NEWBio is led by The Pennsylvania State University, supported by Agriculture and Food Research Initiative Competitive Grant No. 2012-68005-19703 from the USDA National Institute of Food and Agriculture.
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Notice

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

Project Organization and Governance
Project Director Tom Richard continues to lead the overall NEWBio effort, assisted by Associate Director Timothy Volk and Executive Committee members Larry Smart and Jingxin Wang. The committee is supported by Project Manager Barbara Kinne, who coordinates the day-to-day administrative operations.

- **Project Progress**
  Each thrust continues to show satisfactory progress in meeting task objectives and schedules. On December 4th, the NEWBio Leadership Team held an on-site meeting at Penn State to review overall project objectives, Year 4 goals, and to agree on tasks and timelines for filling outstanding data point needs and integrating supply chain, ecosystem services, techno-economic and life cycle analyses for defined, specific systems and targeted demonstration scenarios. Under consideration are six either underway and/or viable case studies, and three hypothetical studies, based on feedstock type, process and product (See Table I.)

- **Advisory Board**
  Advisory Board members are routinely invited to attend monthly All Hands meetings, and will be invited to attend a mid-year board meeting scheduled for February 5, 2016. At that time, NEWBio will report on progress made on board recommendations from the 2015 Annual Meeting.

- **Communications and Collaboration**
  Monthly meetings are the primary means of sharing results and updating project team members. The Executive Committee, Leadership Team, and thrust teams typically hold monthly teleconferences, and we hold a monthly All Hands meeting focused on a particular topic, with internal and external speakers participating.

  NEWBio electronically published three eNEWS issues this quarter, with feature stories on research accomplishments, NEWBio peer-reviewed publications, and upcoming workshops, webinars and other events. The newsletter averaged a 27.4% open rate, with a 21% click through rate.
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Of note this quarter is the publication of NEWBio's Safety and Health team's manual for biomass producers. This 62-page booklet contains multiple hazards checklists and training exercises, and covers these topic areas:

- Establishing Safety Policies and Procedures
- Identifying and Assessing Hazards and Risks
- Preventing and Controlling Hazards and Risks
- Educating and Training Employees
- Evaluating Training Programs and Resources

The manual is available free for download, or at a nominal cost to cover printing and shipping from Penn State Extension: [http://extension.psu.edu/publications/agrs134/view](http://extension.psu.edu/publications/agrs134/view)

- **Financial Matters**
  All NEWBio budgets are on sound draw-down trajectories at this stage of the project.

- **Data Management**
  A systematic review of all peer-reviewed publications was begun in September, the goal of which is to identify NEWBio datasets ready for upload to appropriate repositories. The review is expected to be completed next quarter, and we will then begin uploading and linking datasets to public repositories as appropriate.

- **Plans for Next Quarter**
  - Extend invitations to join NEWBio's Advisory Board to prospects identified at Leadership Team meetings;
  - Hold a mid-year advisory board meeting (teleconference);
  - Begin preparations for our Year 5 reapplication. This will include a comprehensive budget review of draw-downs and project needs for Year 5.
PUBLICATIONS AND PRODUCTS

Listed below are publications, presentations, workshops, etc. reported largely in September. Activities and publications that occurred in July and August 2015 were reported in NEWBio’s Year Three Annual Report.

Peer-Reviewed Journal Articles


Proceedings

Book/Book Chapter
None to report this quarter.

Theses/Dissertations
None to report this quarter.

Conference Presentations
Shrub Willow Cultivars in North America. Oral presentation given to the Bioenergy Systems Community at the 2015 ASA, CSSA and SSSA International Annual Meeting, November 16, 2015, Minneapolis, MN.


Other Publications/Presentations


Fact Sheets
None to report this quarter.
Workshops, Field Days, Demonstrations


Wurzbacher, S. Presentation on bioenergy activity and potential in the region to serve as basis for human systems focus group discussion. October 27, 2015. Meadville, PA. 8 participants.

NEWBio Bioenergy Webinars


**Research Summaries, Case Studies, Videos**

None to report this quarter.

**Media Outreach**


**Proposals Funded**


**Proposals Submitted**

Thrust 1: Human Systems in the Northeast Regional Bioeconomy

Human Systems focuses on understanding the values, legacies, and motivations that drive perceptions and decisions about land management and business development for biomass energy systems. 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.

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

1. Planned Activities
   • Implement mail survey in NY, OH, and PA;
   • Continue to work on model selection;
   • Analyze the impact of price premiums on the potential for expansion of switchgrass on agricultural lands;
   • Contribute to development of a manuscript: Improving water quality in the Chesapeake Bay using payments for ecosystem services for perennial bioenergy feedstock production.

2. Accomplishments
   ✓ Modified on model selection for survey data analysis;
   ✓ Finished modifying online survey;
   ✓ Completed sampling of mailing addresses for survey;
   ✓ Worked on manuscript and analysis of price premiums.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter
   • Implement mail survey; target mail date is January 11, 2016;
   • Collect survey data, begin data entry and data cleaning;
   • Work on second manuscript based on an analysis of marginal land to identify economically marginal land in NEWBio project areas;
   • Continue contributions to Chesapeake Bay ecosystem services manuscript.

Task 1.1.2: Social Acceptability

1. Planned Activities
   • Continue landowner interviews in Pennsylvania;
   • Work on second and third manuscripts based on interview and survey data, respectively;
   • Implement mail survey in early 2016;
   • Begin Chesapeake Bay case study.

2. Accomplishments
   ✓ Completed 15 landowner interviews in Pennsylvania;
   ✓ Continued working on second manuscript based on interview data;
   ✓ Continued working on third manuscript based that will be based on survey data;
   ✓ Began document analysis and literature review for Chesapeake Bay case study.

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

4. Plans for Next Quarter
   • Implement mail survey on January 11, 2016;
   • Continue landowner and key informant interviews in Pennsylvania
   • Work on second manuscript based on interview data
   • Work on third manuscript based on survey data
   • Enter, clean and analyze survey data;
   • Continue Chesapeake Bay case study

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

1. Planned Activities
   • Conduct focus group at demonstration sites, including Crawford County, PA;
   • Transcribe and analyze PA focus group data, and analyze interviews related to demonstration site;
• Develop interview/survey questionnaire for collecting data from NEWBio team members involved in the demonstration sites;
• Develop templates for assessing biomass crop production and supply chain infrastructure.

2. Accomplishments
✓ Crawford County, PA focus group completed on October 27;
✓ Focus group transcription and demonstration site interview analysis underway;
✓ Consulted with the Extension Thrust to compile information already collected on supply chains in NEWBio as a basis for administering surveys or interviews;
✓ Decided on the SCOR framework developed by the APICS Supply Chain Council to assess the demo sites supply chain infrastructure and metrics.

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

4. Plans for Next Quarter
• Continue with key informant and landowner interviews in Crawford County, PA;
• Continue work with Extension and other thrusts to compile information already collected to help with assessment of supply chain infrastructure;
• Attend SCOR training to obtain information and metrics to apply to NEWBio.
Thrust 2: Feedstock Improvement for Perennial Energy Crops

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.

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

1. **Planned Activities**
   - Complete milling and TGA analysis for the remaining samples from the Geneva, NY Association Trial;
   - Continue to map yield and growth traits from Association Trials;
   - Prepare for end of season measurements in the three Association Trials to assess the effects of the fertilizer treatment;
   - Prepare for end of season measurements in the 2013 Family Selection Trial;
   - Collect stem height and diameter measurement in the triploid and tetraploid crossing blocks.

2. **Accomplishments**
   - Milling and TGA analysis was completed for the remaining samples from the 2012 Geneva Association Trial;
Association mapping of growth traits and biomass composition from the first two-year rotation has found significant hits on the *S. purpurea* reference genome for stem height and hemicellulose composition;

End-of-season height and diameter measurements to test for the response to fertilization treatments were completed for the Geneva and Portland, NY Association Trials; Measurements in the WVU trial were postponed due to harvesting activities;

Willow crossing blocks in Geneva were measured for stem height, stem diameters and plant width.

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

4. **Plans for Next Quarter**
   
   - Measure the 2012 WVU Association Trial for maximum stem height and diameters;
   - Begin measuring maximum stem height and diameters in the 2013 Family Selection Trial in Geneva;
   - Deliver oral presentation on GWAS mapping of growth and yield traits at the Plant and Animal Genome Meeting in San Diego, CA in early January;
   - Begin manuscript preparation on GWAS mapping of growth and yield traits;
   - Survey floral development in triploid and tetraploid crossing blocks.

**Task 2.2: Genetic basis for pest and disease resistance in willow and perennial grasses**

1. **Planned Activities**
   
   - Continue to map loci controlling pest resistance;
   - RNA-seq data generated from the 2015 potato leafhopper feeding study will be analyzed for differential gene expression and candidate gene results compared with the results from the 2014 preliminary test. Candidate gene expression will then be confirmed by qRT-PCR assays using RNAs from individual replicate plants;
   - Harvest biomass samples from the anthracnose fungicide study;
   - Weigh biomass samples from anthracnose fungicide study after drying;
   - Start grinding samples from anthracnose fungicide study for composition analysis;
   - Run last year’s samples through NIRS;
   - Present an oral presentation on anthracnose fungicide study at Agronomy Meetings.
2. Accomplishments

**WILLOW**

- Total RNA has been extracted from the 240 *Salix purpurea* x *S. viminalis* leaf samples collected from the 2015 potato leafhopper feeding study. First batch of 96 samples covering full time points of 9 genotypes will be sent for RNA sequencing;
- Rust disease severity rating was performed in the Geneva and Portland, NY Association Trials late in the 2015 growing season as a task of a separate grant from USDA-NIFA Feedstock Genomics Program. Significant negative phenotypic correlations were found between rust severity ratings and growth measurements taken at the end of the 2015 growing season. (Figure 1)

![Figure 1.](image)

**Correlation of all traits measured within each location.**

**Colored cells represent significant correlations at p-value<0.05**

- Association mapping efforts for rust disease severity has revealed a few significant SNP hints on Chromosomes 1 and 2 on the *Salix purpurea* reference genome. QTL mapping of an F2 *S. purpurea* population has found a significant SNP in a very close region of Chromosome 1 to that found by association mapping. (Figure 2)

**SWITCHGRASS**

- Biomass samples from the anthracnose/fungicide trial located in Freehold, NJ were harvested on October 13, 2015, dried, and weighed for biomass yield determination for
the 2015 growing season. All samples have been ground using a Wiley Mill and are ready for analysis using NIRS.

- Data for anthracnose severity (Figure 3) and biomass yield (Figure 4) from 2014 and 2015 were presented at the 2015 Agronomy meetings.
- NIRS data from the 2014 data indicate that total cell wall content varied among cultivars, however, fungicide did not significantly affect any of the characteristics evaluated.

**Figure 2.**

A genome-wide Manhattan plot of 25,565 SNPs for rust severity from the Association Trial data. Funding for this work was from USDA-NIFA Feedstock Genomics Program.

**Figure 3**

Analysis of data from 2014 and 2015 indicated that fungicides were not a significant factor in controlling anthracnose on the 16 cultivars evaluated. In addition, significant variation in susceptibility to infection was detected among the cultivars. Overall, ‘Forestburg’ was the most susceptible to anthracnose in both years compared to all other cultivars evaluated.
Biomass yield was not significantly affected by fungicide application in 2014 and 2015 with the main effect of cultivar accounted for a majority of the variation in the data. The cultivar Forestburg exhibited the lowest yields compared to most cultivars in 2014 and all cultivars in 2015. A significant correlation between anthracnose severity and biomass yield was detected; however, this may be an artifact of Forestburg naturally being a low yielding cultivar.

3. Explanation of Variance
Most activities and accomplishments are on schedule.

4. Plans for Next Quarter
- Present a poster summarizing GWAS and QTL mapping of rust resistance for USDA-NIFA and DOE Plant Genome/Feedstock Genomics PIs Meeting in San Diego, CA in early January;
- Collect willow whips from Geneva nursery beds and prepare cuttings for a new PSU greenhouse trial investigating pest susceptibility in commercial cultivars;
- Biomass samples from the 2015 anthracnose/fungicide trial will be ground and analyzed using NIRS;
- Paper will be submitted to Plant Disease on anthracnose resistance in switchgrass;
- Grant proposal will be developed to study the molecular mechanism of disease resistance in switchgrass (which was not covered under this grant);
- Prepare willow cuttings for potato leafhopper feeding trials for summer 2016.
Task 2.3: Breeding and selection of willow and switchgrass cultivars adapted for Northeast conditions

1. Planned Activities
   - Collect end-of-season growth measurements and stem segments for compositional analysis in the 2012 Rock Springs Yield and Polyculture Trials and the 2013 Fredonia Amendment Trials;
   - Plan and coordinate harvesting of the 2012 Rock Springs Yield and Polyculture Trials and the 2013 Fredonia Amendment Trials. Harvest trials if weather allows;
   - In Ithaca, switchgrass plants will be evaluated for height and vigor and then rows will be hand sampled for quality and harvested with a single row corn chopper. Quality samples will be ground for analysis with NIRS;
   - In NJ, switchgrass plants will be harvested by hand, dried and weighed. Selected plants will be ground for analysis with NIRS.

2. Accomplishments
   
   **WILLOW**
   ✓ Height of tallest stem and diameter data were collected in the 192 plots of the 2013 Fredonia Amendment Trial on November 4-5, 2015.
   ✓ Height of tallest stem and diameter data were collected in all 96 plots of the 2012 Rock Springs Yield Trial and 72 randomly located plots in the 2012 Rock Springs Polyculture Trial on November 23-24, 2015. Stem segments were collected in the yield trial for wood density determination and compositional analysis via Hi-Res TGA. Soil samples from each of the 96 yield trial plots were also collected by the Carlson lab group for microbial DNA sequencing.
   ✓ Harvesting of the 2013 Fredonia Amendment Trial was conducted on the week of December 7, 2015. Soil samples were collected from the 96 plots of the amended portion of the field for microbial sequencing. Border plants between measurement plots were cut and removed. A New Holland FX45 harvester with CRL willow header was used to harvest the 192 measurement plots and Cornell’s self-unloading feeder wagon equipped with load cells was used to weigh the chips from each plot. A 1.5 kg subsample of chips was collected for each plot for moisture content determination. This trial was harvested after two years of aboveground growth to align its rotation with the 2012 yield trials. The material was smaller than desired as a result, however strong fertilization effects were seen. Overall there was a 45% increase in plot fresh weights under fertilization (84 kg N-P-K ha-1 in 2013 and 2014) over the controls. Three of the overall top five yields were new selections from the Cornell breeding program. The interaction effect between cultivar and amendment was not significant. (Figure 5.)
   ✓ In West Virginia, pre-harvest soil samples will be collected and stored for the soil microbial sequencing.
The 2012 Rock Springs Polyculture was harvested December 15-16, 2015 with a New Holland FX45 harvester with CRL willow header. Entire rows of the polyculture trial were collected in either PSU forage wagons or Cornell’s weigh wagon. Row weights collected by PSU wagons were estimated using truck scales. The total fresh weight for the field was about 42 tons, which for the 3.1 acre field is approximately 2.4 dry tons ac-1 yr-1. The mixture blocks accounted for approximately 55% of the fresh weight yield, but this is likely due to lower quality soil conditions where the ‘Preble’ monoculture blocks were located. (Figure 6.)

The 2012 Rock Springs Yield Trial was harvested Dec 16-17, 2015 using a New Holland FX45 harvester with CRL willow header. In total 88 plots were weighed with Cornell’s weigh wagon and eight plots of two Swedish cultivars were excluded due to very poor performance. Based on plot fresh weights there were four new selections including three from the Cornell breeding program that outperformed the current top-yielding cultivars, ‘Preble’ and ‘Fabius’. Soil samples were collected from each of the 96 yield trial plots on Nov 20, 2015 and stored in the Carlson lab for subsequent microbial DNA sequencing.

Soil samples were also collected from each of the 12 plots in the Rockview Demonstration Trial on Nov 23, 2015. Samples were stored in the Carlson lab for subsequent microbial DNA sequencing.

An oral presentation based on a genotype x environment interactions analysis of shrub willow was given to the bioenergy systems community at the 2015 Annual Meeting of the Science Societies in Minneapolis, MN. A manuscript based on the analysis was submitted to Global Change Biology-Bioenergy.

**SWITCHGRASS**

The 40 selected switchgrass lines were harvested from the Freehold, NJ nursery (prime soil location) on October 14 and 15, 2015. Plants were harvested by hand and subsamples were obtained for DW determination. All samples have been dried and weighed and are being stored for grinding/analysis.

In Ithaca, NY switchgrass plants were evaluated for height and vigor. Researchers, along with a Cornell plant pathologist, identified smut, Bipolaris leaf spot, rust, and gall midge damage in the nursery.

Selected switchgrass lines were hand sampled and all lines were harvested with a single row corn chopper from the Ithaca, NY nursery (high clay location) on November 3 and 5, 2015. Subsamples were obtained for DW determination. All samples have been ground through a hammer mill and are being stored for further grinding and NIRS analysis.

3. **Explanation of Variance**

Most activities and accomplishments are on schedule.
4. Plans for Next Quarter

- Weigh moisture content chip samples from the 2013 Fredonia Amendment and 2012 Rock Springs Polyculture and Yield Trials, calculate annualized dry matter yields for all three trials
- Complete wood density measurements from harvested trials and begin milling stem segments for compositional analysis
- Grind all Rutgers switchgrass lines that were harvested in NJ and analyze using NIRS.
- Grind selected Cornell switchgrass lines that were harvested in NY and analyze using NIRS.
- All switchgrass biomass yield data from 2015 along with other measurements will be analyzed and used for the preparation of a manuscript combining data from Rutgers and Cornell
- Deliver an oral presentation at the Plant and Animal Genome Conference on Breeding Willow for Marginal Land in the Northeast.

**Figure 5.**

Mean plot fresh weights from the harvest of the 2013 Fredonia Amendment Trial. Twenty plants were harvested per plot at two years of age.
Figure 6.

Mean plot fresh weights from the harvest of the 2012 Rock Springs Yield Trial. Twenty plants were harvested per plot at three years of age.

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

1. Planned Activities

- Assess the dieback situation at the Mylan Park Yield Trial and determine whether end of growing season measurements will be worth collecting;
- Survey the Philipsburg willow trial for end of first year survival and cutback all stems to promote coppice regrowth in the spring;
- Select switchgrass lines from Cornell will be hand harvested for yield and quality. Samples will be ground for quality analysis using NIRS;
- 40 lines selected and harvested last year will be harvested again from both the nursery located in NJ as well as from the mine land site in PA. Samples will be dried, weighed, and saved for analysis;
• Poster presentation will be made at the Agronomy Society meeting on selection of switchgrass for marginal land. Data will be combined from both NJ and NY.

2. Accomplishments

WILLOW
✓ The 2014 Mylan Park Yield Trial was surveyed for the extent of stem dieback and 30 out of the 40 plots in trial had at least some signs of dieback. Every cultivar was scored as showing symptoms and extent of the dieback seemed to be correlated mainly with position on the slope. The visual symptoms seem to compare with previously observed dieback as a result of severe drought stress, but a plant pathologist from WVU was consulted to test for the presence of pathogens. An isolate of *Colletotrichum* fungus was found on numerous plants and is being cultured to determine the species, however, it may be likely that this was an infection that occurred because of abiotic stress – perhaps a combination of drought and soil chemistry. Plans for end-of-season measurements in the trial were postponed to allow for assessment of the overall condition of the trial.

SWITCHGRASS
✓ The same 40 lines harvested in Freehold, NJ were also harvested in Philipsburg, PA on October 22, 2015. Subsamples from these plants have been dried and weighed and are being saved for grinding/analysis;
✓ Selected Cornell switchgrass lines were harvested in Philipsburg, PA on October 20, 2015. Subsamples were taken to determine DM and have been ground through a hammer mill and are being stored for further grinding and NIRS analysis;
✓ Biomass yield data from 2014 was presented at the 2015 Agronomy Society meeting. The poster featured yields from the Rutgers lines evaluated in Freehold, NJ and Philipsburg, PA along with the Cornell lines evaluated in Ithaca, NY and Philipsburg, PA.

3. Explanation of Variance

Most activities and accomplishments are on schedule.
4. Plans for Next Quarter

- Measure first year post-coppice growth for maximum stem height and diameter in the 2014 Mylan Park Yield Trial;
- Cutback first year growth in the 2015 Philipsburg Yield Trial;
- Data from 2015 will be analyzed and samples from Philipsburg will be ground and analyzed;
- Rutgers and Cornell will work together to develop a manuscript containing data from the prime and marginal locations.
Thrust 3: Harvest, Preprocessing, and Logistics of Integrated Biomass Supply Chains

For perennial crop systems like willow, miscanthus and switchgrass, harvesting and transportation can account for 40 to 60 percent of the delivered cost of biomass. Preprocessing of biomass through drying, size reduction, storage and compaction can increase transportation efficiency, reduce delivered costs, and improve conversion efficiency. 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 will continue to focus on large-scale biomass harvests for demonstrations, calibrate the harvest models, and further refine 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.

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

Task 3.1.1: Optimize the operation of the forage harvester

1. Planned Activities
   - Continue to collect time motion data from large scale willow harvests.

2. Accomplishments
   ✓ Finished the harvesting 150 acres of willow for commercial use;
   ✓ Harvested 50 acres of willow on a site focusing on research plots to specifically validate biomass production data;
   ✓ One paper was published by Biomass and Bioenergy.

3. Explanation of Variance
   Activities and accomplishments are on schedule. No variance to report.
4. **Plans for Next Quarter**  
   - Continue to collect data on harvesting of willow;  
   - Compare commercial and research purposes of willow harvesting.

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

1. **Planned Activities**  
   - Continue to determine time and motion data collections procedures and experimental design.

2. **Accomplishments**  
   ✓ Continued harvesting data analysis.

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

4. **Plans for Next Quarter**  
   - Continue time and motion data collection and analysis.

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

1. **Planned Activities**  
   - Continue to collect time-motion data.

2. **Accomplishments**  
   ✓ Collected field data of logistic and harvesting  
   ✓ One student finishing the thesis on miscanthus harvesting  
   ✓ Harvesting in Illinois has been planned for 2016.

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

4. **Plans for Next Quarter**  
   - Continue to collect data.
Task 3.1.4: Optimize the operation of the perennial grass harvester

1. Planned Activities
   • Discuss a potential harvest to two miscanthus trials in WV.

2. Accomplishments
   None to report this quarter.

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

4. Plans for Next Quarter
   • We will continue to evaluate options to harvest two miscanthus trials in WV.

Task 3.1.5: Feedstock Logistics, supply chain and modeling optimization

1. Planned Activities
   • Complete model development and optimization.

2. Accomplishments
   ✓ Started internal review of a paper on biomass logistics optimization.

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

4. Plans for Next Quarter
   • Plans call for continuing to refine the model.

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

Task 3.2.1: Quantitative metrics of preprocessing parameters of biomass densification

1. Planned Activities
   • Tested hot water extracted and torrefied samples.

2. Accomplishments
   ✓ Received and began analysis of hot water extracted samples.
3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Continue testing of hot water extracted and torrefied samples.

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

1. **Planned Activities**
   - Continue to investigate acidogenic digestion of switchgrass and winter rye.

2. **Accomplishments**
   - The study of acidic digestion is ongoing.

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

4. **Plans for Next Quarter**
   - Continue the compositional analysis.

**Task 3.2.3 Biomass densification**

1. **Planned Activities**
   - Expand densification studies.

2. **Accomplishments**
   - Studied the absorbing properties of NEWBio biomass;
   - Started experiments on willow debarking.

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

4. **Plans for Next Quarter**
   - Continue to expand densification studies.
Task 3.3: Assess the storage requirements and effects of long term storage on the quality of willow and perennial grasses

Task 3.3.1: Storage system development and assessments for perennial grasses

1. Planned Activities
   - Continue long-term storage studies for switchgrass and miscanthus and analysis of storage impacts.

2. Accomplishments
   ✓ Work continues on commercial-scale, temporary storage of feedstock with end users, focusing on sampling procedures.

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

4. Plans for Next Quarter
   - Continue long-term storage studies for switchgrass and miscanthus harvest, and analysis of storage impacts.

Task 3.3.2: Storage system development and assessments for willow

1. Planned Activities
   - Continue long-term storage studies for willow and analyze storage impacts.

2. Accomplishments
   ✓ A paper in under revision;
   ✓ Storage sampling procedures are undergoing refinement to minimize human factors' effects;
   ✓ The characterization file is ready for review.

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

4. Plans for Next Quarter
   - Continue long-term storage studies for willow and analyze storage impacts.
Task 3.4: Techno-economic analysis, cost engineering, and life cycle analysis of densification, storage preprocessing and biorefinery integration

Task 3.4.1: Develop an integrated supply chain model

1. Planned Activities
   • Test and revise algorithms for alternative supply chain scenarios.

2. Accomplishments
   ✓ Finished the generic modeling for TEA and LCA.

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

4. Plans for Next Quarter
   • Continue to test and revise algorithms for alternative supply chain scenarios.

Task 3.4.2: Cost engineering models for satellite preprocessing and storage

1. Planned Activities
   • Refine cost estimates.

2. Accomplishments
   ✓ Internal and external data collected.

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

4. Plans for Next Quarter
   • Continue to refine cost estimates.

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

1. Planned Activities
   • Continue LCA for real case studies.
2. Accomplishments
   ✓ A paper on integrated TEA and LCA of base case was completed and is in process of journal submission;
   ✓ Started the LCA of real cases, including pellet biofuel and biopower generation;
   ✓ Two manuscripts were drafted and are in preparation; one is on cost and LCA of biomass for district heating in New England; a second will explore temporal aspects of life cycle greenhouse gas emissions from forestry biomass used in thermal and biofuel applications.

