activities
   - Define benchmark locations for modeling biomass potential.
   - Characterize growth at locations in NJ (MS, SW), NY (WW), PA (MS, SW, WW), including stem/leaf partitioning.
   - Model growth in the NE and determine yield potential.
   - Characterize yield gap at benchmark locations.
   - Measure biomass yield of mixtures.

2. Accomplishments
   - Finished inventory of existing experiment, defining benchmark locations (32 experiments distributed in 11 locations across NY, PA, and WV, 30 experiments distributed in 14 sites in NY, NJ, and WV)
   - Started consolidation of climate and soils database for yield gap modeling. Also coordinated with scenario and regional modeling activity.
   - Harvested Year 1 of a miscanthus plus switchgrass mixture in Rock Springs experiment. Willow mixture experiment established at Geneva and State College, in cooperation with Feedstock Improvement thrust.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter
   - Define benchmark locations and decide whether to include new sites for miscanthus in Ohio and Western PA.
   - Monitor budbreak to determine onset of growing season across the region, and determine onset for each genotype at Rock Springs and Geneva.
   - For benchmark locations in Ohio and Western PA, obtain long-term climate data, complete missing information (humidity and radiation). Obtain soils data and establish regular data format. Run simulations for yield potential for generic C3 woody crop and generic C4 grass crop with model Cycles.
   - Define structure of yield gap report.

Task 4.1.2: Nitrogen demand and alternative supply

1. Planned Activities
   - Establish the N demand through N dilution curves appropriate for three crops, starting with a generic model for C3 (WW) and C4 (MS, SW). Document deviation from existing parameters.
   - Establish $^{15}$N experiment to track fate of applied N in willow.
   - Monitor response of bioenergy crops to different N sources.

2. Accomplishments
   ✓ Started work on different aspects of N cycle in NEWBio energy crops.
   ✓ Preparation of $^{15}$N application underway for Rock Springs site.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Complete review for N cycling, clarify unknowns, and identify challenges and solutions from sister switchgrass CAP studies.
   - Purchase $^{15}$N fertilizer, finalize experimental design and plot delineation, and apply $^{15}$N in willow.
   - Define specific experiments taking into account existing publications and reclaimed minelands.
Task 4.1.3: Nitrous oxide emissions

1. Planned Activities
   - Monitor NO₃ in benchmark experiments.
   - Track relevant non-NEWBio research.

2. Accomplishments
   ✓ NO₃ monitored for one large-scale experiment; high nitrate accumulation points to sensitive timeframe for managing N, even without fertilizer application.

3. Explanation of Variance
   We have a minor delay in monitoring NO₃ as decisions are made as to which benchmark experiments to include.

4. Plans for Next Quarter
   - Finalize benchmark experiment identification and establish a common sampling protocol.
   - Seek data agreement for experiments conducted outside of NEWBio.
   - Continue development of an overall data management strategy.

Task 4.1.3: Carbon storage

1. Planned Activities
   - Install CO₂ and H₂O monitoring stations (two closed path and two open path eddy covariance systems) at Rockview, PA.

2. Accomplishments
   ✓ Started installation of eddy covariance systems.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Finalize installation of eddy covariance systems and seek to make data available live.
   - Identify sampling sites for determination of rate of change of C in well-established plantations.
Task 4.2: Benchmark scenarios

1. Planned Activities
   - Establish plantation management schedule for each model scenario.
   - Define input and output variables.
   - Establish stable database of inputs (soils, weather, management).
   - Determine simulation schedule.

2. Accomplishments
   ✓ Initiated discussions with the KDF Group at ORNL on strategies for overall data management coordination.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Establish schedules and frameworks for willow and for miscanthus/switchgrass.
   - Continue development of overall data management strategy.

Task 4.3: Regional feedstock supply and environmental assessment

1. Planned Activities
   - Define physical sites for extension and education demonstrations.
   - Define virtual sites for education and regional simulation demonstrations.
   - Establish water quality impacts and air quality impacts for industrial activity and emergent pollutants.
   - Begin to evaluate land use change impact on biodiversity and landscape.
   - Define harmonized database for LCA and non-market impacts
   - Define data management for thrust and overall project.

