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@NARA_Renewables  
@censusabioenergy  
@IBSS6  
@BANR_Bioenergy
Acknowledgements

NEWBio thanks the following departments and individuals who were instrumental in developing and delivering the 2016 Annual Meeting.

Penn State Institutes of Energy and the Environment
Robin Brenneman
Patricia Hickman
Christopher Pfeiffer
Sandra Maitland

Penn State Department of Ecosystem Science and Management
Dana Grove
David Harry
Michael Messina, Department Head

Stone Valley Recreation Area/Penn State Hostetter Business Services
Charlene Detwiler

Penn State Office of Physical Plant
Timothy Smeltzer
Linda Lykens

Penn State Campus Catering
Erika Christiansen

Alan Alda Center for Communicating Science
Stony Brook University

NEWBio also gratefully acknowledges USDA NIFA’s Agriculture and Food Research Initiative for its essential role in supporting the Consortium.
NEWBio is supported by USDA NIFA AFRI Competitive Grant #2012-68005-19703.
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--- 5 ---
### AGENDA

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
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<tbody>
<tr>
<td><strong>TUESDAY, JULY 26, 2016</strong></td>
<td><strong>Field Tours, Group Dinner</strong></td>
</tr>
<tr>
<td>Arrival in time for Field Tour</td>
<td>Travel to Penn State</td>
</tr>
<tr>
<td>01:00 PM—05:00 PM</td>
<td><strong>Field Tour</strong></td>
</tr>
<tr>
<td></td>
<td>- <em>Mineland Reclamation Tour</em> will include NEWBio's Philipsburg, PA planting site and Pennsylvania Grain Processing's ethanol plant in Clearfield, PA.</td>
</tr>
<tr>
<td></td>
<td>- <em>Ecosystem Services Tour</em> will include NEWBio's Rockview willow plantings, a State College, PA &quot;Living Filter&quot; site, and a locally-installed riparian buffer.</td>
</tr>
<tr>
<td>05:00 PM—08:30 PM</td>
<td>Social Hour and Dinner (Civil Engineering Lodge, Stone Valley)</td>
</tr>
<tr>
<td><strong>WEDNESDAY, JULY 27, 2016</strong></td>
<td><strong>Forest Resources Building (FRB) - All Sessions in Steimer Auditorium (Room 112) unless otherwise noted</strong></td>
</tr>
<tr>
<td>07:00 AM—08:00 AM</td>
<td><strong>BREAKFAST and CONCURRENT THRUST MEETINGS</strong></td>
</tr>
<tr>
<td></td>
<td>- Feedstock Improvement (FRB 105)</td>
</tr>
<tr>
<td></td>
<td>- Education (FRB 102)</td>
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<tr>
<td></td>
<td>- System Performance/Sustainability (FRB 104)</td>
</tr>
<tr>
<td>08:00 AM—08:30 AM</td>
<td><strong>Welcome and Introductions</strong></td>
</tr>
<tr>
<td></td>
<td>Tom Richard, Project Director, Penn State</td>
</tr>
<tr>
<td>08:30 AM—09:30 AM</td>
<td><strong>Thrust Short Reports</strong></td>
</tr>
<tr>
<td></td>
<td>- Human Systems: Wei Jiang, Penn State</td>
</tr>
<tr>
<td></td>
<td>- Feedstock Improvement: Wanyan Wang, Penn State</td>
</tr>
<tr>
<td></td>
<td>- Harvest, Preprocessing, Logistics: Yuxi Wang, West Virginia University</td>
</tr>
<tr>
<td></td>
<td>- System Performance/Sustainability: Melanie Kammerer Allen, Penn State</td>
</tr>
<tr>
<td></td>
<td>- Safety and Health: Pankaj Kuhar, Penn State</td>
</tr>
<tr>
<td></td>
<td>- Extension: Sarah Wurzbacher, Penn State</td>
</tr>
<tr>
<td></td>
<td>- Education: John Vance, West Virginia University</td>
</tr>
<tr>
<td>09:30 AM—10:30 AM</td>
<td><strong>Research Highlights</strong></td>
</tr>
<tr>
<td></td>
<td>- Mark Eisenbies, SUNY ESF, <em>Storage, Processing and Quality of Willow Chips</em></td>
</tr>
<tr>
<td></td>
<td>- Damon Hartley, Idaho National Lab, <em>Impact of Yield, Crop Area and Biorefinery Demand on the Delivered Price of Bioenergy Feedstocks</em></td>
</tr>
<tr>
<td></td>
<td>- Lindsey Hoffman, Rutgers University, <em>Switchgrass Feedstock Improvement and GxE</em></td>
</tr>
<tr>
<td></td>
<td>- Eric Fabio, Cornell University, <em>Shrub Willow Feedstock Improvement and GxE</em></td>
</tr>
<tr>
<td></td>
<td>- Weston Eaton, Penn State, <em>Socio-Cultural Factors Shaping Landowner Support for and Willingness to Plant Bioenergy Crops Based on Eddy Covariance Measurements and Model Simulations</em></td>
</tr>
<tr>
<td></td>
<td>- Armen Kemanian, Penn State, <em>Insights on the Water and Nutrient Balance of Energy Crops</em></td>
</tr>
<tr>
<td>10:30 AM—10:45 AM</td>
<td><strong>BREAK</strong></td>
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<tr>
<td>10:45 AM—12:00 PM</td>
<td><strong>Invited Presentations/Discussion</strong></td>
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<tr>
<td></td>
<td>- Emily Heaton, Iowa State University</td>
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<td></td>
<td>- Richard Bergman, U.S. Forest Service</td>
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<tr>
<td></td>
<td>- Anne Kinzel, CenUSA Bioenergy</td>
</tr>
<tr>
<td></td>
<td>Saurabh Bansal, Penn State</td>
</tr>
<tr>
<td></td>
<td><em>The NEWBio Elephant: Need to Combine Individual Expertise into a Composite Picture for Risks</em></td>
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## AGENDA

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</tr>
</tbody>
</table>
| 12:00 PM—01:00 PM | **LUNCH and CONCURRENT THRUST MEETINGS**  
  - Extension (FRB 105) |
| 01:00 PM—03:00 PM | **Project Integration Session**  
  Discussion will center on Ecosystem Services, Commercialization Pathways, and Supply Chain Logistics  
  MODERATOR: Lara Fowler, Penn State—Bioenergy Policy Update  
  INVITED GUESTS:  
  - Kevin Comer, Antares Group Inc.  
  - Daren Daugaard, Cool Planet  
  - Rob Mitchell, USDA-ARS, University of Nebraska  
  - Tom Schwartz, FDC Enterprises  
  - James Shortle, Penn State University |
| 03:00 PM—05:00 PM | **Poster Session** (Rooms 106/107)  
  Posters may be set up after 10am; check listings at room entrances for your room/board # |
| 05:00 PM—06:00 PM | **Advisory Board Meeting** (Room 105) |
| 05:00 PM—08:30 PM | **SOCIAL HOUR and GROUP DINNER**  
  Lobby Area |
| **THURSDAY, JULY 28, 2016** | **Forest Resources Building, Steimer Auditorium (Room 112)** |
| 07:00 AM—08:00 AM | **BREAKFAST and CONCURRENT THRUST MEETINGS**  
  No thrust meetings scheduled at press time |
| 08:00 AM—08:15 AM | **Evaluator Project Review**  
  Jessica Leahy, University of Maine |
| 08:15 AM—10:15 AM | **Communication and Collaboration Plenary Workshop**  
  Laura Lindenfeld, Director, Alan Alda Center for Communicating Science, Stony Brook University |
| 10:15 AM—10:30 AM | **BREAK** |
| 10:30 AM—11:15 AM | **Advisory Board Report Out**  
  Thomas Foust, Chair, National Renewable Energy Laboratory |
| 11:15 AM—12:15 PM | **Thrust Leads Report Out**  
  - Human Systems, Theresa Selfa, SUNY ESF  
  - Feedstock Improvement, Larry Smart, Cornell University  
  - Harvest, Preprocessing, Logistics, Jingxin Wang, West Virginia University  
  - System Performance/Sustainability, Armen Kemanian, Penn State  
  - Safety and Health, Douglas Schaufler, Penn State  
  - Extension, Michael Jacobson, Penn State  
  - Education, Dan Ciolkosz, Penn State  
  - Project Evaluation, Laura Lindenfeld, Stony Brook University |
| 12:15 PM—12:30 PM | **Meeting Wrap Up**  
  Tom Richard, Project Director, Penn State |
| 12:30 PM          | **Adjourn**  
  BOXED LUNCH TO GO! |
Attendees

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### Attendees

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<table>
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<th>Institution/Organization</th>
<th>Name</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antares Group Inc.</td>
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</tr>
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<tr>
<td>Cool Planet Energy Systems</td>
<td>Daren Daugaard</td>
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</tr>
<tr>
<td>Cornell University</td>
<td>Jamie Crawford</td>
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</tr>
<tr>
<td></td>
<td>Eric Fabio</td>
<td><a href="mailto:esf56@cornell.edu">esf56@cornell.edu</a></td>
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<td>Fred Gouker</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>Larry Smart</td>
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<td>Kittikun Songsomboon</td>
<td><a href="mailto:ks899@cornell.edu">ks899@cornell.edu</a></td>
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<tr>
<td>Delaware State University</td>
<td>Mollee Crampton</td>
<td><a href="mailto:mcrampton@desu.edu">mcrampton@desu.edu</a></td>
</tr>
<tr>
<td></td>
<td>Isaac Fisher</td>
<td><a href="mailto:lsfisher13@students.desu.edu">lsfisher13@students.desu.edu</a></td>
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<td><a href="mailto:vkalavacharla@desu.edu">vkalavacharla@desu.edu</a></td>
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<tr>
<td>Double A Willow</td>
<td>Dennis Rak</td>
<td><a href="mailto:dennis.rak@doubleavineyards.com">dennis.rak@doubleavineyards.com</a></td>
</tr>
<tr>
<td>Drexel University</td>
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</tr>
<tr>
<td>ExxonMobil</td>
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<td><a href="mailto:sarah.torkamani@yahoo.com">sarah.torkamani@yahoo.com</a></td>
</tr>
<tr>
<td>Idaho National Laboratory</td>
<td>Damon Hartley</td>
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</tr>
</tbody>
</table>
# Attendees

By Institution/Organization

## Iowa State University

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<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Emily Heaton</td>
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</tr>
<tr>
<td>Anne Kinzel</td>
<td><a href="mailto:akininzel@iastate.edu">akininzel@iastate.edu</a></td>
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## University of Maine

<table>
<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Jessica Leahy</td>
<td><a href="mailto:jessica.leahy@maine.edu">jessica.leahy@maine.edu</a></td>
</tr>
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</table>

## National Renewable Energy Laboratory

<table>
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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Thomas Foust</td>
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<td>Saurabh Bansal</td>
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<tr>
<td>Ryan Baxter</td>
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<tr>
<td>Anahita Bharadwaj</td>
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<tr>
<td>Dan Ciolkosz</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Michael Jacobson</td>
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</tr>
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<tr>
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<tr>
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## Attendees

By Institution/Organization

### Penn State University (cont.)

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<tr>
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<tr>
<td>James Shortle</td>
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<td>Sarah Wurzbacher</td>
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### Rutgers University

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<tbody>
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<td>Stacy Bonos</td>
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### Stony Brook University

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<td>Laura Lindenfeld</td>
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### SUNY College of Environmental Science and Forestry

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<tr>
<td>Mark Eisenbies</td>
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### University of Vermont

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<tr>
<td>Susan Hawkins</td>
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### USDA

### Agricultural Research Stations

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<tbody>
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### Forest Service Forest Products Lab

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<tbody>
<tr>
<td>Richard Bergman</td>
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### National Institute of Food and Agriculture

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<th>Name</th>
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<td>Bill Goldner</td>
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# Attendees

By Institution/Organization

## West Virginia University

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<td>David DeVallance</td>
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## 2016 NEWBio Energy Scholars

### Michigan State University

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<td>Karl Schneider</td>
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### SUNY-ESF

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<td>Lauren Lynn</td>
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### University of Puerto Rico

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<tr>
<td>Nicole Ramos-Solis</td>
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### University of Wisconsin

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<tr>
<td>Alexander Steiner</td>
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### Wesley College

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<tr>
<td>Clara Pena de la Cruz</td>
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### West Virginia University

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<td>Patrick Whitehouse</td>
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SESSION INFORMATION

Welcome and Introductions
Thrust Short Reports
Invited Guest Presentations
Project Integration Plenary
Poster Session with Student Competition
Evaluator Project Review
Communication and Collaboration Workshop
Advisory Board Report Out
Thrusts Report Out and Meeting Wrap-Up
Opening Session

Welcome and Introductions

Tom Richard, Project Director, Penn State University
Tom will introduce members of the NEWBio Advisory Board and invited guests, and provide an overview and a brief project status update.

NEWBio Thrust Short Reports

Thrusts will offer remarks on thrust activities and highlights from NEWBio’s third year.

- **Wei Jiang, Penn State University**
  Human Systems in the Northeast Regional Bioeconomy

- **Wanyan Wang, Penn State**
  Feedstock Improvement

- **Yuxi Wang, West Virginia University**
  Harvest, Preprocessing and Logistics

- **Melanie Kammerer Allen, Penn State University**
  System Performance and Sustainability Metrics

- **Pankaj Kuhar, Penn State University**
  Safety and Health

- **Sarah Wurzbacher, Penn State University**
  Extension

- **John Vance, West Virginia University**
  Education
NEWBio Research Highlights

Mark Eisenbies  
SUNY ESF  
*Developments in the Storage, Preprocessing and Quality of Willow Chips*

Damon Hartley  
Idaho National Lab  
*Impact of Yield, Crop Area and Biorefinery Demand on the Delivered Price of Bioenergy Feedstocks*

Lindsey Hoffman  
Rutgers University  
*Switchgrass Feedstock Improvement and GxE*

Eric Fabio  
Cornell University  
*Shrub Willow Feedstock Improvement and GxE*

Weston Eaton  
Penn State  
*Socio-Cultural Factors Shaping Landowner Support for and Willingness to Plant Bioenergy Crops*

Armen Kemanian  
Penn State  
*Insights on the Water and Nutrient Balance of Energy Crops Based on Eddy Covariance Measurements and Model Simulations*
Invited Presentations

Emily Heaton, PhD
Associate Professor
Department of Agronomy
Iowa State University

I am an Associate Professor of Agronomy at Iowa State University (http://faculty.agron.iastate.edu/heaton/). My group aims to understand the growth and productivity of perennial C₄ grasses, and how they can be managed to provide multiple ecosystem services, especially bioenergy. We use combined field and modelling approaches to investigate the how the environment affects key plant processes (e.g., photosynthesis, biomass accumulation, water and nutrient use), as well as how plants affect the environment (e.g., soil quality, GHG emissions, water and nutrient cycling). Typical activities focus on the plant and field plot scale, with implications at the watershed and ecosystem scale. Through collaboration, we use our data to explain observed phenomena and predict future behavior, with an ultimate goal of providing useful information about the role biomass crops can and should play in the Midwestern USA. I remain involved with my family farm (www.cavenyfarm.com), which employs diverse agricultural methods ranging from heritage poultry grazing to biomass crop production for sustainable and profitable land management.