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

4. Plans for Next Quarter
   • Continue TEA and LCA work.
Thrust 4: System Performance and Sustainability Metrics

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.

Task 4.1: Site- and crop-specific knowledge gaps
Task 4.1.1: Biomass production

1. Planned Activities
   - Complete plant sampling at Rockview (Dennison, Montes);
   - Continue working on Cangiano’s manuscript (Cangiano);
• Continue cooperation with Feedstock Improvement to analyze multi-location willow yield data (Fabio, Montes);
• Harvest at Rockview and Rock Springs in winter 2015/2016 (Kemanian);
• Sample switchgrass and soil at Ithaca site. Ithaca site has three Nitrogen levels (0, 50, 100 lb/a) on established blocks of ‘Shawnee’ switchgrass (Viands, Hansen, Crawford).

2. Accomplishments
   ✓ Sampling at Rockview completed, 36 willow plants collected from six cultivars at Rockview;
   ✓ All eddy covariance data from 2015 has been downloaded and will be integrated with 2014 data;
   ✓ Harvest of 34 acres of willow at Rockview completed (first week of January 2016). Average yield was 17.8 wet tons/ac, with a maximum yield of 24 wet tons/ac in stands with good establishment in the planting year. Average harvest speed during the effective operative time of the harvester was 1.8 ac/hour (31 wet tons/hour), with a maximum speed slightly above 2.0 ac/hour.
   ✓ Both yield and samples for moisture were taken from each of the 132 rows of the experiment;
   ✓ Sampling at Ithaca completed for the third year. This is the final occasion on which these samples will be collected. Switchgrass samples are ground and ready for NIR analysis (Viands, Hansen, Crawford).

Harvest at Rockview, PA, with the New Holland FR9090 Forage harvester from Celtic Energy.

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

4. Plans for Next Quarter
   • Analyze harvested data at Rockview, including a survey of the stand and samples moisture;
- Continue working on Cangiano’s manuscript (Cangiano);
- Continue cooperation with Feedstock Improvement to analyze multi-location willow yield data (Fabio, Montes);
- Soil samples are ready to be shipped to Dairy One. Yield data needs to be summarized. Data will be made available for all three years, three sampling dates per year for soil. Analyses, biomass yield, and biomass quality. Biomass quality data are not available for 2014 Harvest 1 (Viands, Hansen, Crawford).

**Task 4.1.2: Nitrogen demand and alternative supply**

1. **Planned Activities**
   - Continue monitoring experiments (routine);
   - Submit rye and stover manuscript for review (Ramcharan, Richard, Kemanian);
   - Grind willow samples for $^{15}$N analysis (Dennison);
   - Finish individual plant harvest (Dennison);
   - Finish field harvests.

2. **Accomplishments**
   - Plants from Rock Springs have been harvested and placed in cold storage; plant by plant processing still ongoing (Dennison);
   - Plants from Geneva will be harvested during the week of January 25, 2015 (96 plants).

3. **Explanation of Variance**
   The rye manuscript will be submitted next quarter. No other variances to report.

4. **Plans for Next Quarter**
   - Continue monitoring experiments (routine);
   - Submit rye and stover manuscript for review (Ramcharan, Richard, Kemanian);
   - Finish or make progress grinding willow samples for $^{15}$N analysis (Dennison);
   - Complete growth analysis of 15N trial that includes unfertilized controls and fertilized individual plants.

**Task 4.1.3: Nitrous oxide emissions**

1. **Planned Activities**
   - Continue simulation of N$_2$O emissions (Saha, Montes);
   - Work with Brian Richards to simulate the N$_2$O emissions measured at the Ithaca site (9 days of measurements across multiple treatments) (Saha, Kemanian, Montes);
• Submit a new manuscript reporting N₂O measurements in Miscanthus, switchgrass, and CRP (Saha);

2. **Accomplishments**
   ✓ Manuscript ready for submission to Global Change Biology-Bioenergy on N₂O emissions in perennial grasses;
   ✓ Simulations in BCAP area for grasses (miscanthus and switchgrass) continue at good rhythm; simulations for willow not started yet.

3. **Explanation of Variance**
   Harvest preparations and N₂O manuscript preparation delayed work on Richards' data. No other variance to report.

4. **Plans for Next Quarter**
   • Continue simulation of N₂O emissions (Saha, Montes);
   • Work with Brian Richards to simulate the N₂O emissions measured at the Ithaca site (9 days of measurements across multiple treatments) (Saha, Kemanian, Montes);
   • Submit a new manuscript reporting N₂O measurements in Miscanthus, switchgrass, and CRP (Saha); we are only waiting for feedback from co-authors on the last version.

**Task 4.1.4: Carbon storage**

1. **Planned Activities**
   • Send all eddy covariance equipment to Campbell Scientific for a thorough check and recalibration (Montes).

2. **Accomplishments**
   ✓ The four eddy covariance towers were dismantled and sent for calibration taking advantage of the need to harvest and cold winter temperatures. This was a very time-intensive operation.
   ✓ Washing, drying, and grinding of root biomass samples is complete and samples have been sent for C and N concentration analysis.

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

4. **Plans for Next Quarter**
   • Send all eddy covariance equipment to Campbell Scientific for a thorough check and recalibration.
Eddy covariance tower above the willow canopy at Rockview. The tower was removed for harvest and the sensors will be sent for calibration before the beginning of the growing season. Handling the calibration in the winter time minimizes data losses due the low CO$_2$ flux during the cold winter months. (Montes)

**Task 4.2: Benchmark scenarios**

1. **Planned Activities (broad plans)**
   - Continue simulations for both annual and perennial crops;
   - Finish simulations of BCAP area;
   - Complete preparation of local and regional yield database.

2. **Accomplishments**
   - The simulations of for switchgrass in the OH-PA BCAP area are being compared with measurements and prediction with the PRISM-EC model. Current results indicate a substantial agreement between data and models and among models for this area;
   - Simulations for Constableville (NY) and Lancaster (PA) going through the same process for both grasses and willow.

3. **Explanation of Variance**
   We have not completed the model-to-model comparison (PRISM-EC vs Cycles) so we did not deliver the database to the NEWBio team. In addition, we only have a partial pixel by pixel database from PRISM EC (data for NY has been requested). As soon as we obtain this database we will complete the comparison.

4. **Plans for Next Quarter**
   - Continue simulations for both annual and perennial crops;
   - Finish simulations of BCAP area;
   - Complete and deliver to NEWBio a local and regional yield database, pending access to intra-county data from PRISM-EC.
Task 4.3: Regional feedstock supply and environmental assessment

1. Planned Activities
   - Continue work on the manuscript to Biomass and Bioenergy (Woodbury et al), regarding the services provided by switchgrass in the Chesapeake Bay.

2. Accomplishments
   - Substantial progress has been made in assembling an abstract and a working draft on the Chesapeake Bay ecosystem services manuscript.

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

4. Plans for Next Quarter
   - Complete the manuscript for the special issue of Biomass and Bioenergy (Woodbury).

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

1. Planned Activities
   - As in previous quarter, continue data collection to compile techno-economic analysis (TEA) models;
   - Continue work on sustainability matrix towards a specific example, possibly the BCAP area in Ohio / PA, now expanded to case studies in WV, NY, PA, and PA-OH.

2. Accomplishments
   ✓ A manuscript is in preparation on biomass for space heating (also reported under HPL thrust).

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

4. Plans for Next Quarter
   - Data collection and assembly will fulfill now the case study list developed in December.
   - A manuscript on time-dependent life cycle GHG emissions is under preparation along with literature review and data collection.
Thrust 5: Safety and Health in Biomass Feedstock Production and Processing Operations

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” is underway in Year 3.

Task 5.1: Biomass safety program development

1. Planned Activities
   - Completion of respiratory “LearnNow” video

2. Accomplishments
   - The topic of biomass production respiratory hazards is complicated and will require additional work and research planning before undertaking video production. Planning is underway for Pankaj Kuhar’s spring and summer 2016 research activities. This will include visits to NEWBio stakeholders Aloterra and Ernst Biomass to understand the respiratory issues and how they are handled at these production sites.

3. Explanation of Variance
   - Program safety video development and production shifted from respiratory hazards to the use of marginal lands for biomass production and hazards involved with these locations (slopes, poor drainage, proximity to stream banks or other drop-offs, e.g.).

4. Plans for Next Quarter
   - Completion of the marginal lands “Learn Now” video.

Task 5.2: Safety and health hazard inventory

1. Planned Activities
   - Revisit miscanthus and switchgrass operations with fire professional involved with biomass fire seed grant. Obtain images related to the fire professional’s observations.
   - Continue respiratory investigation methods with graduate student pursuing project in this area.
• In cooperation with the Extension thrust, continue to pursue the material available to NEWBio equipment program users.

2. Accomplishments
• Respiratory methodology investigated for graduate student involved with biomass processing. Equipment needs, availability and cost better understood and grant application submitted for aid in funding needed equipment.
• Traveled with fire professional and visited both the miscanthus and switchgrass partners in northwestern PA and northeastern OH to introduce the fire professional to those organizations. These partner organizations will work with the safety thrust to identify fire hazards, especially those unique to biomass production compared to other agricultural operations.
• Fire professional consulting through seed grant project has begun his investigations into the fire hazards present in biomass operations and the requirements of training for rural fire companies operating with biomass operations within their protection area.
• Graduate student working in the respiratory area visited with miscanthus and switchgrass producers to explain methodology of on-site respiratory research for spring/summer of 2016. Initial response by biomass partners on requirements of partners in this research was positive.
• NEWBio equipment that is used for harvesting purposes is now lent only with the operator along. This means that only an experienced operator will be running the equipment and new operators will not be running this equipment as previously believed.

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

4. Plans for Next Quarter
• Continue respiratory investigation methods with graduate student pursuing project in this area.
• Fire professional will continue his investigations into the fire hazards of biomass production, needs of rural fire companies dealing with a biomass industry within their protection zone, and other issue.
• In cooperation with the Extension thrust, continue to pursue the material available to NEWBio equipment program users.
Task 5.3: Develop, conduct and evaluate a comprehensive safety and health management program

1. Planned Activities
   - Webinar introducing “Safety and Health Management Planning for Biomass Producers” through the NEWBio project;
   - Promotion of this manual through the Extension Thrust.

2. Accomplishments
   ✓ Presentation of manual to NEWBio members through All Hands Meeting presentation on October 22, 2015.

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

4. Plans for Next Quarter
   - Procure and distribute copies of “Safety and Health Management Planning for Biomass Producers” to producers and NEWBio stakeholders in PA, NY and possibly other NEWBio partner states;
   - Introduce other CAP projects to the availability of this manual.
Thrust 6  Extension

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.

Task 6.1: Integrated demonstration sites

1. Planned Activities
   - Complete necessary planting, replanting, maintenance, and harvesting activities at demonstration fields as seasonally appropriate;
     - Crop scouting tasks: Follow up on GPS data collected around low growing areas with GIS analysis of soil properties;
   - Work with equipment access task priorities to target harvesting in demonstration areas for field days, harvesting observation, etc.;
   - Continue developing other outreach opportunities via field days, tours, and demonstrations. In this quarter, special attention is placed on National Bioenergy Day activities;
   - Continued assistance and coordination by extension staff to facilitate research in demonstration regions;
   - Especially in continuing to facilitate human systems focus group research and investigations related to water quality, harvesting, yield, etc.
2. Accomplishments

✓ NY Demonstration site
  o Completed necessary planting, replanting, maintenance, and harvesting activities at demonstration fields as seasonally appropriate;
    ▪ Crop scouting undertaken to identify where replanting and other maintenance activities would be required in spring;
  o Local presentations, publications, field events on NEWBio work relevant to demonstration site completed (see Publications and Products for details):
    ▪ New York Farm Bureau Media Tour;
    ▪ South Jefferson High School Field Tour;
    ▪ Copenhagen High School Field Tour.

o Stakeholder Engagement:
  ▪ Following up with BCAP enrollment: drafted a list of BCAP barriers and potential solutions to help stakeholders in this demo area better seize future BCAP opportunities;
  ▪ Fielded general inquiries about willow potential, 1-on-1 basis;
  ▪ Discussions were held with a group exploring repowering the Huntley power plant in western NY to include biomass. Information on willow crop potential and associated anticipated job creation was shared;
  ▪ Two loads of leaf-on willow harvested from Constableville yield trial were provided to a local stakeholder with biomass boiler and a 16,000 square-foot building interested in burning and possibly growing willow. From a follow-up interview:
    • Size and consistency of willow chips were suitable for his boiler;
    • Noticeable increase in ash content over debarked hardwoods;
    • Feedstock does not dry out effectively when spread out outside with a little bit of rain; advised to leave it in piles, and he has since moved it to inside storage. Burned acceptably when green, right after delivery;
    • Mixed with hog fuel and other low grade chips, and burned 100% willow. No major differences in system operation, but low heating demand now. Planning to mix willow with debarked hardwood as the weather gets colder and demand increases. Energy content seems to be high relative to other feedstocks he is burning.
  o Assisted with coordination and organization of harvesting schedule for willow plantings in this region – see task 6.2;
  o Repairs and maintenance are being conducted on the SUNY-ESF FX45 harvester and CRL header to prepare it for trial harvesting in Geneva;
  o Continued assistance and coordination by extension staff to facilitate research in this demonstration region;
Student research continues on demonstration plantings. Otherwise, no new activities reported.

**NW PA/NE OH Demonstration site:**
- Local presentations, publications, field events on NEWBio work relevant to demonstration site completed (see Publications and Products);
  - National Bioenergy Day Live Outreach Events:
    - Switchgrass Crop and Pellet Plant Open House and Tour;
    - Forest, Fields, and Home Open House and Tour;
    - Wood Energy Open House.
  - National Bioenergy Day Remote Outreach Events:
    - Webinar: Biomass Energy and Pennsylvania’s Clean Power Plan;
    - Webinar: Biomass on the Farm - Staying Safe and Healthy;
- Assisted with coordination and organization of harvesting schedule for willow plantings in this region – see task 6.2;
- Consultation given on Philipsburg reclamation site planting plan, conventional tree planting vs. energy crops, by Michael Jacobson (Penn State);
  - Working on testing switchgrass and willow on site.
- Continued assistance and coordination by extension staff to facilitate research in this demonstration region;
  - In support of human systems research in this demonstration region:
    - Hosted human systems focus group at local office on October 27, provided presentation on bioenergy activity and potential in the region to serve as basis for focus group discussion;
    - Assisted with follow-up to focus group activities, including facilitating next discussion or outreach for one-on-one meetings.

**WV Demonstration site:**
- Necessary maintenance/management applied to planted demonstration areas;
  - All seven research sites (containing switchgrass and miscanthus) were harvested for biomass estimates this year. The samples will be dried and weighed. Some of the miscanthus and switchgrass biomass will be prepared and analyzed by Near-Infrared Reflectance Spectroscopy to determine carbohydrate contents and estimate theoretical ethanol yield. Soil samples will also be extracted and analyzed;
  - Four willow sites continue to be monitored.
- Continued assistance and coordination by extension staff to facilitate research in this demonstration region;
  - Student research continues on demonstration plantings. Otherwise, no new activities reported.
3. **Explanation of Variance**
   Activities and accomplishments are on schedule. No variance to report.

4. **Plans for Next Quarter**
   - Complete necessary planting, replanting, maintenance, and harvesting activities at demonstration fields as seasonally appropriate;
   - Work with equipment access task priorities to target harvesting in demonstration areas for field days, harvesting observation, etc.;
   - Continue developing other outreach opportunities via field days, tours, and demonstrations
     - Tabling at the PA Farm Show is a major event for next quarter;
     - Explore outreach opportunities related to planned harvest activities;
   - Continued assistance and coordination by extension staff to facilitate research in demonstration regions;
   - Especially in continuing to facilitate human systems focus group research and investigations related to water quality, harvesting, yield, etc.

**Task 6.2: Biomass equipment access program**

1. **Planned Activities**
   - Continue managing scheduling and distribution of equipment;
   - Continue investigating safety procedures, updating knowledge on this subject;
   - Make progress on the current proposed harvesting schedule (listed in this report under “accomplishments”) as time/equipment/other factors permit;
   - Continue identifying potential buyers of material yielded from harvesting activity on research lands;
   - Clarify how Celtic breakdown will affect harvesting plan, explore alternatives.

2. **Accomplishments**
   - Continued monitoring use of machine reservation schedule;
   - Completed Harvests (about 130 acres)
     - Celtic Energy
       - (1) Ava, NY
         - (a) About 90 planted acres
     - SUNY-ESF
       - (1) Constableville, NY
         - (a) 1.5 acre yield trial
       - (2) Solvay, NY (completed)
         - (a) About 30 acres
(b) Bioremediation site, unusual ground conditions.

✓ Cornell NY Sites
  (1) Fredonia, NY (Yield/amendment trial)
    (a) 1.5 acres, 2 year old

✓ Pennsylvania (NEWBio sites and East Lycoming School)
  (1) Rock Springs
    (a) yield trial (1 acres, 1.5 days)
    (b) polyculture trial (3 acres, 0.5 day)
  (2) Hughesville, PA (East Lycoming School)
    (a) 15 acres

✓ Planned Harvesnts
✓ SUNY-ESF
  (1) Syracuse, NY (Lafayette Road)
    (a) 25-30 acres

✓ Cornell NY Sites
  (1) Verona, NY (Vernon-Verona-Sherrill High School)
    (a) 4 acres
    (b) Biomass could be delivered to Renmatix
  (2) Geneva, NY (various)
    (a) About 27 acres

✓ Pennsylvania (NEWBio sites)
  (1) Rockview
    (a) 30 acres

✓ Quebec
  (1) AGRINOVA Sites
    (a) Two 25-acre willow fields
    (b) One 2-acre poplar trial

✓ Several site visits to coordinate harvesting plans have taken place;
✓ Safety procedures regarding machinery, logistics continue to be monitored based on
  existing systems (field visits to current biomass operations);
✓ Fact sheet detailing “willow upgrade” machinery allowing a dairy FR harvester to operate
  in willow has been drafted and is in review detailing willow harvest machinery costs.
  This follows interest from last quarter into organizing such a list of upgrades.

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

4. Plans for Next Quarter
• Continue managing scheduling and distribution of equipment;
• Continue investigating safety procedures, updating knowledge on this subject;
• Make progress on the current proposed harvesting schedule (see Accomplishments) as
  time/equipment/other factors permit;
• Explore outreach opportunities associated with harvesting activities;
• Continue identifying potential buyers of material yielded from harvesting activity on research lands.

Task 6.3: Small business and economic development

1. Planned Activities
• Complete a marketing fact sheet based on lessons learned from supply chain research;
• Continue work on biomass business models:
  o Biomass transportation models – research transportation structure in biomass industry;
  o Supply chain risk survey – submit to Penn State IRB and administer to selected members of the NEWBio research team;
  o Identify respondents for the survey on biomass business models;
• In conjunction with the Human Systems thrust, develop plan for assessing supply chains of demonstration sites;
• Begin discussing plans for small business development work to be completed over the final two years of the project

2. Accomplishments
✓ Planned marketing fact sheet draft is completed and is in review.
✓ Biomass business model work
  o Biomass transportation models
    ▪ Literature search is complete, questionnaire is being developed.
  o Supply chain risk survey
    ▪ Questionnaire is complete, but progress is delayed due to IRB requirements.
    ▪ Plans are to administer this in early summer (Q2 or Q3)
  o Identify respondents for the survey on biomass business models.
    ▪ Exploring possibility of collaboration with Human Systems Thrust work.
✓ In conjunction with the Human Systems thrust, develop plan for assessing supply chains of demonstration sites
  o Collaboration plan has been developed, to begin by compiling information within NEWBio, then applying to SCOR framework;
✓ With Extension Thrust input, Saurabh Bansal has developed a case study on biomass supply chains for an MBA class this semester before further refinement for publication.

3. Explanation of Variance
Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter

- Planned marketing fact sheet draft is completed and is in review;
- Biomass business model work:
- Biomass transportation models:
  - Literature search is complete, questionnaire is being developed;
- Supply chain risk survey:
  - Questionnaire is complete, but progress is delayed due to IRB requirements;
  - Plans are to administer this in early summer (Q2 or Q3);
- Identify respondents for the survey on biomass business models:
  - Exploring possibility of collaboration with Human Systems Thrust work;
- In conjunction with the Human Systems thrust, develop plan for assessing supply chains of demonstration sites:
  - Collaboration plan has been developed;
    - Begin by compiling information within NEWBio, then applying to SCOR framework;
- With Extension Thrust input, Saurabh Bansal has developed a case study on biomass supply chains for an MBA class this semester before further refinement for publication.

Task 6.4: Expand eXtension.org for willow and warm-season grasses

1. Planned Activities

- Maintain and update NEWBio index of resources on eXtension website;
- Manage NEWBio Ask an Expert section on the eXtension site;
- Publish two expert bios for NEWBio extension collaborators on eXtension;
- Publish information sheet providing overview of NEWBio commercial collaborators;
- Publish two research summaries:
  - Maximizing Planted Area and Biomass Production in Shrub Willow Bioenergy Fields -Heavey and Knipfing;
  - EcoWillow 2.0: An Updated Tool for Financial Analysis of Willow Biomass - Heavey and Volk;
- Publish two case studies of successful biomass businesses:
  - ReEnergy Holdings: Offering Markets for Biomass in the Northeast - Harlow;
  - Renmatix Turns Biomass into Sugars for Industrial Use - Harlow;
- Publish two fact sheets:
  - Anthracnose (Colletotrichum navitas) of Switchgrass - Hoffman, Chaves, Mayton, Weibel, Bonos;
- Continue posting NEWBio webinars to eXtension Learn;
- Utilize eXtension Farm Energy and NEWBio Facebook and Twitter accounts to broadcast NEWBio events and resources;
- Interaction with other CAPs-Extension – use network to improve outreach efforts.
2. **Accomplishments**

- NEWBio index of resources updated and maintained on eXtension website;
- No 'Ask an Expert' questions were fielded (0 posted this quarter);
- NEWBio webinars continue to be posted to eXtension Learn;
- Facebook and Twitter used to broadcast NEWBio events and resources;
- Joined Cross-CAP calls to discuss outreach techniques within other bioenergy CAPs, marketing strategies/industry interactions (1+):
  - Early in the quarter, coordinated with other CAPs to cross-promote a week of webinars around National Bioenergy Day, with contributions from all CAPs. Our “Biomass on the Farm: Staying Safe and Healthy” presentation was NEWBio’s contribution to this series;
- December 10 meeting focused on organizing a “Biomass in the Clean Power Plan” Webinar Series; this series will be a major collaborative effort between the CAPs to advertise and find speakers for this series.

3. **Explanation of Variance**

Coordinators for eXtension resources within NEWBio have recently experienced staffing changes and delays in publications output due to unplanned leaves of absence. Planned publications activities related to eXtension have therefore been postponed. Many of these materials have already undergone the review process and are almost complete; we aim to publish most of these previously planned materials in the next quarter.

4. **Plans for Next Quarter**

- Maintain and update NEWBio index of resources on eXtension website;
- Manage NEWBio Ask an Expert section on the eXtension site;
- Publish two expert bios for NEWBio extension collaborators on eXtension;
- Publish information sheet providing overview of NEWBio commercial collaborators;
- Publish two research summaries:
  - Maximizing Planted Area and Biomass Production in Shrub Willow Bioenergy Fields - Heavey and Knipfing;
  - EcoWillow 2.0: An Updated Tool for Financial Analysis of Willow Biomass - Heavey and Volk;
- Publish two case studies of successful biomass businesses:
  - ReEnergy Holdings: Offering Markets for Biomass in the Northeast - Harlow;
  - Renmatix Turns Biomass into Sugars for Industrial Use - Harlow;
- Publish two fact sheets:
  - Anthracnose (Colletotrichum navitas) of Switchgrass - Hoffman, Chaves, Mayton, Weibel, Bonos;
Market Opportunities for Biomass - Paperboard [name TBD] - Ruamsook; Thomchick - this will provide a prototype for other papers on alternate markets;

- Continue posting NEWBio webinars to eXtension Learn;
- Utilize eXtension Farm Energy and NEWBio Facebook and Twitter accounts to broadcast NEWBio events and resources;
- Interaction with other CAPs-Extension – use network to improve outreach efforts.

Task 6.5: Interactive and innovative learning-lessons tools

1. Planned Activities
   - Continue developing “successful biomass industry” profile series for publication;
   - Continue NEWBio outreach at field days, presentations, events;
   - Continue delivery of bioenergy webinars;
   - Continue to prepare fact sheets;
   - Continue to populate website, NEWBio blog;
   - Continue to complete educational presentations;
   - Send out monthly e-newsletter;
   - Utilize NEWBio social media presence (Facebook, Twitter) to broadcast NEWBio events.