2. Accomplishments
   ✓ Defined physical and virtual sites, developed tiers, and benefited from a county offering of acreage for an additional Extension site.
✓ Began exploration of issues related to isoprene emissions in willow, an important emergent challenge. Exploratory conversations with Jose Fuentes, Penn State’s Meteorology Department.
✓ Interviews with post-doctoral candidates to assess land use impacts underway.
✓ Coordination begun with ORNL on data management, and distribution of data format standards is underway.

3. Explanation of Variance
   • Water quality impact activities had limited funding in the NEWBio proposal and we are working synergistically to couple the Cycles agroecosystem model with the Pennsylvania Integrated Hydrologic Model (PIHM). Comparison with the Sparrow model is also under consideration, and will be the subject of a complementary proposal.

4. Plans for Next Quarter
   • Continue efforts on the following tasks:
     o Finalize site definitions.
     o Begin coupling water quality models and defining a strategy for handling isoprene impacts.
   • Define a working regional assessment strategy and methodology for monitoring.
   • Promote development of a data model for each NEWBio thrust.

Task 4.4: Biomass to biofuel life cycle analysis and multi-criteria sustainability

1. Planned Activities
   • Define system boundaries for NEWBio feedstocks re: preprocessing methods and end-use markets.
   • Perform peer review of proposed USDA National Agricultural Library data archiving methods for preparation of LCA data sets.
   • Prepare proposal to seek funding for complementary research.

2. Accomplishments
   ✓ Held meetings with the sustainability, feedstock and logistics groups to coordinate plans for LCA model development and use of software tools (SimaPro and Aspen Plus).
   ✓ Reported findings and plans on LCA modeling to NEWBio leadership group on November 1, 2012 and to NEWBio All Hands on December 10, 2012.
3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Initiate data collection to compile techno-economic analysis (TEA) models.
   - Design feedstock measurement data structure that will populate the LCA model.

**Thrust 4 Publications, Presentations, and Proposals Submitted**

**Research Presentations**
Thrust 5: Safety and Health in Biomass Feedstock Production and Processing Operations

Safety and health aspects of the biomass product supply chain will be addressed from a holistic, systems perspective, including review of hazard and risk exposures, development and application of hazard and risk management tools, education and training, and limiting damage caused by unwanted events. Engineering and educational programs and interventions will be viewed from the Pre-event, Event and Post-event phases of any injury incident, and will focus on relevant human, equipment and environmental factors. Mechanical and industrial hygiene exposures and risks will be targeted.

Task 5.1: Biomass safety program development

1. Planned Activities
   - Recruit student researchers.
   - Develop outline for literature searches.

2. Accomplishments
   ✓ Two student researchers hired.
   ✓ Literature search outline develop and searches commenced.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Continue literature review.
   - Identify framework for describing injury prevention opportunities and risk evaluations.

Task 5.2: Safety and health hazard inventory

1. Planned Activities
   No activities planned for the current reporting period.

2. Accomplishments
   None to report for this period.
3. **Explanation of Variance**
   No variance to report.

4. **Plans for Next Quarter**
   - Will begin hazards inventory.

**Task 5.3: Develop, conduct and evaluate a comprehensive safety and health management program**

1. **Planned Activities**
   No activities planned for the current reporting period.

2. **Accomplishments**
   None to report for this period.

3. **Explanation of Variance**
   No variance to report.

4. **Plans for Next Quarter**
   No activities planned for the next reporting period.

**Thrust 5 Publications, Presentations, and Proposals Submitted**
None to report this period.
Thrust 6  Extension

Extension will transfer NEWBio project knowledge and skills developed to support rapid deployment of willow- and warm-season grass-based bioenergy systems for economic, social and environmental benefits. Our program will enable informed public decision-making, practical problem solving, and effective business development for the bioenergy economy for our key audiences.

Task 6.1:  Integrated demonstration sites

1. Planned Activities
   • Hire Penn State Extension Associate and begin recruiting process for additional personnel as needed.
   • Establish field demonstration sites.
   • Organize, schedule and deliver field days and workshops.