Richard Bergman, PhD
Research Forest Product Technologist
USDA Forest Service

Rick conducts research on the holistic environmental impacts of wood products and novel bioenergy systems using life-cycle assessment (LCA). His PhD in 2012 focused on evaluating the dynamics of GHG emissions for long-lived products. Along with conducting LCAs for developing environmental product declarations, Rick is on committees for green building standards and codes and is part of a team developing an integrated LCA modeling tool for biofuel production from an ecosystem perspective on beetle-killed forests.

Major research objectives include:
- developing LCA data for wood products and for novel bioenergy systems that make synthesis gas, biochar, briquettes, and torrified wood,
- investigating the time value of carbon and associated GHG emissions related to forest management practices and the final disposition of wood products
- conducting LCAs on Tall Wood Buildings
Anne Kinzel, JD
Chief Operating Officer
CenUSA Bioenergy
Iowa State University

Anne Kinzel is the COO of CenUSA Bioenergy where she helps the trains run on time in this $25 million project devoted to creating a Midwestern regional system for producing advanced transportation fuels and bioproducts derived from perennial grasses grown on land either unsuitable or marginal for row crop production. Prior to joining CenUSA, Anne served as a large trauma center and teaching hospital general counsel and as a health care policy and reform researcher. Anne currently speaks three languages English, French and health policy and is diligently learning ag and bioenergy speak.

The NEWBio Elephant: Need to Combine Individual Expertise into a Composite Picture for Risks

Saurabh Bansal
Assistant Professor
Department of Supply Chain Management
Smeal College of Business
Penn State University

A critical part of NewBio’s mission is to understand and project various risks to a sustainable business model for biomass production and use. The expertise required to make these risk assessments is spread across multiple teams in several institutions associated with the project. Each expert sees the a part of the big picture, and multiple experts have complementary understanding of these risks. There is a need to aggregate this knowledge and come up with consolidated estimates of risks. The talk will briefly discuss a quantitative approach to do this aggregation, and will seek participation from experts at various institutions associated with NewBio.
Project Integration Plenary

This session’s goal is to further project discussion on three inter-related topics [Commercialization Pathways, Supply Chain Logistics and Ecosystem Services] that form the backbone for the development of the biomass industry in the Northeast United States: commercialization trajectories, including ecosystem services monetization, crops/feedstocks that are produced cost-effectively, and markets for these crops for when these crops are transformed into products.

Moderator: Lara Fowler, JD, Penn State

Guest Panelists:
- Kevin Comer, PE, Antares Group Inc.
- Daren Daugaard, PhD, PECool Planet
- Rob Mitchell, PhD, USDA-ARS, University of Nebraska
- Tom Schwartz, MS, CWB, FDC Enterprises
- James Shortle, PhD, Penn State

Lara Fowler, JD
PSIEE Assistant Director for Outreach and Engagement
Professor, Penn State Law

Fowler is an attorney and mediator who focuses on environmental, energy, and natural resource law, with a specific focus on water related issues. She has a joint appointment between Penn State Law and the Penn State Institutes of Energy and the Environment where she is working on questions related to water, the Chesapeake Bay, and energy. Prior to joining Penn State, she was an attorney at Gordon Thomas Honeywell LLP in Seattle, Washington, where she focused on mediation and dispute resolution of complex natural resource issues. She and co-authors K.S. Dahmann and Paul M. Smith recently published a book chapter on U.S. Law and Policy and the Biofuel Industry in The Law and Policy of Biofuels (Eds Le Bouthillier et al). Edward Elgar, Publisher, 2016.

Kevin Comer, PE
Associate Principal
Antares Group Inc.

Comer is a mechanical engineer specializing in energy and environmental systems. He is experienced in: R&D and market assessments for advanced energy systems; power plant performance testing and analysis; biomass fuel supply studies; biomass repowering and cofiring in fossil fuel-fired boilers; energy use evaluation and energy auditing (including lighting system upgrade evaluations); performance and economic modeling for energy systems; developing custom spreadsheets and models for evaluating technical and economic performance of energy systems; environmental permitting for power generation projects; feasibility and design studies for solar photovoltaic systems; feasibility and design studies for anaerobic digestion systems; project management and performance assessment for installation of solar photovoltaic systems; and public outreach for “green” energy.
Project Integration Plenary

Dr. Daren E. Daugaard, PhD, PE
Head of Operations
Director of Research & Development
Cool Planet Energy Systems

Daren Daugaard was raised in South Dakota on a family farm. He graduated with a BS in Mechanical Engineering from Iowa State University (ISU) in 1995 and was employed in the power distribution industry. In 1999, Dr. Daugaard initiated his research in biomass fast pyrolysis at ISU where he obtained his PhD in 2003. He continued his research efforts in pyrolysis with the University of Texas at San Antonio as an associate professor. From 2007 to 2011, Dr. Daugaard served as a research engineer at ConocoPhillips Company responsible for leading a biomass pyrolysis to fuels program. Starting in 2011, Dr. Daugaard transitioned from investigative research in the oil industry to active research and commercial development at Cool Planet Energy Systems.

Rob Mitchell
USDA Research Agronomist
Adjunct Professor, Department of Agronomy
University of Nebraska

Rob Mitchell is a Research Agronomist with the USDA-Agricultural Research Service Grain, Forage and Bioenergy Research Unit in Lincoln, Nebraska and adjunct Professor in the Department of Agronomy and Horticulture at the University of Nebraska-Lincoln. He is the Coordinator of the USDA Central-East Regional Biomass Research Center. He is a Fellow in the Crop Science Society of America and a Fellow in the American Society of Agronomy. In 2000, he was named the American Association of State Colleges of Agriculture and Renewable Resources National Outstanding Teacher. He has authored or co-authored more than 200 refereed journal publications, book chapters, proceedings, popular articles, cultivar releases and extension publications, and given more than 120 national and international invited presentations. Research interests include all aspects of establishment, management, harvest, storage, and sustainability of perennial grasses for bioenergy and forage production in the Great Plains and Midwest, USA.
Project Integration Plenary

Tom Schwartz
Vice President of Marketing, M.S., CWB
FDC Enterprises

FDC Enterprises is comprised of a team of professionals with a passion for conservation and bioenergy. Our on the ground experience and production capabilities combined with collaborative efforts with other industry leaders, prestigious universities and state/federal agencies separates us from others in the industry. We have leveraged our experience in site evaluation, superior input products and production efficiencies to develop a turn-key service that results in predictable success on every project.

James Shortle
Distinguished Professor of Ag and Environmental Economics
Director, Environment and Natural Resources Institute
Penn State University

The primary focus of my research is the design of economic incentives for managing environmental externalities. A second interest is integrated assessment for environmental decision making. Applications address water resources, agri-environmental policy, and climate change. Current research projects examine economic and policy design issues for nutrient pollution and stormwater management, and integrated assessment models for climate change. I have served on the Environmental Economics Advisory Committee to the Environmental Protection Agencies Science Advisory Board, and on the National Research Council Committee on Science for the Environmental Protection Agencies Future. I am currently serving on the Editorial Boards of Agriculture and Resource Economics Review and the European Review of Agricultural Economics.
Poster Session

The poster session will be on Wednesday, July 27th, from 3:00—5:00 PM in Rooms 106/107. Presenters may set up their posters Wednesday morning after 10:00 AM. Posters should be no more than 46” X 46” and may only be placed on the boards using Velcro tape (no thumbtacks or tape).

Ballots will be provided at the conference. There will be separate judging for Undergraduate and Graduate Student presenters.

Undergraduate Student Presenters and Abstracts

**Carlie Leary (Cornell University)**

**U1 Phenotypical variations in shrub willow under water stress**

**AUTHORS:** C. Leary (The New School and Cornell University), A. Agloro (Saint Martin’s University and Cornell University), E. Fabio (Cornell University), L. Smart (Cornell University)

Shrub willow is a fast-growing, high-yielding crop that requires little maintenance, making it a favorable bioenergy crop for woodchips and biofuels. Shrub willow has a high water demand, and water availability can determine establishment success and potential yields. To evaluate heritabilities and to begin to map key traits of interest, we generated a series of F1 species hybrid families with *Salix purpurea* as a common parent. Parents and one randomly selected progeny from each cross, 14 genotypes in total, were placed in a greenhouse trial to assess the impact of water stress on biomass yield. Each genotype was exposed to: no water stress, moderate and extreme water stress. Measurements of soil moisture, pot weight, chlorophyll content, specific leaf area, stem length, above ground biomass, and below ground biomass were collected to assess which parents and hybrids are more vulnerable or resistant to water stress and to see if hybrid vigor was present in any of the progeny. This is a first step in selecting genotypes that can produce high yields in water stressed conditions.

**Clara Pena de la Cruz (Delaware State University)**

**U2 Assessing the potential of calcium carbonate and related soil amendments to inhibit root pathogens of food and bioenergy crops.**

**AUTHOR:** C. Pena de la Cruz (Delaware State University)

Fungal pathogens affect plant stand and root health in both food and energy crops causing significant losses world-wide. Calcium based soil amendments such as lime in various forms commonly used to increase pH in acidic soils. The study aims at evaluating potential calcium based soil amendments for their ability to inhibit growth of two economically important fungal pathogens *Fusarium graminearum* and *Rhizoctonia solani* associated with seed and root rot. The methods used involved growing pure cultures of the fungi in liquid and solid medium amended with agricultural lime (91% CaCO$_3$), spent lime (a byproduct of the sugar industry containing 26% CaCO$_3$ and other nutrients, that is often used as a soil amendment) and pure CaCO$_3$. Fungal biomass and radial growth was measured to evaluate the inhibitory effect of the amendments. Based on initial experiments, only pure CaCO$_3$ added in rates equivalent to its concentration in spent lime was found to reduce radial growth of *R. solani*.

**Nicole Ramos-Solis (University of Puerto Rico)**

**U3 Mechanical Properties of Miscanthus**

**AUTHORS:** N. Ramos-Solis (University of Puerto Rico), Y. Sun (Penn State University), D. Morehouse (Penn State University), J. Liu (Penn State University)

With the recent rise of the agro industrial and renewable energy, bioenergy plays an important role as a research focus. This research explored the mechanical properties of an energy crop: miscanthus. The purpose of this research was to reveal and simulate engineering processes during harvest and process of Miscanthus. Some of the mechanical properties that we tested include cutting, bending, and compression. Collected data include cutting force and cutting energy, as bending and compression strength. Test sample was a single stem. There were 20 replications or 20 plants for each test. For the cutting test, we used a sickle bar cutting blade. Plant samples were separated into two groups: node and internode with a cutting speed of 5 in/min. The second test was a stem compression test. The compression test was aimed at testing the effect of vertical compression force, displacement, energy required to compress miscanthus. For the bending process we used the same
“Instron”. The samples were 90 mm long, and were separated into node, internode and random samples. The third test was the bending test, where three-points bending method was used, and samples were loaded in the mid-span. The energy consumption was calculated using the loading force and displacement measured, the raw data showed will give an idea of the energy consumption of the mechanical properties of miscanthus. For the compressing test the average of maximum force was 445.13N and the average for energy was 48.06J. Also the average of energy composition for the cutting test was 25.81N and the average of maximum force was 1046.31N. The bending test is on the process of analysis and recompilation of result. The statistical model will be developed based on the experimental result for give better conclusion and result of the research.

Allison A. Rutherford (SUNY-ESF)  
Feasibility of Pellet Production and End Use from a Shrub Willow Evapotranspiration Cover  
AUTHORS: A. Rutherford (SUNY-ESF), T. Volk (SUNY-ESF), J. Heavey (SUNY-ESF)

Short-rotation shrub willow (Salix spp.) crops are functioning as an evapotranspiration (ET) cover on a former industrial site near Syracuse, NY. Currently, 100 acres are planted and being managed on a four-year harvest rotation. Another 400 acres could be planted upon state approval. This study assessed the potential for offsetting purchased pellets for a combined heat and power (CHP) system on the SUNY ESF campus, with pellets made from willow harvested from the ET cover using three differing blend ratios. A 50/50 willow and hardwood pellet blend would yield the highest quantity of pellets, offset the largest portion of purchased pellets, and have the lowest ash content, but would require purchasing hardwood chips. An 80/20 willow and Phragmites australis blend would utilize Phragmites harvested as part of an invasive weed management program. These pellets would have the lowest energy content and the highest ash content. A 100% willow pellet would have the second highest energy content, the lowest production quantity and offset of purchased pellets. Other elements of feasibility explored in this study include pellet production machinery, transport, storage, mixing, and end use.

Karl Schneider (Penn State University)  
Biomass Pricing for Woody Biomass in Pennsylvania  
AUTHORS: K. Schneider (Penn State University)

This poster explores the development, distribution, and analysis of results of a survey to forest producers examining the price and tonnage of woody by-products produced at each firm. Based off of the model produced by West Virginia University, this pricing and availability information could potentially create markets for available by-products and encourage the utilization of woody biomass for heating by new businesses and schools. Additionally, this survey will attempt to measure the perceptions of recent changes in market demand, questions regarding the ease of sale of by-products, and internal usage for heat & electricity.

Secondarily, this poster examines data derived from the Penn State Timber Market Report to examine the quarterly variation of Private and Bureau of Forestry pulpwood and investigates potential explanatory variables for the fluctuation, including macroeconomic conditions (economic growth), and quarterly variation. Understanding pulpwood pricing variation proves an important component in the potential viability for expanded use of woody Bioenergy within the Commonwealth of Pennsylvania.

Alexander Steiner (West Virginia University)  
Thermal Characterization of Directional Liquefaction Lignin for High Value Applications  
AUTHORS: A. Steiner (West Virginia University), X. Xie (West Virginia University), J. Wang (West Virginia University)

Lignin is the second most abundant natural polymer on Earth. Many of lignin’s properties make it an excellent candidate for high value applications such as theroplastics and electronics. However, the vast majority of lignin produced in biorefineries and paper mills is burned as fuel, discarded, or used in low value applications. Researchers at West Virginia University’s Division of Forestry and Natural Resources have developed a novel method to extract pure lignin from biomass called directional liquefaction, a process that reacts biomass, methanol, and an acid catalyst at high temperatures. Lignin from four species of plants, representing a mixture of hardwood, softwood, and grass, was extracted using directional liquefaction at 200° and 220°C, and subsequently studied for thermal stability and thermal rheology. Thermal stability was studied using a TGA Q50. Thermal rheology was studied using a DSC Q20 to assess glass transition temperature, heat capacity, and material repeatability upon reheating. Overall, preliminary results have shown apparent glass transitions temperatures around 190°C and strong material repeatability. More research must be conducted to determine the veracity of these results.
Northeast Woody/Warm-season Biomass Consortium 2016 Annual Meeting

Patrick Whitehouse (West Virginia University)  U7
Growing conditions and their effect on chlorophyll fluorescence
AUTHORS: P. Whitehouse (West Virginia University)

Different site conditions affect the ability of plants to thrive. Like most plants, the purple willow performs best on a silty loam soil texture in medium to well drained sites. However from a biofuel perspective it is being marketed to farmers as a marginal crop. Marginal land is a vague term encompassing anything from abandoned agriculture fields to reclaimed mine sites. These different growing conditions can determine whether a plant will be successful or if it will fail. During this test we will explore three growing conditions, a fertilized soil, a non-fertilized soil, and an abandoned mine site. Measuring the stress of a plant is a good way of seeing how well it is performing given these different growing conditions. One way to measure the stress of a plant is to use a chlorophyll fluorometer to measure the photosynthesis potential.