2. Accomplishments
   - Staffing changes and subsequent publication delays (see task 6.4) have postponed the publication of planned materials until next quarter, but most biomass industry profiles, research summaries, fact sheets, etc. are through the review process and very close to publishing readiness;
   - Bioenergy webinars delivered monthly (see deliverables). December’s webinar had to be postponed due to problems with Adobe Connect software, but was rescheduled for January. Two presentations in October for National Bioenergy month kept us on track for three presentations this quarter;
   - Multiple field days and tours completed at demo sites in addition to several tabling/poster presentation opportunities (see Publications and Products);
   - NEWBio website remains up-to-date and a major source of traffic to external sites—eXtension resources, webinar attendance, blog, etc.;
   - New version of Willowpedia (http://willow.cals.cornell.edu/) was launched on October 21. It is based on WordPress, is easier to maintain and update, is scalable for phones and tablets, and has a blog function for news updates;
   - ESF Willow website (http://www.esf.edu/willow/) statistics: 2,702 total pageviews, 390 downloads of willow brochure, 300 visits to publications page, EcoWillow accessed 245
times, 200 views of living snow fence resource, 50 visits to NEWBio section, 50 visits to BCAP section;

✓ Northeast Energy Blog progress:
  o Three blog entries completed this quarter:
    ▪ Heavey, J. October 12, Sustainable Forestry Initiative, Renergy, ESF Tree Planting Record Official. 58 views.
    ▪ Wurzbacher, S. November 10, Reflections on Switchgrass as Poultry Bedding Webinar. 64 views.
    ▪ Heavey, J. December 22, Willow Harvesting Updates. 86 views.
  o Blog pageviews reached an all-time high of 1,090 views/month in October (2,713 total views this quarter) with 208 direct views to date for this quarter’s posts;

✓ Multiple relevant presentations completed (see Publications and Products);
✓ E-newsletters with NEWBio news and events sent out monthly (see Publications and Products);
✓ Maintained active social media presence via Facebook, Twitter.

3. Explanation of Variance
Activities and accomplishments are on schedule, with the exception of publications delays noted in task 6.2. No variance to report.

4. Plans for Next Quarter
• Continue developing “successful biomass industry” profile series for publication;
• Continue NEWBio outreach at field days, presentations, events;
• Continue delivery of bioenergy webinars;
• Launch new “Bioenergy in the Clean Power Plan” webinar series with the cooperation of other Bioenergy CAPs;
• Continue to prepare fact sheets;
• Continue to populate website, NEWBio blog;
• Continue to complete educational presentations;
• Send out monthly e-newsletter;
• Utilize NEWBio social media presence (Facebook, Twitter) to broadcast NEWBio events.
Thrust 7  Education

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.

Task 7.1:  Secondary educator training

1. Planned Activities
   - Begin planning for Y4 workshops;
   - Initiate follow-up support of past program participants, thanks to NEWBio seed grant support for this activity.

2. Accomplishments
   ✓ Dates have been selected for 2016 workshops in West Virginia (20-24 June) and Pennsylvania (11-15 July). We are excited to announce that we will be holding a workshop in New York State in 2016 (date TBD);
   ✓ The Center for Science and the Schools (CSATS) is reaching out to former participants in the workshops and carrying out follow-ups.

3. Explanation of Variance
   Activities and accomplishments are on schedule, with the addition of one extra planned workshop. No variance to report.

4. Plans for Next Quarter
   - Market workshops to schools;
   - Finalize plans for New York State workshop.

Task 7.2:  Regional Bioenergy Scholars

1. Planned Activities
   - Participant assessment will be carried out;
   - Mentors and project topics will be identified for Y4;
• Recruitment will begin for Y4.

2. Accomplishments
   ✓ Scholars were asked to complete an assessment survey of their experiences;
   ✓ Mentors and project topics were identified and posted;
   ✓ Announcements have been distributed of NEWBio opportunities, via website and email.

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

4. Plans for Next Quarter
   • Continue recruitment for Y4;
   • Scholars will be selected for Y4.

Task 7.3: Graduate distance education in bioenergy

1. Planned Activities
   • Complete delivery of ABE 884 – Bioenergy Systems; ABE 888 – Bioenergy Harvest and Logistics.
   • Market program.

2. Accomplishments
   ✓ ABE 884 and 888 were completed;
   ✓ Four scholarships were awarded for FORestry 880 during Spring Semester 2016:
     o Kara Cafferty
     o Mohit Rastogi
     o Kittikun Songsomboon
     o Gonca Yilmaz

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

4. Plans for Next Quarter
   • Complete delivery of FOR 880;
   • Market program.
Thrust 8 Leadership, Stakeholder Involvement, Knowledge-to-Action (K2A) and Program Evaluation

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.

Task 8.1: Executive and thrust conference calls

1. Planned Activities
   - Continue monthly teleconferences for Executive Committee and Leadership teams.

2. Accomplishments
   - Held Executive Committee teleconferences on October 8, November 5 and December 3;
   - Held Leadership teleconferences on October 15, November 12, December 4 and December 10.
   - Held a total of 12 thrust and working group teleconferences to address such subjects as the data management, switchgrass harvesting, feedstock budgets, ecosystem services, and techno-economic analysis efforts.

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

4. Plans for Next Quarter
   - Continue monthly scheduling for Executive Committee and Leadership team meetings.
   - Continue participation in thrust team meetings.
Task 8.2: All Hands teleseminars and meetings

1. Planned Activities
   - Continue monthly teleseminar schedule to deliver project updates and share thrust progress toward goals and objectives.
   - Engage thrusts, especially graduate students and corporate stakeholders, in the planning and organization of our monthly teleseminars and the August annual meeting.

2. Accomplishments
   ✓ Held three All Hands teleseminars on October 22, November 19 and December 17, with these presentations:
     ○ October 22 featured a project team exercise on communication: *Deliberate Listening to Deepen Collaborative Capacity*. The exercise was led by NEWBio external evaluators Laura Lindenfeld and Jessica Leahy (both from the University of Maine).
     ○ November 19 featured presentations by NEWBio's Safety and Health and Human Systems thrusts. Doug Schaufler (Penn State) introduced the Safety team's new manual, *Safety and Health Management Planning for Biomass Producers* (see Appendix D). Wes Eaton (Penn State) gave a social science research update on findings from the Human Systems team's landowner interviews, key stakeholder focus groups and their landowner survey.
     ○ December 17 was devoted to an overview with key findings and recommendations from Laura Lindenfeld (University of Maine) on Lindenfeld and Jessica Leahy (also from UMaine)

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

4. Plans for Next Quarter
   - Schedule Spring 2016 All Hands teleseminar topics/speakers.

Task 8.3: External Advisory Board meetings and strategic planning

1. Planned Activities
   - Board members will be kept informed of NEWBio meetings and field activities.
   - Invitations will be issued for additional board members to represent stakeholder groups identified as underrepresented at the annual meeting.
   - A mid-year meeting will be scheduled.
2. Accomplishments

✓ Following upon Board recommendations from NEWBio's annual meeting, the Leadership team discussed external stakeholders to whom invitations would be issued to enhance industrial, commercialization and environmental participation on the board.

✓ Polling will take place on a late-January/early February meeting date and time for a mid-year meeting.

3. Explanation of Variance

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

4. Plans for Next Quarter

• Hold a mid-year advisory board meeting.

Task 8.4: Task and project evaluation

1. Planned Activities

• Participate in leadership and team teleconferences. As part of the Year Three project evaluation:
  o Complete and analyze the Y3 evaluation survey distributed to the entire NEWBio project team.
  o Complete and tabulate Executive and Leadership Team interviews.
  o Complete and tabulate NEWBio Board and non-Board stakeholders interviews.


2. Accomplishments

✓ Year 3 Technical Report completed.

✓ Results delivered to NEWBio project team during December 17, 2015 All Hands Meeting. Approximately 57% of NEWBio team members responded to the survey request (leadership team members, senior personnel, graduate students and other participants responded). The survey itself

✓ Respondents continue to agree or strongly agree that the opportunity to collaborate on NEWBio with faculty in fields other than theirs is important to them.
  • Year 1: 95%
  • Year 3: 95%

✓ Respondents agreed or strongly agreed that the opportunity to collaborate on NEWBio with stakeholders outside of the university was important to them.
  • Year 1: 95%
  • Year 3: 89%

✓ Fewer respondents (but still many) agreed or strongly agreed that NEWBio could serve as a model research project for interdisciplinary research.
  • Year 1: 92%
  • Year 3: 72%
replicated the Year 1 survey, and the evaluators called out a few results particularly as they related to communication and collaboration.

The table below summarizes key recommendations for the project and areas where opportunities to strengthen the team exist.

<table>
<thead>
<tr>
<th>Key Strengths:</th>
<th>Key opportunities:</th>
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<tbody>
<tr>
<td>- Strong team in place across disciplines</td>
<td>- Build on strengths</td>
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<tr>
<td>- Frequent communication and high levels of collegiality</td>
<td>- Focus – demo sites, business development</td>
</tr>
<tr>
<td>- Good focus within themes</td>
<td>- Alternative market</td>
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<tr>
<td>- Emergence of cross-thrust foci: Ecosystems services</td>
<td>- Collaboration and cooperation</td>
</tr>
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</table>

**Recommendations**

- Shake things up a bit!
- Reframe the story from a higher scale
- Create permeable boundaries
- Focus, focus, focus internally and on mission and vision specifically
- Enable mission and vision to inform stakeholder engagement
- Make leadership a theme
- How will you share best practices with other groups?

3. **Explanation of Variance**

Activities and accomplishments are on schedule. No variance to report.
4. Plans for Next Quarter
   - Participate in leadership and team teleconferences.
   - Observe team interactions.
Appendix A

NEWBio Objectives
**TABLE 3.**

NEWBio Objectives

[Revised September 2015]

| I. | Understand the values, legacies, and motivations that drive perceptions and decisions about land management and business development for biomass energy and bioproduct systems. |
| II. | Generate price-supply curves, facility siting and forward contracting tools to provide entrepreneur and investor confidence in biomass feedstock supply. |
| III. | Develop and deploy as industry standards sustainable production practices for perennial grasses and short rotation woody crops to improve yield 25% and reduce costs by 20%. |
| IV. | Commercialize the current pipeline of improved willow (*Salix* spp) and switchgrass varieties and develop genomic tools to accelerate breeding for marginal land. |
| V. | Develop harvest, transport, storage and preprocessing systems that increase feedstock value as biomass moves through the supply chain toward advanced bioenergy, biochemical and biomaterial refineries. |
| VI. | Create a culture of safety in the biomass production, transport and preprocessing sectors that addresses machinery hazards and environmental risks to protect workers. |
| VII. | Transform standards of practice for biomass value chains to greatly improve carbon paybacks, net energy yields, soil and water quality, and other ecosystem services. |
| VIII. | Deploy safe, efficient and integrated supply chains in three demonstration regions, each providing 50 to 100 tons/day of high-quality low-cost sustainable biomass. |
| IX. | Create learning communities of farmers, entrepreneurs, employees and investors informed about the best practices and emerging technologies in their biomass interest areas. |
| X. | 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 SRWC and grasses. |
| XI. | 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. |
| XII. | 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. |
Appendix B

NEWBio Task List

Major Milestones and Timeline
# NEWBio Task List and Timeline

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<tr>
<td>Task 1.1</td>
<td>Understanding social and economic constraints</td>
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<td>Task 1.2</td>
<td>Assess demonstration sites as they pursue scale up of biomass crop production and supply chain infrastructure</td>
<td>O</td>
<td>X</td>
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<tr>
<td>Task 2.1</td>
<td>Breeding of non-invasive triploid hybrids of willow displaying hybrid vigor</td>
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<td>Task 2.2</td>
<td>Genetic basis for pest and disease resistance in willow and perennial grasses</td>
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<td>Task 2.3</td>
<td>Breeding and selection of cultivars adapted for NE conditions</td>
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<td>Task 2.4</td>
<td>Breeding and selection of willow and switchgrass yields on reclaimed mine lands</td>
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<tr>
<td>Task 3.1</td>
<td>Significantly reduce the harvesting cost per ton of biomass feedstocks from willow and perennial grasses in the NE</td>
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<td>O X</td>
<td>O X</td>
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<td>Task 3.2</td>
<td>Quantify the role of preprocessing for densification and storage on transportation efficiency and downstream fuel</td>
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<tr>
<td>Task 3.3</td>
<td>Assess the storage requirements and effects of long term storage on the quality of willow and perennial grasses</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<td>Task 3.4</td>
<td>Techno-economic analysis, cost engineering, and LCA of densification, storage, preprocessing, biorefinery integration</td>
<td>X</td>
<td>O X</td>
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<th>Thrust 4</th>
<th>System Performance and Sustainability Metrics</th>
<th>2012</th>
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<td>Task 4.1</td>
<td>Site- and crop-specific knowledge gaps</td>
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<td>Task 4.2</td>
<td>Benchmark Scenarios</td>
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<td>Task 4.3</td>
<td>Regional feedstock supply and environmental assessment</td>
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<td>Task 4.4</td>
<td>Biomass to biofuel LCA and multi-criteria assessments</td>
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<td>Task 5.1</td>
<td>Biomass Safety Program Development</td>
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<td>Task 5.2</td>
<td>Safety and Health Hazard Inventory</td>
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<td>O</td>
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<td>Task 5.3</td>
<td>Develop, conduct and evaluate a comprehensive safety and health management program</td>
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<td>O</td>
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# NEWBio Task List and Timeline

## Thrust 6: Extension

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<td>6.1 Integrated demonstration sites</td>
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<td>6.2 Biomass equipment access program</td>
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<td>6.3 Small business and economic development</td>
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<td>O</td>
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<td>6.4 ExpandExtension.org for willow and warm-season grasses</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>6.5 Interactive and innovative learning-lessons tools</td>
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## Thrust 7: Education

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<td>7.1 Secondary educator training</td>
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<td>7.2 Regional Bioenergy Scholars</td>
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<td>7.3 Graduate distance education in bioenergy</td>
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## Thrust 8: Leadership, Stakeholder Involvement, and Program Evaluation

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<td>8.1 Leadership, management and thrust team conference calls</td>
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<td>O</td>
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<td>8.2 All-Hands teleseminars and meetings</td>
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<td>O</td>
<td>O</td>
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<td>8.3 External advisory board meetings and strategic planning</td>
<td>O</td>
<td>O</td>
<td>O</td>
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<td>O</td>
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<tr>
<td>8.4 Task and project evaluation</td>
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<td>8.5 Administrative program evaluation</td>
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<td>X</td>
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<tr>
<td>8.6 Final evaluation and program report</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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</tr>
</tbody>
</table>

## Key Deliverables

- **Project Milestones**: O
- **Fact Sheets, Reports, Articles, Videos**: X

## Activity Level

- Low Activity
- High Activity
Appendix C

Safety and Health Management Planning for Biomass Producers

Developed by:
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Dennis J. Murphy, Ph.D., Nationwide Insurance Professor of Agricultural Safety and Health
Safety and Health Management Planning for Biomass Producers

PennState Extension
Agricultural Safety and Health Program
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College of Agricultural Sciences
The Pennsylvania State University

Developed by:
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Acknowledgment:
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Introduction

Agriculture is one of the most dangerous industries in the United States. As farmers and ranchers grow more biomass crops, they are exposed to the many hazards in the agricultural workplace each day. In particular, individuals who have been farming for less than ten years are particularly susceptible to worksite hazards due to their limited experience.

This best practices manual provides risk-reduction information and resources for agricultural entrepreneurs and will help biomass producers plan for effective safety and health management programs. This program planning manual has five units of recommended safety and health best practices for biomass production.

A safety and health management plan must be in a written format to be viable and effective. There can be serious legal and financial consequences for producers when workers or guests are injured or become ill and the farm has no written safety and health plan. Written safety and health plans should include these major components:

1. **Establishing Safety Policy and Procedures.** The safety policy statement for your business should be the foundation of your safety program. A safety policy is a statement of goals, objectives, and operational procedures that are created and approved by the highest-ranking owner/manager at the farm. The policy should be written and then shared with all workers on the farm. The policy should include the most important safety and health procedures that apply to all workers, family members, managers, and owners. It should also identify ways that workers are actively involved in the development and implementation of the plan.

2. **Identifying and Assessing Hazards and Risks.** A list of methods that the business can use to inspect and/or monitor the worksite for hazardous equipment, chemicals, and environmental conditions should be compiled. It should include control procedures for eliminating or reducing the hazard to employees, customers, and the general public. See examples of hazard inspection forms in this section.

3. **Preventing and Controlling Hazards and Risks.** The most positive approach to preventing injury and property loss is the elimination of hazardous conditions. Management should also make specific statements in the written safety program about risk reduction through the use of personal protective equipment (PPE).

4. **Educating and Training Employees.** All aspects of employee training and education related to hazardous work conditions and safe work procedures are part of safety and health planning. Both the timing and type of training are important. Training and education should take place before new workers start work, for hazards and risks identified during seasonal tasks, for workers who are in need of retraining, and to meet legal obligations. In order for the training and education to be effective, it should be completely described with appropriate evaluation methods and tools included.

5. **Evaluating Training Programs and Resources.** The only way to determine if safety and health training has been effective in correcting hazards and reducing risk is to evaluate the training program. Methods include:
   - Observing employees after the training has been conducted. This is referred to as “observational analysis.”
   - Administering short pre- and post-tests before and after the training session to determine if the desired knowledge gain has been achieved.
   - Having employees demonstrate their newly learned skills and capabilities after the training has been completed.

Samples of post-test evaluation tools are found in Unit 5.
Establishing Safety Policies and Procedures

The initial unit in this manual covers the importance of implementing safety policies that are appropriate for your business. You are also provided with suggestions for getting employees involved with, and committed to, following safety and health procedures that reduce their risk for injury and illness.

Safety policies describe the “who-what-when-where-why” of a company’s focus on safety and health. The policy should:

1. Express the importance of safety and health in your operation.
2. Include a statement of safety and health goals.
3. Identify who is responsible for various parts of the safety and health program.
4. Make clear that responsible parties have the authority to act as needed.
5. Identify general safety rules to be followed.
6. Establish accountability procedures for complying with the safety and health program.

Guidelines for general safety rules that are part of the safety policy should be:

1. Broad and cut across all hazards and all workers, including family members and management.
2. Simply stated for the least knowledgeable worker.
3. In a language that all workers can understand.
4. Logical and enforceable.
5. Developed through involvement of employees.

A written safety policy is only as effective as management’s support for it. If management doesn't follow the policies, workers can't be expected to follow them either. Talk is cheap; you have to demonstrate a commitment to your safety policy and procedures. Enforce your safety and health policies consistently across all employee levels within your business.

Your safety policy should specify who is responsible for what rules and procedures related to the written safety and health program. This is the accountability component mentioned above. One approach is to establish an organizational chart that spells out safety and health program responsibilities. For very small operations, this chart might be simpler or perhaps not needed.

Operator/manager:
- Establishes and promotes safety policy and procedures
- Identifies and corrects hazardous workplace conditions
- Purchases and provides appropriate PPE
- Enforces safety policy and procedures
- Conforms to OSHA recordkeeping requirements (see page 28 in Unit 3)

Supervisor/crew manager:
- Performs periodic safety inspections
- Reports and records safety problems
- Communicates safety procedures
- Provides employee safety and health training
- Evaluates and documents safety training
Workers:
- Follow safety policy and procedures
- Operate equipment in a safe manner
- Wear assigned PPE at all times
- Report hazards and close calls

Because it is has been documented that new employees have a higher injury rate than established workers during their initial six months of employment, the employer's safety policy must be discussed thoroughly with all workers during their first day on the job. Safety training should be a fundamental part of a new employee's orientation and integrated into the orientation schedule. Document the initial presentation of the safety and health policy to employees through both employee and supervisor signatures and dating of the signed document. Each employee should be given a personal copy of the document and a copy should be kept in the company's employment files. An example of this safety orientation document is shown as Figure 1.

Included in this unit are two examples of a safety and health policy. Figure 2 is for larger operations that may have numerous workers, while Figure 3 is for smaller operations that may have only a few workers, some of whom may be part-time employees. Both examples include an area to provide signatures and dates for documentation. These examples can be modified to suit your biomass operation. They are followed by suggestions for ways to get workers involved and enthusiastic about your safety and health management plan.

Getting Workers Involved and Enthusiastic

Below are suggestions for gaining support and participation by workers in your safety and health management plan. By implementing some or all of these suggestions, you are establishing a level of employee ownership for a safety and health plan that they can buy into. It demonstrates that you are truly committed to worker involvement in the planning and implementation of a full-time safety and health program with the best interests of all employees in mind.

Worker involvement suggestions:
1. Include workers in the development, review, and improvement of the safety policy.
2. Organize a joint worker-management safety committee, and establish a system for rotating active membership among your workforce.
3. Select workers to actively participate in hazard reviews and periodic safety inspections.
4. Involve workers in injury and property damage incident investigations.
5. Develop a system whereby workers can make safety suggestions and recommendations in a nonthreatening atmosphere at the workplace.
6. Recognize good safety practices and behaviors by workers with appropriate verbal and written acknowledgments and financial rewards.
7. Demonstrate desired safety behaviors by setting a good example at all times.
8. Be sure all worker safety and health training activities are conducted on company time and documented by trainers.
9. Enforce your safety and health policy and procedures consistently across all employee levels within your business.
10. Develop and implement safety recognition and incentive programs based on accepted safety behaviors rather than on injury reporting data.

Note: Basing recognition and incentive programs on injury data may encourage workers to hide minor injuries that could turn into major injuries because they weren't treated properly when the injury occurred.
New Employee Safety Orientation
(to be completed by the employee)

__________________________
Employee Name

__________________________
Date of Hire  Date of Orientation

□ New employee
□ Transfer
□ Rehire
□ Other: ____________________________

__________________________
Position/Job Assignment

Safety training will cover the following:
• Reporting of incidents or injuries to supervisor
• Responsibility of employees for safety
• Overview of safety regulations
• Hazards on the job
• Injury or incident prevention policies
• Required personal protective equipment (PPE)
• Workplace security policies
• Calling for help/using 911
• Entrances/exits of buildings
• Location/operation of fire extinguishers
• Locations of first aid kits, eye wash stations, PPE, showers
• Locations and names of persons trained in CPR and first aid
• Procedure for chemical emergencies
• Severe weather procedures
• Safety committee policies and procedures
• Safe and correct way to perform required jobs
• Instruction on who to talk with when given a new or unfamiliar task

__________________________
Employee Signature

__________________________
Supervisor Name (print)

__________________________
Date

__________________________
Supervisor Signature

__________________________
Date

Figure 1 | Sample of new employee safety orientation checklist.
ABC Biomass Production, Inc.
Safety and Health Policy

The safety and health of workers on our farm is just as important as farm production output and product quality. Our farm will comply with all applicable workplace safety and health regulations and support and enforce occupational safety and health standards that equal or exceed the best practices for our industry. An employee safety committee that is representative of our entire employment team will be supported.

Based on input from all employees and managers, our farm’s specific work safety and health goals are to:
1. Strive to achieve a “zero incidents” goal.
2. Train our work staff to perform all work tasks safely.
3. Provide personal protective equipment (PPE) appropriate for all job activities.
4. Improve and maintain safe equipment and environmental conditions on the farm.
5. Perform regularly scheduled work inspections and document and remediate all hazards.
6. Prepare and train all employees to react appropriately under emergency conditions.
7. Establish a continual reporting system for “close call” and “near miss” incidents.
8. Reward workers appropriately for their safety and health achievements in the workplace.

Supervisors are responsible for training workers in specific safe work practices. Supervisors must enforce company rules and ensure that employees follow safe practices during their work. All workers have responsibility for their own safety as well as for the safety of their fellow workers. Workers are expected to participate in the safety and health program, which includes immediately reporting accidents, hazards, and unsafe work practices to a supervisor or safety committee representative; wearing required personal protective equipment; and participating in and supporting safety committee activities.

The following workplace safety rules apply to everyone employed at this farm operation:
1. No employee is required to do a job that he or she considers to be unsafe.
2. No horseplay will be tolerated at our farm worksites.
3. No illicit drugs or alcohol are permitted on the farm.
4. A No-Smoking policy is strictly enforced on our farm.
5. Injuries and/or unsafe work practices should be reported to management immediately.
6. Employees are not permitted to operate machines that they have not been trained on.
7. Failure to follow these safety rules can result in verbal or written warnings, job reassignment or retraining, or employment termination.

As a worker at ABC Biomass Production, Inc., I have read, understand, and will abide by the safety and health policies as stated above.

Name of Employee

Name of Manager

Signature of Employee   Date

Signature of Manager   Date

Figure 2 | Sample of policy statement for larger business firms.
ABC Biomass Production, Inc.
Safety and Health Policy Statement

The employees of ABC Biomass represent the key to the economic viability of our businesses. Our employees are the most important asset of our organization, and we take your health, welfare, and safety very seriously. Our commitment to a sustainable safety and health program includes written workplace safety procedures, training on identified worksite hazards, maintaining workplace equipment and tools in a safe manner, provision of personal protective equipment (PPE) as needed for all employees, first aid and CPR training, and adherence to all standards, rules, and regulations governing workplace safety and health.