2. Accomplishments
   ✓ Hired Cornell Extension Associate on September 1, 2012 for one year.
   ✓ Identified potential field demonstration sites in Pennsylvania, New York and West Virginia.
   ✓ Delivered the following workshops:
     o Perennial Grass Energy in the Northeast, Meadville, PA, October 15, 2012, 40 participants.
     o Farming Wood for Heat and Biofuels, NYS Agricultural Experiment Station, Geneva, NY, December 18, 2012, 60 participants.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Complete hiring process for additional personnel.
   • Organize and deliver “Business of Biomass” workshop.
   • Develop and consolidate demonstration site plans and objectives.
   • Identify potential cooperators at demonstration sites.
Task 6.2: Biomass equipment access program

1. Planned Activities
   • Initiate equipment leasing protocol process.
   • Develop loan equipment schedule.
   • Deliver safety training to farmers and other equipment users.

2. Accomplishments
   ✓ Equipment access plan in development.

3. Explanation of Variance
   The determination of equipment needs and scheduling is dependent upon demonstration site locations. These locations will be finalized during the next quarter.

4. Plans for Next Quarter
   • Finalize equipment needs.
   • Purchase equipment.
   • Develop equipment leasing plan.

Task 6.3: Small business and economic development

1. Planned Activities
   • Identify businesses and needs.
   • Identify supply chain gaps.

2. Accomplishments
   ✓ Began literature review of business models and comparison of supply chain models.

3. Explanation of Variance
   The review and selection of the most appropriate modeling approach is in process and will be completed by mid-year.

4. Plans for Next Quarter
   • Develop frameworks for business opportunities.
   • Prepare working paper on comparing supply chain models.
Task 6.4: Expand eXtension.org for willow and warm-season grasses

1. Planned Activities
   • Identify NEWBio expert to contribute materials.

2. Accomplishments
   ✓ Selected individual team members to review eXtension materials.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Develop eXtension website.
   • Identify priority topics for publication.

Task 6.5: Interactive and innovative learning-lessons tools

1. Planned Activities
   • Develop NEWBio publicity materials for use at workshops, conferences, etc.
   • Develop NEWBio energy crop profile fact sheets on willow, miscanthus and switchgrass.
   • Organize and produce bioenergy webinar series.

2. Accomplishments
   ✓ Created promotional materials (desktop displays, poster, banner).
   ✓ Developed shrub willow, miscanthus and switchgrass fact sheets (see Appendix D):
   ✓ Developed NEWBio brochure/fact sheet (see Appendix D).

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Continue delivery of bioenergy webinars.
   • Develop NEWBio “Frequently Asked Questions” sheet and additional fact sheets as needed.
Thrust 6  
Publications, Presentations, and Proposals Submitted

Non-Refereed Publications
Jacobson, M. 2012. NEWBio Energy Crop Profile: “Shrub Willow Fact Sheet”, Penn State University, College of Agricultural Sciences, University Park, PA.
Jacobson, M. 2012. NEWBio Energy Crop Profile: “Miscanthus Fact Sheet”, Penn State University, College of Agricultural Sciences, University Park, PA.
Jacobson, M. 2102. NEWBio Energy Crop Profile: “Switchgrass Fact Sheet”, Penn State University, College of Agricultural Sciences, University Park, PA.

Extension and Outreach Presentations

The following were presented by NEWBio collaborators and stakeholders:
Thrust 7  Education

The NEWBio education program will develop critical human capital by preparing learners to understand, contribute to, and lead the Northeast US bioenergy industry via three coordinated, complimentary programs that inform, engage, and enable students at secondary, undergraduate, and graduate levels. These programs dovetail with our research and extension programs and leverage existing program infrastructure and expertise within the team to allow for maximum impact.

Task 7.1:  Secondary educator training

1. Planned Activities
   - Set up system to receive and collect applications for Bioenergy and Bioproducts Education Program Applicants.
   - Recruit for Summer 2013.
   - Organize and plan training.

2. Accomplishments
   ✓ Online application systems ready for applicants: (http://www.bioenergyed.org/)
   ✓ Selected Pennsylvania training site and partner: Penn State University Park Campus and Penn State Center for Science in the Schools.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   - Set up system to receive and collect applications.
   - Continue recruiting for Summer 2013.
   - Organize training and work with site directors to plan programs.