Chlorophyll fluorescence is a measure of the status of the photosystem II, and its ability to react to light. When reaction centers are open, the photon yield is significantly lowered than when they are closed. To close these reaction centers the leaf must be “dark adapted” by either waiting until the sun has gone down or by covering a portion of the leaf using clips until the reaction centers have closed. The dark adaption test uses two pulses of light, one measuring the low levels of light radiation using an infrared beam and measured as Fo and one using the high end of the spectrum measured as Fm. When light hits the leaf it can be used to create ATP, it can be dissipated as heat, or it is re-emitted as fluorescence. The machine uses high intensities of light to achieve maximum fluorescence by directing the light waves to be re-emitted as fluorescence instead of the other forms of energy transfer. Fo should always be lower than Fm. Fv is the difference between the Fo and Fm. Fv/Fm and Fv/Fo are exactly as they sound, they are Fv divided by Fo and Fm respectively. Fv/fm is the most commonly used measurement to predict plant stress. Optimal values for Fv/fm should be in the range of 0.79 to 0.84 to indicate a perfectly healthy plant.

Graduate Student Presenters and Abstracts

Anahita Bharadwaj (Penn State University)  G1
Using microbial consortia to produce carboxylic acids from lignocellulosic biomass
AUTHOR: A. Bharadwaj (Penn State University)

Non-edible lignocellulosic biomass such as crop residue an energy crops are important sources of various value-added chemicals without the ethical issues related to first generation biofuels and bioproducts. In this study, microbial consortia derived from rumen, compost and silage were used for the bioconversion of immature switchgrass into organic acids. The fermentation process carried out at various temperatures and the adaptation of the microbial culture to the reactor conditions were studied via 16s rRNA sequencing. Our results indicated that the microbial consortium at mesophilic temperatures primarily consisted od Clostridia, Megasphaera sp., Prevotella sp., and Lactobacilli. These microbial populations are known for the cellulolytic and carboxylate producing microbes. However, even under thermophilic conditions, some species with these functionalities exist and may prove useful.

Eric S. Fabio (Cornell University)  G2
Genetic and environmental effects on variability in first rotation shrub willow biomass composition
AUTHORS: E. Fabio (Cornell University), T. Volk (SUNY-ESF), R. Miller (Michigan State University), M. Serapiglia (USDA-ARS), A. Kemanian (Penn State University), F. Montes (Penn State University), R. Hangs (University of Saskatchewan), J. Kuzovkina (University of Connecticut), G. Kling (University of Illinois), L. Smart (Cornell University)

Commercial production and conversion of lignocellulosic feedstocks for bioenergy will require an understanding of factors that affect both yield and biomass quality. Genetic and environmental factors will likely be significant predictors of variability in biomass traits. Shrub willow has been identified as a strong candidate for dedicated biomass production, possessing several key characteristics such as wide genetic diversity, ease of interspecific hybridization, clonal propagation and adaptability to land with low productive potential. In order to better characterize the influence of genetics and environment on variation in biomass quality, we analyzed first-rotation biomass samples from two shrub willow yield trial networks. The first trial network spanned 17 locations across North America and contained four commercial cultivars. The second trial network contained 19 genotypes, including commercial cultivars and newly selected breeding material in five locations in northeastern and upper Midwestern US. Biomass composition was characterized using high-resolution thermo-
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gravimetric analysis. For the first trial network, cellulose content varied between 36.4 and 44.0%, while ash content varied between 0.89 and 3.6% across 17 environments. In the second trial network, cellulose content ranged from 41.8 to 44.8%, and ash ranged from 1.3 to 3.2% for 19 genotypes. Triploid hybrids tended to have the greatest cellulose content. Multivariate statistics revealed both genotype and environment as significant sources of variance. Strong positive relationships were apparent for yield and cellulose, which were both negatively correlated with lignin and ash content. Hemicellulose did not have a strong relationship with any of the other biomass traits, suggesting independent biological control. These results indicate that selection for higher yielding genotypes should result in simultaneous selection for genotypes with biomass composition more amenable to conversion to liquid biofuels.

Isaac Fisher (Delaware State University)

RAB18 Expression Across Different Switchgrass (Panicum virgatum L.) Genotypes Under Drought Conditions

AUTHORS: I. Fisher (Delaware State University), A. Brown (Delaware State University), M. Crampton (Delaware State University), R. Hayford (Delaware State University), V. Kalavacharla (Delaware State University)

Switchgrass (Panicum virgatum L.) is being examined as a potential biofuel feedstock because of its large biomass and minimal inputs for growth. Drought, salinity, and extreme temperatures are abiotic factors that can negatively affect agricultural crops but can be combated via more stress-tolerant cultivars. Plants have adapted to overcome unfavorable environmental conditions by expressing stress-specific genes that allow them to withstand these conditions. We set out to measure the expression levels of such a gene, RAB18 (Responds to Abscisic Acid). The gene transcribes for a protein known as a dehydrin, which is known to be active under drought stress. For this work we are comparing three genotypes originating from different environments; a lowland cultivar “Alamo” and two uplands, “Cave-In-Rock” and “Blackwell”. We grew the three genotypes within a greenhouse and subjected half of the plants to drought conditions while the other half received full watering. Samples were collected for RNA isolation, cDNA synthesis, and qPCR to compare gene expression. Our results showed that all drought-treated plants expressed a higher level of RAB18 compared to that of the control plants, with the lowland “Alamo” expressing a higher level in comparison to the upland “Cave-In-Rock” and “Blackwell”. This information can be further used in attempting to understand this gene’s expression and functions, or for future breeding programs geared toward a higher tolerance to environmental stress conditions. Our future research will be to test different genotypes and genes, as well as compare biomass weights of the treated plants against untreated.

Fred E. Gouker (Cornell University)

G4 Evaluation and association analysis of natural accessions of Salix purpurea L. in response to nitrogen fertilizer

AUTHORS: F. Gouker (Cornell University), C. Carlson, L. Evans (West Virginia University), C. Smart, S. DiFazio (West Virginia University), L. Smart (Cornell University)

A considerable amount of variation exists within natural populations of shrub willow due to obligate outcrossing and historical levels of recombination. In this study, we exploited the broad genetic variation of 112 Salix purpurea accessions and examined 26 biomass, morphological, phenological, physiological and wood composition traits from three replicated field trials across three years. Marker-based estimations of broad- and narrow-sense heritabilities for all traits were low to moderately high and an association analysis identified loci that putatively control several of these traits. Morphological phenotypes across multiple years were found to be highly predictive of final biomass yield at harvest in the first rotation. Additionally, nitrogen use efficiency (NUE) was assessed through fertilizer amendments in the second harvest rotation. Genotype x N interactions were evaluated and were significant for all biomass-related traits. There were significantly greater SPAD values for fertilized plots across sites and significant differences in NUE between genotypes. Mean stem diameter, total stem area, and mean stem height were positively correlated with SPAD measurements and also exhibited significantly greater means with fertilizer treatment. Sexual dimorphism for yield was observed, where yield was significantly greater in male plants. Males also exhibited greater NUE under fertilizer amendment, but were also more susceptible to fungal infection by Melampsora spp. These results demonstrate a positive response of shrub willow to N fertilization, suggesting that there is potential to improve NUE in future breeding approaches.

Wei Jiang (Penn State University)

Assessment of Willingness to Supply Dedicated Energy Crops on Marginal Lands in the Northeastern United States

AUTHORS: W. Jiang (Penn State University), M. Jacobson (Penn State University), K. Zipp (Penn State University)
A major critique of large scale biomass production is the land competition between food and energy crops. A commonly suggested solution is to limit energy crop production to marginal lands. Physical marginality is often used when discussing marginal lands. However, as important is the socioeconomic marginality. This research fills this gap by evaluating willingness to supply bioenergy crops for landowners who have marginal lands. We firstly identify marginal lands using crop growth model and geospatial analysis in three studies regions. Contingent valuation survey is conducted in the same area with three model crops: switchgrass, miscanthus and willow. Random utility theory is applied to evaluate factors influencing decision maker’s choice to plant energy crops. The initial results indicate that landowners who own marginal lands are more likely to plant energy crops and they require a lower willingness to accept price compared with landowners who do not have marginal lands. At the same time, we noticed that landowners are unfamiliar with these new crops in general. Economic concerns are the top reasons preventing them from planting energy crops.

**Weiguo Liu (West Virginia University)**

*Integrated Techno-Economic and Life Cycle Analysis of Biomass for Bioproducts: Real Case Studies in the Northeastern U.S*

**AUTHORS:** J. Wang (West Virginia University), W. Liu (West Virginia University), X. Xie (West Virginia University), T. Brown (SUNY-ESF), S. Spatari (Drexel University)

To specifically address the economic and environmental issues associated with biomass utilization in the Northeast to promote the region’s rural economies, an integrated TEA and LCA model will be developed and three real case studies will be conducted. Three components are included in this integrated model: logistics, TEA and LCA. The logistics model considers biomass feedstock establishment, harvest, transportation, preprocess and storage, and will be optimized for the lowest delivered cost. TEA model is developed based on the pathways of bioenergy. LCA model is developed by including relative processes from feedstock establishment to bioproduct production. The models will be integrated by match different scope processes based on system definition and boundary. The parameter adjustments will be followed with the change of the major output of the model. The major output will be cost, economic benefit associated environmental impacts and benefits. Three real case studies will be conducted for pellet fuel, lignocellulosic sugar and biopower, respectively. The environmental impact which is associated with cost will be the major outputs that allow us evaluate the environmental and economic impact of real cases on the local region.

**Kittikun Songsomboon (Cornell University)**

*Heritability of Resistance to Leaf Spot Caused by Bipolaris oryzae.*

**AUTHOR:** K. Songsomboon (Cornell University)

Yield is the key trait for biomass crops like switchgrass (*Panicum virgatum* L.). Leaf spot caused by Bipolaris oryzae (Breda de Haan) Shoemaker can significantly reduce biomass yield of switchgrass by 80%. Breeding switchgrass for the disease resistance leads to sustainable biomass production. Narrow-sense heritability based on half-sib and individual plant selection were estimated from replicated half-sib progenies in lowland ‘Kanlow’. Half-sib seeds were produced from 113 random ‘Kanlow’ plant in the greenhouse in 2014. The first and second heritability estimations were conducted with 3 replicates in 7 flats with 200 cells each, in which 16 to 17 half-sib progenies were randomly assigned. The heritabilities were non-significantly different from zero either for half-sib- or individual-based heritability (half-sib = 0.14 ± 0.18 and individual plant = -0.09 ± 0.07, and half-sib = 0.08 ± 0.16 and individual plant = 0.01 ± 0.01 for the first and second estimation, respectively). The third heritability estimation was conducted with 5 replicates with an entire replicate within one flat with 288 cells, in which 47 half-sib progenies were randomly assigned. The heritability was significantly improved to 0.51 ± 0.21 and 0.22 ± 0.09 for half-sib-and individual-based selection, respectively. These results indicate that tray-to-tray variability significantly reduces heritability. Therefore, we suggest using grid selection by each tray in recurrent phenotypic selection. Moreover, the individual-based heritability was confirmed with similar realized heritability at 0.20 from one cycle of phenotypic selection in ‘Kanlow’.

**John Vance (West Virginia University)**

*Analysis of Chipping Operation and Chip Quality for Bioproducts*

**AUTHORS:** J. Vance (West Virginia University), J. Wang (West Virginia University), X. Xie (West Virginia University)

A whole-tree chipping operation was investigated on two mixed hardwood harvesting sites in eastern Ohio. The harvesting system observed included a Morbark 27RXL whole-tree chipper, fellerbuncher, two grapple skidders and transportation by truck with chip-van trailers. Production and machine rate data were collected through time-and-motion study methods for 50 truckload cycles of the chipper. The volume of the stems being chipped was recorded between skidding and chipping processes, while a video camera was used to record the timing for each cycle of the chipper. The
chipping time data were then further broken down into elemental times of feeding, chipping, and loading. Data collected for trucking included payload size, distance to mill, and time for each round trip from harvesting site to mill. Samples of chips were randomly taken from 36 cycles of the chipping operation to evaluate wood properties and characteristics of the chips for potential use as a biomass feedstock. Properties evaluated include moisture content, bulk density, bark content, heating value, and ash content. Results from this study will be useful for further development of woody biomass utilization for bioenergy and bioproducts.

Wanyan Wang (Penn State University) G9
Study on Shrub Willow (Salix spp.), as a Bioenergy Crop, and Its Interaction with Environmental Factors
AUTHORS: W. Wang (Penn State University)

The growth of perennial shrub willow (Salix spp.), a short rotate woody biomass, has superior properties to be used as an energy crop: short harvest cycle, high yield and adaptability to a wide range of site conditions, high net energy ratio, low demand for fertilizer and management and favorable environmental impact, like soil conservation and biodiversity. Understanding the interactions between environmental factors and shrub willow will be important for optimizing willow growth conditions and also aid in developing improved cultivars best adapted for particular environment.

Yuxi Wang (West Virginia University) G10
Optimization of multiple biomass supply chain in Northeast United States
AUTHORS: Y. Wang (West Virginia University)

Biomass-based product has great potential to supply energy services at low levels of greenhouse gas emission with meeting the rural development goals compared to fossil fuels. Short rotation willow and warm-season grasses have the ability for widespread abandoned and marginal lands in Northeast U.S, which are proper feedstock for renewable energy production. The study configured the mixed biomass supply chain, and optimized harvest, storage, transport with the lowest delivery cost, by developing a mixed integer programming model. Optimal facility locations were determined since the choice of the optimum site is of great importance when trying to meet the goal of cost-effective, due to the spatial dispersion of the feedstock and the high transportation cost of getting the material to the processing facility. The average delivery cost was figured from $65.9 to $90.1 per dry ton. Factors were analyzed and showed their effects on the delivery cost, which were feedstock availability, transportation distance.

Faculty/Staff Presenters and Abstracts

Ryan Baxter (Penn State University) F1
Spatial Analysis of Biofuel Production Potential in Northeastern United States
AUTHORS: R. Baxter (Penn State University)

The methods and analysis presented in this poster aim to improve spatial decision-support in lignocellulosic biorefinery siting and biomass feedstock procurement, with particular emphasis on decisions related to regional scale policy and investment planning. Our approach unfolds in three parts. First, we map the spatial density of biomass production potential. We build from the 2014 USDA Cropland Data Layer (CDL) data layer, excluding non-agriculture and non-forest classes and extracting hydrographic buffer zones and land conservation areas. Remaining productive land classes are aggregated to general categories and, based on available yield datasets, are reclassified to generate a yield map. Second, focal statistics are run to map resource density across the region, to search for sites that might host a commercial scale biorefinery with the resources available within 100km driving distance. Third, we identify prospective sites for a new large-scale biorefinery. Here, we base our analysis on the Delta Airlines refinery at the Philadelphia Airport. Finally, road network analysis is used to model biomass supply-distance curves for the study site. Supply-distance curves are the basis for generating supply-cost curves, which will be the subject of further research. This method can be applied to generate supply-distance and supply-cost curves for any site in the NEW-Bio region.