The management team of ABC Biomass fully understands the organization’s obligation to protect our employees from risks and hazards found at the workplace, and we pledge to do our best to fulfill our responsibilities for implementing this policy statement and all associated safety and health workplace rules and guidelines.

By signing and dating this policy document, I pledge to support the efforts of ABC Biomass to maintain a workplace free of preventable injury and property damage incidents.

_________________________________________  ____________________________________________
Printed Name of Employee                  Printed Name of Management Representative

_________________________________________  ____________________________________________
Signature of Employee                      Signature of Management Representative

_________________________________________  ____________________________________________
Date                                        Date
Unit 2.
Identifying and Assessing Hazards and Risks

In this unit, you will learn about identifying and ranking hazards that can create unsafe work environments at your biomass operation. This is a three-step process: (1) hazard identification; (2) hazard assessment or analysis; and (3) prioritizing the hazards so that those with a higher degree of risk are corrected most quickly.

A hazard is any existing or potential condition that can result in injury, illness, death, and/or property damage or environmental loss. Therefore, almost anything on the farm can be considered a hazard. Common categories of hazards include tractors, machinery, equipment, buildings, structures, shops, hand and power tools, roadways, chemicals, and working surfaces. Hazards may involve activities such as driving tractors, preparing land for planting, maintenance of equipment or buildings, traveling between locations, lifting, etc.

For many operations, identifying hazards is a hit-or-miss, unplanned process where you or a worker stumble onto or notice a hazard at the workplace. Examples include damaged or missing PTO driveline guards, broken ladder rungs, burned-out security and/or safety lighting, and leaking or damaged fuel containers. However, a more structured and systematic process involving at least three actions for each hazard is more effective in identifying and assessing hazards and risks that need your attention.

These three actions are (1) a systematic method for identifying hazards; (2) assessment of the identified hazards; and (3) ranking or prioritizing the hazards for corrective action. Assessing and ranking hazards tend to overlap and intertwine as opposed to being discretely different functions. Let’s look at identifying hazards first.

Identifying Hazards

Identifying hazards, also commonly referred to as hazard auditing, is an ongoing process, and many tools exist to help with this process. The most common tool is a hazard inspection form, which is meant to remind you of existing and potential hazards. These inspection forms exist in a variety of formats. Some are simple checklists (Figure 4 and Figure 5), but the more useful inspection forms also allow you to designate how serious the hazard is, what action(s) might be needed to correct it, what the corrective action will cost, and a target date for implementing corrective action. See Figures 6 through 9 for examples of more useful hazard inspection forms.

Forms similar to these are available on websites from insurance companies, farm safety organizations, and land-grant universities, and at create.extension.org/node/88797.
## Simple Hazard Checklist
### General

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>NA*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractors/Machinery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS) on all tractors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seatbelt available on all ROPS tractors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTO master shields installed and undamaged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bypass starter covers installed</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SMV installed and undamaged for highway use</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Keys out of ignitions in secure storage area</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Facilities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shop area housekeeping rules established</td>
<td></td>
<td></td>
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<tr>
<td>Flammable fuels in approved containers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk areas maintained in slip-proof manner</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ladders maintained in safe condition</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Chemicals stored in designated and signed areas</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fire extinguishers charged and visible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoke and fire detectors installed and working</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Lockout/tagout capabilities available and used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Personal protective equipment (PPE)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing and eye protection available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separate storage area for PPE</td>
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<td></td>
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</tr>
<tr>
<td>Separate storage area for PPE</td>
<td></td>
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<tr>
<td><strong>Confined Spaces</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas detection equipment available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signage used to designate hazardous conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workers trained on confined space hazards</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not applicable. These potential hazards do not apply to my operation.*
## Simple Hazard Checklist
### Biomass Production

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>NA*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractors/Machinery</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS) on all tractors</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Seatbelt in good condition on all ROPS equipped tractors</td>
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</tr>
<tr>
<td>PTO master shields installed and undamaged</td>
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<tr>
<td>PTO driveline protection installed and undamaged</td>
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<tr>
<td>Bypass starter covers installed</td>
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</tr>
<tr>
<td>SMV installed and undamaged</td>
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<tr>
<td>Tires adapted or replaced for biomass conditions</td>
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</tr>
<tr>
<td>Windshields in good condition and protected if necessary</td>
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<tr>
<td>Steps and hand rails in good condition and clear</td>
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<tr>
<td>Cab heater working and in good condition</td>
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<tr>
<td>Cab air filtration working and in good condition</td>
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<td></td>
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<tr>
<td>Fire extinguisher charged and visible</td>
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<tr>
<td><strong>Indoor/Outdoor Facilities</strong></td>
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<tr>
<td>Biomass storage area flat, firm, and well drained</td>
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<tr>
<td>Biomass storage areas separated for fire control</td>
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<tr>
<td>Dust control in place</td>
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<td>Fire extinguisher charged and visible</td>
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<tr>
<td>Hearing and eye protection available</td>
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<tr>
<td><strong>Other</strong></td>
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<tr>
<td>Emergency plans in place</td>
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<tr>
<td><strong>Confined Spaces</strong></td>
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</tbody>
</table>

*Not applicable. These potential hazards do not apply to my biomass operation.

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**Figure 5** | Simple hazard checklist—biomass production.
Expanded Hazard Checklist
General

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>Action Required</th>
<th>Date Fixed</th>
<th>NA*</th>
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<tr>
<td>Workers trained on confined space hazards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not applicable. These potential hazards do not apply to my operation.

Figure 6 | Expanded hazard checklist—general.
## Expanded Hazard Checklist
### Biomass Production

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>Action Required</th>
<th>Date Fixed</th>
<th>NA*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractors/Machinery</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS) on all tractors</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seatbelt in good condition on all ROPS equipped tractors</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PTO master shields installed and undamaged</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PTO driveline protection installed and undamaged</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bypass starter covers installed</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SMV installed and undamaged</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Tires adapted or replaced for biomass conditions</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windshields in good condition and protected if necessary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steps and hand rails in good condition and clear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cab heater working and in good condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cab air filtration working and in good condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire extinguisher charged and visible</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Indoor/Outdoor Facilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Biomass storage area flat, firm, and well drained</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Biomass storage areas separated for fire control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust control in place</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fire extinguisher charged and visible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing and eye protection available</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency plans in place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not applicable. These potential hazards do not apply to my biomass operation.*

---

**Figure 7** | Expanded hazard checklist—biomass production.
## Safety Priority Hazard Checklist
### General

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>Priority</th>
<th>Target Date</th>
<th>NA*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractors/Machinery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS) on all tractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seatbelts available on all ROPS tractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTO master shields installed and undamaged</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTO driveline protection installed and undamaged</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bypass started covers installed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMV installed and undamaged for highway use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keys out of ignitions in secure storage area</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Facilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shop area housekeeping rules established</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Flammable fuels in approved containers</td>
<td></td>
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<tr>
<td>Walk areas maintained in slip-proof manner</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ladders maintained in safe condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemicals stored in designated and signed areas</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fire extinguishers charged and visible</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Smoke and fire detectors installed and working</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lockout/tagout capabilities available and used</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Personal protective equipment (PPE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hearing and eye protection available</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separate storage area for PPE</td>
<td></td>
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</tr>
<tr>
<td><strong>Confined Spaces</strong></td>
<td></td>
<td></td>
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<tr>
<td>Gas detection equipment available</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Signage used to designate hazardous conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workers trained on confined space hazards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not applicable. These potential hazards do not apply to my operation.*

---

Figure 8 | Safety priority hazard checklist—general.
# Safety Priority Hazard Checklist
## Biomass Production

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Yes</th>
<th>No</th>
<th>Priority</th>
<th>Target Date</th>
<th>NA*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tractors/Machinery</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rollover protection (ROPS) on all tractors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seatbelt in good condition on all ROPS equipped tractors</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PTO master shields installed and undamaged</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>PTO driveline protection installed and undamaged</td>
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<tr>
<td>Bypass starter covers installed</td>
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<tr>
<td>SMV installed and undamaged</td>
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<tr>
<td>Tires adapted or replaced for biomass conditions</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windshields in good condition and protected if necessary</td>
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</tr>
<tr>
<td>Steps and hand rails in good condition and clear</td>
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<tr>
<td>Cab heater working and in good condition</td>
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<tr>
<td>Cab air filtration working and in good condition</td>
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<td>Fire extinguisher charged and visible</td>
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<tr>
<td><strong>Indoor/Outdoor Facilities</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Biomass storage area flat, firm and well drained</td>
<td></td>
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<td></td>
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<tr>
<td>Biomass storage areas separated for fire control</td>
<td></td>
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</tr>
<tr>
<td>Dust control in place</td>
<td></td>
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<td></td>
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<tr>
<td>Fire extinguisher charged and visible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hearing and eye protection available</td>
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<tr>
<td><strong>Other</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Emergency plans in place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not applicable. These potential hazards do not apply to my biomass operation.

Figure 9 | Safety priority hazard checklist—biomass production.
While simple checklists are handy and easy to use, the dichotomous nature of a checklist (i.e., only two choices: safe or unsafe, satisfactory or unsatisfactory, yes or no) isn't very precise because hazards do not often exist in a yes-or-no fashion. Hazards aren't either “there” or “not there”; rather, they exist in various degrees and shades. One example is a simple checklist that includes only the YES or NO option on a tractor's slow-moving vehicle (SMV) emblem (Figure 10). A simple checklist might indicate (YES) that an SMV was properly mounted on the rear of the tractor, but it does not indicate the condition of the SMV. It may be dirty, faded, or damaged and not effective in warning other vehicle drivers about the dangers associated with the slow-moving farm equipment on which it is attached.

Hazard checklists should be limited to questions that denote the physical condition of the equipment, implement, structure, or other item that is being assessed. People using checklists can't typically answer questions about operator behavior since they often can't observe that behavior. An example of this situation is this two-part checklist question on biomass harvesters. It begins by asking, “Does harvester have mounting steps and railings in place, clear, and in good condition?” This is observable by the person completing the checklist and considered to be a reasonable question for a YES or NO response. The second part of the question, “Does operator use three points of contact to safely mount and dismount the harvester?” is behavioral and can't be reliably answered unless the person using the checklist observes the operator mounting and dismounting each time the machine is used.

A hazard identification tool that identifies hazards in degrees and is limited to the physical condition of equipment, facilities, tools, or other items is exemplified by the Penn State FARM-HAT (Farm/Agricultural/Rural Management Hazard Analysis Tool) inspection form.

FARM-HAT is a simple inspection method that allows a person to assess the degree or level of hazard that may exist at the time of the audit process. Because it uses a consistent scale from Most Protection (least hazardous) (1) to Least Protection (most hazardous) (5), it also helps to evaluate and rank the seriousness of the hazard (the second and third actions mentioned earlier). FARM-HAT has three formats for each hazard topic that clearly depict and describe the level of hazard. This simple ranking system provides critical safety and health knowledge and information with minimal text. Figures 11, 12, and 13 are examples of the three formats for the FARM-HAT for PTO drivelines. Figure 14 shows how to prioritize correcting hazards using FARM-HAT. More than 150 machinery/equipment and building/facility hazard topics are found at www.agsafety.psu.edu/farmhat. These are in alphabetical order by category and then by topic once the category has been accessed.

While a good hazard identification tool such as FARM-HAT and others found at create.extension.org/node/88797 can help assess hazards, they do not provide a good mechanism for ranking risk. Tools for this are described next.
Agricultural Machinery PTO Drivelines

Most Protection

1. Driveline shaft shield is in place, is in good condition, and it can easily rotate by hand. Chain prevents shield from rotating.

2. Driveline shaft shield is in place but is bent, cracked, sliced and/or does not rotate freely.

3. Driveline shaft shield is missing or the equipment never had one.

Reminders

PTO drivelines present a wrap point hazard.

Always walk around equipment when the PTO shaft is connected to the tractor.

Turn off tractor and disengage the PTO before servicing, adjusting, or unplugging equipment.

Personal Protective Equipment

When working around PTOs wear:

Least Protection

Figure 11 | FARM-HAT hazard audit tool for PTO drivelines.
### Figure 12 | FARM-HAT hazard audit combo tool for multiple PTO driveline machines.

#### Agricultural Machinery

**PTO Drivelines**

**Most Protection**

1. Driveline shaft shield is in place, is in good condition, and it can easily rotate by hand. Chain prevents shield from rotating.

2. Driveline shaft shield is in place but is bent, cracked, sliced and/or does not rotate freely.

3. Driveline shaft shield is missing or the equipment never had one.

**Least Protection**

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
<th>Item</th>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
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<td>4</td>
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<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

### Figure 13 | FARM-HAT hazard audit tool for multiple PTO driveline machines.

#### Farm/Ag/Rural Management Hazard Audit Tool

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
<th>Item</th>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>
Even though the words *hazard* and *risk* are often used interchangeably, there is a difference between them. Understanding this difference is important for assessing and ranking risk. A hazard is any existing or potential condition that can result in injury, illness, death, or other loss. Risk involves hazards but means something different. Risk is a measure of the probability and severity of possible harm. Risk is found by combining a rating of the probability (or likelihood) that something bad will happen with a rating of the possible consequences (severity) of the harm that results.

Following are examples of commonly used words and explanations for describing probabilities and consequences of injury or loss.

<table>
<thead>
<tr>
<th>RANK</th>
<th>PROTECTION</th>
<th>HAZARD LEVEL</th>
<th>CORRECTIVE ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MOST PROTECTION</td>
<td>NEGLIGIBLE OR LOW</td>
<td>Hazard should be fixed, repaired, or improved when possible.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>MODERATE</td>
<td>Hazard should be fixed, repaired, or improved soon.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>SEVERE OR HIGH</td>
<td>Hazard should be fixed, repaired, or improved immediately.</td>
</tr>
<tr>
<td>5</td>
<td>LEAST PROTECTION</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Assessment and Ranking of Risk**

Figure 14 | FARM-HAT hazard prioritization table with suggested corrective actions.
Examples of Ranges for Probability/Likelihood

3 Level (Simplest)
- High Probability
- Moderate Probability
- Low Probability

5 Level (More Detailed)
- Frequent—likely/probable to occur almost daily
- Probable—likely/probable to occur several times in a period of time (week/month)
- Occasional—likely/possible to occur sometime in a period of time (year/couple of years)
- Remote—not likely to occur but is possible (years, life cycle)
- Improbable—possible but probability hard to distinguish from zero

Example of Range for Consequences (Severity)
- Catastrophic—imminent danger, one or more deaths, widespread illness, loss of major facilities or equipment
- Critical—severe injury, serious illness, property and equipment damage (amputations, fractures, long term/permanent impairment, and temporary loss of property or equipment)
- Marginal—less serious injury, illness or property damage (sutures, deep bruises, strains, short-term disability, short-term loss of equipment or property)
- Negligible—first aid cases, easy or quick repair of equipment or property

These probability and consequences are assigned numbers or letters and put into a risk matrix that identifies the most serious risks. A risk matrix helps to assess and rank hazards. Figure 15 is a risk matrix that suggests how to think about the consequence and frequency of each cell.

<table>
<thead>
<tr>
<th>CONSEQUENCE FREQUENCY</th>
<th>CONSEQUENCE</th>
<th>CONSEQUENCE</th>
<th>CONSEQUENCE</th>
<th>CONSEQUENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catastrophic (1) Death, permanent disability</td>
<td>Critical (2) Disability, &gt; 3 mos.</td>
<td>Marginal (3) Minor, lost work time</td>
<td>Negligible (4) First aid, minor treatment</td>
</tr>
<tr>
<td>Frequent (A) Likely to occur; repeatedly</td>
<td>A1 High: shut down now</td>
<td>A2 High: shut down now</td>
<td>A3 Serious: high priority fix</td>
<td>A4 Medium: fix soon</td>
</tr>
<tr>
<td>Probable (B) Likely to occur several times</td>
<td>B1 High: shut down now</td>
<td>B2 High: shut down now</td>
<td>B3 Serious: high priority fix</td>
<td>B4 Medium: fix soon</td>
</tr>
<tr>
<td>Occasional (C) Likely to occur sometime</td>
<td>C1 High: shut down now</td>
<td>C2 Serious: high priority fix</td>
<td>C3 Medium: fix soon</td>
<td>C4 Low: fix or leave as is</td>
</tr>
<tr>
<td>Remote (D) Not likely to occur</td>
<td>D1 Serious: high priority fix</td>
<td>D2 Medium: fix soon</td>
<td>D3 Medium: fix soon</td>
<td>D4 Low: fix or leave as is</td>
</tr>
<tr>
<td>Improbable (E) Very unlikely</td>
<td>E1 Medium: fix soon</td>
<td>E2 Low: fix or leave as is</td>
<td>E3 Low: fix or leave as is</td>
<td>E4 Low: fix or leave as is</td>
</tr>
</tbody>
</table>

Figure 15 | Risk matrix table defining high risk to low risk.
Risk matrixes are best used when just starting to develop an overall safety and health management plan. It helps to organize and prioritize what group or types of risks to pay attention to and address first. Figure 16 is an example of a completed risk matrix.

Once the workplace hazards are identified, assessed, and ranked, you are now ready to think about methods and techniques to prevent and control them. Since ranking them helps to establish a level of priority for each, Unit 3 will cover recommended methods and techniques for limiting safety and health risks at your operation.

---

**Risk Matrix**

**Biomass Production Operation**

<table>
<thead>
<tr>
<th>Consequence</th>
<th>Catastrophic</th>
<th>Critical</th>
<th>Marginal</th>
<th>Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Death, permanent disability</td>
<td>Disability, &gt;3 mos.</td>
<td>Minor, lost work time</td>
<td>First aid, minor</td>
</tr>
<tr>
<td>Frequent</td>
<td>Worker trips in wet field</td>
<td>Worker cuts finger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probable</td>
<td>Workers strains shoulder moving biomass bale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occasional</td>
<td>Tractor overturn with no ROPS</td>
<td>Worker entangled in unguarded PTO</td>
<td>Tractor overturn with ROPS cab</td>
<td></td>
</tr>
<tr>
<td>Remote</td>
<td>Worker falls from truck while loading truck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improbable</td>
<td>Tornado hits equipment building</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*Figure 16 | Risk matrix for a biomass production operation.*
Preventing and Controlling Hazards and Risks

This unit will help organize your thoughts and approaches to hazard and risk prevention and control. There are several principles that can help guide development of your safety and health management plan. Some are simple and very straightforward, while others take a little more time to understand and apply. This chapter also identifies safety and health regulations that are relevant and may dictate portions of your safety and health management plan.

Let's discuss the principles and look at examples and tools for how to make use of them. While these principles represent best practices, not all are applicable to all biomass operations.

**Principle 1: An injury incident normally derives from multiple causes rather than a single cause.**

While it is common to identify the cause of an incident as the last identifiable human activity that directly resulted in injury (or property loss), there are always multiple actions and events that led up to the final activity. This means that there are always multiple opportunities for interventions to prevent the same incident from happening again.

One way to identify multiple prevention and control opportunities is to use the Haddon Matrix. The goal of safety is to prevent damage to people, products, and the environment. Unwanted and undesired events most often occur sequentially or in “phases,” and each phase presents an opportunity for prevention or control. Additionally, prevention or control can be applied to people; products, objects, and things; and the physical environment (called “factors”). By putting these factors and phases into a matrix, we end up with nine opportunities to either prevent or control how much damage is done. Figure 17 is an example of an uncompleted Haddon Matrix.

The most practical use of the Haddon Matrix is when thinking about a single item or activity that has a broad range of hazards associated with it. In some cases, there will be no prevention or control strategy for a cell. Figures 18 and 19 are examples of how a completed Haddon Matrix would look when thinking about tractor safety and an overall biomass production operation. See Figure 19 for an example of applying the Haddon Matrix to a biomass operation from a systems perspective.
# Haddon Matrix: Tractor Operations

<table>
<thead>
<tr>
<th>PHASES</th>
<th>FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-event</strong></td>
<td>Training on safe tractor operation</td>
</tr>
<tr>
<td><strong>(before it happens)</strong></td>
<td>Pre-operation tractor inspections</td>
</tr>
<tr>
<td></td>
<td>Agricultural hand signals</td>
</tr>
<tr>
<td></td>
<td>Equipment on public roads</td>
</tr>
<tr>
<td></td>
<td>Identify best route to fields considering narrow roadways and poor visibility</td>
</tr>
<tr>
<td></td>
<td>Working lights and flashers</td>
</tr>
<tr>
<td></td>
<td>Clear platform</td>
</tr>
<tr>
<td><strong>Event</strong></td>
<td>Tractor operators using seatbelt on ROPS tractors</td>
</tr>
<tr>
<td><strong>(while it happens)</strong></td>
<td>ROPS with working seatbelt on all tractors</td>
</tr>
<tr>
<td></td>
<td>Fire extinguisher on equipment</td>
</tr>
<tr>
<td></td>
<td>Safe procedure for pulling out stuck equipment</td>
</tr>
<tr>
<td></td>
<td>Emergency marking and lighting with SMVs in use for highway operation</td>
</tr>
<tr>
<td></td>
<td>Communicating in areas of limited cell phone coverage</td>
</tr>
<tr>
<td><strong>Post-event</strong></td>
<td>Update training in first aid and CPR for all workers</td>
</tr>
<tr>
<td><strong>(after it happens)</strong></td>
<td>Tractors with updated first aid kits and charged fire extinguishers</td>
</tr>
<tr>
<td></td>
<td>Ability to notify EMS</td>
</tr>
<tr>
<td></td>
<td>Worker emergency response training</td>
</tr>
<tr>
<td></td>
<td>Tractors with updated first aid kits and charged fire extinguishers</td>
</tr>
<tr>
<td></td>
<td>GPS locators</td>
</tr>
<tr>
<td></td>
<td>Plan for emergency rescue services for remote field locations</td>
</tr>
<tr>
<td></td>
<td>Emergency helicopter landing availability</td>
</tr>
</tbody>
</table>

Figure 18 | Haddon Matrix for safe tractor operation.
# Haddon Matrix

**Biomass Operation from a Systems Perspective**

<table>
<thead>
<tr>
<th>PHASES</th>
<th>FACTORS</th>
<th>Workers</th>
<th>Equipment, Products, and Structures</th>
<th>Physical Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-event</td>
<td>Safety and health management plan for biomass operations</td>
<td>Tractors with roll bar and seatbelt</td>
<td>Limit degree of slopes for planting and harvesting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety and health training for:</td>
<td>Machines properly guarded</td>
<td>Clear obstructions for safe entry and exit of lands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-personal protective equipment</td>
<td>Interlocking guards and sensors</td>
<td>Confined spaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-agricultural hand signals</td>
<td>Proper lighting and marking of equipment</td>
<td>Provide field sanitation facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-special populations (young, immigrant, aged, etc.)</td>
<td>Equipment with reverse gathering mechanisms</td>
<td>Shade and water for hot-weather activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-equipment on public roads</td>
<td>Properly sized equipment</td>
<td>Heaters or shelter for cold-weather activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-securing loads for transport</td>
<td>Heat detection and sensor systems</td>
<td>Engineering controls to reduce environmental hazards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Best safety practices for biomass production and storage</td>
<td>Use trucks for hauling</td>
<td>Optimization of road travel to limit exposure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separate management and labor functions</td>
<td>Safe facility layout (fuel tanks, size of storage structures, etc.)</td>
<td>Adapting equipment and practices for winter conditions (northern climates)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stability monitoring devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>New designs to assist extraction from equipment and structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Event</td>
<td>Equipment occupant restraints</td>
<td>Tractors with roll bar and seatbelt</td>
<td>Communicating in areas of limited cell- phone coverage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fall arrest systems</td>
<td>Auto shutoff of overturned equipment</td>
<td>Have multiple workers onsite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuses, slip clutches</td>
<td>Availability of firefighting resources (water, volunteer firefighters, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sprinkler systems in storage structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire extinguishers on equipment</td>
<td>Safe entry into confined spaces</td>
<td></td>
</tr>
<tr>
<td>Post-event</td>
<td>Ability to notify EMS</td>
<td>GPS locators</td>
<td>Ability of emergency responders to access incident sites</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farm worker emergency response training</td>
<td>Insurance coverage</td>
<td>Emergency helicopter landing availability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First aid and CPR training</td>
<td></td>
<td>Trained emergency responders available</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insurance coverage</td>
<td></td>
<td>Proximity to hospitals, trauma centers</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 19* | Haddon Matrix for biomass operations from a systems perspective.
Principle 2: The selection of an injury prevention or control strategy is not dependent on the rank order or importance of casual factors.

In other words, just because “something” is a major contributor to an injury incident, it doesn't always mean that working directly with that “something” is the most effective or efficient means of injury prevention.

Examples of this principle:
- People smoking in bed often cause home fires, but development of self-extinguishing cigarettes is a more effective way of stopping home fires than trying to motivate people to stop smoking in bed.
- Good housekeeping would prevent many tripping incidents, even though a person could and should be more careful where they walk.
- Farmers tip their tractors over backward because they may have improperly hitched the tractors to something and pulled. But if every tractor had an enclosed ROPS cab, few farmers would ever be killed.