Task 7.2:  Regional Bioenergy Scholars

1. Planned Activities
   - Develop action plan and undergraduate candidate application.
   - Recruit mentors and research topic opportunities from within the NEWBio team.
   - Recruit student candidates for Summer 2013.
2. **Accomplishments**
   ✓ Identified project mentors and research topics.
   ✓ Created program application.
   ✓ Circulated program information; currently accepting applications. Program information available online: [http://www.newbio.psu.edu/education/bioenergyScholars.asp](http://www.newbio.psu.edu/education/bioenergyScholars.asp)

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Continue candidate recruiting, review applications and select candidates.
   - Organize host sites.

**Task 7.3: Graduate distance education in bioenergy**

1. **Planned Activities**
   - Develop marketing plan for promoting courses to potential students.

2. **Accomplishments**
   ✓ Developed marketing strategy and draft marketing materials. Final versions to be available next quarter.

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Market the program to potential students via online and print materials distributed through web, email and surface mailings.
   - Develop formative evaluation plan.

Research Presentations
Thrust 8  Leadership, Stakeholder Involvement, Knowledge-to-Action (K2A) and Program Evaluation

The primary focus for Thrust 8 is to link stakeholder involvement to all NEWBio activities. Through team meetings, teleseminars, and a rigorous annual evaluation, expected outcomes will include demonstrated transdisciplinary collaborations, knowledge and perspectives; research that is more closely aligned with stakeholder needs; and more effective and efficient dissemination of scientific knowledge that will support the expansion of perennial energy crops within the Northeast.

Task 8.1:  Executive and thrust conference calls

1. **Planned Activities**
   - Establish regular teleconference schedules for Leadership team, joint Leadership-Management team (Management includes all thrust co-leaders), and individual or joint Thrust teams.

2. **Accomplishments**
   - Held Leadership teleconferences on October 4, November 15, and December 13.
   - Held Leadership-Management teleconferences on September 13, October 11, November 1 and December 20.
   - Held a total of twelve Thrust teleconferences.

3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Continue monthly teleconferences for Leadership and Leadership-Management teams.
   - Target bi-monthly teleconferences for each Thrust team.

Task 8.2:  All Hands teleseminars and meetings

1. **Planned Activities**
   - Organize and deliver initial NEWBio All Hands meeting.
   - Establish regular teleseminar schedule to deliver project updates and share Thrust progress toward goals and objectives.
2. Accomplishments

✓ Held first annual NEWBio All Hands meeting/retreat at Penn State University on August 20-21, 2012; 68 attended, including External Advisory Board members, industry and agency partners, and USDA program managers.

✓ Held All Hands teleseminars on September 20, November 8, and December 6 with the following featured presentations:
  o Thomchick, E. “Supply Chain Management: The Uncertainty Framework”, Penn State University, December 6, 2012.

3. Explanation of Variance

Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter

• Continue monthly teleseminars.

Task 8.3: External Advisory Board meetings and strategic planning

1. Planned Activities

• Attend annual NEWBio All Hands meeting.
• Participate in monthly All Hands teleseminars as available.

2. Accomplishments

✓ Eight members of advisory board attended August 20-21, 2012 retreat.

3. Explanation of Variance

Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter

• Establish an annual rotation of one advisory board representative for each of the eight thrusts.
• Involve advisory board expertise for Seed Grant proposal reviews.

Task 8.4: Task and project evaluation

1. Planned Activities
   • Participate in NEWBio initial All Hands meeting and in subsequent Management and All Hands teleconferences.
   • Draft initial program evaluation survey.

2. Accomplishments
   ✓ Attended All Hands retreat in August 2012, participated in subsequent teleconferences, observed team interactions.
   ✓ Reviewed and commented on draft templates for NEWBio reporting purposes.
   ✓ Completed program evaluation survey draft.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.

4. Plans for Next Quarter
   • Finalize evaluation survey and secure Institutional Review Board approval.
   • Distribute survey to NEWBio faculty, staff, and graduate student team members.