Mollee Crampton (Delaware State University) F2
Comparison of AP13 and VS16 Switchgrass (Panicum virgatum) Methylomes Using High-Throughput Sequencing
AUTHORS: M. Crampton (Delaware State University), M. Saha (Samuel Roberts Noble Foundation Inc.), V. Kalavacharla (Delaware State University)

Switchgrass (Panicum virgatum) is a target crop for use as a bioenergy feedstock for ethanol produc-
tion. Switchgrass possesses many appealing qualities, including high biomass conversion, high water use efficiency, and broad adaptability. There are two major ecotypes of switchgrass; lowland ecotypes, which are typically tetraploids adapted to the southern east coastal region and upland ecotypes, usually octoploid but also tetraploid, and adapted to northern regions of the U.S. Both the genotypes AP13 (lowland) and VS16 (upland) profiled for methylation in this study are tetraploid (2n = 4x = 36). The switchgrass version 2.1 genome sequence is assembled in 18 scaffolds (Schmutz et al., unpublished). In these scaffolds, 1,505.2 Mb of sequence has been localized, with another 184.3 Mb of sequence that is arranged in contigs (1,689.6 Mb total).

Genome annotation and assembly are critical in providing resources for selection and breeding of biotic and abiotic stress-resistant plants. Response to stresses is correlated with changes in gene expression, which is partially regulated by transcription factors and also epigenetic factors. This study focuses on one epigenetic factor, called DNA methylation. Genome-wide methylated DNA immunoprecipitation-sequencing (MeDIP-Seq) and whole genome bisulfite-sequencing (BS-Seq) was performed to compare methylation levels between the two genotypes. MeDIP-Seq surveys overall differences between the genomes, particularly highly methylation, repetitive sequences and BS-Seq gives specific methylation statuses of individual cytosines. There were a total of 18,290 common MeDIP-seq peaks between the genotypes. We found that AP13 had 1,219 significantly more methylated regions than VS16. VS16 was found to have 63 significantly more methylated regions. Targeted gene methylation analysis may aid in the identification of genes of interest in the adaptation of ecotypes to specific environments.

**Weston M. Eaton (Penn State University)**

**F3 Bioenergy Experts and their Imagined Publics: Implications for Public Participation and Dialogue**

**AUTHORS:** W. Eaton (Penn State University)

The ways experts conceptualize or “imagine” the behavior of “publics” has implications for public engagement. Experts often assume public acceptance is caused by education or exposure to facts. Such “deficit models” (Wynne, 1993) are problematic: they limit public participation with the design and selection of technologies publics will live with, and can lead to controversy (Marris, 2015; Burningham, et al., 2015). We interviewed “bioenergy experts” in the Northeast U.S. to understand how they envision opportunities and challenges for achieving successful perennial grass bioenergy development and found they envision publics through the lens of three deficit models. We suggest a “hermeneutic-dialectic” approach, which emphasizes the role of dialogue between experts and publics for achieving new and mutually agreed upon understandings, as one possible alternative to public deficit models.

**Julie Hansen (Cornell University)**

**F4 Height, Vigor, and Yield of Cornell University NEWBio Switchgrass Genotypes in 2015**

**AUTHORS:** R. Crawford (Cornell University), P. Salon (USDA-NRCS), J. Crawford (Cornell University), J. Hansen (Cornell University), L. Hoffman (Rutgers University), S. Bonos (Rutgers University), M. Hall (Penn State University), D. Viands (Cornell University)

Switchgrass breeding nurseries consisting of replicated half-sibling (“half-sib”) progeny rows from 72 parents (16 lowland ecotypes and 56 upland ecotypes) were established in 2013 on a reclaimed mine field in Philipsburg, PA and on a high clay, marginal field in Ithaca, NY. Height and vigor data (where a vigor score is a holistic rating encompassing plant size, health, and uprightness) were collected in 2014 and 2015 and the tallest and most vigorous half-sibs were harvested in both locations in 2014 and 2015. In Ithaca, the mean yield of the harvested half-sibs was 532 grams per plant in 2014 and 588 grams per plant in 2015 (a yield increase of 11%) and there was correlation coefficient of 0.86 between 2014 and 2015 yields of the harvested half-sibs. In Philipsburg, the mean yield of the harvested half-sibs was 122 grams per plant in 2014 and 395 grams per plant in 2015 (a yield increase of 324%) and there was a correlation coefficient of 0.80 between 2014 and 2015 yields of the harvested half-sibs. Averaging height and vigor data over two years for each half-sib, there was a correlation coefficient of 0.85 between height and vigor ratings of the harvested half-sibs in Ithaca and 0.86 in Philipsburg, while the correlation coefficient between vigor rating and yield of the harvested half-sibs was 0.52 in Ithaca and 0.70 in Philipsburg.

In 2014, another breeding nursery was established on an eroded and poorly drained marginal field in Ithaca, NY. The nursery consisted of replicated half-sib progeny rows of all of the upland germplasm planted in the 2013 nurseries, as well as about 200 additional upland half-sibs. Height and vigor data were collected in 2015. When comparing the half-sibs common to all three nurseries, the 2014 nursery’s height data had correlation coefficients of 0.59 and 0.41 with height data measured in the 2013 Ithaca and Philipsburg nurseries, respectively. The 2014 nursery’s vigor data had correlation coefficients of 0.46 and 0.33 with vigor data in the 2013 Ithaca and Philipsburg nurseries, respectively. Additional tall, vigorous half-sibs are present in the 2014 nursery that may
serve as sources of germplasm in breeding populations going forward.

**Damon Hartley (Idaho National Laboratory)**

*Modeling a torrefied wood pellet supply chain in the Mid Atlantic United States*

**AUTHORS:** D. Hartley (Idaho National Laboratory), T. Heron

The burning of coal for the generation of electricity in power plants accounted for about 26% of the United States’ total carbon dioxide emissions during the year 2015. The use of torrefied biomass is an alternative feedstock that is under consideration. Through the torrefaction process the energy density of the feedstocks are increased and the resulting material has an energy density similar to coal, with the potential benefits of reducing greenhouse gas emissions and potentially creating jobs in rural areas. This project used a mixed-integer linear program to model a proposed supply chain configuration that replaces 10% of the coal for an operating power station. In the modeling scenario, distributed torrefaction facilities were used as aggregation points for raw biomass and as supply points for the power station. The resulting cost minimized solution sited 22 torrefaction facilities, ranging between 15,000 and 20,000 tons per year production, with an average delivered cost of $147.59 per tonne.

**Armen Kemanian (Penn State University)**

*Net Ecosystem Carbon Exchange of Maize and Willow*

**AUTHORS:** A. Kemanian (Penn State University)

The sustainability of biomass production systems is in largely determined by both the systems’ ecosystem carbon dioxide (CO2) net exchange (NEE) and evapotranspiration (ET). We present a comparison of NEE and ET of maize and shrub willow in the northeastern United States using eddy covariance (EC) systems. We installed one open path and one closed path EC sensor array in two contiguous 10 ha fields of maize and shrub willow. These arrays have hardware to measure NEE, net radiation, soil heat flux, latent heat flux, soil temperature, soil moisture, wind speed, wind direction and air temperature and moisture, at 30 min intervals. We report the NEE for the months of March (beginning of the growing season) to October (end of the growing season) for the second year after willow coppicing. Total ET for willow and maize were 450 and 550 mm, respectively, with the net CO2 exchange being 2 kg m$^{-2}$ larger for willow than for maize. Based on the aboveground biomass gained by willow, we surmise that a substantial portion of the biomass accrued was accumulated in underground structures (crown and roots). The measurements show that willow’s higher ET is explained by its earlier leaf out and late leaf fall, but in July when both canopies fully cover the ground, the ETs of shrub willow and maize are comparable. This information can be used to both make a comparative analysis of the growth and water used of these crops, and to determine the carbon and water footprint of willow-based biomass products.

**Brian Richards (Cornell University)**

*Perennial Grass Bioenergy Feedstocks on Wetness-Prone Marginal Soils in New York: Yield, Emissions, and Soil Carbon Trends*

**AUTHORS:** B. Richards (Cornell University), C. Stoof (Cornell University), C. Mason (Cornell University), S. Das (Cornell University), R. Crawford (Cornell University), J. Hansen (Cornell University), J. Crawford (Cornell University), H. Mayton (Cornell University), T. Steenhuis (Cornell University), M. Walter (Cornell University), D. Viands (Cornell University)

Our project seeks to help define the sustainability of perennial grass bioenergy production on wetness-prone marginal lands in the Northeast US. Our primary goals are characterizing crop yields, trends of soil carbon (C), and emissions of nitrous oxide (N$_2$O) and methane (CH$_4$). These impacts are being determined using current production practices for switchgrass (*Panicum virgatum* Shawnee), reed canarygrass (*Phalaris arundinacea* Bellevue), and, since spring 2015, giant miscanthus (*Miscanthus x Giganteus* Illinois). Permanent sampling subplots established along natural soil moisture gradients in a wetness-prone marginal site allow us to examine the effects of soil wetness class on biomass yield, soil characteristics, emissions, and soil C. Using repeated measurements of soil moisture and perched water table levels since 2012, we assigned these subplots to soil moisture quintiles reflecting their long-term tendency vis-a-vis the field average levels. We are in the sixth year of field-scale research.
Communication and Collaboration
Plenary Workshop

Led by
Laura Lindenfeld
Professor, School of Journalism
Director, Alan Alda Center for Communicating Science
Stony Brook University
Stony Brook, NY

Dr. Lindenfeld will provide general principles on how to craft short, clear, conversational statements, intelligible to non-scientists, about what you do and why it matters. The session will consist of an interactive presentation and discussion on interpreting technical material using examples and analogies to illuminate unfamiliar concepts to your audience. This plenary session will address problems and solutions in public interactions as well as peer-to-peer communication.
Advisory Board Report Out
Tom Foust, Board Chair, will report to the meeting on the prior evening’s Advisory Board Meeting

NEWBio Advisory Board Members

Thomas Foust, National Renewable Energy Lab, Board Chair
  Dan Arnett, Ernst Conservation Seeds
  George Boyajian, Primus Green Energy
  Dante Bonaquist, Praxair
  Scott Coye-Huhn, Aloterra Energy
  Daniel Dostie, USDA NRCS
  Calvin Ernst, Ernst Conservation Seeds
  Glenn Kenny, Ernst Conservation Seeds
  Frank Lipiecki, Renmatix, Inc.
  Lee Lynd, Dartmouth College

Matthew McArdle, Mesa Reduction Engineering and Processing
  Mike Palko, Biomass Renewable Energy LLC
  Prafulla Patil, American Refining Group
  John Posselius, CNH America LLC
  Dennis Rak, Double A Willow
  Kevin Smith, CNH America LLC
  Ann Swanson, Chesapeake Bay Commission
  Sarah Torkamani, ExxonMobil Research and Engineering
Closing Session

Thrusts Report Out

Thrust leads will summarize discussions from the meeting and plans for next year.

- **Theresa Selfa, SUNY ESF**
  Human Systems in the Northeast Regional Bioeconomy

- **Larry Smart, Cornell University**
  Feedstock Improvement

- **Jingxin Wang, West Virginia University**
  Harvest, Preprocessing and Logistics

- **Armen Kemanian, Penn State**
  System Performance and Sustainability Metrics

- **Douglas Schaufler, Penn State**
  Safety and Health in Biomass Feedstock Production and Processing Operations

- **Michael Jacobson, Penn State**
  Extension

- **Dan Ciolkosz, Penn State**
  Education

Evaluation Report Out

- **Laura Lindenfeld, Stony Brook University**
- **Jessica Leahy, University of Maine**
- **NEWBio External Evaluators**

Meeting Wrap Up

- **Tom Richard, Project Director, Penn State**
PROJECT INFORMATION

NEWBio Objectives
Accomplishments Related to Objectives
2015 Advisory Board Annual Meeting Report
2015 Evaluation Team Recommendations
Northeast Woody/Warm-season Biomass Consortium 2016 Annual Meeting

NEWBio Objectives

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

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

3. 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%.

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

5. Develop harvest, transport, storage and preprocessing systems that increase feedstock value as biomass moves through the supply chain toward advanced bioenergy, biochemical, and biomaterial refineries.

6. Create a culture of safety in the biomass production, transport and preprocessing sectors that addresses machinery hazards and environmental risks to protect workers.
NEWBio’s vision is to build robust, scalable, and sustainable value chains for biomass energy and the bioeconomy in the Northeast. The project directly addresses USDA NIFA’s grand challenges to break barriers for the expansion of alternatives to fossil fuels while increasing the understanding of ecosystem functions and services for the rapidly evolving bioenergy industry and the bioeconomy.

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

Deploy safe, efficient and integrated supply chains in four demonstration regions, each providing 50 to 100 tons/day of high-quality low-cost sustainable biomass.

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

Provide business support services to generate at least 10 supply contracts and support over 5 new supply chain businesses to harvest, transport and preprocess biomass from short rotation woody crops and warm-season grasses.

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

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

NEWBio Accomplishments as Related to Objectives

Since NEWBio’s start in September 2012, there have been both positive and negative trends in the external environment. In the words of one Advisory Board member, the shale gas boom and drop in oil prices has ‘crushed’ interest in bioenergy. Company R&D efforts have slowed, and uncertainty about federal programs (RFS2, the Clean Power Plan) are discouraging further investment. Preliminary analysis of landowner survey data tells us that there are significant numbers who know little to nothing about energy crops and are unlikely to plant energy crops. At the same time, there are successes in bioproducts that are providing profitable rewards for current commercial feedstock companies: Aloterra’s supplying miscanthus for the compostable dinnerware market, and Ernst Conservation’s switchgrass pellets as absorbents for chemical and wastewater spills are examples.

We are seeing success in establishing willow and switchgrass on reclaimed mine lands, which represent an opportunity of over one million acres in the NEWBio region. Delta Airlines and Renmatix are progressing on commercialization pathways, and working with NEWBio researchers on assessing feedstock resource and supply chain possibilities. With the success of the willow feedstock planting and harvest equipment loan program and reauthorization of BCAP, we are working with several companies and private landowners to expand will acreage, with 200 acres expected this year in NY. NEWBio is working to couple bioenergy GHG benefits with quantified water quality benefits, partnering with the Chesapeake Bay Commission to leverage the massive investments in water quality improvements mandated for the Chesapeake Bay watershed. Finally, in concert with our commercialization partners, NEWBio is closely monitoring several other recently announced EPA regulatory efforts that could increase incentives for biofuels, including the 2016 RFS2 cellulosic biofuels target, the authorization of RFS2 for biogas transportation, truck mileage efficiency standards, and aviation greenhouse gas emission reductions.