The important point here is to always look beyond the direct cause of an incident to see if there might be effective methods of prevention or control that have little to do with the direct cause of a particular incident.

Principle 3: Passive strategies that provide automatic protection against injury are more effective than active strategies that require participation by those being protected.

Active strategies normally involve human behavior, and there is ample evidence that people can't always be relied on to follow directions or to make good decisions. Once active participation by workers is required to ensure safety at work, problems may arise when they forget what they were supposed to do, don't follow through because they feel it is extra “busy” work, or have seen others perform duties unsafely and get away with it.

Examples of this principle:
- Motor-vehicle airbags will automatically deploy in a crash and protect drivers even if they didn’t buckle their seatbelts.
- Fuses will automatically shut off an overloaded electrical circuit even if a worker overloads the circuit by plugging in too many tools.
- One effective way to make sure potentially dangerous walkways and stairs are lighted properly is to install motion detectors that automatically turn on lighting as employees enter a work area. These lighting systems will also automatically turn off the lights when workers have safely left the area.

Some passive strategies can be combined with active strategies to achieve optimal protection against hazards and risks. For example, a roll bar on a tractor (passive strategy) will provide considerable protection to an operator in case of a rollover. However, if the operator also buckles the seatbelt (active strategy), he or she will be afforded the maximum amount of protection available.

Principle 4: There is a “hierarchy of control” for preventing and controlling injury.

The purpose of the hierarchy in Figure 20 is to provide a systematic approach to eliminate, reduce, or control the risks from different hazards. The most effective controls are at the top of the hierarchy with each of the following steps considered less effective than the one before it. Sometimes a combination of these approaches can be used to achieve an acceptable level of risk.
A. **Eliminate hazard or risk.** It is obvious that eliminating hazards is the most effective method to reduce risks associated with a specific hazard because once the hazard is eliminated, there is no risk. For some hazards, this may be easy to do, but not so easy for others. For example, not handling pesticides at all eliminates the risk of being poisoned. On the other hand, the risk of a tractor overturn can't be eliminated unless you ban all tractor use. Banning tractors may not be a realistic option on many farms. This is obviously not a realistic solution to the problem.

B. **Substitute product or activity.** This step often works in tandem with elimination of hazard or risk, but it can be a unique step. Examples of this step include substituting a less hazardous pesticide (CAUTION label) for a more dangerous one (WARNING or DANGER label) as in Figure 21, or substituting a wide front-end tractor for a narrow front-end tractor.

![Hierarchy of Control Diagram](image-url)
C. **Engineering controls.** This control refers to using guards, barriers, or other devices (Figure 22) that either provide separation between you and the hazard or minimize the damage from the hazard. Guards over rotating shafts, augers, gears, belts, and chains are common examples of providing a barrier between you and the hazard. A tractor roll bar is an example of using engineering to minimize damage and injury from an overturn. Roll bars do not eliminate the risk of an overturn, but if the tractor overturns, the roll bar is designed to limit the degree of roll and provide a zone of protection so that the operator is not crushed by the tractor. Using the seatbelt helps keep the operator within a zone of protection. Making use of automatic hitching couplers between tractors and implements would be an example of using engineering controls to reduce risks associated with crushing or run-over-type incidents when a worker is attempting hitching.

Figure 21 | **Pesticide substitution labels.** A pesticide label depicting a less hazardous product (on the left) that can be substituted for a higher toxicity product (shown on the right).

Figure 22 | **Equipment with engineered hazard protection.** The photo on the left shows that all of the engineered entanglement protection has been removed. The photo on the right shows attached and well-engineered protective guarding and shielding over rotating driveline shafts.
D. **Warnings.** Warnings include safety decals, pictograms, and signage commonly found on farms (Figure 23). These remind us that a hazard or risk is present. This control is important but not particularly effective at preventing or controlling risk of injury or other damage. There are two reasons to use this control: (1) warnings are often legally required by safety regulations; and (2) a person must be aware of a hazard or risk before he or she can be expected to avoid it or to follow needed safety practices. The lack of sufficient warning is a costly liability for employers in the event that a worker becomes injured or ill at the workplace.

There are many reasons why warnings are not very effective. Warning signs and decals often become dirty, scratched, or worn and are unreadable. More important, a warning means that a hazard exists and relies on the person interacting with the item to follow instructions or safety practices that are on the warning. Research shows that many people do not follow the instructions on safety warnings. One reason is that people encounter so many warnings on a daily basis that these messages lose their power to influence an individual’s decision making.

E. **Administrative controls.** Administrative controls are appropriate for the workplace (Figure 24). For example, if a machine is running, you can limit the time any worker is exposed to excessive noise or dust by rotating workers so that the duration of the individual exposure time is limited.
When it comes to providing safety training or education, research shows that people aren’t reliable at following directions, which is why it is low on the totem pole of the control hierarchy.

People have their own reasons for not following safety practices and the training they have received, but most reasons revolve around saving money, time, and effort. Additionally, when workers engage in unsafe practices and are not hurt, this simply enforces the concept of taking more risk.

F. **Personal protective equipment (PPE).** This control is last because it does nothing to prevent or correct hazards; rather, it limits the amount of damage or level of injury or illness that the hazard causes. It is problematic since it relies on human behavior to ensure that workers wear their assigned PPE. Workers often resist wearing PPE because it doesn’t fit comfortably, is too expensive, not readily available when needed, and may not look fashionable. Proper PPE, as seen in Figure 25, is mandated by some safety regulations, and employers are required to purchase and provide it for their workers.

### Occupational Safety and Health Regulations

Producers must be knowledgeable about occupational safety and health regulations to incorporate them into safety and health management plans. Understanding occupational safety and health regulations that apply to biomass operations can be very confusing. There are both state and federal regulations that may be applicable. This manual addresses federal regulations that have wide applicability to biomass operations. If there is an injury incident, these regulations could result in legal liability for the operation. Some federal regulations have state-level counterparts, and this will be explained.

Learn about your state’s occupational safety and health regulations for agriculture by contacting your state’s departments of labor and agriculture.

While there can be significant adverse consequences (e.g., fines, criminal proceedings, lawsuits) for not complying with occupational safety and health regulations, what is important to remember is that regulations often represent “best safety practices” for workplace safety and health. Complying with at least the spirit of the regulations provides you with guidelines for implementing hazard control plans and risk prevention strategies.

**Federal OSHA.** The Occupational Safety and Health Act (OSHA) is the primary regulation that governs occupational safety and health in the United States. However, OSHA is applicable only to work operations that involve employers and employees, thus, family-only operations are not under OSHA’s jurisdiction. OSHA regulations became effective in 1970, but in 1976 Congress passed what is known as the “small farm exemption.” This exemption prohibits enforcement of OSHA regulations on farms with ten or fewer employees over the previous twelve months and those with no temporary labor camps. Additionally, OSHA sometimes specifically excludes all agricultural operations from certain standards. Two examples of this are OSHA 1910.146, *Permit-Required Confined Spaces*, and 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*, standards. Consequently, OSHA has little direct impact on most farm operations because the vast majority use only family labor or have ten or fewer employees.
If a producer employs eleven or more nonfamily workers and is inspected for any reason, OSHA can use its “general duty clause” to cite the employer for violation of easily recognized best safety practices. The OSHA General Duty Clause says that an employer must provide a place of employment free of recognized hazards. The hazards associated with non-ROPS tractors, unguarded machines, excessive noise, poorly maintained ladders, manure storage, grain bins, and a host of other common farm hazards are well documented. A serious or fatal injury to a hired worker often triggers an OSHA investigation. They will use their General Duty Clause to cite you for commonly known hazards that are uncorrected and work practices that do not represent best safety practices. They can do this even when agriculture has been exempted from a standard. For example, if a worker is injured by an electrically powered machine that starts up unexpectedly, you can be cited under the General Duty Clause for violating the lockout/tagout standard even though agriculture is exempt from this standard.

**Federal OSHA Injury and Illness Recordkeeping (29 CFR 1904).** Under the OSHA Recordkeeping regulation, covered employers are required to prepare and maintain records of serious occupational injuries and illnesses, using the OSHA 300 log. All employers must orally report the death of an employee or the in-patient hospitalization of three or more employees as the result of a work-related incident within eight hours. Employers with more than ten workers and those that are not classified as a partially exempt industry must record work-related injuries and illnesses using the OSHA 300, 300A, and 301 forms. Additional information on the recordkeeping requirements can be found in OSHA Publication 3169, or by visiting the OSHA website at [https://www.osha.gov/recordkeeping/](https://www.osha.gov/recordkeeping/).

**State OSHA.** Twenty-five states have some form of their own Occupational Safety and Health regulations (Figure 26). One provision in the federal OSHA Act mandates that if a state adopts a state OSHA plan, it has to be as strict as or stricter than the federal regulations. This means that in states with their own OSHA plan, farm operations may not have the same exemptions from standards or enforcement of standards that exist in states where only federal OSHA is in effect. As some state plans cover only state and local government workers, farmers and ranchers need to know if their state has a state OSHA plan, and how farms and ranches may be affected.

**States with OSHA Plans**

<table>
<thead>
<tr>
<th>State Name</th>
<th>State Name</th>
<th>State Name</th>
<th>State Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>Iowa</td>
<td>New Mexico</td>
<td>Vermont</td>
</tr>
<tr>
<td>Arizona</td>
<td>Kentucky</td>
<td>New York</td>
<td>Virginia</td>
</tr>
<tr>
<td>California</td>
<td>Maryland</td>
<td>North Carolina</td>
<td>Washington</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Michigan</td>
<td>Oregon</td>
<td>Wyoming</td>
</tr>
<tr>
<td>Hawaii</td>
<td>Minnesota</td>
<td>South Carolina</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>Nevada</td>
<td>Tennessee</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>New Jersey</td>
<td>Utah</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 26 | States with approved OSHA plans.*

**Agriculture Regulations.** This section identifies the primary federal OSHA regulations that are applicable to farms. OSHA agricultural standards are identified as *29 CFR (Code of Federal Regulations) Part 1928* and can be accessed by typing in “OSHA and Agriculture” in your web browser. You are encouraged to review the details of these standards and incorporate them into your safety and health management plan.

- **Rollover Protective Structure (ROPS) (29 CFR 1928.51).** This standard specifies that a certified ROPS must be installed on each tractor operated by an employee. It further states that each ROPS-equipped tractor shall have a seatbelt and that each employee should use the seatbelt. It also requires annual safety training on safe tractor operation.
• **Guarding of Farm Field Equipment, Farmstead Equipment and Cotton Gins (29 CFR 1928.57).** This standard provides for the protection of employees from the hazards associated with moving machinery parts on farm field equipment, farmstead equipment, and cotton gins used in any agricultural operation. It also has an annual safety training requirement.

• **Field Sanitation (29 CFR 1928.110).** This standard applies to any agricultural establishment where eleven or more employees are engaged on any given day in hand-labor operations in the field. It includes requirements for hand-washing facilities, toilet facilities, and potable (drinking) water.

This next section identifies OSHA regulations applicable to agriculture that were included in OSHA’s general industry standards (29 CFR Part 1910) when passed in 1970. These can be accessed by typing “OSHA Standards” in your web browser.

• **Storage and Handling of Anhydrous Ammonia (29 CFR 1910.111).** This standard applies to the design, construction, location, installation, and operation of anhydrous ammonia systems, including refrigerated ammonia storage systems. It primarily affects producers through specifications for nurse tanks, filling of applicator tanks, protective clothing, emergency procedures, and communicating hazard exposures to workers.

• **Temporary Labor Camps (29 CFR 1910.142).** This standard addresses environmental aspects of housing for camps, such as site selection and construction, ventilation, heating, sanitation for cooking, eating, toilets, etc.

• **Specifications for Accident Prevention Signs and Tags (29 CFR 1910.145).** This standard applies to the design, application, and use of signs or symbols to indicate and define specific hazards that could harm workers, the public, or cause damage to property. These specifications are intended to cover all safety signs except those designed for streets, highways, and railroads. These specifications do not apply to plant bulletin boards or to safety posters. This is the standard that specifies the use of a slow-moving vehicle (SMV) emblem on agricultural equipment operated on public roads.

This next section contains several 29 CFR 1910 standards for general industry that have been passed since 1970. Agriculture was not specifically excluded from these standards, so they are relevant if you employ eleven or more workers at any time during the year. Compliance with these standards is something OSHA often looks at when they conduct worksite inspections.

• **Occupational Noise Exposure (29 CFR 1910.95).** The purpose of this standard is to provide protection against occupational noise exposure during an eight-hour work day. Employers must administer a continuing, effective hearing conservation program if workers are exposed to noise levels of 85 decibels or higher.

• **Personal Protective Equipment (PPE) (29 CFR 1910.132).** This standard provides that protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition whenever hazards are encountered that could cause injury, illness, or impairment.

• **Respiratory Protection (29 CFR 1910.134).** This standard is designed to protect workers against the inhalation of harmful dusts, fogs, fumes, mists, gases, vapors, smoke, and sprays. It requires that the employer develop and implement a written respiratory protection program that specifies required procedures for respirator use by employees.

• **Hazard Communications (29 CFR 1910.1200).** The purpose of this standard is to effectively communicate the hazards involved with all chemicals used or found at the workplace. The communication of the information to workers can be achieved by sharing label information, posting of signage indicating the hazards, maintaining safety data sheets for all chemicals, and through documented worker training programs. **Note:** Although pesticides are chemicals, the EPA’s Worker Protection Standard (WPS) generally only governs the use and storage of this classification of chemicals.
These next two OSHA standards specifically exclude agriculture, but OSHA has been known to fine employers under the General Duty Clause when violations of these standards have been observed during worksite inspections, particularly if the inspection is the result of an injury to an employee.

- **Permit-Required Confined Space (29 CFR 1910.146).** This standard contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. Among other things, a written confined space entry program is required.

- **Lockout/Tagout (29CFR 1910.147).** This standard involves the control of hazardous energy during the operation, servicing, or maintenance of equipment that functions through electrical power. It requires that power sources be physically disabled.

**Federal U.S. DOL Youth Regulations.** The U.S. Department of Labor (U.S. DOL) also has regulations that impact producers and their employment practices, especially those involving the hiring of younger workers. The Hazardous Occupations Order for Agriculture (HOOA) includes regulations that specify the types of farming activities that may be assigned to youth younger than 16 years of age. Changes to HOOA that were being considered in 2012 were not acted upon and have now been removed from further consideration by U.S. DOL. Employers should check the following website for current regulations: [www.dol.gov/dol/topic/youthlabor/agriculturalemployment.htm](http://www.dol.gov/dol/topic/youthlabor/agriculturalemployment.htm).

**State Child Labor Regulations.** Most states have their own specific regulations on the employment of minors. Because of the variability among the states, you should check with your state’s department of labor to ensure that you are in compliance with all child labor regulations relevant to your business operation.

**Worker Protection Standard.** The U.S. Environmental Protection Agency (EPA) has a standard, the Worker Protection Standard (WPS), which governs the safety and health of workers who could be potentially exposed to pesticides. This standard deals with applicator licenses, restricted-use pesticides, the requirements for worker training and notification, personal protection, and field reentry intervals. It applies to all producers who apply, or hire the application of, chemicals used to control pests on crops or livestock and in storage facilities.

In addition to the above regulated areas, the WPS also requires employers to “take any necessary steps to prevent heat illness while personal protective equipment is being worn.” These necessary steps include worker training; monitoring and adjusting work schedules based on high temperatures and humidity, especially during heavy workload activities; and providing ample drinking water to replace body fluids lost from sweating while working.

**State Motor-Vehicle Codes.** There are also state regulations associated with operating farm tractors and equipment on public roads. State regulations include different definitions of implements of husbandry, speed limits for slow-moving vehicles, lighting and marking standards, age limitations on young operators, and more. You should be cognizant of the regulations in your state and access them as needed.
Unit 4.

Educating and Training Employees

Once you have implemented safety policies and procedures and instituted and analyzed hazard assessments for your biomass operation, you are now ready to develop and deliver safety and health training for your employees. This unit is designed to improve your success rate with adult learners who have a unique set of requirements for effective learning environments. Some major components of good safety education and training for adults include:

- Identifying hazards and adopting control measures
- Learning about safe working behaviors and practices
- Training on the proper use, maintenance, and storage of PPE
- Gaining knowledge about emergency procedures and first aid
- Methods for obtaining additional information

But there is much more to understand to be effective with safety and health education and training efforts and activities. These next sections will identify several factors that are important for producers to understand about safety education and training. In addition, several tools and techniques are identified to help with building safety and health knowledge and skills among your workforce. Be sure all worker safety and health training activities are conducted on company time and documented by trainers.

Education versus Training

Everyone should understand that there is a difference between the terms “education” and “training,” even though most people use them interchangeably. Education emphasizes broader principles, concepts, and knowledge about something, while training emphasizes practical applications of the information presented. For example, a person may be able to learn a considerable amount of information about a hazard (education) but may not learn how to recognize the hazard (a skill) if never given the opportunity to experience it in the workplace. On the other hand, learning to recognize a hazard (a skill) normally involves some understanding of why it is a hazard (education). In putting together a safety and health plan, both education and training are needed.

Adult Learning Principles

Most safety education and training on farms for operators and workers is going to involve adults eighteen years of age or older. Adults normally demand more control over their own learning than youthful learners, and an adult’s motivation to learn is often driven by internal factors (e.g., self-improvement) rather than external factors (e.g., required attendance by state law or to receive a grade). In addition, adult learners often pursue knowledge that provides immediate results. Instructors of adult learners must understand that adults have life experiences and want to apply what they learn.

Here are a few additional tips for developing and delivering education and training to adult learners:

- **Meaningfulness.** Workers need to understand why a certain procedure is better than another one. Adequate explanation of why one method of completing a task can decrease risk or exposure to a hazard gives meaningfulness to doing the task safely.

- **Legitimate, personalized examples.** Adult learners need legitimate, concrete examples of how they can apply the information being provided to their own situations.

- **Learning through practice.** Good safety training involves regular practice until the correct and safe way of doing things becomes a habit.
• **Consistent feedback.** Adults want constant and consistent feedback on how they are progressing during the learning process.

• **Small group learning exercises.** Adults like the intimacy of smaller group learning where they are not “lost in the shuffle.”

• **Positive reinforcement.** Adults like the recognition brought on by positive reinforcement for following and adopting a safety practice as opposed to negative recognition when a person is not following a recommended safety practice.

### Keep Safety and Health Training Interesting

There are several ways to keep safety and health training interesting for workers. Many of these methods are implied by the adult learning principles discussed above. For example, the adage “Tell me, I forget. Show me, I may remember. Involve me, I understand” incorporates the concepts of meaningfulness and practice.

Here are some other ways to keep your safety training interesting for your employees:

• **Keep it relatively short.** There are times when a five- to ten-minute session is long enough. Training or education that is not interactive or hands on should not go longer than 30 to 45 minutes. Examples of short, concise, and frequent safety training are exemplified by “tailgate” safety training. Shorter training sessions conducted at the worksite maintain the interest level of the trainees and minimize preparation time for the trainers.

• **Safety training needs to be hands on.** Each worker is given the opportunity to experience the hazard or risk under a controlled training environment. Fit-testing a respirator is an example of hands-on training where the trainee learns the proper methods for achieving maximum protection from a known airborne hazard.

• **Workers should report close-call incidents.** Be sure workers are comfortable speaking about any unsafe practices or chances that may have taken place. Other workers may easily relate to what their fellow workers are reporting because they are likely exposed to the same work scenarios that resulted in the close-call incident.

• **Avoid canned or generic programs.** Training slides and videos can be boring and are not always relevant to the work your workers are used to on a daily basis. An example might include a mowing safety video that depicts workers on large, commercial mowers in the middle of a manicured golf course. Remember that visuals should be used as an aid to instruction, not the instruction itself.

• **Strive for variability in the training.** Don’t use the same format every time. For example, every few training sessions use individualized training instead of group training. Let need and topic determine method of instruction or meeting format.

• **Include emergency response actions as a part of training.** Teach CPR and first aid, first-on-the-scene responses, and how to properly report and document emergencies.

• **Use outside presenters.** Seeing new faces and hearing different voices can spice up safety training. Universities, Cooperative Extension, insurance companies, community health professionals, safety equipment representatives, local emergency service providers, and safety consultants are all possibilities for guest speakers, and most are free of charge. In some cases, accident victims can be inspiring, but be sure that they spread a message of preventing and following safety practices as a part of their presentation.
Job Instruction Training

Job instruction training (JIT) is a simple yet systematic method for how you teach or train others. It is widely used in industry because it has proved to be an effective and efficient way to do safety and health training. JIT consists of four steps that an instructor follows when teaching workers how to do something:

- **Step 1: Preparation.** Trainer puts worker at ease by explaining the job to be taught, asking what he or she already knows about the subject, and why doing the job safely is important. Treat the worker as a peer.

- **Step 2: Presentation.** Trainer demonstrates the work process one step at a time, stressing key points. Explain the “why” of each step. Workers involved in the training should be observing and asking questions.

- **Step 3: Performance.** Worker performs the task one step at a time and explains out loud the steps and key points back to the trainer. Trainer notes discrepancies and corrects immediately. Worker repeats tasks and explanations as many times as necessary. Repeating instructions helps the worker internalize instructions. Until the worker can confidently repeat the instructions, he or she doesn’t know the task well enough.

- **Step 4: Follow-up.** Trainer must monitor performance and correct any errors or unsafe acts before they become a habit. Check performance often at first, and then gradually taper off.

To use JIT effectively, the trainer should know the job thoroughly, be a safe worker, and have the patience, skills, and desire to train. Training should be with real tools and equipment at the worksite, the same for all workers, and with adequate time allowed. Advantages of using the JIT method include more easily motivated workers because the training is personal; identifying and correcting deficiencies as they occur in the training; being able to evaluate the training immediately; and encouraging questions and learning because the training is practical, realistic, and demonstrated under actual conditions. The JIT method is also a way to take advantage of adult learning principles and keep training interesting.

Job Safety Analysis

Job safety analysis (JSA) is a four-step written procedure that identifies the hazards or potential hazards associated with each step of a job and then develops solutions that will eliminate or guard against the hazards. Like other tools described in this manual, it has multiple uses. For example, it could easily be included in Unit 2 because it helps to identify hazards, or it could have been mentioned in Unit 3 because it can be a major safety program component. It is included in this unit because its best use is as a training guide for new workers and/or new jobs. It often helps improve the efficiency of jobs and work tasks because of the way jobs are broken down in this process. JSAs are sometimes also referred to as job hazard analysis (JHA).

Below are the four steps of a JSA with key explanations for each step that make this a useful training tool. Following these steps are examples of applying the JSA technique to common jobs on the farm (Figures 27 and 28). As you read about the steps, look at the examples for clarification of key points.

- **Step 1: Select the job.** A job is a sequence of separate steps or activities that together accomplish a goal. A job step is a single and separate activity that clearly advances a work assignment and is a logical portion of that assignment. Job steps can’t be too broadly defined (e.g., farming, building a facility, rebuilding an engine) or too narrowly defined (e.g., flipping on a light switch, pushing a button, tightening a screw). Jobs that can be broken down logically into anywhere from four to eight or nine steps are ideal for a JSA. Jobs that require ten to twelve steps or more begin to get cumbersome for the JSA process.

- **Step 2: Break the job into steps.** The three key points for breaking down a job include the following: (1) each step should accomplish some major task; (2) begin each step with an action word; and (3) each step tells “what is
done,” not “how it is done.” Explaining “what is done rather than how it is done” is one of the most difficult factors to apply. It helps to keep the number of words describing a step to a minimum. Other helpful hints include using one or more experienced workers to break the job down, and breaking a job down into all steps before considering hazards or solutions associated with the steps. To maintain order within the JSA, use gridlines or number each successive step.

- **Step 3: Identify potential hazards.** Examine each step to identify hazards, actions, or conditions that could lead to an injury. Ask yourself, “How can a person get hurt when doing this step or this job?” It is important to identify both obvious and potential hazards, including those that may have minor consequences and low probability of occurrence. Use hazard checklists to remind yourself of possible hazards. It’s also important to list both how the injury can occur and what the injury might be.

- **Step 4: Develop solutions and recommended actions.** For each step decide what is necessary to eliminate, control, or minimize the hazards. Be specific; say exactly what needs to be done. Avoid general statements like “be careful” because that isn’t specific. Provide a recommended action for each hazard. It is OK to repeat recommended actions as often as necessary. You can include personal protective equipment (PPE) for each hazard, or if it is the same for all hazards, include it at the top of the form as a general instruction.

Here are a couple of examples of completed JSAs (Figures 27 and 28). These can be typed into a computer or handwritten on 5-by-7-inch or larger cards. Your JSA for the same job may be different from someone else’s because of subtle differences in equipment, facilities, or processes, or because you choose to break down a job differently.