Task 8.5: Administrative evaluation

1. Planned Activities
   No activities planned for the current reporting period.

2. Accomplishments
   None to report for this period.

3. Explanation of Variance
   No variance to report.

4. Plans for Next Quarter
   No activities planned for the next reporting period.
Task 8.6: Final evaluation and program report

1. Planned Activities
   No activities planned for the current reporting period.

2. Accomplishments
   None to report for this period.

3. Explanation of Variance
   No variance to report.

4. Plans for Next Quarter
   No activities planned for the next reporting period.

Thrust 8 Publications, Presentations, and Proposals Submitted
None to report for this period.
Appendix A

NEWBio Task List and Timeline
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<thead>
<tr>
<th>NEWBIO TASK LIST AND TIMELINE</th>
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<th>2014</th>
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<td><strong>Thrust 1</strong> Human Systems</td>
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<td>Task 1.2 Assess demonstration sites as they pursue scale up of biomass crop production and supply chain infrastructure</td>
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<td>Task 2.1 Breeding of non-invasive triploid hybrids of willow displaying hybrid vigor</td>
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<td><strong>Thrust 3</strong> Harvest, Preprocessing, and Logistics of Integrated Biomass Supply Chains</td>
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<td>Task 3.1 Significantly reduce the harvesting cost per ton of biomass feedstocks from will and perennial grasses in the NE</td>
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<td>Task 3.3 Assess the storage requirements and effects of long term storage on the quality of willow and perennial grasses</td>
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<td>Task 3.4 Techno-economic analysis, cost engineering, and LCA of densification, storage, preprocessing, biorefinery integration</td>
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<td>Task 4.1 Site- and crop-specific knowledge gaps</td>
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**Key Deliverables**

- Project Milestones:  
  - O: Low Activity  
  - X: High Activity

- Fact Sheets, Reports, Articles, Videos:  
  - O: Low Activity  
  - X: High Activity
Appendix B

NEWBio Advisory Board Roster

The advisory board’s core mission is to support the goals and objectives of NEWBio.

<table>
<thead>
<tr>
<th>Name</th>
<th>Company/Institution</th>
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<tbody>
<tr>
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Appendix C

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1. Human Systems in the Northeast Regional Bioeconomy
2. Feedstock Improvement for Perennial Energy Crops
3. Harvest, Preprocessing, and Logistics of Integrated Biomass Supply Chains
4. System Performance and Sustainability Metrics
5. Safety and Health in Biomass Feedstock Production and Processing Operations
6. Extension
7. Education
8. Leadership, Stakeholder Involvement, Knowledge-to-Action (K2A), and Program Evaluation
Appendix D

Willow, Miscanthus and Switchgrass

Fact Sheets
NEWBio Energy Crop Profile: Shrub Willow

Note: "NEWBio" is the Northeast Woody/Warm Season Bioenergy Consortium, a USDA-AFRI funded regional project promoting next generation bioenergy production in the Northeast US.

Willow, comprises over 400 species in the Salix genus. The species ranges from large weeping willow trees to dwarf alpine shrubs. Willows are naturally found in cold to temperate climates including the northeastern United States. It is commonly found along streams and areas with moist soils because willow has characteristics that give it a competitive advantage in these environments. In the 19th and early 20th centuries willow was used to make baskets and furniture. It also has strong analgesic properties (salicin acid) in the bark, from which aspirin was derived.

Shrub willow is a very attractive biomass crop because it is high yielding, fast growing, requires few inputs, has multiple stems and re-sprouts after being cut. The shrub willow reaches heights of 5 to 7 meters (15 to 25 feet) in 3 years and averages 10-15 dry tonnes per hectare (4.6 tons per acre) per year. Substantial breeding and research trials in recent years show promise for higher yielding cultivars in the near future.

**Planting**
Willow planting is done using pieces of live stems - dormant un-rooted cuttings 15-25 cm (6-10 inches) in length in late spring at a density of about 15,000 cuttings per hectare (6,000 per acre). Planting is done with mechanized planters specifically designed for planting this material. To facilitate the management of the site with farm machinery, willows are planted in a double-row system with 1.8 meters (six feet) between double-rows, 0.75 meters (two and a half feet) between rows, and 0.6 meters (two feet) between plants within rows.

Willow cuttings are made from one year old stems and are kept dormant in cold storage until they are planted.

**Establishment of the Crop**
Willow sprouts need weed control initially, but once the willow stand closes canopy during the second year, weeds become much less of a problem.

After the first growing season, plants should be cut back (cooped) close to the ground (5-10 cm height) with a mower equipped with sharp blades for a clean cut. The willows re-sprout in the next spring, growing multiple shoots and take on a characteristic shrub form.

Some pests and diseases such as Japanese beetles, potato leafhopper and rust are known to damage willow. Care is needed in areas of high deer browse. Willow, being a
perennial woody species, sequesters more carbon than other crops and provides other important wildlife and biodiversity benefits.