Stakeholder Engagement Models

The BCAP willow scale up effort in northern NY has truly been collaborative effort among NEWBio participating institutions (SUNY ESF), state and government agencies (NYSERDA, USDA Farm Service Agency staff and BCAP program administrators in New York and Washington, DC) and NEWBio commercial partners (Celtic Energy Farm, DoubleA Willow, and ReEnergy. This teamwork made a recently-approved [May 2016] BCAP willow expansion in New York possible. These stakeholders have the desire to engage and the willingness to invest funds, time and energy. USDA is very supportive of the willow effort in northern NY and appreciates the ongoing outreach and extension efforts to support growers and end users. Similarly, NEWBio commercial partner Aloterra will also receive BCAP funding for miscanthus expansion in 2016. Aloterra collaborated with Ohio State and Penn State on an initial public outreach event to show Aloterra processing facilities and farm operations. This tour reached new audiences in the area. Reviews of the event showed marked increases in knowledge about miscanthus and the regional potential for biomass crops.

Socioeconomic Analyses and Forecasts

Data analyses are underway from landowner surveys, interviews and focus group discussions. Preliminary findings suggest opportunities for bioenergy development among landowners who see keeping land in agricultural production as a social good, whereas others indicate bioenergy crops compete with existing land uses, including cash crops and conservation initiatives.

Accelerated breeding to develop stress-resistance & improve yields

Whole transcriptome sequencing has been applied to the study of resistance to potato leaf hopper in Salix, revealing candidate genes that help defend Salix purpurea from hopperburn damage. Evaluation of pest and disease resistance in switchgrass (anthracnose) is allowing us to gain a better understanding of the impact of disease on switchgrass yields.
Project Information
NEWBio Accomplishments, continued

Injury Surveillance and Hazard Assessment, Safety and Health Management
Final edits were completed in mid-2015 on NEWBio’s Safety and Health Management Planning in Biomass Producers, a user’s manual providing risk-reduction information and resources. The manual includes hazards checklists and audit tools for assessing machinery and biomass production operations. The manual went online, made available to the public in October 2015. Douglas Schaufler, Penn State Research Associate and P.E., presented a NEWBio webinar on weaving the manual’s recommendations into a production setting. The Safety and Health team also produced two “LearnNow” videos: Hazards of Biomass Production on Marginal Land, and, Biomass Harvesting in Winter Conditions, videos that have had 23 views since May 13, 2016 and 53 views since January 1, 2016, respectively. The team focused their program delivery on the web when it became obvious that biomass producers were too geographically dispersed across the Northeast to meet the critical mass necessary for on-site workshops.

Models and Decision Support Systems for Sustainable Biomass Production, Harvesting, Preprocessing and Logistics
EcoWillow 2.0, a financial analysis tool developed by SUNY ESF, was updated in 2015. The tool allows users to model the costs and revenues of willow biomass production through every stage of the feedstock life cycle, from site preparation through planting, harvesting, and transport to an end user for renewable energy. It has been downloaded by over 1,000 users in 70 countries since its original release in 2008. The 2015 update included a new base case scenario and three new crop production scenarios developed and tested by SUNY ESF using the latest best practice targets and potential incentive programs (such as USDA’s Biomass Crop Assistance Program).

The NEWBio Leadership Team met in December 2015 to determine which of the several demonstration scenarios under study would be prioritized for continued data collection, model development and completion. Eight scenarios were identified: four real cases in operation (bioproducts production, grass pellet production, wood pellet production, and willow biopower), and four hypothetical cases (lignocellulosic sugars supercritical extraction, torrefied biomass cofiring, institutional-scale wood-fired boilers, and district-scale combined heat-and-power).

Biomass Cropland Resource Assessments
NEWBio contributed to the willow component of the Billion Ton Update for 2016 (BT2016), and is working with ORNL to include ecosystem service information in the BT2016 Sustainability volume.

Over 10,000 Acres of Perennial Crop Production
As we approach the end of NEWBio’s Year 4, there are approximately 10,000 acres of dedicated biomass crops in production in the region, with 5,000 acres of miscanthus, over 4,000 acres of switchgrass, and approximately 1,000 acres of willow. A portion of fiscal year 2016 BCAP funds will be provided to two existing BCAP projects in New York and Ohio/ Pennsylvania, both allied with NEWBio, to expand acreage planted to shrub willow and giant miscanthus. Additionally, the recent reboot of Pennsylvania’s Chesapeake Bay restoration program calls for 95,000 acres of riparian buffer plantings by 2025. Perennial bioenergy crops (shrub willow and switchgrass) are specifically identified as playing a critical role this effort, and the NEWBio team is working with state agencies and private companies to develop appropriate incentives so this working buffer program can succeed.

Corporate commitments for two commercial biorefineries in the NE
We continue to engage with Renmatix and Delta about a regional biorefinery, both of whom are interested in procuring large quantities of biomass in our region but are facing strong economic headwinds competing with the low costs of petroleum. Current TEA/LCA supply chain analysis is focused on supporting their business plans to deliver affordable and reliable biomass quantities.
Project Information

NEWBio Accomplishments, continued

10 Supply Agreement & Pricing Programs, 5 New Small Businesses
NEWBio continues to engage Penn State MBA and law students in assessing contract issues for biomass feedstocks. We are pleased to report that we are working with two new bioenergy start-ups, Enchi and Proterro. Enchi purchased the cellulosic biofuel portfolio from Mascoma when they were acquired and is partnering with NEWBio on both supply chain and conversion research. Proterro is another Boston-based start-up working on photosynthesis for carbon capture and utilization. NEWBio is also in discussion with several individuals considering forming companies to take advantage of the RFS RINs credits for biogas as transportation fuel.

Educating students, citizens, landowners and policymakers
A key objective for NEWBio is to increase public understanding of the social, economic and environmental impacts of sustainable bioenergy is a key NEWBio objective. We have a very active outreach to the general public through our Extension activities, as outlined elsewhere. The Education Thrust connects with students by coordinating three high-impact delivery vehicles: graduate online biomass courses, undergraduate mentoring via the Bioenergy Scholars, and secondary educator training.
Project Information

2015 Advisory Board Recommendations

The NEWBio Advisory Board convened during the August 2015 Annual Meeting, tasked by the NEWBio Executive Committee to provide feedback on project activities to date, and to offer guidance going forward. Tom Foust, Director of the National Bioenergy Center at the National Renewable Energy Laboratory and Chair of the NEWBio Advisory Board, presented the Board’s recommendations and topical areas for current and future project efforts.

Meeting Attendees

Board Members: Kevin Smith (CNH Industrial), Tom Foust (National Renewable Energy Laboratory), Manyuk Çolakyan (Renmatix Inc.), Glenn Kenny (Ernst Conservation)

USDA NIFA Program Manager: Fen Hunt

NEWBio Executive Committee: Tom Richard (Penn State), Tim Volk (SUNY ESF), Larry Smart (Cornell University), Jingxin Wang (West Virginia University), Barbara Kinne (Penn State)

NEWBio External Evaluator: Jessica Leahy (University of Maine)

Invited Guests: Tim Rials (University of Tennessee), Jessica McCord (University of Tennessee), Michael Wolcott (Washington State University)

Key Observations from 2015

- NEWBio should continue to build scenarios to provide specificity and continuity to system level analysis.
- Add value to better engage producers and existing environmental representatives.
- Add major industry players to the advisory board and expand our environmental board representatives to provide continuing guidance to the project.
- For the annual meeting, if cross-thrust meetings continue, implement additional structure for these sessions (such as slide decks, noting the topics and action items in advance) to provide a roadmap for the Board and guests.
- Choose two or three research highlights to present at the next meeting. Put some of our students up in front to present their work.
Project Information

2015 External Evaluation Recommendations

Evaluators
- Jessica Leahy, Associate Professor of Human Dimensions of Natural Resources, University of Maine
- Laura Lindenfeld, Director, Alan Alda Center for Communicating Science and Professor of Journalism, Stony Brook University

Our recommendations emerged out of ideas shared in the survey results with NEWBio team members, and interviews with NEWBio team members and external stakeholders - combined with our own assessment of the team’s transdisciplinary progress.

Shake Things Up a Bit
Create new interactions across thrusts modeled after the ecosystem services group and the business development supply chain modeling group. Is it possible to modify the reporting structure without disrupting the project? The seven individual thrusts and respective reporting structure may not reflect the new working groups and dynamic relationships that have emerged. We encourage the team to experiment with meeting frequency, style, and content to avoid burnout, create a fresh picture, and engage people in a different way.

Reframe the Story from a Higher Scale
Help the team communicate in ways that take the perspectives of other team members into perspective. If you are a researcher involved in this month’s trial crops, for example, and those crops failed, frame this so that it is meaningful to team members not involved in this work so they understand the importance. Understanding that different researchers live in different research worlds (for example, social science is not there to persuade external constituents, but rather to develop through data collection and analysis theoretical understandings, for example, of people’s perceptions and beliefs, the relationship of these to their actions and willingness to engage or change.) These are important stories to tell in a team that is striving to integrate different perspectives. We encourage the team leadership to consider investing in communication and engagement training for the team at the next annual All Hands meeting. This can help advance a higher level story and energize the team’s interest in reaching outside of itself in new, compelling ways.

Create Permeable Boundaries
The literature on organizations suggest that some groups are more permeable than others to outsiders. NEWBio needs to bring in more people and engage them in ways that excite and include them. We encourage the team to experiment with new forms of facilitation at All-Hands meetings, especially annual meetings. Bringing in skilled facilitators who can create an inclusive, engaging space, will make the project’s boundaries more permeable and enhance its ability to broaden and grow its constituents.

Focus, Focus, Focus
Especially on areas with demo sites and business development - brainstorming sessions could help strengthen connections with organizations and companies working in this arena. There are big potential opportunities (Delta, for example, which could help to turn the context of biofuels because of consumer interests) and smaller opportunities (local companies, for example, who are interested in alternative uses of biomass.) Certainly, helping stakeholders understand the externalized costs (e.g., through the Chesapeake Bay work), can bring “greater reward to buyers or farmers.” Focusing on the production of a clear goal, for example, putting a system together focused on producing 100 gallons of fuel/product, can help move the system forward.
Focus internally
Focus also refers to focusing on tangible outcomes and holding groups and individuals accountable. All Hands meetings “could use some excitement” to generate new ideas and bring forth new information. There’s an opportunity to disperse the workload and have different representatives, who might provide one tight bullet point, for example, to provide an update. This internal lens should consider how funds are allocated and where adjustments could be made, taking into consideration that this could cause disruption and unhappiness that may not outweigh the benefits. It is also important to focus on the end of the project and plan for the future beyond the current funding.

Focus on Mission and Vision Specifically
Explicitly discuss/redefine the vision and mission and restate it so that people see themselves in these concepts. Have people work through mission and vision statements to align their own work with it in a conscious and deliberate fashion. This is an important frame for the project that can generate creative opportunities and enhance commitment. It’s not enough to state your mission and vision - you have to use it. One participant stresses, “This is never going to work if we don’t agree on vision.” Vision is critical to creating a cohesive picture. We recommend interactive sessions (one participant mentioned the Alan Alda training, for example) as a way to bring the team closer together and create greater synergy.

Enable Mission and Vision to Inform Stakeholder Engagement
There’s an opportunity align stakeholder engagement with specific, focused efforts. Meeting particular stakeholders where they live and work for a shorter period of time might prove more successful than trying to bring the Advisory Board to the annual meeting. As one person stresses, it is easier for people to commit 2 - 3 hours rather than 2 - 3 days. Suggestions from the participants emerged, including creating more in-depth discussions with a smaller group of key stakeholders who are committed to the project. Similarly, stakeholders may need a different form of communication.

Make Leadership an Ongoing Theme
While some ideas for leadership emerged in our interviews, people mostly point to what leadership could accomplish rather than how it should function. We encourage the team to prioritize conversations about leadership structures and opportunities. Leadership can focus both on deliverables and setting priorities, but also on culture and aspirational vision. Both are important to this project moving forward.

Consider How You Will Share Best Practices with Other Groups
How can your experience on NEWBio help to shape other projects’ successes? How can you help others to avoid certain pitfalls, build effective teams, and advance linkages between knowledge and action? Consider pathways for communicating your experiences as a team to others so they can benefit from what you have learned. Certainly, this evaluation team stands ready to help get the word out about what you have learned and accomplished.
Human Systems
Feedstock Improvement
Harvest, Preprocessing and Logistics
System Performance and Sustainability Metrics
Safety and Health in Biomass Feedstock Operations
Extension
Education
Leadership, Stakeholder Involvement, K2A, and Evaluation
Thrust Information

Human Systems in the Northeast Regional Bioeconomy

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Patrick Boleman, Penn State University
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West Eaton, Penn State University
Andrea Feldpausch-Parker, SUNY ESF
Clare Hinrichs, Penn State University
Wei Jiang, Penn State University
Matt Langholtz, Oak Ridge National Laboratory
Yaru Grace Liu, Penn State University
Kusumal Ruamsook, Penn State University
Theresa Selfa, SUNY-ESF
Evelyn Thomchick, Penn State University

Objectives

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. The social science component at SUNY ESF collected and analyzed media content data over five years to understand community perceptions about the biomass industry in four regions near production sites in New York, with parallel media content analysis and preliminary interviews with switchgrass growers in Pennsylvania by Penn State. A database was completed with policies related to biomass in New York. IMPLAN analysis was initiated to evaluate economic impacts from biorefinery development in the region. The economic component has leveraged modeling work with the Cycles model and feedstock supply and price projections from Oak Ridge National Lab to evaluate potential production from marginal lands in the Northeast. Data compiled includes energy crop production budgets and soil, land cover, and weather data. The Cycles growth model is used to project energy crop yields, map biophysical marginal lands for BCAP areas, and is performing statistical analysis of POLYSYS outputs to examine drivers of land use change projections focusing on dedicated biomass feedstocks.

Accomplishments

✓ 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. During Y4, the team completed a mail survey, sent to ~3,000 landowners in New York, Ohio, and Pennsylvania. 907 surveys were returned, with an additional 64 landowners responding online. The overall response rate for the survey was 32.5%, which is acceptable by survey research standards and impressive today given wide recognition that survey response rates have been falling in the U.S. (Dillman et al., 2009). Survey data is currently being analyzed. Preliminary findings include: 90 percent of respondents reported they are “unlikely” to plant energy crops, whereas 50 percent indicated they are “supportive” of bioenergy development in their communities. Landowners indicating more favorable views about technology were more likely to say they would plant, and were more supportive of bioenergy development in their community than were landowner respondents indicating less favorable or pessimistic views on technology.

✓ Landowner interviews and focus groups are ongoing in New York, Ohio, Pennsylvania and West Virginia. 59 total interviews have been conducted, and 4 focus groups held. Preliminary findings suggest opportunities for bioenergy development amongst landowners who see keeping land in agricultural production as a social good, whereas others indicate bioenergy crops compete with existing land uses, including cash crops and conservation initiatives.

✓ The Human Systems team contributed to an analysis of farmgate prices that would be needed for perennial energy crops to match the profitability of corn production in Pennsylvania.

✓ We also contributed to the Sustainability Thrust’s Chesapeake Bay study on payments for ecosystem services through biomass feedstocks for improving water quality, and began work on a related case study targeting active bioenergy related initiatives in the region.