<table>
<thead>
<tr>
<th>Job Safety Analysis</th>
<th>Type of job: Helping to hitch a wagon to a tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>March 2, 2013</td>
</tr>
<tr>
<td>Personal Protective Equipment to be worn:</td>
<td>Work boots with steel toes, leather gloves</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Basic Job Steps</th>
<th>Potential Hazards</th>
<th>Recommended Action or Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check wagon wheels</td>
<td>Wagon could roll when tongue is picked up, causing a crushing injury.</td>
<td>Be sure wheels of the wagon are blocked.</td>
</tr>
<tr>
<td>(Operator) Back tractor to within a few inches of wagon tongue.</td>
<td>Crushed between tractor and wagon if tractor operator miscalculates while backing.</td>
<td>Backs with low gear and low engine speed. Stand outside of tractor and wagon until tractor driver stops tractor and puts in park or neutral and sets brakes. Use hand signals.</td>
</tr>
<tr>
<td>(Helper) Align wagon tongue/pin hole with tractor drawbar/pin hole.</td>
<td>Straining the back if the tongue is heavy.</td>
<td>Use leg muscles to lift; use portable jack if tongue is heavy.</td>
</tr>
<tr>
<td>Back tractor to match pin holes, drop pin when aligned.</td>
<td>Crushed between tractor and wagon if tractor operator miscalculates while backing crushing injury to the hands.</td>
<td>Backs with low gear and low engine speed. Use hand signals. Keep hands in back of drawbar connection point.</td>
</tr>
<tr>
<td>Insert safety clip or pin. Attach safety chains if present.</td>
<td>Crushing injury to the feet if the wagon tongue slips off of the tractor drawbar.</td>
<td>Operator puts tractor in park or neutral and sets brakes before helper attaches safety pin, chains. Helper steps from between tractor and wagon before tractor operator moves tractor.</td>
</tr>
</tbody>
</table>

Figure 27 | Completed JSA for helping to hitch a wagon to a tractor.
JSAs are also useful for injury investigations. Comparisons can be made between how the job was supposed to be performed with how it was being done at the time of the incident. It can also be used to observe workers to see if they are performing tasks as efficiently as possible. JSAs are most effectively developed on site, using actual tools, equipment, and jobs. Ideally, an owner/manager can work with two or three employees who perform the job to develop the JSA. JSAs can also uncover unsafe shortcuts and maintenance that has been put off and provides an opportunity for workers to suggest better or alternate methods of completing tasks.
Learning from News Articles and Other Media

Using newspaper and magazine articles, photographs, TV news reports, and like sources of media takes advantage of what teenage and adult workers bring to the job—previous experiences that impact their own thinking and understanding and a desire to be actively engaged in learning activities. The key to this type of learning and training is that the instructor organizes the way a group talks about a topic so that specific learning takes place. The structuring usually takes place through the asking of questions that lead to thoughtful analysis of a particular incident or issue. To use this as instructional material, break the training audience into groups of four. Everyone should read the news clipping and then answer questions. Everyone is encouraged to express their opinion and thoughts on each question. One person should summarize all answers for their group and be prepared to discuss them with the whole group.

For example, by using stories from newspaper clippings that describe injury incidents or perhaps an editorial about a controversial issue such as the age at which a child should be allowed to operate equipment, workers can gain insight into risky behaviors. Examples of how to use this technique are on the following pages. Figures 29 and 30 are news stories about injury incidents. Identifying information has been removed. If you have enough participants, you could divide them into groups and let each group report. If time doesn’t allow everyone to voice their opinion on each question, be sure that everyone is able to express their thoughts at least once.

Adapted from news story involving fatal injury from baled hay

Title: Hay bale kills (local) farmer  
Source: Associated Press, Pennsylvania

A farmer died of chest trauma Tuesday after a large hay bale fell from a stack, crushing him against the ground, according to the County Deputy Coroner.

The farmer was working at a local farm feeding the livestock when the bale fell from the stack.

Special rescue units from around the county were dispatched on Tuesday morning. The farmer was pronounced dead at the hospital at 12:40 p.m. Police believe the incident was an accident and an autopsy will not be performed.

Figure 29 | Abstract of newspaper clipping on fatal injury involving baled hay.

Read the news clipping and then answer the following questions. Everyone should express their thoughts on each question.

1. Do you think the victim understood the weight of a large hay bale and the risk that the weight presents?
2. What do you think caused the bale to fall from the stack?
3. What ideas do you have for how this task could have been accomplished without being exposed to the falling bale?

Read the news clipping and then answer the following questions. Everyone should express their thoughts on each question.

1. Do you think the victim understood the hazards of getting off a running tractor?
2. What do you think caused the tractor to roll after the victim got off the tractor?
3. What could have been done to prevent this injury incident? Was there another way to accomplish the work goal?
Here are some additional hints for using this technique effectively:

- This is a low-cost alternative to other types of training.
- It requires being alert to news stories about safety issues that can be useful to you as an operator/manager/trainer with employees.
- Always use open-ended questions to structure the dialog.
- Ask no more than three or four questions.
- The last question should always be how the problem can be resolved.
- Remember that the goal is to engage the workers in learning; it is not to resolve difficult situations. But if most or everyone reaches consensus about causes or preventive measures, so much the better.

**Tailgate Training**

Another type of effective training is tailgate training. Tailgate training refers to ten- to fifteen-minute sessions on a single safety topic to a small group of workers around the tailgate of a truck, in the field, or in another work location that's comfortable for workers. Supervisors or the workers themselves are the presenters. Tailgate sessions should be held early in the work day and preferably early in the week when workers are rested. Always allow time at the end of each session for questions. Tailgate training is most effective when held on at least a weekly basis, even during the busy season. Training topics should be seasonal and relate to the work being done. For example, if lifting and carrying bags of fertilizer or mulch is part of the day’s work, a tailgate session on proper bending and lifting techniques would be in order.

Recent “close-call” incidents are another good option for tailgate training topics. Training on close-call incidents is also a proactive approach to mitigating an incident before it happens. There is much to be learned from discussing and documenting close calls with workers. As previously stated, discussions among workers and supervisors/managers involving close calls must be done in a nonthreatening environment where the workers do not feel that their openness about the incidents will be held against them.

Weekly tailgate training lets your workers know that safety is a high priority in your operation. It can also be used as evidence of training if you are inspected by OSHA or face a lawsuit in connection with an alleged safety-related violation. Tailgate safety sessions can enhance two-way communication between workers and owners/managers. Following are several examples of tailgate training resources with evaluation tools for farmers and their employees. Included are “Safely Starting and Stopping a Tractor” (Figure 31), “Chock and Block” (Figure 32), and “Preventing Lifting and Overexertion Injuries” (Figure 33) from the Agricultural Tailgate Training Program at The Ohio State University. More tailgate training topics can be found at www.ohioline.osu.edu.
Training Module: Safely Starting and Stopping a Tractor

Objective: To be able to start and stop a tractor the proper way.

Trainer’s Note: Have an experienced tractor operator demonstrate the proper techniques for safely starting and stopping a tractor. An extra rider is only allowed for training purposes.

Background

Before mounting the tractor, make sure guards and shields are in place and in good working condition. Use provided handrails for mounting and dismounting. Adjust the operator’s seat for fit and easy access to controls.

Before starting the engine remember to:

- Place the gearshift lever in “neutral” or “park.”
- Place all hydraulic controls in neutral.
- Disengage the PTO.
- Apply the brakes.
- Depress the clutch pedal.

Tractors will start in gear if normal starting circuitry is bypassed. Start the engine from the operator’s seat with the transmission in park. Do not start the engine by shorting across starter terminals. Never start the engine while standing on the ground.

If jumper cables are needed to start the engine, make sure polarity is correct. Reversed polarity will damage electrical system. Always connect the positive cable first and then the negative cable. Avoid sparks around the battery because escaping gas can cause an explosion. Avoiding sparks is difficult, so position the ground connection away from battery. This will help keep sparks away from the battery. Follow the instructions in the tractor operator’s manual. Always wear eye protection when working around batteries.

Stopping the tractor safely involves more than just applying the brakes and turning off the engine. Use the following safety suggestions to avoid accidents:

- Apply the brakes evenly.
- Disengage the PTO.
- Lower all hydraulically powered equipment to the ground.
- Put the gearshift lever in “park” or “neutral”, and set the brakes.
- Turn the ignition key off and remove it to prevent tampering or accidental starting.

Figure 31 | Tailgate training exercise from The Ohio State University Agricultural Tailgate Safety Training series on safe tractor operations.
Additional Safety Hints:
- Keep a copy of the operator’s manual on the tractor.
- To prevent falls, keep the surface area of the tractor free of oil, grease, and mud.
- Keep trash away from the exhaust system to prevent a fire.
- Keep tires properly inflated.
- Maintain control lights and gauges.
- Ventilate to avoid asphyxiation, when operating tractors indoors.

Review The Following Points
- No extra riders (except for specific training purposes).
- Never start the engine by shorting across starter terminals.
- When jump starting an engine, avoid sparks around the battery, and wear eye protection.
- Always apply brakes evenly and disengage the PTO before when stopping the tractor.

Safely Starting and Stopping a Tractor Quiz

True or False  

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Never start the engine by shorting across starter terminals.</td>
<td>T</td>
</tr>
<tr>
<td>2. If jumper cables are needed to start the engine, avoid sparks around the battery.</td>
<td>T</td>
</tr>
<tr>
<td>3. Follow the instructions in the operator’s manual.</td>
<td>T</td>
</tr>
<tr>
<td>4. Never start the engine when standing on the ground.</td>
<td>T</td>
</tr>
<tr>
<td>5. To stop the tractor just apply the brakes and quickly shut off the engine.</td>
<td>T</td>
</tr>
</tbody>
</table>

True or False Answer Key
Training Module: Chock and Block

Objective: To be able to secure a vehicle or piece of equipment using the proper chock and block method.

Trainer’s Note: To demonstrate the chock and block principles, have the training session in the farm shop or in the field. Give employees the opportunity to demonstrate how they would chock/block equipment if they were using it in the field or working on repairs in the shop.

Background

The purpose of the chock is to pin the wheels and hold them stationary. When unhooking farm equipment from a tractor, make sure the tires on the implement have been chocked to prevent the operator or bystanders from being injured if a roll back occurs. The rear most axle should be the one that is chocked. Tires may need to be chocked in both the front and the rear, on some equipment. Operators can be caught between a tractor and the equipment or a piece of equipment and the shop wall because the proper chocking procedures were not followed. It is a simple concept, but many farm employees forget to use this procedure when working with or around equipment. In some cases, workers have been killed or injured because they have failed to follow this procedure.

When loading or unloading bags or pallets from a semitrailer it may be necessary to block freight inside the trailer to prevent the movement. Blocking reduces the chance of a load shift, which can cause a trailer to turn over and damage the cargo or injure a worker. Cargo doesn’t have to be round to move, so block all four sides of the cargo separately. Use sound blocking material. Make certain that nails or spikes are long enough and the lumber is thick enough to prevent the cargo from shifting. Other freight should never be used as a block.

When working on equipment don’t rely on jacks or hoists to support the equipment. They are made to lift, not to support. The equipment should be blocked to support it while you are working on it.

The principal used in both chocking and blocking is the same: securing to prevent movement.

Tips to Remember:
- Chock wheels at the rear axle.
- Block freight inside the trailer when loading or unloading farm supplies.
- Do not unhook farm equipment that has not been chocked.
- Never put hands, fingers, etc. between equipment and blocks.
- Double-up and alternate the positioning of blocks while building the platform.
- Use larger blocks on the bottom. Make the platform as wide as possible.
Review The Following Points

• Rear axles need to be chocked.
• Do not attempt to unhook farm equipment that has not been chocked.
• Freight should be blocked when loading or unloading a trailer.
• Other freight should not be used as a block. Use proper materials for blocking.
• Keep hands and fingers from in between equipment and blocks.

True or False

1. There is no need to chock farm equipment before it is unhooked from the tractor. T  F
2. The purpose of the chock is to pin the wheels and hold them stationary. T  F
3. It is a good safety measure to block cargo inside trailers when loading or unloading. T  F
4. When chocking a loaded hay wagon, chock the rear axle. T  F
5. Cargo should be blocked separately. T  F

True or False Answer Key
Training Module: Preventing Lifting and Overexertion Injuries

Objective: To be able to lift properly to avoid injuries.

Trainer’s Note: Problems can arise from overexertion. On a flip chart list guidelines and suggestions for proper handling. Describe jobs that might result in overexertion. Ask a worker to demonstrate appropriate lifting techniques. Cover some practical tips to avoid overexertion.

Background

Approximately 25 percent of workplace injuries in Ohio result from lifting, pulling or pushing objects. The part of the body most often injured is the back.

Material Handling — Think Before Lifting

- Have a handling plan that avoids slippery hazards and includes a destination.
- Test the load to ensure that it can be safely carried.
- Know the limits! If the load is too heavy, awkward or bulky to carry alone, get help.
- Use machinery or equipment, such as pushcarts, hand truck, wheelbarrow, forklift or hoist.
- Do not overlook the use of levers, incline planes or rollers to move loads.

Serious back injuries occur because of improper lifting techniques. Some common improper lifting techniques people often use include:

- Bending from the waist to pick up objects.
- Lifting boxes above the chest.
- Twisting the body to carry or lift a heavy box or object.
- Lifting objects when in poor physical shape.

Guidelines for safe lifting:

- Get a good grip. Grasp the load firmly. Use gloves if they allow for a better grip.
- Get a good footing. Center body weight to provide a powerful line of thrust and good balance.
- Keep it close. Grasp the load firmly and lift towards the belt buckle. Hold the load close to the body to avoid putting pressure on the back.
- Lift smoothly. Raise, carry and lower the load smoothly. Never jerk a load.
- Avoid twisting. If turning is required while lifting or carrying a load, turn the feet and body instead of twisting the back.
- Push. Push rather than pull the load.

Figure 33 | Tailgate training exercise from The Ohio State University Agricultural Tailgate Safety Training series on safe lifting techniques.
Review The Following Points

- Approximately 25 percent of work related injuries in Ohio result from overexertion, mainly from lifting.
- Think and plan **before** lifting.
- Push rather than pull the load.
- Use mechanical means whenever possible.
- Avoid twisting when lifting or setting down a load. Turn the body instead of twisting the back.

Preventing Lifting and Overexertion Injuries Quiz

**True or False**

1. For best results, always pull rather than push a load.  
2. Wear gloves if they allow for a better grip.  
3. Approximately 25% of all injuries in Ohio result from overexertion, mainly from lifting, pulling or pushing objects.  
4. Use mechanical means to handle materials when possible.  
5. To prevent injuries, you should turn the body instead of twisting the back.

**Name__________________________**

<table>
<thead>
<tr>
<th>Question</th>
<th>T</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For best results, always pull rather than push a load.</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>2. Wear gloves if they allow for a better grip.</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>3. Approximately 25% of all injuries in Ohio result from overexertion, mainly from lifting, pulling or pushing objects.</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>4. Use mechanical means to handle materials when possible.</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>5. To prevent injuries, you should turn the body instead of twisting the back.</td>
<td>T</td>
<td>F</td>
</tr>
</tbody>
</table>

**True or False** Answer Key  
State and Federal Regulations that Require Training

A number of OSHA regulations identified as pertinent to agriculture in Unit 3 have education and training requirements associated with them. Some of these requirements are relatively short and straightforward, others not so much. Below are training requirements that are easily stated or summaries of training requirements with links to the text of the standard.

Rollover Protective Structure (ROPS) (29 CFR 1928.51). Every employee who operates any agricultural tractor must be informed of the operating practices below and any other practices necessary to maintain a safe working environment. Such information must be provided at the initial assignment and at least once a year thereafter.

1. Securely fasten your seatbelt if the tractor has a ROPS.
2. Where possible, avoid operating the tractor near ditches, embankments, and holes.
3. Reduce speed when turning, crossing slopes, and on rough, slick, or muddy surfaces.
4. Stay off slopes too steep for safe operation. (See the tractor's operator manual!)
5. Watch where you are going, especially at row ends, on roads, and around trees.
6. Do not permit others to ride. (This is referred to as “no extra riders.”)
7. Operate the tractor smoothly—no jerky turns, starts, or stops.
8. Hitch only to the drawbar and hitch points recommended by tractor manufacturers.
9. When the tractor is stopped, set brakes securely. Use parking brake lock if available.

Guarding of Farm Field Equipment, Farmstead Equipment, and Cotton Gins (29 CFR 1928.57). At the time of assignment and at least annually thereafter, employers must instruct every employee in the safe operation and servicing of all equipment with which they will be involved, including at least the following safe operating practices:

1. Keep all guards in place when the machine is in operation.
2. Permit no riders on farm field equipment other than the people required for instruction or assistance in machine operation.
3. Stop engine, disconnect the power source, and wait for all machine movement to stop before servicing, adjusting, cleaning, or unclogging the equipment. The only exception is when the machine must be running to be properly serviced or maintained, in which case the employer shall instruct employees as to all steps and procedures necessary to safely service or maintain the equipment.
4. Make sure everyone is clear before starting the engine, engaging power, or moving and operating machinery.
5. Lock out electrical power before performing maintenance or service on farmstead equipment.

Lockout/Tagout (29CFR 1910.147). Employers shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by employees. The training shall include the following:

- Each authorized employee shall receive training in the recognition of applicable hazardous energy sources; the type and magnitude of the energy available in the workplace; and the methods and means necessary for energy isolation and control.
- Each affected employee shall be instructed in the purpose and use of the energy control procedures.
- All other employees whose work operations are, or may be, in an area where energy control procedures may be used, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment that are locked out or tagged out.
- When tagout systems are used, employees shall also be trained on the following limitations of tags:
  - Tags are essentially warning devices affixed to energy-isolating devices and do not provide the physical restraint on those devices that is provided by a lock.
  - When a tag is attached to an energy-isolating means, it is not to be removed without authorization of the authorized person responsible for it. And it is never to be bypassed, ignored, or otherwise defeated.
• Tags must be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.
• Tags and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the workplace.
• Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.
• Tags must be attached securely to energy-isolating devices so that they cannot be inadvertently or accidentally detached during use.
• Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment, or processes that present a new hazard, or when there is a change in the energy control procedures.
• Additional retraining shall be conducted whenever a periodic inspection under paragraph (c)(6) of this section reveals or whenever the employer has reason to believe that there are deviations from or inadequacies in the worker’s level of knowledge or use of the energy control procedures.

**Occupational Noise Exposure (29 CFR 1910.95).** Employers shall train each employee who is exposed to noise at or above an eight-hour time weighted average of 85 decibels in accordance with the requirements of this section (1910.95). The employer shall institute a training program and ensure employee participation in the program. The training program shall be repeated annually for each employee included in the hearing conservation program. Information provided in the training program shall be updated to be consistent with changes in protective equipment and work processes. The employer shall ensure that each employee is informed of the following:

  - Permanent effects of excess noise on hearing
  - Purpose of hearing protectors, advantages/disadvantages, and instructions on selection, fitting, use, and care
  - Purpose of audiometric testing and an explanation of the test procedures
  - Location of, and access to, information and training materials

**Personal Protective Equipment (PPE) (29 CFR 1910.132).** Employers shall provide training to each employee who is required by this section to use PPE.

  - Each such employee shall be trained to know at least the following:
    - When the use of PPE is necessary
    - What type of PPE is required
    - How to properly don, doff, adjust, and wear PPE
    - The limitations of the PPE
    - The proper care, maintenance, useful life, and disposal of the PPE
  - Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to don and use PPE properly, before being allowed to perform work requiring the use of PPE.
  - When the employer has reason to believe that any affected employee who has already been trained does not have the understanding and skill required by paragraph (f)(2) of this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:
    - Changes in the workplace render previous training obsolete
    - Changes in the types of PPE to be used render previous training obsolete
    - Inadequacies in an affected employee’s knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill

A number of factors impact the effectiveness of training on the use of PPE in the agricultural workplace. One of the most important is the failure of supervisory or management personnel to wear the same PPE that their workers are trained to wear. Failure to set a good example by not wearing the assigned PPE can limit or destroy the best training efforts.
A second factor involving the purchase and availability of proper PPE is important to consider. Employers are required to purchase most PPE for workers (see OSHA 1910.132 for details). This requirement has been clarified recently by OSHA.

Another factor involves the comfort, fit, and style of PPE. It is crucial that PPE be comfortable to wear and to realize that one size and style does not fit all wearers. This means workers should be allowed to try different samples of sizes and styles before PPE is purchased. Some workers may feel that PPE makes them look silly or less masculine. In these cases, PPE training should emphasize the following points:
1. PPE is the choice of smart and productive workers.
2. An injury or illness from not wearing PPE can result in missing work and a paycheck.
3. Injuries from not wearing PPE often leave a person with scars or other nonflattering marks.

Respiratory Protection (29 CFR 1910.134). Employers must provide effective training prior to initial respirator use (unless another employer provided the required training within the past twelve months) to employees, including:
1. Why the respirator is necessary
2. How to properly fit, use, and maintain for maximum protective effect
3. Known limitations and capabilities of the respirator
4. How to use in emergency situations
5. How to inspect, put on, and remove, use, and check the seals
6. Procedures for maintenance and storage
7. Ability to recognize medical signs and symptoms that may limit or prevent effective use
8. Training on the general requirements of this standard

Permit-Required Confined Space (29 CFR 1910.146). Employers must provide effective training on those confined spaces that workers may encounter in the workplace. Among agricultural confined spaces are under-building manure storage facilities, grain bins, silos, walk-in refrigerated and controlled-atmosphere lockers, and tanks used for storage of effluent or chemicals. The training requirements under OSHA 29 CFR 1910.146(g) include:
1. Provision of training for all employees whose work involves entry into or in association with confined spaces
2. Provision of training prior to assignment of duties in confined spaces
3. Training when there is a change in permit-required operations that present a new hazard
4. Additional training when the employer believes that inadequacies exist in the employee's knowledge of confined space procedures
5. Issuance of certification including employee name, trainer's name or initials, and training dates
6. Documentation of the training certification and its availability for inspection by employees and their authorized representatives

Hazard Communications (29 CFR 1910.1200). Employers must provide effective information and training on hazardous chemicals in the workplace at the time of the employee's initial assignment. The training should include at least the following:
1. The location of the written hazard communication program, including a listing of hazardous chemicals, and the material safety data sheet (MSDS) for each chemical present at the worksite
2. Methods that can be used to detect the presence or release of hazardous chemicals in the workplace
3. Information on the physical, health, simple asphyxiation, combustible dust, and pyrophoric gas hazards of the chemicals in the workplace
4. Methods that employees can take to protect themselves (including PPE) from these chemical hazards
5. Details of the written hazard communication program developed by the employer, including an explanation of the labels and workplace labeling system(s) used at the worksite
**Hazardous Occupations Order for Agriculture (HOOA).** The U.S. Department of Labor (U.S. DOL) in 1969 stated that many agricultural tasks are hazardous for youth younger than age sixteen. A declaration known as the Hazardous Occupations Order for Agriculture (HOOA) requires that a youth younger than sixteen years of age receive training before being hired to operate farm tractors and powered machinery. The only exemption for youth under this order are youth who are working exclusively on their home or family farm.

The HOOA states that the successful completion of a ten-hour training program (the tractor operation program) permits youth ages fourteen and fifteen to operate a tractor over twenty-PTO horsepower, with no powered equipment attached. For example, it allows fourteen- and fifteen-year-old certified tractor operators to hitch and tow a hay wagon, but does not allow them to operate a PTO-driven piece of equipment like a flail mower behind the tractor. The regulations state that operating powered equipment with the tractor requires the successful completion of the twenty-hour tractor and machinery operation program. Employers are required to maintain proof and documentation of successful completion of the tractor and/or the machinery program in the form of a certificate of completion provided by a recognized state or local educational authority. This includes certification of youth ages fourteen and fifteen through a vocational agriculture (agricultural sciences) program in a public school or through a 4-H Cooperative Extension training program.

**Worker Protection Standard (WPS).** The U.S. Environmental Protection Agency (EPA) has determined that some chemicals used to control pests of agronomic, ornamental, vegetable, and fruit crops and livestock can be hazardous to chemical applicators and workers who are exposed while performing their normal work assignments. As a result, the EPA promulgated the Worker Protection Standard, known as the WPS, to provide regulations for protecting the safety and health of agricultural workers who could be exposed. The WPS was revised in late 2015, with many of its new provisions to take effect in early 2017.

A few major changes include:
- Annual mandatory training to inform farmworkers on the required protections afforded to them.
- Expanded training that includes instructions to reduce take-home exposure from pesticides on work clothing and other safety topics.
- First-time-ever minimum age requirement: Children under 18 are prohibited from handling pesticides.
- Changes in personal protective equipment will be consistent with DOL’s standards for ensuring that respirators are effective, including fit test, medical evaluation, and training.
- Specific amounts of water to be used for routine washing, emergency eye flushing, and other decontamination, including eye wash systems for handlers at pesticide mixing/loading sites.
- Continue the exemption for farm owners and their immediate families with an expanded definition of immediate family.

If you use pesticides you should visit [www2.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps](http://www2.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps) to learn about additional major changes and effective dates.