Harvest
Harvesting occurs in the third year after coppice, and every third year thereafter for up to seven cycles (21 years). No annual maintenance of the crop should be necessary and compared to other crops, willow requires few fertilizer inputs, but nitrogen fertilizer can be applied as needed. Harvesting requires a specialized cutting head attached to a forage harvester.

Harvesting willow biomass crops with a specially designed cutting head attached to a forage harvester.

Uses of the Crop
The harvested wood is usually sold in chip form, and as such it has multiple uses and is generally more marketable than perennial grasses. Wood chips have low ash and are easily stored for relatively long periods. Typical uses include direct combustion for heat or heat-power, or conversion to cellulose biofuel. Non-energy uses include mulch, animal bedding, and fiberboard. One great feature of willow is that it can be “stored on the stump” – held over for a year if the market is poor or conditions are not favorable for harvest. This is not possible with perennial grasses, which must be harvested annually.

Economics
The largest expenses of growing willow are establishment and harvesting costs. One can expect to pay about 12 cents per cutting and total site preparation and planning costs will average about $2,400 per ha ($1,000 per acre). Depending on the yields, and the distance the material needs to be hauled, break-even prices range from $30-50 per ton at the farm gate.

NEWBio Project Work
In the U.S., planting stock of varieties bred and tested by researchers at SUNY College of Environmental Science and Forestry and Cornell University are available through a NEWBio consortium partner “Double A Willow” (http://www.doubleawillow.com).

Summary
Shrub willow is a short rotation woody crop that provides multiple bioenergy products and environmental benefits especially in more northern climates where other energy crops don’t grow as well. They grow very well on underutilized and marginal fallow land and can improve soil conditions and microbial diversity. Significant gains have been made in breeding cultivars for improved yields. Although the establishment and harvesting costs are relatively high, once the crop is established, very little maintenance is required and rate of returns over the twenty plus years can be favorable.

Prepared by Michael Jacobson, Penn State Department of Ecosystem Science and Management

References:
Willowpedia Cornell University:
http://willow-eals.cornell.edu/

SUNY ESF Shrub Willow Biomass Producers handbook:

For more information on the NEWBio project, visit:
http://www.newbio.psu.edu

Visit the Penn State Extension renewable energy programs website: http://energy.extension.psu.edu

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An Outreach program of the College of Agricultural Sciences
NEWBio Energy Crop Profile: Giant Miscanthus

Note: “NEWBio” is the Northeast Woody/Warm Season Bioenergy Consortium, a USDA-AFRI-funded regional project promoting next generation bioenergy production in the Northeast US.

The genus *Miscanthus* comprises twelve perennial grass species native to Asia. A close relative of sugarcane, this tall reed or cane-like plant was introduced to the U.S. as an ornamental plant in the 19th century. Recognizing its growth potential and ability to withstand cold conditions and poor soils, it has become widely known for bioenergy production. Giant Miscanthus (*Miscanthus x giganteus*), a sterile hybrid of *Miscanthus sinensis* and *Miscanthus sacchariflorus*, is the species most commonly used for bioenergy. The plant reaches heights of up to 3.5 meters (12 feet) and in research trials has shown to be among the highest yielding perennial energy crops, producing an annual average of up to 12-17 dry tonnes per hectare (5-7 tons per acre).

**Planting**

Miscanthus is planted using rhizomes (root growths) which make it more expensive to establish than other energy crops from seed. The planting rate is about 10,000 plants per hectare (4,000 plants per acre). Planting is typically done in late spring after the last frost, but it may be hard to obtain plant material and planting equipment at that time. Access to rhizomes is difficult due the low number of nurseries propagating the material. Planting rhizomes requires specialized machinery that is still being developed.

**Establishing the Crop**

Establishment of Giant Miscanthus takes two to three growing seasons before a full crop can be expected. Weed control is essential in the first year and possibly the second year. A critical establishment issue is frost kill during the first winter after planting. However, once it gets through its first winter it usually survives subsequent winters and is weed free, as it tends to crowd out all other plants in the field. Miscanthus has low nutrient requirements during establishment and has not shown much response to nitrogen fertilizers. In fact, some studies show nitrogen is counterproductive by encouraging greater weed growth during establishment.
Harvest
Harvest can occur in the second year and conventional hay or silage harvesting equipment is used. Although the highest biomass yield occurs from a late summer harvest, it is more common to harvest the crop in the late winter or early spring to allow nutrients to translocate down into the crown and rhizomes for use the following year. This annual harvest can be carried out for an estimated 15-20 years before the field needs to be replanted.