✓ The business development task decided to use the Supply Chain Operations Reference framework developed by APICS Supply Chain Council to assess NEWBio demonstration sites’ infrastruc-
ture and metrics. Team members attended training to further enhance our knowledge on applicable metrics.

✓ These peer-reviewed manuscripts were published or submitted for publication during Y4:

Year Five Activities
Task 1.1: Understanding Social and Economic Constraints
Activities will include the selection of an econometrics model and validation of “willingness to accept” (WTA) prices with other reported energy WTA crop prices, and continuation of Phase 3 Chesapeake Bay Watershed (CBW) landowner and key informant interviews for the purpose of understanding ownership motivations and behaviors.

Outputs will include deriving land supply curves for NEWBio feedstocks, and combining biophysical and economic assessments for marginal lands, and CBW interview transcriptions and content analyses.

Milestones will include identifying soil types that are biophysically and economically suitable for planting energy crops, and completion of CBW interview analyses.

Anticipated outcomes include identifying economic factors associated with landowners who are likely to supply energy crops and require a lower WTA price, and a summary of CBW landowner risk perceptions, motivations and behaviors as related to energy crop production and watershed protection.

Task 1.2: Identify, monitor, and address the positive and negative social impacts of demonstration sites over the course of the project on community infrastructure needs.
Activities, outputs, milestones and outcomes for this task greatly overlap with efforts as detailed in Tasks 1.1.1 and 1.1.2. There are elements of this task that are also covered in Harvest, Preprocessing and Logistics Task 3.4 and Extension’s Tasks 6.1 and 6.3.
Thrust Information

Feedstock Improvement

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John Carlson, Penn State University
Curt Carter, Cornell University
Jamie Crawford, Cornell University
Ryan Crawford, Cornell University
Stephen DiFazio, West Virginia University
Luke Evans, West Virginia University
Eric Fabio, Cornell University
Lauren Ferragut, Cornell University
Dawn Fishbach, Cornell University
Fred Gouker, Cornell University
Marvin Hall, Penn State University
Julie Hansen, Cornell University
Lindsey Hoffman, Rutgers University
Larry Smart, Cornell University
Zachary Tischendorf, Penn State University
Don Viands, Cornell University
Wanyan Wang, Penn State University
Ran Zhou, West Virginia University

Objectives

Feedstock Improvement is identifying cultivars of switchgrass and shrub willow with improved performance and expanded range on marginal lands in the Northeast. Through year 3 of the project, Cornell has conducted 148 crosses, producing 63 families (51 of them new). Of the families produced, 41 have diploid progeny, 16 have triploid progeny, two have tetraploid progeny, and 4 have pentaploid or unknown ploidy progeny, all together representing over 7,800 novel seedling individuals. Three crossing blocks have been established to generate half-sib families of tetraploid progeny for recurrent selection and novel triploid progeny. A total of 43 new accessions have been added to our breeding collection through acquisition from collaborators, nurseries, or arboreta. Association panels of S. purpurea have been established, measured for key growth traits, and harvested on three contrasting sites. These accessions have all been genotyped for mapping studies. A QTL and selection trial has been established with over 270 new progeny. Yield trials to evaluate new willow cultivars have been established on eight sites across four states, including two on reclaimed mine land. Between the Cornell and Rutgers switchgrass programs a total of 18,000 new switchgrass genotypes were generated. Three experimental selections were also developed. A switchgrass trial including new lines from the Cornell and Rutgers breeding programs has been established on reclaimed mine land in PA. A 200 plant QTL mapping population of switchgrass was evaluated for anthracnose. Field trials of switchgrass and willow have been surveyed for pest and disease incidence and new methods are being developed to characterize mechanisms of resistance.

Accomplishments

✓ Feedstock Improvement continues to identify cultivars of switchgrass and shrub willow with improved performance and expanded range on marginal lands in the Northeast. Through Y4 to date, Cornell and Rutgers programs have generated a total of 4 experimental selections of switchgrass including over 180 genotypes. Cornell has conducted 167 shrub willow crosses, producing 79 families with over 9,300 unique progeny seedlings.
✓ A high density molecular marker system has been developed for Salix purpurea as a reference willow species. A high quality genetic map has been produced for a F2 mapping population, which is being used to identify QTL for key biomass traits. These markers have also been applied to an association mapping population planted in two sites in NY and one in WV, revealing loci that control key traits.
✓ Whole transcriptome sequencing has been applied to the study of resistance to potato leaf hopper in Salix, revealing candidate genes that help defend Salix purpurea from hopperburn damage. Evaluation of pest and disease resistance in switchgrass (anthracnose) continued through
Y4 to date, allowing us to gain a better understanding of the impact of disease on switchgrass yields.

☑ Yield measurements at harvest age were completed for all NEWBio willow yield trials, which are being subjected to a genotype-by-environment analysis, which will help to identify patterns in specific adaptation by genotypes under challenging growing conditions.

☑ The willow trial at our Mylan Park reclaimed mineland site in West Virginia suffered from abiotic stress late in the summer, but the primary cause is still unexplained. The plan is to apply additional organic amendments here and at the Philipsburg, PA mineland site to improve the soil and reduce the impact of abiotic stress. Investigation of the interactions between cultivars, amendments, and site features continue.

☑ The following peer-reviewed manuscripts were published or submitted for publication during Y4:

Year Five Activities

Task 2.1: Breeding of non-invasive triploid hybrids of willow displaying hybrid vigor
Activities will include executing recurrent selection and planting programs for tetraploid and diploid species, continued analysis of genotyping-by-sequencing markers for use in analyzing tetraploids, and planting and maintaining triploid progeny in the field.
Outputs will include maturity, vigor ratings, disease and insect ratings, and the acquisition of other data identifying variation in progeny performance.
Milestones reached will include the production of new progeny and the successful establishment of tetraploid, diploid and triploid seedling plantings in the field.
Anticipated outcomes and impacts include improved yields and shortened breeding cycles, and the development of genomic tools to accelerate breeding for marginal lands.

Task 2.2: Genetic basis for pest and disease resistance in willow and perennial grasses
Activities will include the ongoing studies of willow germplasm for susceptibility to rust, potato leafhopper, beetles and rust; the evaluation of anthracnose, disease injury and survival in the switchgrass mapping population, and evaluation of treatments for disease resistance.
Outputs will include expanded data collection on population variations in pest and disease resistance and heritability estimates.
Milestones will include an assessment of pest and disease resistance among willow cultivars, and the determination of whether disease (anthracnose) influences dry biomass yield among cultivars of switchgrass.
Anticipated outcomes will include improvement in breeding resistance to the greatest emerging biotic threats to sustainable production of perennial bioenergy feedstocks.

Task 2.3: Breeding and selection of cultivars adapted for Northeast conditions
Activities will include measurements of willow growth at various yield trial locations, and the analysis of willow biomass composition from samples in Pennsylvania and Michigan; the assessment of switchgrass winter survival in nurseries at Cornell and Rutgers, and growth, disease and insect resistance in field plots; the preparation of seedlings for field planting and the maintenance of nursery plantings; and the establishment of three new nurseries for the Northern Switchgrass Panel in NY and NY.
Outputs will include population means of survival and variations in clone responses to maturity, vigor, disease and insects, and variations in progeny performance of bioenergy traits.
Milestones will include the identification of superior progenies or mother lines for use in future breeding efforts and the successful establishment of seedling plots and the successful establishment of two healthy new nurseries. Plants will be potted and kept in a greenhouse in Pennsylvania for future planting at a reclaimed mineland site.
Anticipated outcomes will integrate willow feedstock improvement data with Task 4.1 (Sustainability thrust) and result in improved germination under low soil temperatures and improved vigor on poorly drained and sandy marginal soils.

Task 2.4: Breeding and selection of willow and switchgrass yields on reclaimed mine lands.
Activities will include a survival survey and measurement of first-year post-coppice growth for Pennsylvania and West Virginia mineland trials; bioinformatic analysis of soil DNA sequences, including comparisons to first samplings, is planned to evaluate microbial populations on mineland sites in comparison with agricultural sites.
Outputs will include additional data to inform the ongoing evaluation of mineland sites.
Objectives
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. During the first year of the project, the team designed willow and switchgrass harvesting protocols and collected time-motion data for various pieces of harvesting equipment, and developed base case models for these feedstock supply chains and models for optimizing biomass harvest and logistics scenarios. During year two the team refined the supply chain model, incorporating biomass harvest production and cost data analysis from our own research. Year Two also included biomass storage, pelletization and torrefaction research, as well as development of a high throughput technique to evaluate pyrolysis for a range of biomass feedstocks. Year Three efforts included further refinement of the supply chain optimization model, evaluation of dry matter losses during biomass storage, and characterization of biomass quality across the supply chain. Further tests are also being conducted on torrefaction, pelletization and pyrolysis. Year Four continues to focus on large-scale biomass harvests for demonstrations, calibrating the harvest models, and further refining the optimization models of biomass logistics and supply chains. We will also conduct the integrated techno-economic and life cycle analyses in considerations of three real cases for the production of pellets, lignocellulosic sugars, and biopower with our stakeholders.

Accomplishments
- Data collection and analysis continued for time-motion and fuel studies to calibrate our harvest models and further refine the optimization models of biomass logistics and supply chains.
- TEA/LCA models have been developed, with work continuing on model integration; the TEA/LCA of hypothetical cases have been accomplished.
- Biomass storage studies have focused on pile size, sampling location, depth, and the changes of chip quality.
✓ Field studies of herbaceous biomass densification were accomplished. Characterization of torrefied biomass was also conducted.
✓ HPL has taken the lead on developing NEWBio commercial scale simulations of supply chains for three demonstration scenarios: pellet production, supercritical extraction of lignocellulosic sugars, and biopower generation with three regional stakeholders.
✓ The following peer-reviewed manuscripts were published or submitted for publication during Y4:

Year Five Activities
Task 3.1: Significantly reduce the harvesting cost per ton of biomass feedstocks from willow and perennial grasses
Activities will include finalizing willow and miscanthus harvest efficiency models using large-scale harvest production, fuel consumption and emissions, and economic data. Outputs will include harvester productions efficiency rates and related costs of large-scale harvests to inform and revise balanced and optimized production systems. Milestones will include manuscripts on willow harvester production rates, production and fuel consumption equations, miscanthus round and square baling model parameters and production rates, and an optimized perennial grass harvester system. Anticipated outcomes and impacts are improvements in the efficiency of feedstock harvesting and its supply chain, especially in the reduction of the delivered cost of materials.

Task 3.2: Quantify the role of preprocessing for densification and storage on transportation efficiency and downstream fuel conversion
Activities will include finalizing torrefaction pre-processing results and expanding cross-lab analyses of feedstocks. We will continue to analyze measurements of energy and fuel yields from torrefied biomass and investigate acidogenic digestion of switchgrass and rye. Densification studies will be finalized for switchgrass and miscanthus. Outputs will include a database of characteristic physical properties of torrefied feedstocks, and energy and potential fuel yields. Results will be gathered on impacts of densification on biomass quality as well as dry mass losses and efficiency. Milestones will include presentation of at least one scientific talk on our results, preparation of a fact sheet on densification impacts, and a manuscript detailing our results. Anticipated outcomes and impacts include publication of results to better inform the development of harvest, preprocessing and logistics systems to move biomass feedstocks through the supply chain to a bioeconomy end user.

Task 3.3: Assess the storage requirements and effects of long-term storage on the quality of willow and perennial grasses
Activities will include the continued monitoring of ongoing long-term storage studies for switchgrass, miscanthus and willow. Outputs will include additional results on impacts of wet and dry storage, and dry matter losses.
Milestones will include the publication of a spreadsheet-based analysis tool. Anticipated outcomes and impacts will include location, duration, pile size and quality of biomass, which could improve the economics of the biomass supply chains.

Task 3.4: Techno-economic analysis, cost engineering, and life cycle analysis of densification, storage preprocessing and biorefinery integration

Activities will include finalizing TEA/LCA models for both woody and herbaceous biomass, with further refinement of cost engineering models and integration of TEA/LCA models and uncertainty analyses.

Outputs will include a refined logistics model of forage harvester supply chain unit costs with capital expenditure and operating costs of process components detailed according to the different pathways for our demonstration scenarios.

Milestones will include the publication of a spreadsheet-based analysis tool with a report on our analytical demonstration scenario results.

Anticipated outcomes and impacts include an integrated model that project the yield of both biofuel and bioproducts along with economic returns and life cycle impacts.
Northeast Woody/Warm-season Biomass Consortium 2016 Annual Meeting

Thrust Information

System Performance and Sustainability Metrics

Pieter Billen, Drexel University
Maria Laura Cangiano, Penn State University
Kristie Dennison, Penn State University
Melanie Kammerer Allen, Penn State University
Armen Kemanian, Penn State University
Felipe Montes, Penn State University
Dave Mortensen, Penn State University
Long Nguyen, Drexel University
Amanda Ramcharan, Penn State University
Bahar Rizai, Drexel University
Brian Richards, Cornell University
Debasish Saha, Penn State University
Nathan Sleight, SUNY ESF
Sabrina Spatari, Drexel University
Peter Woodbury, Cornell University
Jeffrey Yanosky, Penn State University
Katherine Y. Zipp, Penn State University

Progress Toward Objectives

The System Performance and Sustainability Metrics team continues to make progress on all tasks. Building towards a consistent database of biomass yield in the NEWBio region, we are comparing both the simulated potential yield and the soil- and climate-limited yield results from our CYCLES modeling effort to those reported by the PRISM-EC model, which reports county averages for many biomass crops including miscanthus, switchgrass and shrub willow. We are comparing these yields at three specific sentinel sites that cover the geographic extent of NEWBio. If the databases generated by these two modeling approaches are sufficiently comparable, then we will have a common database of biomass yields to be used across the project thrusts. In the PA-OH BCAP area, simulated yields with both grain and forage systems (corn-alfalfa) and those of our perennial biomass crops have been used to assess the comparative economics of these systems; this work will be extended to the NY BCAP area in the coming year. The sustainability team is also leading an effort to quantify ecosystem services associated with bioenergy crops. The current focus is on the Chesapeake Bay, and is quantifying nutrient benefits of substituting switchgrass in areas now cropped with corn. This work includes developing generic economic and nutrient management budgets (completed), yield response of switchgrass to nitrogen fertilizer (completed), and estimations of the delivery of edge of field nutrients to the Chesapeake Bay (completed based on simulations provided by USGS with the Sparrow model and further supported by literature reviews). A similar comparative analysis of cover crops (a current practice that is currently subsidized at $60 per acre in Maryland) is scheduled to be completed in the next quarter. Assessment of carbon storage in the belowground biomass of shrub willow continues; a preliminary summary of field data has been completed and reported during the NEWBio annual meeting. Soil sampling to measure residual nitrate in the field has been completed in Pennsylvania. These results are being integrated in a comprehensive Techno-Economic and Life Cycle Analysis of full biomass supply chains, in collaboration with the HPL thrust. These system-level analyses are tailored to different supply chains based on grass or shrub willow biomass and include comparison with other wood-based biomass supply chains.