**Self-Contained Packaged Safety Training Programs**

Packaged safety training programs are available from numerous commercial sources that can be found by searching your web browser. You may find excellent safety training programs, usually for a fee, while others may be too generic and not applicable to your operation. Packaged safety programs provided by grower and trade associations are often good alternatives for specific groups of commodity producers like greenhouse and nursery operators and organic growers. Packaged safety training programs for tractors and machinery available through Penn State are listed below. Other land-grant universities may have similar resources.
• **National Safe Tractor and Machinery Operation Program (NSTMOP).** This is a comprehensive training program originally designed to allow youth ages fourteen and fifteen to be legally employed to operate tractors and some farm machinery. In recent years, the program has also been used for training adults who have little or no experience with tractors and machinery. The program can be accessed at [www.nstmop.psu.edu](http://www.nstmop.psu.edu).

• **AgSafety4U Certificate Course.** The Penn State agricultural safety team recognized a need for formalized online training for agricultural employers and employees. There are six modules to this program, including introductory, safety basics, agricultural hazards, farm tractors, connecting and using implements, and materials handling. Access this program through extension at [campus.extension.org](http://campus.extension.org); under Agriculture and Animals, click on “Safety & Health,” and then select the AgSafety4U course.
Unit 5.
Evaluating Training Programs and Resources

Once you have begun delivering training programs to your employees, you must consider the question, “Did the workers learn from what I (or other instructors) have just taught them?” The only way to collect evidence about the success or failure (effectiveness) of the training is to conduct ongoing and post-training evaluation. The following concepts are important to sustaining an effective level of safety and health training for your employees.

Informal Evaluation

Evaluation of training can be informal, such as verbally asking workers if they understood the information and/or liked the training session. During this informal evaluation, you can not only ask questions, but you could ask a trained employee to demonstrate any skills or behaviors that were taught during the training session. For example, if the training included mounting a tractor and safely starting a ROPS-equipped tractor, you could have the worker:

- Access the operator's station using the three points of contact method
- Adjust the seat to their individual size, stature, and comfort level
- Affix the seat belt properly around their waist
- Visually check 360 degrees around the tractor for dangers and continue with all safe starting procedures for the tractor

If you have a sequenced checklist for the above steps, and you have carefully observed the trained worker’s actions, you have now used an informal type of evaluation called observational analysis. This type of evaluation is very useful in a skills demonstration session to determine if each trained worker is capable of following the safety procedures that have been taught.

Formal Evaluation

The evaluation process can also be more formal. Formal evaluation is typically better because it is more complete, objective, allows you to improve training over time, and helps document in writing the effectiveness of the training. Not every training effort has to be formally evaluated, especially if you are conducting weekly or short, ten- to fifteen-minute training sessions. But evaluating and documenting training a few times a year will also demonstrate to workers that you take their safety training seriously.

There are several ways you can conduct formal evaluations, including administering pre-tests to determine their level of knowledge before the training; administering post-tests to measure knowledge gain after the training; or using pre- and post-tests together to measure knowledge gain before and after the training session. Another type of formal evaluation includes conducting follow-up assessments several weeks or months after the initial training to measure the retention level of the training information that was initially presented.

Be sure to evaluate all components of the training program, including the training curriculum (content), training environment (location), and the trainer (instructor) who conducted the training. If you don't conduct an assessment of the training content, training environment, and the individual who delivers the training, you may not end up with an accurate assessment of the reasons why the training was or was not successful. Let's look at each of the components in a training program with examples of shortcomings that could impact the assessment or evaluation of the effectiveness of the training.
Training curriculum (content):
- Training materials may be “packaged” and not relevant to the trainee’s work routine.
- Training materials may need updated because they relate to previous work conditions.
- Training materials may be in a language that the workers can’t understand.
- Training materials may not consider important cultural differences between the workers and their trainer.
- Training materials may not have relevant learning objectives.

Training environment (location):
- Training environment may not be big enough to comfortably accommodate all trainees.
- Training environment may be too cold or too warm or have other weather-related problems.
- Training environment may have distractions like excess noise or interference.

Trainer (instructor):
- Training instructor may not be prepared for presenting the training materials.
- Training instructor may not allow enough time to cover the training topic effectively.
- Training instructor may not seek input from the trainees during the training.
- Training instructor may not use evaluation tools that measure training effectiveness.

Following are examples of evaluation tools that may be used as is or can be adapted to your operation (Figures 34 through 37). The examples range in order from less informative for improving your training or program to more informative feedback. You can also find other examples by searching for program evaluation forms on the Internet.
Please evaluate today’s program using these categories:

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program content</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>Presenter(s) knowledge</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>Presenter(s) delivery</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>Training met my expectations</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>Overall quality of training</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>

**Additional comments:**
| Rate the overall quality of this program     | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Rate the overall quality of instructor(s)   | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Rate the clarity of the presentation       | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Rate the adequacy of the instructor's      | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| knowledge of the subject matter            |   |   |   |   |   |   |   |
| Rate the instructor’s skill in encouraging  | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| participation and discussion               |   |   |   |   |   |   |   |
| Rate the adequacy of the instructional     | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| resources used (visuals, supplies, etc.)   |   |   |   |   |   |   |   |

**Additional comments:**
Indicate the extent to which you agree with the following statements by circling the number.

1 – strongly agree; 2 – agree; 3 – neutral; 4 – disagree; 5 – strongly disagree

Program:
1. Course objectives were clear
2. Program content was thorough and complete
3. Course objectives were related to my job

Instructor:
1. Demonstrated knowledge of the course material
2. Communicated the information clearly
3. Responded to questions effectively
4. Taught enthusiastically about the subject

Materials:
1. Handouts were easy to read and useful
2. Exercises/activities/materials were interesting and appropriate
3. Instructional resources were helpful

Overall reaction:
1. Overall, I would rate this instruction as valuable.

Additional comments:
Indicate your opinions toward the following questions. List as many items as you feel appropriate.

**Training course:**
List two things you liked about the course.

List two things you disliked about the course.

**Training instructor:**
List two positive qualities about the instructor.

List two areas the instructor could improve upon.

**Training materials:**
What materials did you find beneficial to the learning process?

What materials could be improved upon to make the course more effective?

**Overall reaction:**
Use the back of this sheet to describe how you would rate the course. Please list anything that you feel could be done to make this course more effective.

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**Figure 37 | Evaluation with self-descriptive feedback.** This type of evaluation form allows trainees or participants to use their own words to describe the quality of training that was presented.
Appendix D

NEWBio Evaluation:
Linking Knowledge to Action
Technical Report - Year 3

Jessica Leahy and Laura Lindenfeld
NEWBio External Evaluators
December 2015
NEWBio Evaluation:
Linking Knowledge to Action
Technical Report – Year 3

Jessica Leahy and Laura Lindenfeld
NEWBio External Evaluators
December 2015
ACKNOWLEDGEMENTS

We would like to express our gratitude to NEWBio team and external stakeholders for participating in our survey and interviews.

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INTRODUCTION

NEWBio aims to expand the role of biomass, a long-standing resource for energy and materials in the northeastern U.S., in the coming decades. Perennial energy crops, especially willow and warm-season grasses, can play a central role in creating a sustainable bioenergy future for the region. This region, stretching from New England to the Ohio River, encompasses less than 10% of the land area of the U.S. yet contains over 20% of its population. Although it includes four of the eleven largest metropolitan regions in the nation, the landscape is dominated by rural communities with ample but often underutilized natural resources, with many communities suffering from decades of decline. NEWBio envisions biomass energy as key source that can help drive social, economic and ecological change in the Northeast. The ability of NEWBio to align the science and scientific products it produces with societal needs depends on the project’s ability to advance interdisciplinary collaboration across universities and transdisciplinary engagement with external stakeholders and institutions. This depends, in large part, on the team’s ability to communicate and collaborate across a number of geographically dispersed institutions of higher education.

This technical report summarizes Year 3 evaluation findings for the NEWBio Consortium. It focuses on two distinct areas. First, we focus on the team’s perspective of the NEWBio Consortium’s progress. Second, it considers views of external stakeholders who are not members of NEWBio Consortium’s Advisory Board. The study was designed to gather information from NEWBio Consortium team members through an online survey of the entire NEWBio team and interviews with the project’s Leadership Team and external stakeholder group members. This information will be used support the team’s decision-making in subsequent project years based on understanding how the team is communicating and collaborating. This information builds on Year 1 and 2 evaluations to deepen understanding of how the team changes over time, and help to understand how effectively the team is collaborating with external stakeholders.

Specific objectives of this study included:

- Evaluate NEWBio’s progress in advancing interdisciplinary collaboration and identify key strategies for advancing the team’s ability to collaborate across multiple disciplines and different geographic settings;
- Identify strengths and weaknesses with regard to project management and communication and collaboration infrastructure and practices;
- Understand team members’ perceptions of key stakeholders and stakeholder groups and their needs for project research, extension, and education activities;
- Understand stakeholder perspectives of the team’s goals and progress;
- Assess the team’s capacity to collaborate with stakeholders;
- Utilize the data collected in this Year 3 evaluation to provide guidance the project’s future.

The results obtained through our two-part study provide important and useful data for understanding team members’, the leadership team’s, and the stakeholders’ views on the project and its ability to advance effective its goal of linking knowledge with action to promote bioenergy in the northeastern US.

The conceptual framework of this evaluation emphasizes the importance of developing effective communication across inter/transdisciplinary projects as a way of helping to improve project networks and strengthen collective capacity and the ability achieve high levels of integration. Such integration depends on the development of what Thompson terms “collective communication competence,” a framework that depends on core processes such as the establishment of trust, ability to spend time working together, and explicit discussions about disciplinary language differences. Dewulf et al. stress the need for creating context through the use of frames that help “make

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sense of the issues of importance in a specific research context. The external evaluators are experienced with studying the dynamics of transdisciplinary teams. Important background that guides this evaluation include:


**STUDY METHODS AND ADMINISTRATION**

We conducted an online survey in Summer 2015 and phone interviews in Fall 2015. Survey participants were recruited from the NEWBio consortium directory of researchers including faculty, staff, post-docs, and graduate students. Undergraduate students were excluded. All research, extension, and education team participants were invited via email to participate in the survey, administered online through Qualtrics. Before the emails were sent, an announcement about the study was made by the NEWBio consortium director, Professor Tom Richard, at monthly all-team meetings and at the All-Hands Team Meeting in August 2015. Participants for the surveys were then recruited via an email that invited them to take the survey. The email included a link to the survey. Those who wished to participate completed the surveys online by following the link. Participation in the surveys was voluntary. In total, 61 participants completed the survey out of an invited 107 participants. This led to a response rate of 57%.

Participants for the interviews were recruited via email from members of NEWBio’s Leadership Team, which included all NEWBio Executive Committee members and Thrust Leaders. External stakeholders were recruited via email as well, following suggestions from the Leadership Team for stakeholders involved in NEWBio but not on the Advisory Board. The qualitative data supplement quantitative data collected via the survey instrument and help to understand in greater depth how the project is advancing its work across disciplines and institutions and with key project stakeholders. The interviews also enable a deeper understanding of what challenges and threats the project is facing and what opportunities, strengths, and assets might help to advance the project’s goals. Participants were asked to reflect on the project’s mission and vision for its final two years and to consider how the team might most effectively advance its ability to fulfill this mission and vision. Individuals received a copy of the informed consent, which explained the purpose of the study, and were invited to participate in the interview. Participation in the interview was voluntary. Our interviews for the Year 3 Evaluation targeted members of the Leadership Team and external stakeholders who are not members of the Advisory Board. Thirteen in-depth

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interviews were conducted with Leadership Team members, and three with stakeholders for a total of fifteen interviews. Interviews lasted approximately 30 – 40 minutes.

The purpose of the study is to improve knowledge of inter-/transdisciplinary research teams, assess the strengths and weaknesses of the NEWBio Consortium’s development, and provide feedback to the team as a means of improving its collaborative structure, strengthening its research, extension, and outreach outcomes, and contributing to a broader scholarly dialog on large interdisciplinary teams. Given the aims of NEWBio to link the project’s knowledge with tangible action, the ability to create a dynamic, collaborative environment is central to the project’s ability to achieve its aims. The evaluation is meant to encourage progress in these areas, especially midway through the 5-year project.

DATA ANALYSIS

For the purposes of this technical report, we analyzed the survey response data using Qualtrics software. We calculated descriptive statistics, such as mean, median, mode, standard deviation, and frequency distributions, for all survey items; the frequency distributions of these statistical analyses are reported in the results section of this report. While many questions from the Year 1 evaluation were replicated in order to make comparisons between Year 1 and 3, statistical testing was not completed because of small sample sizes and different study populations (NEWBio faculty and staff in Year 1 vs. a broader group of NEWBio team members, including post-docs and graduate students in Year 3).

Interviews were transcribed and coded according to questions used to frame the study. We identified and organized data using open coding to preserve the participants’ language and explore emergent issues, concerns, and ideas. To protect confidentiality, identifying markers such as names, titles, and addresses were removed from the data sets. Interview recordings were kept secure and evaluated only by Leahy and Lindenfeld. Furthermore, only certain sections of interview transcripts are shared in this report to ensure confidentiality.

STUDY LIMITATIONS

As with any evaluation, there are limitations to the data collected. First, the survey sampled NEWBio team members who were willing participate in the study. The response rate was only 57%. The interviews targeted the Leadership Team and external stakeholders. While we had a high response rate, some leadership team and external stakeholders chose not to participate in the study. In particular, it was challenging to recruit external stakeholders who felt familiar enough with NEWBio and were willing to be interviewed. The data presented represent the views and opinions of these team members and external stakeholders who chose to participate and, thus, of a particular set of individuals. These data offer valuable insight into the input we received from the participants, but it is not generalizable to a larger population. Rather, it forms the basis for ongoing collaboration and provides valuable input for the team as it seeks to advance NEWBio.

SURVEY RESULTS

Description of Participants

Of the 107 NEWBio members invited to participate in the online survey, a total of 61 participated for a response rate of 57%. This is a decline from Year 1, which featured many of the same questions. The Year 1 survey included 37 responses and had a response rate of 69%. There are differences between the Year 1 and Year 3 samples, including who was included as NEWBio team members. In Year 3, new team members had joined the group, and post-docs and grad students were also included. This is reflected in the composition of respondents in Year 3: 60% were faculty, 20% were graduate students, 8% were post-docs, 8% were staff, and 3% selected the “other” category. By comparison in Year 1, most of the survey participants were faculty members (69%). Graduate students (11%), staff (11%), and other personnel (9%), such as those with federal agencies, were also involved.
There was at least one participant from each of the university and federal partners, except for the University of Vermont. Mirroring the population structure of NEWBio, Penn State and Cornell had the most participants in Year 3, as they did in Year 1. The difference between Year 1 and Year 3 evaluation participants includes an increase in the representation from West Virginia University and SUNY-ESF in Year 3.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
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<td>Penn State</td>
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<td>Cornell University</td>
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<td>16.9%</td>
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<td>West Virginia University</td>
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<td>10.2%</td>
</tr>
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<td>Delaware State University</td>
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</tr>
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<td>Drexel University</td>
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<tr>
<td>SUNY ESF</td>
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<td>USDA ARS</td>
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<tr>
<td>Total</td>
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In Year 3, around 65% of respondents were male, 30% were female and another 5% selected the “preferred not to respond” option. This differs from Year 1, where 54% were male, 37% were female and 9% “preferred not to respond.”

<table>
<thead>
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<th>Answer</th>
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<tr>
<td>Male</td>
<td>37</td>
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<tr>
<td>Female</td>
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<td>29.8%</td>
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<td>Prefer not to respond</td>
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<td>5.3%</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>100.0%</td>
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</tbody>
</table>

There was at least one participant from each of the university and federal partners, except for the University of Vermont. Mirroring the population structure of NEWBio, Penn State and Cornell had the most participants in Year 3, as they did in Year 1. The difference between Year 1 and Year 3 evaluation participants includes an increase in the representation from West Virginia University and SUNY-ESF in Year 3.
Participants were asked to select their primary thrust, recognizing that many NEWBio members participate in multiple thrusts, or are on a thrust and the Leadership Team. Each of the thrusts was well represented by survey participants. Most members of the Leadership Team selected a technical thrust as their primary “home” within NEWBio. There were no noticeable changes in the distribution of thrusts between Year 1 and Year 3.

<table>
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<th>Response</th>
<th>%</th>
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<tbody>
<tr>
<td>Human Systems in the Northeast Regional Bioeconomy</td>
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<tr>
<td>Feedstock Improvement for Perennial Energy Crops</td>
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<td>Harvest, Preprocessing, and Logistics of Integrated Biomass Supply Chains</td>
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<tr>
<td>System Performance and Sustainability Metrics</td>
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<td>Safety and Health in Biomass Feedstock Production and Processing Operations</td>
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<td>Leadership, Stakeholder Involvement, and Program Evaluation</td>
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<td>Total</td>
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</tbody>
</table>

The survey asked how long team members had been involved with NEWBio. While the project is officially in Year 3, many people have been with the project for longer than that during the proposal writing phase. Twenty individuals, or 35%, reported being with the project longer than 3 years. Another 33% had been involved for 2-3 years, 12% for 1-2 years, 14% for 1 year and 7% for less than one year. The Year 3 results differ from the Year 1 results, obviously from the increasing time that original team members have been with the project.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 months</td>
<td>4</td>
<td>6.9%</td>
</tr>
<tr>
<td>7-12 months</td>
<td>8</td>
<td>13.8%</td>
</tr>
<tr>
<td>13-24 months</td>
<td>7</td>
<td>12.1%</td>
</tr>
<tr>
<td>25-36 months</td>
<td>19</td>
<td>32.8%</td>
</tr>
<tr>
<td>37 or more months</td>
<td>20</td>
<td>34.5%</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Overall

Survey respondents continued to share strong understanding, support, and value for NEWBio despite the slight declines in many of the items’ means between Year 1 and Year 3. For instance, 95% of all respondents said that they agreed or strongly agreed that they understand the vision of NEWBio. Similarly, 91% of all respondents said that the work they do with NEWBio is important to them professionally. As in Year 1, the Year 3 results showed that people disagree that their department, university, college, or research institution adequately credits them for the work they do on NEWBio. Of potential alarm, is that 15% of respondents either strongly disagreed or disagreed that “The accomplishments of NEWBio will have a significant impact outside the Northeast.”

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I understand the vision of NEWBio</td>
<td>0.0%</td>
<td>0.0%</td>
<td>4.9%</td>
<td>60.7%</td>
<td>34.4%</td>
<td>4.5</td>
<td>4.3</td>
</tr>
<tr>
<td>I support the mission and vision of NEWBio</td>
<td>0.0%</td>
<td>1.6%</td>
<td>9.8%</td>
<td>45.9%</td>
<td>42.6%</td>
<td>4.6</td>
<td>4.3</td>
</tr>
<tr>
<td>The work I do with NEWBio is important to me personally</td>
<td>0.0%</td>
<td>3.3%</td>
<td>14.8%</td>
<td>47.5%</td>
<td>34.4%</td>
<td>4.3</td>
<td>4.1</td>
</tr>
<tr>
<td>The work I do with NEWBio is important to me professionally</td>
<td>0.0%</td>
<td>0.0%</td>
<td>9.8%</td>
<td>47.5%</td>
<td>42.6%</td>
<td>4.6</td>
<td>4.3</td>
</tr>
<tr>
<td>I feel that my contributions to NEWBio are valued</td>
<td>0.0%</td>
<td>4.9%</td>
<td>14.8%</td>
<td>60.7%</td>
<td>19.7%</td>
<td>4.1</td>
<td>4.0</td>
</tr>
<tr>
<td>My role in NEWBio is clear to me</td>
<td>0.0%</td>
<td>6.6%</td>
<td>13.1%</td>
<td>50.8%</td>
<td>29.5%</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>I am satisfied with my role in NEWBio</td>
<td>0.0%</td>
<td>3.3%</td>
<td>21.3%</td>
<td>49.2%</td>
<td>26.2%</td>
<td>3.9</td>
<td>4.0</td>
</tr>
<tr>
<td>My department credits me adequately for the work I do on NEWBio</td>
<td>0.0%</td>
<td>13.1%</td>
<td>37.7%</td>
<td>36.1%</td>
<td>13.1%</td>
<td>3.5</td>
<td>3.5</td>
</tr>
<tr>
<td>My university, college or research institution credits me adequately for the work I do on NEWBio</td>
<td>0.0%</td>
<td>11.5%</td>
<td>39.3%</td>
<td>39.3%</td>
<td>9.8%</td>
<td>3.4</td>
<td>3.5</td>
</tr>
<tr>
<td>I have the resources and administrative support I need to do my NEWBio work</td>
<td>3.3%</td>
<td>8.2%</td>
<td>23.0%</td>
<td>54.1%</td>
<td>11.5%</td>
<td>3.5</td>
<td>3.6</td>
</tr>
<tr>
<td>The accomplishments of NEWBio will have a significant impact within the Northeast</td>
<td>0.0%</td>
<td>9.8%</td>
<td>26.2%</td>
<td>50.8%</td>
<td>13.1%</td>
<td>4.2</td>
<td>3.7</td>
</tr>
<tr>
<td>The accomplishments of NEWBio will have a significant impact outside the Northeast</td>
<td>3.3%</td>
<td>11.7%</td>
<td>40.0%</td>
<td>38.3%</td>
<td>6.7%</td>
<td>3.9</td>
<td>3.3</td>
</tr>
</tbody>
</table>
The survey respondents were overall satisfied with the process, participants, and outcomes of NEWBio to date. While ratings slightly shifted between levels on the Likert-scale, the means between Year 1 and Year 3 remained nearly unchanged.

<table>
<thead>
<tr>
<th>Question</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Neutral</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>0.0%</td>
<td>3.3%</td>
<td>21.3%</td>
<td>54.1%</td>
<td>21.3%</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Participants</td>
<td>0.0%</td>
<td>0.0%</td>
<td>8.2%</td>
<td>67.2%</td>
<td>24.6%</td>
<td>4.1</td>
<td>4.2</td>
</tr>
<tr>
<td>Outcomes</td>
<td>0.0%</td>
<td>6.6%</td>
<td>31.1%</td>
<td>52.5%</td>
<td>9.8%</td>
<td>3.8</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Communication**

The survey asked a number of items to assess communication. Overall, the results showed that participants were highly positive about various aspects of NEWBio’s communication strategies. Furthermore, the means remained relatively consistent between Year 1 and Year 3. It is worth noting a few areas of minor concern within the results. By combining strongly disagree, disagree and neither agree nor disagree (a neutral of sorts) categories, we capture 39% of participants in responding to the sentence, “The internal NEWBio website functions as an effective communication platform.” Another 28% selected these three categories for the sentence, “The public NEWBio website functions as an effective communication platform;” 19.5% for the sentence, “The monthly All Team Meetings as an effective communication platform,” and 19.4% for the sentence, “The communication systems of NEWBio work effectively.” All of these could areas to explore more in the future.
<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective outlets for communication across NEWBio are available</td>
<td>0.0%</td>
<td>3.3%</td>
<td>13.1%</td>
<td>62.3%</td>
<td>21.3%</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>The internal NEWBio website functions as an effective communication</td>
<td>1.6%</td>
<td>6.6%</td>
<td>24.6%</td>
<td>50.8%</td>
<td>16.4%</td>
<td>3.6</td>
<td>3.7</td>
</tr>
<tr>
<td>platform</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The public NEWBio website functions as an effective communication</td>
<td>1.7%</td>
<td>1.7%</td>
<td>20.0%</td>
<td>61.7%</td>
<td>15.0%</td>
<td>3.8</td>
<td>3.9</td>
</tr>
<tr>
<td>platform</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The monthly All Team Meetings are an effective communication platform</td>
<td>0.0%</td>
<td>6.6%</td>
<td>23.0%</td>
<td>50.8%</td>
<td>19.7%</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>The All Hands summer meetings are an effective communication platform</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Year 3]/The initial All Hands Kick Off Meeting held in August 2012 was</td>
<td>0.0%</td>
<td>6.6%</td>
<td>16.4%</td>
<td>31.1%</td>
<td>45.9%</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td>an effective communication platform [Year 1]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The communication systems of NEWBio work effectively</td>
<td>1.6%</td>
<td>4.9%</td>
<td>23.0%</td>
<td>60.7%</td>
<td>9.8%</td>
<td>3.9</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Within NEWBio, significant work has been done to connect researchers to each other. The comparable means between Year 1 and Year 3 hide the shifts within Likert-scale categories. For instance, in Year 1, 44.5% of respondents indicated they were not aware of research being conducted in other thrusts when combining neutral and both disagree response categories. In Year 3, this percentage has been reduced to 31.7%. While more cross-thrust communication opportunities would be beneficial, the team should be proud of the major gains made here.
<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a NEWBio member, I am aware of the research projects being conducted in thrusts other than my own</td>
<td>1.7%</td>
<td>10.0%</td>
<td>21.7%</td>
<td>53.3%</td>
<td>13.3%</td>
<td>3.5</td>
<td>3.7</td>
</tr>
<tr>
<td>As a NEWBio member, I feel connected to other project members</td>
<td>3.4%</td>
<td>13.6%</td>
<td>32.2%</td>
<td>37.3%</td>
<td>13.6%</td>
<td>3.6</td>
<td>3.4</td>
</tr>
<tr>
<td>I feel that my input is important to NEWBio</td>
<td>1.6%</td>
<td>8.2%</td>
<td>19.7%</td>
<td>59.0%</td>
<td>11.5%</td>
<td>4.0</td>
<td>3.7</td>
</tr>
</tbody>
</table>