Uses of the Crop
While the current market is limited, Giant Miscanthus can be pressed into fuel pellets or biomass logs for combustion, or it can be used as a feedstock for cellulosic biofuel production. Non-energy possibilities for Miscanthus include animal bedding, absorbents, and bio-based materials such as fiberboard.

Economics
The largest expense for establishing Miscanthus is purchasing planting material. Assuming rhizomes at 10-25 cents each and about 4,000 to 5,000 rhizome per acre cost to over $1,500 just for plant material. Other planting expenses are similar to other row crops at about $400/acre. Harvest cost range from $300 to $500 per acre depending on the type of machinery used for harvest. Depending on the yields, breakeven prices range from $40-80 per ton at the farm gate.

NEWBio Project Work
Miscanthus trials are ongoing across the eastern and midwestern United States. A NEWBio partner, Alotera LLC, is increasing Miscanthus biomass and rhizome availability by planting up to 50,000 acres of Miscanthus primarily in Ohio and Pennsylvania.

Summary
One of the highest yielding perennial energy crops in the region, Miscanthus requires little maintenance, no annual replanting and only one annual harvest. It has excellent traits as an energy crop on marginal land due to its high productivity in colder climates, its deep roots exploiting soil nutrients and its high water-use efficiency. However, there are some constraints with planting material availability and costs, planting costs, and ensuring first year winter survival. However, over a life of 20 years, the returns for growing Miscanthus are favorable compared to other crops.

References
eXtension Farm Energy COP. Miscanthus (Miscanthus x giganteus) for Biofuel Production.

For more information on the NEWBio project, visit http://www.newbio.psu.edu

Visit the Penn State Extension renewable energy programs website: http://energy.extension.psu.edu
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Densified Miscanthus bales ready for transport
NEWBio Energy Crop Profile: Switchgrass

Note: “NEWBio” is the Northeast Woody/Warm Season Bioenergy Consortium, a USDA-AFRI funded regional project promoting next generation bioenergy production in the Northeast U.S.

**Switchgrass**, Panicum virgatum, is a warm season bunch grass native to the tall grass prairie region. It is found across much of the eastern and southern U.S. Commonly grown as a conservation crop or for forage and wildlife benefits, in recent years it has gained importance as an energy crop because of its high yields, adaptability to marginal lands, and relatively low establishment and management costs.

![Switchgrass harvest using hay mowing equipment](image)

It is a hardy deep rooted perennial grass that grows to as high as 2 meters in a year (6 feet) and can produce an annual crop for up to 20 years. Switchgrass does well on a wide variety of soil types, including wet, shallow or rocky soils and is drought-tolerant. Its deep roots can break through tough soil layers improving long term soil structure. It is also excellent for wildlife habitat, providing seeds, browse, and shelter for a variety of species.

There are many varieties of switchgrass that are distinguished either as upland or lowland species based on the location from which they originate. Upland species can grow on drier landscapes and are naturally more cold tolerant and found in northern parts of the country in areas not subject to flooding. Lowland types come from the warmer floodplain regions in the south and are known to have better yields. Both types grow well in our region and the key is finding a cultivar that matches specific site conditions. Currently average annual yields are in the 10-15 dry tonnes per hectare (4-6 tons per acre) range, but there is substantial work on selecting and breeding improved cultivars. Common varieties in the Northeast include “Timber”, “Cave in Rock”, and “Kanlow”.

**Planting**

Switchgrass is grown from seed and can be broadcast planted or drilled. Typically the seed is planted in late spring, after the soil has warmed, at a rate of 8 and 12 kg/ha (8 and 12 lbs/acre) when drilled and broadcast, respectively. Switchgrass seedlings are not aggressive. Therefore, weed control prior to planting is important.