Accomplishments

- Progress continued toward a major goal: a consistent database of biomass yields. The publicly available county level database provided by the PRISM-EC model was downloaded and compared with simulations with Cycles, and other databases. The results are considered suitable for county level analysis. The database is available upon request and will be accessible to all NEWBio users.
- Sustainability leads the effort to quantify ecosystem services associated with bioenergy crops, focusing on the Chesapeake Bay and quantifying nutrient benefits of substituting switchgrass in areas cropped with corn. The results of this effort will be published shortly in a special issue of
Biomass and Bioenergy. A second year of a side-by-side comparison of carbon dioxide and vapor flux in a willow and corn field was collected through 2015. Willow is not only a strong carbon sink early in the growing season (May), but shows large evapotranspiration with a promising role as a regulator of hydrology when used in floodplains and riparian buffers.

- Roots of willow stands of different ages were sampled and the carbon stored underground estimated.
- Willow plants fertilized and labelled with 15N were harvested after three years of growth at two locations, Rock Springs, PA and Geneva, NY. At the low fertility site at Rock Springs, willow responded to a one-time nitrogen fertilization application of 50 kg N/ha, increasing yield by 44 percent. At this location, preliminary results indicate that 40 percent of the N in the plant was from the fertilizer. No response to the nitrogen fertilization was observed in the high fertility site.
- Measurements of the emissions of the potent gas nitrous oxide indicate that in switchgrass and miscanthus, emissions of this gas only surpass those of conservation reserve programs at lower landscape locations that accumulate water; these areas can be a small fraction of the landscape. In addition, we report an efficient and location-specific sampling design method to obtain accurate estimates of cumulative nitrous oxide emissions with a minimum of costly sampling events.
- Life-cycle inventories and analyses are begin completed for the simulated supply chains described in the Harvest, Preprocessing and Logistics thrust. Preliminary results indicate significant differences in supply chain greenhouse gas emissions for the different bioenergy crops and uses. Emission credits for fossil energy substitution are expected to exceed these emissions for most end uses.

The following peer-reviewed manuscripts were submitted for publication during Y4:
- Woodbury, P.B., M. Langholtz, M. Jacobson, and A.R. Kemanian (201X). Improving water quality in the Chesapeake Bay using payments for ecosystem services for perennial bioenergy feedstock production. Submitted to Biomass & Bioenergy Special Issue

Year Five Activities

Task 4.1: Site- and crop-specific knowledge gaps
Activities will include the continued monitoring and accumulation of biomass measurements at various experimental sites on yield progression over time, nitrogen demand and nitrogen sources, nitrous oxide emissions and carbon storage. Outputs will include various measurements, such as field measurements of radiation interception or hydraulic properties that differentiate cultivars, leaf and stem mass, and 15N, N2O and C sampling. Several manuscripts are planned. Milestones will include the creation of a biomass production database, yield and knowledge gap reports, and lists of knowledge gap issues. Anticipated outcomes will include manuscripts on: 15N recovered from harvest plants and retained in live plants; carbon storage in shrub willow root masses; and yield potential/yield realizable using NEWBio demonstration sites as benchmark locations. A table for estimating N2O emissions for all crops in NEWBio demonstration sites is planned.

Task 4.2: Benchmark scenarios for crop management and simulations
Activities will include soils analyses for the New York BCAP areas, and running scenarios in Cycles (this work has been competed for Ohio and Pennsylvania). Outputs will include critical summary tables of simulation results, comparative analyses for our BCAP areas and development of a manuscript. Milestones will include development of management schedules for each plantation, and a management schedule that compares annual crops with energy crops, and final reports on BCAP simulations. Anticipated outcomes will include development of plausible scenarios with detailed schedules of management practices establishing land preparation operational standards, herbicide prescriptions, nitrogen management (type and fertilizer rate) and harvesting strategies.

Task 4.3: Regional feedstock supply and environmental assessment
Activities will include the evaluation of land use change impact on biodiversity and wildlife at three locations where bioenergy crops are to be used (two BCAP areas and an
existing site in Lancaster, PA), inventories of pre- and post-planting conditions at these sites, and continued monitoring of plantings.

Outputs will include capturing point and landscape-level indicators/criteria for regional scenario building, and completion of a white paper on evaluating ozone and biogenic VOCs related to willow expansion.

Milestones will include a unified outcome regarding ‘abandoned’ cropland and the identification of potential areas for bioenergy crops (primarily in Pennsylvania), and the definition of variables that are and are not assembled in LCA (e.g. “perceptions”, a variable for which there is no energy or monetary value determined), and the include development of a land use protocol for air quality to be applied at demonstration sites.

Anticipated outcomes will include advancing NEWBio’s understanding of these environmental impacts on the biomass value chain, and the application of this research to NEWBio demonstration sites and research trials.

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

Activities will include detailed analyses of the commercial-scale TEA/LCA models for both woody and herbaceous biomass described in Task 3.4.

Outputs will include expanded life cycle inventories contributed to public databases such as the LCA Commons (part of the USDA National Ag Library Ag Data Commons) on greenhouse gas and water quality impacts of biomass production and supply chains for switchgrass, willow and miscanthus.

Milestones reached will include completion of multi-objective LCA for three commercial biomass supply chains and submission of journal articles detailing the results. Anticipated outcomes and impacts will include quantitative understanding of the greenhouse gas, water quality and biodiversity opportunities as well as challenges for perennial biomass crops in the Northeastern US, with increased engagement of citizens, companies, NGOs and government in developing a sustainable bioeconomy for the region.
Thrust Information

Safety & Health in Biomass Operations

Pankaj Kuhar, Penn State University
Dennis Murphy, Penn State University
Rick Orange, Consultant
Douglas Schaufler, Penn State University

Progress Toward Objectives

Safety and health aspects of the biomass product supply chain are being addressed from a holistic, systems perspective. The Safety team participates in biomass production activities with NEWBio partners, including the harvesting and storage of biomass crops. This provides insight into hazards present in biomass production not found in traditional agricultural crops, and how safety committees within organizations function. Fire and respiratory hazards are being investigated as areas of particular concern to biomass producers. Development of a “Safety and Health Management Training Manual for the Biomass Production Industry” was completed in Year 4.

Accomplishments

✓ NEWBio’s Biomass Safety Program developed three key risk-reduction and best practices educational resources that are now fully available to the public:
  ○ “Safety and Health Management Planning for Biomass Producers” is a best practices manual for agricultural entrepreneurs, especially those who are new to farming and to biomass production. The manual has five units of recommended best practices for biomass production: Establishing Safety Policies and Procedures, Identifying and Assessing Hazards and Risks, Preventing and Controlling Hazards and Risks, Educating and Training Employees, and Evaluating Training Programs and Resources. The manual has been distributed free of charge to known biomass producers in Pennsylvania and New York, and to NEWBio’s sister CAPs, and has been viewed more than 250 times online.
  ○ “Biomass Harvesting in Winter Conditions”, a Learn Now video, which addresses considerations and challenges for harvesting in typically adverse weather conditions has had 53 views since it went online on January 1, 2016.
  ○ “Hazards of Biomass Production on Marginal Land”, the second in the Learn Now video series, highlights safety concerns and considerations for biomass operations on terrain that may be steep, have heavy soils or poor drainage has had 23 views since it went live on May 13, 2016.

✓ A fire professional has been retained to visit biomass production facilities and assess fire hazard possibilities in biomass processing and storage. The consultant is also reviewing OSHA, National Electrical Code and National Fire Protection Association standards that apply to biomass facilities, particularly in rural areas, and cataloguing fire and explosion incidents involving biomass materials during harvesting, storage and processing scenarios. The objective will be a publicly available education resource on fire hazards and mitigation.

✓ Respiratory hazards research is being investigated by Pankaj Kuhar, a Penn State graduate student in Agricultural and Bioengineering. Kuhar obtained additional grant funding ($10,000) for equipment and travel needs from Johns Hopkins Education and Research Center for Occupational Safety and Health to support this important work.

✓ The team also worked with Extension professionals to include safe practices as fact sheets were developed describing agronomic and harvesting practices of biomass crops.
Year Five Activities

Task 5.1: Biomass safety program development
Activities will include examining existing fire safety and associated fire code literature, and, injury and exposure reports. Existing fire safety programs will also be evaluated, with corresponding deficiencies and gaps noted in the literature and programs.
Outputs will include a database of these findings, and development of a technical or white paper.
Milestones will include presentation of the technical report.
Anticipated outcomes will include making the fire safety technical report available to the public.

Task 5.2: Safety and health hazard inventory
Activities will include the continuation of visits to biomass production sites in the Northeast U.S. to determine hazard and risk potential and effects on rural communities.
Outputs will include documentation of machines and technologies observed during site visits, including the fire response capabilities and needs of biomass facilities, the evaluation of respiratory hazards, and the documentation of applicable rural codes. This documentation will be summarized and made publicly available through a variety of print and social media.
Milestones will include the identification and evaluation of fire and respiratory risk and hazard potential, and the characterization of respiratory particles.
Anticipated outcomes will include increased utilization of this information by commercial stakeholders and workers.

Task 5.3: Develop comprehensive safety and health management resources
Activities will include the continued promotion of “Safety and Health Management Planning for Biomass Producers,” a comprehensive manual completed in October 2015, and the creation of additional safety and health videos.
Outputs will include the development of a short video on fire hazards in biomass production.
Milestones will include production of video(s) and continued presentations as requested throughout the Northeast.
Anticipated outcomes will include greater public awareness of risks and hazards associated with biomass production and an increased culture of safety in the industry.
Thrust Information

Extension

James R. Ayoub, Penn State
Erik Draper, Ohio State University
Shawn Grushecky, West Virginia University
Susan Harlow, University of Vermont Extension
Wendy Sue Harper, University of Vermont Extension
Sue Hawkins, University of Vermont Extension
Justin Heavey, SUNY ESF
Michael Jacobson, Penn State
Ed Johnstonbaugh, Penn State
Yaru Grace Liu, Penn State
David Marrison, Ohio State University
Jeff Skousen, West Virginia University
Sarah Wurzbacher, Penn State

Objectives
Working with NEWBio advisory board members, industry partners, and other organizations, Extension identified field demonstration sites in Pennsylvania, New York and West Virginia that serve as bases of operation for NEWBio outreach work and research. In participation with the Crawford County (PA) Commissioners, Extension has organized a field-scale perennial grass planting at a public farm. In New York, over 830 acres of new willow biomass crops were established in the spring of 2013, and previously established acres were harvested; almost 2,500 tons of biomass from these fields have been delivered to a ReEnergy biopower facility in Lyonsdale, NY. In West Virginia, a MeadWestvaco 30-year-old reclaimed surface mine site was planted with willow, switchgrass, and Miscanthus. The equipment access program, which makes specialized energy crop farming equipment available to farmers, has assisted in the purchase of two willow harvesters and a willow planter in cooperation with advisory board member and corporate partners Double A Willow and Celtic Farm Energy. Our bioenergy workshops and webinars utilize industry and NEWBio team members as presenters; participants are drawn from industry, academia, and the public. The Extension and Education Teams also developed fact sheets, display materials, and other printed and online media to assist in communicating NEWBio content. Working with eXtension.org, NEWBio has a landing page to index all NEWBio publications and outreach resources. Priority topics are identified along with contributors for these publications.

Accomplishments
✓ NEWBio outreach continues to support the development of a Northeastern U.S. biomass/bioenergy industry through integrated demonstration site activities, development of fact sheets, research summaries, case studies and interactive learning-lesson tools. Examples of these efforts include “Maximizing Planted Area and Biomass Production in Shrub Willow Bioenergy Fields” (a research summary) and “Renmatix Turns Biomass into Sugars for Industrial Use” (a case study). NEWBio resources are cross-posted on the project’s website and eXtension.org.
✓ NEWBio’s Sarah Wurzbacher headed the multi-CAP effort to launch the monthly “Bioenergy in the Clean Power Plan (CPP)” webinar series. Series presenters come from university, policy and governmental entities on a range of topics (Bioelectricity under the CPP, Emissions Accounting for Biomass under the CPP, Incorporating Traditional Forest Product Markets in CPP Biomass Evaluations are examples). These webinars continue to be well-attended, despite recent court actions that have put a hold on CPP implementation.
✓ SUNY ESF drafted a report on the 2015 New York BCAP program that was submitted to USDA Farm Service Agency and BCAP program administrators in Syracuse, NY and Washington, D.C.
The report discussed opportunities and challenges for expanding the existing New York willow BCAP program to new and existing stakeholders.

- NEWBio completed its first public outreach event involving commercial partner Aloterra in northeast Ohio, with field, processing and farm operations tours. New audiences were reached, and reviews of the event showed marked increases in knowledge about miscanthus, regional potential for biomass crops, and other relevant subject material. Additional stakeholder engagements occurred with a collaboration between ESF and a team from Argonne National Lab using ESF’s EcoWillow 2.0 software to evaluate the cost and benefits of using willow as buffer plantings in corn fields. A manuscript developed from this was submitted recently to the Journal of Bioproducts and Biorefining for peer review. Stakeholder meetings were facilitated in West Virginia on a collaborative approach to bioenergy production on surface mine sites with All Star Ecology and Earth Stewards CE.

- NEWBio’s Biomass Equipment Access Program, managed at SUNY ESF, saw increased usage this past year with 250+ acres of shrub willow cut across 13 sites. The willow chips utilized by a variety of end users and applications: commercial biomass, a school district, a remediation project, and various NEWBio trials and nursery beds. NEWBio equipment traveled to Mississippi and Tennessee to help sister CAP IBSS harvest poplar trials, too. Multiple media outlets attended these harvesting events, with coverage available online.

- A literature search was completed on biomass transportation models and will inform a supply chain risk survey planned for the last quarter of Y4. A case study on biomass supply chains has been developed and is in beta testing with a spring 2016 Penn State MBA class.

**Year Four Activities**

**Task 6.1: Integrated demonstration sites**  
Activities will include extension activities in support of production research and research facilitation at demonstration sites in Pennsylvania, Ohio, New York and West Virginia. New York activities will include BCAP crop monitoring.  
Outputs will include two field days or related workshop events, the development of a BCAP grower directory and needs assessment, and the identification of potential co-operators.  
Milestones reached will include hosting workshops, field demonstrations and seminars in Pennsylvania, New York and West Virginia, and a BCAP area final summary that includes crop status, equipment use, acres harvested and crop utilization.  
Anticipated outcomes will include the continued development of learning communities engaged in the bioenergy arena.

**Task 6.2: Biomass equipment access program**  
Activities will include publicizing information on the program and equipment availability, incorporating relevant safety information and coordinating equipment scheduling as data on harvest sites and acreage are received.  
Anticipated outputs will include detailed harvesting schedules logging more frequent equipment use as multiple growers are supported by reduced cost usage of specialized willow planting and harvesting equipment.  
Milestones reached will include summary documents detailing actual equipment usage and the deployment of resources on the equipment, the economics of its use, and relevant safety issues.  
Anticipated outcomes will include the increase use of specialized equipment by small landowners, and increased public awareness of the safety hazards inherent in the use of large, complicated machinery.

**Task 6.3: Small business and economic development**  
Activities will include establishment and facilitation of a warm-season grass grower group and program development and delivery that incorporates business development strategies and resources. Extension will develop an integrated white paper on findings from papers on business models, market identification and market analyses.  
 Outputs will include identification of successful business models and competitive strategies for biomass businesses.  
Milestones reached will include advancing the body of business and market knowledge necessary to create a culture of opportunity for development of the biomass supply chain.
Anticipated outcomes will include establishment of a warm-season grass stakeholder group capable of collaborative activities that grow the industry or increase awareness around perennial grass crops that continues after NEWBio’s conclusion.

Task 6.4: Expand eXtension.org for willow and warm-season grasses
Activities will include maintenance of the current index of all NEWBio publications and outreach materials, providing guidance on the use of the “Ask an Expert” system, facilitate the ongoing development of summaries of NEWBio research, and facilitate the development of fact sheets by NEWBio project team members.

Outputs will include links to NEWBio resources wherever they are published, by resource type and platform; identification of fact sheet and research summary topics; continuation of social media content to promote biomass and bioenergy.

Milestones reached will include 100% response rate to “Ask an Expert” queries, 5-10 publications published on eXtension Farm Energy, semi-monthly social media postings, and monthly multimedia postings (webinars, images, videos), with public access of all outputs.

Anticipated outcomes will include dynamic and interactive educational resources that raise the general public’s bioenergy awareness and contribute to capacity building for biomass growers and entrepreneurs.

Task 6.5: Interactive and innovative learning-lessons tools
Activities will include the identification of important, relevant issues and the ongoing development and delivery of informative Fact Sheets, NEWBio Blog posts, monthly bioenergy webinars, social media postings (Twitter, Facebook, Pinterest), a monthly electronic newsletter, and additional interactive outreach components to support the diversity of resource types that comprise the NEWBio suite of platforms.

Outputs will include the continued profiling of successful biomass businesses and NEWBio partners, the design of programs and workshops highlighting NEWBio activities and information, the identification and timely delivery of webinars on important issues, and the enhancement of multimedia resources.

Milestones reached will include the publication of ten fact sheets, 12 blog posts, five research summaries and 12 newsletters; the completion of 40 presentations at various expos, poster sessions, field days and the like; the broadcast of ten bioenergy webinars; and continuous social media posts on Twitter and Facebook platforms.

Anticipated outcomes will include raised public and industry awareness about the best practices and emerging technologies in their bioenergy interest areas.
Thrust Information

Education

Natalie Aiello, Penn State University
Stacy Brown, Wings of Eagles Discovery Center
Leah Bug, Penn State University
Nicole Burt, Wings of Eagles Discovery Center
Daniel Ciolkosz, Penn State University
David DeVallance, West Virginia University
Deborah Dietrich, Penn State University
Prosper Doamekpor, Tuskegee University
Sue Fredenburg, Wings of Eagles Discovery Center
Matt Johnson, Penn State University
Tiffini Johnson, Delaware State University
Venu Kalavacharla, Delaware State University
Kalpalatha Melmaiee, Delaware State University
Corey Rutzke, Cornell University
Annmarie Ward, Penn State University

Progress Toward Objectives
The NEWBio education thrust has effectively strengthened the education pipeline to support the biomass industry in the region in the following ways: by training undergraduate students in bioenergy from multiple institutions (eight students trained in summer 2013; seven trained in Summer 2014), and providing graduate bioenergy education to working professionals (21 scholarships awarded thus far). Furthermore, the long-term education pipeline was enhanced through the training of K-12 educators who are in turn teaching bioenergy concepts to their students.

Accomplishments
✓ The NEWBio education thrust has effectively strengthened the education pipeline to support the biomass industry in the region by training undergraduate students in bioenergy from multiple institutions (eight students trained in Summer 2013; seven trained in Summer 2014, eight trained in Summer 2015, and eight scheduled for Summer 2016). Of note is the peer-reviewed publication of 2013 NEWBio Scholar Charles Bush:
✓ Graduate bioenergy education was provided to working professionals through NEWBio’s Distance Education program, with 32 scholarships awarded thus far, with an additional five anticipated during the Summer 2016 session;
✓ The long-term education pipeline was enhanced through the training of 51 K-12 educators who are in turn teaching bioenergy concepts to their students, with another 30 anticipated during Summer 2016 as a third workshop site will be offered in Horseheads, NY.

Year Five Activities
Task 7.1: Secondary Educator Training
Activities will include applicant recruitment and receipt/review of candidate applications, the identification of program dates and locations for Summer 2017 workshops, and collaboration with site directors to plan local tours and identify local speakers. Outputs will include maintenance of online resources for the program, development of a recruitment brochure, and delivery of the workshops. Milestones reached will include organization of the training for ~30 educators, and follow-up evaluation of the program. Anticipated outcomes and impacts will include an increase in knowledge of bioenergy on the part of the trained educators, and integration of this knowledge in the educators’ subsequent teachings on the subject to foster increased public understanding of the
social, economic and environmental impacts of sustainable bioenergy systems in the Northeast.

Task 7.2: Regional Bioenergy Scholars Program

Activities will include obtaining feedback from Year 4 scholars and host institutions, recruitment of Year 5 scholars, maintenance of online resources for the program, application review and placement with host institutions.

Outputs will include the identification of eight new scholars for summer 2017 trainings.

Milestones will include eight trained students added to a growing cohort of bioenergy scholars in the region.

Outcomes and impacts will include increased knowledge on the part of the scholars with demonstrated interest in a bioenergy career.

Task 7.3: Graduate Distance Education in Bioenergy

Activities will include the marketing of the program, receipt and review of student applications and identification of scholarship recipients for spring 2017 courses.

Outputs will include the delivery of Fall 2016 and Spring 2017 online graduate-level bioenergy courses.

Milestones will include the completion of Fall 2016 and Spring 2017 coursework by ~five graduate students, as well as program evaluation and modifications as needed for succeeding year offerings.

Outcomes and impacts will include increased knowledge on the part of the graduate students, and the potential formation of their plans to develop or participate in future bioenergy business endeavors.
Thrust Information

Leadership, Stakeholder Involvement, K2A, Evaluation

Austine Decker, Penn State University
Lara Fowler, Penn State University
Joshua Herne, Penn State University
Barbara Kinne, Penn State University
Jessica Leahy, University of Maine
Laura Lindenfeld, University of Maine
Tom Richard, Penn State University
Larry Smart, Cornell University
Timothy Volk, SUNY-ESF
Jingxin Wang, West Virginia University

Advisory Board
Tom Foust, National Renewable Energy Laboratory, Chair
Dan Arnett, Ernst Conservation Seeds
Dante Bonaquist, Praxair Inc.
George Boyajian, Primus Green Energy
Scott Coye-Huhn, Aloterra Energy LLC
Daniel Dostie, USDA NRCS
Calvin Ernst, Ernst Conservation Seeds
Glenn Kenny, Ernst Conservation Seeds
Frank Lipiecki, Renmatix
Lee Lynd, Dartmouth College
Matthew McArdle, Mesa Reduction Engineering and Processing
Michael Palko, Biomass Renewable Energy LLC
Prafulla Patil, American Refining Group
John Posselius, CNH
Dennis Rak, Double A Willow
Kevin Smith, CNH America LLC
Ann Swanson, Chesapeake Bay Commission
Sarah Torkamani, ExxonMobil Research and Engineering

Progress Toward Objectives
NEWBio’s external evaluators’ first and second year reports focused on project infrastructure, communication and collaboration. The third year evaluation is including stakeholder engagement as well as team assessments, including participation in the NEWBio annual meeting and phone interviews. The reports provide recommendations to maintain the project’s high level of momentum and team member enthusiasm, and to further engage with our external stakeholders and advisory board. Team meetings continue to play an important role in the collaborative process. We use our monthly e-newsletter (25-30 % open rate, over 500 active contacts) to relate research updates and other articles and news related to biomass and bioenergy to the project team, our advisory board, industry and agency partners, and the general public. Critical leadership discussions are ongoing with existing and potential conversion partners who are investigating potential biorefinery sites and are evaluating needs related to biomass pricing and quantities. We are actively exploring several opportunities for integrative, transdisciplinary high impact activities, using our demonstration regions as a platform.
Accomplishments

Team meetings continue to play an important role in the development of NEWBio’s collaborative process. Communication of NEWBio activities is accomplished through several complementary mechanisms. We use our monthly e-newsletter (25-30% open rate, over 500 active contacts) to relate research updates and other articles and news related to the bioeconomy, biomass and bioenergy to the project team, our advisory board, industry and agency partners, and the general public.

Critical leadership discussions occurred to identify achievable vs hypothetical demonstration scenarios and to focus attention on the development of each scenario’s respective supply chain data needs.

Our data management plan is now in the implementation phase, with NEWBio contributions being shared internally. Conversations with various national data repositories are ongoing as to their data needs, formats and sharing capabilities.

External evaluators completed their annual evaluation, documenting continued positive reviews and several improvements in team satisfaction and performance that we believe reflect our response to previous evaluation input. The evaluators compiled and shared a variety of additional recommendations that are being implemented.

NEWBio’s Advisory Board grew by four members during Y4, with two environmental and two commercialization stakeholders joining the project:
- Kevin Comer, Antares Group Inc.
- Matthew McArdle, Mesa Reduction Engineering and Processing
- Michael Palko, Biomass Renewable Energy LLC
- Sarah Torkamani, ExxonMobil

Year Five Activities

Task 8.1: Executive and Thrust Conference Calls
Activities will include monthly leadership team conference calls, and monthly joint leadership-management team conference calls, and at least monthly but in some cases (depending on the time of year) more frequent thrust team conference calls.
Outputs from these calls will include communication of progress-to-date within and across teams, and identification of items requiring immediate action or longer-term resolution.
Milestones reached will include 11 leadership conference calls, 11 joint leadership-management conference calls, and an estimated 60+ thrust team calls.
Anticipated outcomes and impacts will include broad distribution of the total team effort to all project members, and to the public at large through postings to the NEWBio public website.

Task 8.2: All Hands Teleseminars and Meetings
Activities will include monthly teleseminars and a final annual meeting or symposium to provide project outcomes to the NEWBio project team, our advisory board, industry and agency partners and interested members of the public. Teleseminars include one or more NEWBio research, extension or education presentations, with participation by our corporate partners.
Outputs will include the communication of project efforts and results to the larger NEWBio team and the public.
Milestones reached will include 11 teleseminars, and one annual meeting that will occur near the end of the funding year. We anticipate the final annual meeting will be reformatted as a public conference/symposium to widely publicize results.
Anticipated outcomes will be the creation of synergistic opportunities for project team efforts to further align with stakeholder needs and communication of project findings to the public.

Task 8.3: External Advisory Board Meetings and Strategic Planning
Activities will include an annual stakeholder review of NEWBio tasks and performance facilitated by external evaluators, board involvement in evaluating the NEWBio seed grant program, and the establishment of an active feedback loop for strategic planning.
Outputs will include an updated strategic plan with goals, strategies and tactics for the coming year.
Northeast Woody/Warm-season Biomass Consortium 2016 Annual Meeting

Milestones reached will include at least one mid-year board meeting, and participation by the board at the final NEWBio annual meeting or symposium.

Anticipated outcomes and impacts from this effort will include a more focused investment of time and resources to fulfill project goals and achieve commercial implementation of NEWBio-developed supply chain processes.

Task 8.4: Task and Project Evaluation

Activities will include evaluation of stakeholder engagement processes and assessment of NEWBio capacity to create stronger linkages between knowledge and action (K2A) via a survey of internal project team members and the Advisory Board. Interviews will be conducted with a sub-set of NEWBio’s Leadership Team, non-Leadership Team personnel, and non-Advisory Board external stakeholders.

Outputs will include a final technical report from survey data collected in fall 2016; data collected through interviews conducted in summer and fall 2016; and ongoing evaluator participation in management, all hands, and annual meetings.

Milestones reached will include delivery of the technical report based on the survey, interviews, and participant observation that includes assessment of and recommendations for improving interdisciplinary collaboration and stakeholder engagement. Reports will provide recommendations aimed at improving project efficacy, especially with regard to transferring research to practice via stakeholder engagement.

Anticipated outcomes and impacts will include information to guide future development of sustainable bioenergy Coordinated Agricultural Projects and similar transdisciplinary projects.

Task 8.5: Administrative Evaluation

Activities will include evaluation of program administration via a team survey and interviews with key team members.

Outputs include a technical report from survey data collected in fall 2016; data collected through interviews conducted in summer and fall 2016; and ongoing participation in management, all hands, and annual meetings.

Milestones reached will include delivery of a technical report based on the survey, interviews, and participant observation that includes assessment of and recommendations for improving program administration. Reports will provide recommendations aimed at improving project efficacy through enhanced administrative capacity.

Anticipated outcomes will include guidance for program administration to enhance administrative capacity and create stronger inter- and transdisciplinary collaborations.

Task 8.6: Final Evaluation and Program Report

The final evaluation report will provide an overview of the entire project and how outputs and outcomes aligned with goals and objectives as originally envisioned or as modified due to external influences and realities.
APPENDIX

Meeting Evaluation

Travel Reimbursement Instructions
Meeting Evaluation

Evaluation of the meeting will occur within the overall Evaluation Survey that is scheduled to be discussed in the Evaluation Report Out. The survey will be online, with the link distributed during the 2016 meeting, and available afterward on our internal website. We look forward to your comments and input as we plan for NEWBio 2017.

Travel Reimbursement Instructions

Reimbursement forms are available using the links below. Please note that Penn State uses a per diem reimbursement system for lodging, meals and incidental expenses. Attendees staying at the Days Inn will have their hotel rooms group billed to Penn State. Attendees staying elsewhere will have their lodging expense reimbursed on the per diem basis of $95 (plus taxes and parking if included in your hotel bill). Per diem reimbursement for State College is $59.

Penn State Employee Travel Form:
https://www.ers.psu.edu/

Non-Employee Travel Reimbursement Form

Visitor Information (aka Non-Employee Information Form [NEIF])
http://guru.psu.edu/formpublic/VisitorsInformationSheet.pdf

The Visitor Information Form is required for all non-Penn State attendees, regardless of whether you file for expense reimbursement. If you submitted expenses for any of NEWBio’s past Annual Meetings, an NEIF is on file for you. Please check with Barbara Kinne if you are unsure.

Please complete page one of the “Non-Employee Information Form”, scan and email to Barbara Kinne at bbk1@psu.edu. Barbara will attach a completed page two (host name, etc.) for you, and if necessary, help determine if you need additional visa documents as described on page two of the NEIF. Depending on your country of origin, the paperless visa system may simply require a photocopy of your entry stamp on your passport during your stay here.

A Note on I-94 documentation

As of May 2013, the US Customs and Border Protection Agency implemented an electronic system to replace the paper I-94 Card. All Non-U.S. Citizens entering the country BY AIR will no longer receive an I-94 card. Only persons entering by land (Canada or Mexico) will be issued I-94 cards. Upon entrance into the U.S., an Immigration Officer will stamp an Admission Classification, entry date and admitted until date in the individual’s Passport. A copy of this information stamp is what the University will need to authorize any payment to a Non-U.S. Citizen, replacing the previous requirement of a copy of the I-94 card.