**Establishing the Crop**

Switchgrass is slow to establish, taking 3 years to develop into a harvestable stand in most locations. In the first year, seedlings focus on root development, which means that above ground competition between it and weeds can be an issue. Switchgrass is a warm season grass, and it does not begin to grow until later in the spring. Weed control and/or mowing are important initially, and fertilization is not recommended since it benefits weed growth. Thereafter, it is generally maintenance free, except for occasional applications of nitrogen as needed. Switchgrass tolerates low fertility conditions but responds well to nitrogen applications after establishment.

**Harvest**

Conventional hay mowing and baling equipment is used for harvesting switchgrass. If the biomass is being used for bioenergy, harvesting is typically done in the winter after first frost or in the early spring before growth is initiated. Spring harvesting can reduce biomass yield significantly but stand vigor and yield consistency is better in subsequent years due to nutrients being returned to roots during the dormant season.
Uses of the Crop

Switchgrass biomass can be condensed into fuel pellets for combustion, or it can be used as a feedstock for cellulosic biofuel production. Bioenergy markets for switchgrass are emerging. Non-energy possibilities for switchgrass include use as a low grade feed, and for animal bedding.

Economics

Total costs for planting, annual maintenance and harvesting switchgrass average about $1,000 per acre over the first 5 years. Depending on the yield, break-even prices can vary from $40 to $80 per ton at the farm gate. The largest expenses include one-time establishment costs and annual harvesting.

NEWBio Project Work

Switchgrass trials and breeding for the NEWBio project are now being carried out in the Northeast. Ernst Biomass, a NEWBio project partner, harvests and pelletizes over 1,000 hectares (2,500 acres) of switchgrass in Northwest PA.

Summary

Currently, switchgrass is the most commonly grown perennial grass energy crop in the U.S. It is adaptable to a wide range of conditions, and there are numerous cultivars to select from. Switchgrass requires little maintenance, no annual planting and only one harvest per year. Established from seed, it is less costly to plant than Miscanthus or willow, but once established provides attractive rates of return if a market is available for the harvested crop.

Prepared by Michael Jacobson, Penn State Department of Ecosystem Science and Management

References:

Switchgrass (Panicum virgatum) for Biofuel Production:
http://www.extension.oregonstate.edu/P-PE2633/switchgrass-panicum-virgatum-for-biofuel-production

NRCS Technical Note # 3, Planting and Managing Switchgrass as a Biomass Energy Crop:

Consortium partner Ernst seed has an excellent guide to switchgrass production:

For more information on the NEWBio project, visit:
http://www.newbio.psu.edu

Visit the Penn State Extension renewable energy programs website: http://energy.extension.psu.edu

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Appendix E. Bioenergy Scholars Announcement

The Bioenergy Scholars Program offers summer research work to undergraduates, who can apply to work at one of several universities in the Northeast US (including Penn State, Cornell, Rutgers, West Virginia University, SUNY ESF, Delaware State University, and others). After a one-week orientation program at Delaware State, students will be brought to their host university to spend the summer working side by side with graduate students and researchers on important bioenergy topics. Students will participate in a formal course on the work for presentation at the end of the summer. Applicants should have an interest in bioenergy, but students from a wide variety of backgrounds and majors are encouraged to apply.

What it offers:
- The Bioenergy Scholars Program gives undergraduate students an excellent opportunity to meet and work with other students interested in bioenergy, to gain hands-on knowledge of the topic, and to learn about exciting opportunities in this field. All of this comes while earning a summer paycheck, working at one of the beautiful college campuses in the Northeast US.

For more details,
- Project description, career and application available online at: http://www.newbio.psu.edu/bioenergy/scholars.php

Submit your completed application form, along with a resume, statement of interest, college transcripts and two reference letters for review. Please visit our Web site for more program details and dates at http://www.newbio.psu.edu/education/bioenergyscholars.asp.

Students can come from any part of the country, but positions will be at Northeast US universities.

Some of the highlights of what you will gain from the program include:
- Impressive resume preparing yourself to compete globally;
- Great research experiences under field or lab conditions; and,
- You are opening a gateway for graduate studies or for better career opportunities.
NEWBio’s vision is to build robust, scalable and sustainable value chains for biomass energy in the Northeast United States.

This project is supported by Agriculture and Food Research Initiative Competitive Grant No. 2012-68005-19703 from the United States Department of Agriculture National Institute of Food and Agriculture (USDA-NIFA).

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