In Year 1, survey respondents had strong communication method preferences. The top three preferred or highly preferred communication methods were: emails (80.6%), conference calls (77.8%) and the public NEWBio website (77.8%). Least preferred communication methods were blogs (36.1% not preferred) and webcams (e.g., 24-hour webcams of NEWBio fields or laboratories) (30.6%). Rather than ask this same question in Year 3, we decided to ask a question about actual use. The Year 3 results indicated that the most used communication methods were emails, the annual All Hands Meeting, conference calls, the Monthly All Team meeting, and phone calls. Respondents were accurate in identifying blogs and webcams as not likely to be popular. These were two of the five least used communication methods. The other three platforms were Facebook, Twitter, and the NEWBio Resources on eXtension.org resource. Given the amount of effort Extension thrust members have put into eXtension.org, it would be good to find a way to increase its communication value. If significant resources are being devoted to social media (Facebook and Twitter), perhaps that should be re-evaluated. It may also be desirable to reach out to current social media subscribers (Twitter followers) to learn more about them and what their information needs include.
**Interdisciplinary & Engaged Research**

The survey respondents were strong believers in interdisciplinary research and engaged scholarship with stakeholders. For instance, 95.1% of survey respondents agreed or strongly agreed that the opportunity to collaborate on NEWBio with faculty in fields other than theirs is important to them. Another, 88.5%, indicated that the opportunity to collaborate on NEWBio with stakeholders outside of the university was important to them. There was a concerning drop in the percentage of respondents that agreed or strongly agreed that NEWBio could be held up as a model research project for interdisciplinary research. In Year 1 the percentage was 91.9% and it has dropped to 72.1% in Year 3. This could be due to expansion of the study population to include post-docs, graduate students, and others who were the not the core team members who initiated the project. Finally, there was a belief that the interdisciplinary nature of the research would lead to synergies that might not be possible from working alone (88.5% agree or strongly agree).
The opportunity to collaborate on NEWBio with faculty in fields other than mine is important to me

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>The opportunity to collaborate on NEWBio with stakeholders outside of the university is important to me</td>
<td>0.0%</td>
<td>0.0%</td>
<td>11.5%</td>
<td>54.1%</td>
<td>34.4%</td>
<td>4.5</td>
<td>4.2</td>
</tr>
<tr>
<td>NEWBio can serve as a positive model for interdisciplinary research efforts</td>
<td>1.6%</td>
<td>8.2%</td>
<td>18.0%</td>
<td>34.4%</td>
<td>37.7%</td>
<td>4.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Working as a group, NEWBio teams will be able to accomplish much more together than members could working individually</td>
<td>0.0%</td>
<td>0.0%</td>
<td>11.5%</td>
<td>39.3%</td>
<td>49.2%</td>
<td>4.4</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Despite the strong response above to collaborating with stakeholders, at the time of the Year 1 survey, only 33% of the survey respondents had personally collaborated with stakeholders as a part of the NEWBio project. We defined stakeholder as an individual or group external to NEWBio who has a vested interest in the project’s outcome. By Year 3, this number had increased modestly to 39%. However, this should still be applauded because with the increase in post-docs and graduate students, who sometimes are not included in stakeholder engagement efforts, it might have expected that the percentage of respondents who had contact with a NEWBio stakeholder might have declined.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes – Year 1</td>
<td>12</td>
<td>33%</td>
</tr>
<tr>
<td>Yes – Year 3</td>
<td>23</td>
<td>39%</td>
</tr>
<tr>
<td>No – Year 1</td>
<td>21</td>
<td>58%</td>
</tr>
<tr>
<td>No – Year 3</td>
<td>30</td>
<td>51%</td>
</tr>
<tr>
<td>Unsure – Year 1</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>Unsure – Year 3</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>Total – Year 1</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>Total – Year 3</td>
<td>59</td>
<td>100%</td>
</tr>
</tbody>
</table>
Participants were presented with a list of possible stakeholders to the NEWBio project and asked to indicate which ones they consider most important in advancing bioenergy in the Northeast. Ninety three percent of respondents selected industry, followed by federal (72%) and state agencies (62%).

<table>
<thead>
<tr>
<th>Answer</th>
<th>Year 1 %</th>
<th>Year 3 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>State government agencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal government agencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry</td>
<td>69%</td>
<td>72%</td>
</tr>
<tr>
<td>County or city government agencies</td>
<td>44%</td>
<td>23%</td>
</tr>
<tr>
<td>Individual citizens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Professional organizations</td>
<td>25%</td>
<td>26%</td>
</tr>
<tr>
<td>Environmental organizations</td>
<td>42%</td>
<td>33%</td>
</tr>
<tr>
<td>Other organizations</td>
<td>8%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Those who have had stakeholder contact related to NEWBio indicated that it was both a very positive interaction and very useful. Nearly 50% gave each of these two variables a “very positive” or “very useful” rating.

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Year 1 Mean</th>
<th>Year 3 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Negative: Very Positive</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>10%</td>
<td>14%</td>
<td>24%</td>
<td>48%</td>
<td>9.17</td>
<td>9.17</td>
</tr>
<tr>
<td>Very Not Useful: Very Useful</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>19%</td>
<td>29%</td>
<td>48%</td>
<td>8.92</td>
<td>8.92</td>
<td></td>
</tr>
</tbody>
</table>

Four different models for engaging stakeholders were presented to survey participants: Lead, Consulting, Facilitating, and Full. They were instructed, “Stakeholder-NEWBio partnerships can be structured in many ways. By partnerships, we mean ways NEWBio researchers and stakeholders can work together to address salient issues. We are interested in your opinion of four alternative participation strategies for stakeholders involved in stakeholder-NEWBio partnerships. In all cases, we assume implementation is handled by stakeholders.” The four models are presented below:
<table>
<thead>
<tr>
<th>Type of partnership</th>
<th>Problem Identification</th>
<th>Research</th>
<th>Proposed Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEWBio as <strong>Lead</strong> Partner</td>
<td>NEWBio researchers</td>
<td>NEWBio researchers</td>
<td>NEWBio researchers</td>
</tr>
<tr>
<td>NEWBio as <strong>Consulting</strong> Partner</td>
<td>NEWBio researchers and Stakeholder</td>
<td>NEWBio researchers</td>
<td>NEWBio researchers</td>
</tr>
<tr>
<td>NEWBio as <strong>Facilitating</strong> Partner</td>
<td>NEWBio researchers and Stakeholders</td>
<td>NEWBio researchers</td>
<td>NEWBio researchers and Stakeholders</td>
</tr>
<tr>
<td>NEWBio as <strong>Full</strong> Partner</td>
<td>NEWBio researchers and Stakeholders</td>
<td>NEWBio researchers</td>
<td>NEWBio researchers and Stakeholders</td>
</tr>
</tbody>
</table>

Survey participants were asked to select the stakeholder engagement strategy they most preferred. There were interesting shifts in responses between the Year 1 and Year 3 survey. The percentage of respondents most preferring the consulting model more than doubled from 6% to 15%. The percentage preferring facilitating slightly declines, while the full stakeholder engagement model increased slightly. Lead and other categories remained virtually the same between Year 1 and Year 3.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead – Year 1</td>
<td>3</td>
<td>9%</td>
</tr>
<tr>
<td>Lead – Year 3</td>
<td>4</td>
<td>7%</td>
</tr>
<tr>
<td>Consulting – Year 1</td>
<td>2</td>
<td>6%</td>
</tr>
<tr>
<td>Consulting – Year 3</td>
<td>9</td>
<td>15%</td>
</tr>
<tr>
<td>Facilitating – Year 1</td>
<td>15</td>
<td>44%</td>
</tr>
<tr>
<td>Facilitating – Year 3</td>
<td>22</td>
<td>37%</td>
</tr>
<tr>
<td>Full – Year 1</td>
<td>13</td>
<td>38%</td>
</tr>
<tr>
<td>Full – Year 3</td>
<td>24</td>
<td>41%</td>
</tr>
<tr>
<td>Other – Year 1</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Other – Year 3</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Total – Year 1</td>
<td>34</td>
<td>100%</td>
</tr>
</tbody>
</table>

Even greater changes were noticed between responses in Year 1 and Year 3 when it came to asking the participants which participation strategy they believe their stakeholders most prefer. The percentage of respondents selecting consulting increased from 6% to 23% between Year 1 and Year 3. This appears to have partially come from the declines in those selecting Lead (-3%), Facilitating (-5%), and Full (-2%).
Survey respondents were also asked to what extent they agreed or disagreed that they trusted stakeholders because of variety of factors such as trusting stakeholders because they provide scientific information or because they provide unbiased information. The highest point of agreement was that the researchers trusted the stakeholders because they present useful information. The only items in which less than 50% of respondents selected “agree” or “strongly agree” were “provide unbiased information,” “are familiar,” and “share my values.”
Annual Meeting

In the Year 3 survey, we also carried out an evaluation of the 2015 NEWBio Annual All Hands Summer Meeting, which was held in Morgantown, WV. Forty-three of the 61 respondents (71%) had attended this meeting. The questions about the annual meeting were only asked of these 43 team members using a skip pattern within the online survey.

People rated the overall experience at the 2015 All Hands Summer Meeting very positively.

<table>
<thead>
<tr>
<th>Answer</th>
<th>Response</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Fair</td>
<td>3</td>
<td>7.1%</td>
</tr>
<tr>
<td>Good</td>
<td>13</td>
<td>31.0%</td>
</tr>
<tr>
<td>Very Good</td>
<td>14</td>
<td>33.3%</td>
</tr>
<tr>
<td>Excellent</td>
<td>12</td>
<td>28.6%</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

In looking at combined responses of “agree” and “strongly agree,” the highest rated item of the meeting was the overall agenda (62%), followed by the meeting format (52%), opportunity for thrust and/or small group discussions (50%), and opportunities for cross-thrust interactions (43%).

<table>
<thead>
<tr>
<th>Question</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall agenda</td>
<td>0.0%</td>
<td>9.5%</td>
<td>28.6%</td>
<td>45.2%</td>
<td>16.7%</td>
<td>42</td>
</tr>
<tr>
<td>Meeting format</td>
<td>0.0%</td>
<td>23.8%</td>
<td>23.8%</td>
<td>31.0%</td>
<td>21.4%</td>
<td>42</td>
</tr>
<tr>
<td>Opportunity for thrust and/or small group discussions</td>
<td>9.5%</td>
<td>21.4%</td>
<td>19.0%</td>
<td>28.6%</td>
<td>21.4%</td>
<td>42</td>
</tr>
<tr>
<td>Opportunity for cross-thrust interactions</td>
<td>4.8%</td>
<td>26.2%</td>
<td>26.2%</td>
<td>26.2%</td>
<td>16.7%</td>
<td>42</td>
</tr>
</tbody>
</table>

Finally, we asked respondents to rate a variety of statements about the 2015 All Hands Summer Meeting. Seventy-four percent of respondents agreed or strongly agreed that, “the meeting purpose and objectives were clearly stated.” Also, remarkable, is that 71% of respondents agreed with the statement, “I was satisfied with this meeting.” The least agreement was for shared decision-making and the convenience of the location. Open ended comments presented later had several positives to say about the location, especially the ability to see colleagues’ field sites, despite the inconvenience.
<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither disagree nor agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Total Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>The meeting purpose and objectives were clearly stated.</td>
<td>0.0%</td>
<td>9.5%</td>
<td>16.7%</td>
<td>47.6%</td>
<td>26.2%</td>
<td>42</td>
</tr>
<tr>
<td>Our meeting time was convenient for me.</td>
<td>2.4%</td>
<td>7.1%</td>
<td>11.9%</td>
<td>52.4%</td>
<td>26.2%</td>
<td>42</td>
</tr>
<tr>
<td>Our meeting place was convenient for me.</td>
<td>7.1%</td>
<td>16.7%</td>
<td>19.0%</td>
<td>33.3%</td>
<td>23.8%</td>
<td>42</td>
</tr>
<tr>
<td>We shared decision-making at this meeting.</td>
<td>0.0%</td>
<td>7.1%</td>
<td>38.1%</td>
<td>47.6%</td>
<td>7.1%</td>
<td>42</td>
</tr>
<tr>
<td>All meeting participants were actively involved.</td>
<td>4.8%</td>
<td>21.4%</td>
<td>11.9%</td>
<td>47.6%</td>
<td>14.3%</td>
<td>42</td>
</tr>
<tr>
<td>We used our meeting time effectively.</td>
<td>0.0%</td>
<td>16.7%</td>
<td>14.3%</td>
<td>50.0%</td>
<td>19.0%</td>
<td>42</td>
</tr>
<tr>
<td>I was satisfied with this meeting.</td>
<td>0.0%</td>
<td>11.9%</td>
<td>16.7%</td>
<td>52.4%</td>
<td>19.0%</td>
<td>42</td>
</tr>
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</table>

*Open Ended Questions and Comments*

Survey respondents also provided significant additional feedback on NEWBio through open-ended comments. Italics are used to indicate direct quotes from survey participants.

**What was the best part of the 2015 Annual Meeting and why?**

**Discussion and Collaboration Time**

- Honest discussion about current challenges facing bioenergy
- Direct interaction with close collaborators
- Face to Face Thrust meeting, however we needed more time than just one hour for this. We did not scratch the surface of what we needed to discuss.
- Personal interactions and small-group discussions allowed for sharing of ideas and information in an effective manner.
- I am new to the team, it was great to hear ideas from other thrusts.
- Interactions with the many great people participating in this project.
- Being able to spend some time in face to face discussions with other team members and outside partners.
- Seeing people that I usually only hear over conference calls.
- Face-to-face interactions with fellow researchers
- Definitely the opportunity to meet people involved in NEWBio face-to-face and discuss research in a relaxed atmosphere.
- Face to face time with people on the project
- The best part was the face-to-face meetings with collaborators and other thrusts. We were able to discuss project progress and plan for the next phase of research and grant writing.

**Outside Speakers**

- Listening to other CAPS project reports and the private company accounts of their operations.
- Invited speaker’s perspectives.
- Interesting to hear the industry/government panel.
- Invited speakers’ presentations
• Some of the presentations by guests were also very informative. I learned a fair bit.
• The guest speakers, especially Mike Wolcott and Kevin Comer.
• Outside speaker talks - they showed the strong industry collaboration and product demonstration that we are aiming for.

Field Trip
• Field trip.
• The opportunity to visit sites at a NEWBio partner’s home location. It’s important to see first hand what field research is taking place at other locations.
• Tours as they allowed for more personal interaction with other team members and demonstration of what West Virginia University has for field sites and facilities. Always nice to get out and see other people’s worksites.
• While the field trip entailed a lot of driving for short lectures about what was going on, it did provide an opportunity to meet new folks, which is important in designing the teacher workshops.

Poster Session
• Poster session. Lots of students participating and lots of engaged faculty.

Other
• It was nice to see that everyone involved in the project really wanted to do good work.
• Very well hosted by the local organizers.
• Social time to get to know others better.
• The social interactions with the other partners working on the grant and getting to know them and their work better.

We would like to learn your ideas for creating improved collaboration between NEWBio researchers. Please share any ideas with us that you have:

Aspirational and Other Goals
• I think NEWBio needs one or two aspirational but achievable transdisciplinary projects like the NARA 1000 gallons of jet fuel. In addition to a product, a large scale demonstration of the synergies between bioenergy production and water quality would be powerful.
• Have a focus[ed] objective; we [are] too spread out.
• More clearly defined goals for individual research projects, and budgets that are directly tied to meeting those goals.
• Clearer definitions of overall goals/aims and how they are related to different parts of the NEWBio team. What should each part of the team do to achieve this?

Leadership
• Leadership should help focus on specific outcomes and worry less about market travails. Focus on long lasting analyses.
• Research roles and responsibilities appear to be well-defined within thrusts. Critical personnel were hired in Y2 and Y3 and introductions made to the project team at large. It will be useful to refresh the collective team mind by sharing thrust listings, and the responsibilities and roles that each thrust member fulfills.

Cross-Thrust Interactions
• A lot of cross-thrust collaboration seems forced, or just "I need this from you, what do you need from me". Not organic and not working toward a shared goal. Everyone just trying to complete their own objectives and if that requires collaboration between thrusts then they will muddle through it to meet their own ends.
• Focus on specific topics seems to be a good way to build collaboration. The cross thrust interactions could have been much better this year if they had specific objectives and were better able to incorporate outside stakeholders.

• During the cross thrust meetings there appeared to be no agenda. Furthermore, there was little material or organization or direction given beforehand that might have made the cross thrust meetings more productive. That is, groups did not appear to have been given or to have created discussion points, or to have had any materials, ideas, concerns, issues, topics, etc. prepared that might have spurred cross thrust productivity, or generated deliberate and intentional cross disciplinary interaction. Perhaps in future cross thrust meetings some person or small committee could be tasked with brainstorming better formats for interaction. Extension would likely have facilitation ideas, but this should only be loosely structured. However, loose structure would be more productive than no structure at all.

• More focused/well planned cross thrust activities at the annual meeting (as compared to 1 hour where people just mention what they need) and other times throughout the year.

• I wish we could learn more about details and findings from different teams at annual meetings so we could have more substantive discussions.

Other Interactions

• More face to face time would be beneficial. There are ongoing projects were just data is shared but there is no interaction around the ideas, models or research that is being done. It is more satisfying to engage in a collaborative research project rather than just share data.

• NEWBio sponsored retreats for selected thrusts. Groups of thrusts could put in proposals, outlining purpose, objectives, proposed outcomes for a retreat. Could be competitive, so that only one or two proposals are accepted. Then that group gets a 2 day retreat that NEWBio pays for in order to provide a relaxed atmosphere for collaboration.

• We get along well with the other NEWBio researchers that we collaborate with. The key to improved collaboration is organization. The collaboration works well as long as everyone is organized, completes tasks in a timely manner, and communicates their successes and challenges to the rest of the group.

• Incentivize collaborations with stakeholders that are mutually beneficial. Right now the two entities are very separate and have different goals with the research.

• Need periodic two thrust face-to-face meetings in fall and spring.

• Need more effective thrust updates during all hands calls to highlight needs for cross-thrust interaction.

Collaborative Deliverables & Future Funding

• Improved collaboration opportunities for joint proposal preparation: identifying and calling attention to potential opportunities would help facilitate securing add-on and related synergistic funding.

• Working together on collaborative deliverables such as publications, presentations, and proposals;

• This is really tough. Everyone is so focused on their own day-to-day. I think NewBio has done the best job I've seen at encouraging cross-discipline interaction. However unless there is a specific issue or a specific funding opportunity that creates a need for two different groups to work together it is unlikely to progress to the next level on its own.

• The structure of large projects like NEWBio, in which large teams assemble under limited resources that need to be distributed between many partners, create many individuals interested in a large project, but each individual is invested only in a small shared way in the project. There are some individuals that have larger roles in the project and therefore are more invested on it. The large majority has smaller stakes on the project. This create the need to find other ways to fund, advance or move other projects with larger importance forward, in spite of NEWBio, diluting the focus that NEWBio initially had.

Data

• We should establish which datasets we are going to use and everyone should use the same ones.

• Much data has been collected, analysis is ongoing, and the time for dissemination is now. It is unclear how much data sharing occurs between thrusts. Refresh communication options available to the team. While
email is the favored mode of communication, there has been an uptick in Y3 on numbers of team members using the intranet - and this is primarily the Drive - for accessing and posting information on the project.

**Other**

- There's not really time left to do that, but it would be good to set up more research topics that are paired - i.e. one piece of the research question dealt with at one institution, the other piece dealt with at another institution. I think this was done some, but could be expanded upon.
- I am concerned about undue efforts to force collaboration, to assume it is an unalloyed good, necessary in all situations at all time. It can be nurtured and people can be trained to do it better. And it certainly is important. But not all researchers are equally capable of or interested in collaborating with every other researcher.

We would like to learn your ideas for creating improved collaboration between NEWBio researchers and stakeholders, especially to achieve commercialization goals. Please share any ideas with us that you have:

**Goals and Approaches**

- Need clear goals first and understanding of everyone's role.
- Conduct real case studies with stakeholders and get them involved for their interests.
- Focus on one or 2 business objectives.
- Show stakeholders how the research can help them more clearly.
- Include stakeholders in publications.
- Meetings of stakeholders with researchers to discuss specific topics. Would have been good to conduct such meetings at initial annual meetings, but could still help. Stakeholders have addressed the project as whole, with discussions held with NEWBio leadership as I understand.
- Need a clear goal for product delivery with a novel supply chain. Need clear scenario planning around demo areas, then elucidation of barriers that need to be overcome. Perhaps need input from venture capitalists to define barriers that we can overcome. Need stronger elucidation of policy options that would lower barriers.
- Greater trust on the part of some industry partners in academic process and its potential to deliver useful products and insights?
- It seems to me that focusing on magnanimous goals like "supply cost-effective, reliable and sustainable woody and warm-season biomass feedstocks that will encourage the production of advanced biofuels, enhanced ecosystem services, and vibrant communities" in a period of 5 years is not a good strategy. The goal implies that the strategy is scientifically, economically and socially viable, when the assumption is clearly not true. Is it viable to supply cost-effective, reliable and sustainable woody and warm-season biomass feedstocks that will encourage the production of advanced biofuels with gasoline close to 2 dollars in 5 yeas? No. Is it viable to promote buffer zones plated with Willow or Miscanthus, when the cost to move the harvesting machine to location, prepare the sites for harvest and transport and deliver the material are more economically expensive than the return on investment, or energy? Probably not. A more humble goal would be to identify barriers to the overall goal proposed, to try and promote pilot ideas and test them. It is viable for a 5 year project to be involved in creating viable and vibrant communities? I do not believe that vibrant communities are created by design in 5 years; I think they evolve uncontrolled and at their own pace dictated by the environment surrounding them (gasoline prices, economic development, common interests) over periods larger than 5 years. I think the Calvin Ernst case best illustrates the case for humble more modest ideas that evolve and adapt as they develop, instead of a grand goal that dictates the rate at which things must be done. I think sustainable advanced biofuels are a good idea by all means. I do not think that the way to develop them and promote them forward is through a large bureaucratic project, with additional priorities like funding education, promoting research, keeping research programs going, etc. Those are goals of the academic institution or the government agency that dilute the main goal of developing sustainable advanced biofuels. It is my opinion that smaller more
focused projects, with the flexibility to adapt and evolve rapidly would be better; a small entrepreneurial point of view would be better than a large academic institutional one.

Leadership

• NEWbio leaders should reach out to industry partners (one at a time) along with some key faculty members to appreciate their support and discuss long term collaboration plan.

Listening to Stakeholders

• As a start, it would be good to understand how industry envisions the goals, capacity, and agendas of the various thrust groups within NEWBio. What might stakeholders want or expect from us?
• It would be good to receive more regular updates on macro issues, trends, and developments from the stakeholder perspective.
• I wonder if stakeholders have an idea of what the vision and mission of NewBio is and how they fit it. If we understood this issue we might begin to have some insights about how to engage more effectively. Do we really understand what stakeholders want from their interaction with NewBio? It is not clear that we have asked stakeholders and spent enough time really listening to them to understand this.
• Field trips outside of annual meetings to facilities that use biomass in the NE region. Any other opportunities for the stakeholders to be the teachers and the researchers to be the learners.

Advisory Board

• I am really unfamiliar with most of the stakeholders. It seems that they only interact with the advisory board, not the rest of the NEWBio members. For example, I know who most of them are but am unsure of the role or interest they really have in NEWBio research and results.
• Many of the initial NEWBio stakeholders seem to have moved in different directions. We need to find new stakeholders who are excited and eager to engage.
• There is no substitute for reality, and engaging with our partners to see real world applications of research are invaluable. Opportunities are missed, however, when the partner(s) cannot or will not engage. It is disappointing again this year to see the non-participation of about 50% of our advisory board in our annual meeting. We know who is invested in NEWBio's research, who our go-to partners are. In most cases, these are the result of pre-NewBio personal/professional relationships. Who else is out there that we can tap to replace the non-engagers on our board? Do we need to reassess our contacts within our partners? Perhaps resources are too thin, and identifying a different person would facilitate the collaboration.

Other

• It is great to ask for input, but really, large companies or people with skin in the game have a lot more motivation for commercialization. Not many researchers can connect the dots the way Richard does. The easiest way is to replicate cases that work and build experience, for example willow chips combustion or switchgrass pellets. Adding areas of these crops without a clear market is bad policy.
• Increase the extension budget. The majority of the budget goes to research, but the majority of the project goals are extension goals.
• The stakeholders need to want to process more switchgrass and create markets. The landowners are not going to plant switchgrass without a market and an incentive. Also, many landowners are not looking for any return from their land and I think the amount of land devoted to hay for horses and horse pastures is underestimated.
• If there are well defined commercialization goals on NEWBio's 'bucket list' I'm not aware of them. I am aware of 'commercialization' as a general, overarching goal, but I don't know what the specific products or services are that are in the NEWBio commercialization pipeline. If there are some specific opportunities, perhaps NEWBio could create a sort of "Shark Tank" (entrepreneurs' tv show) type review of the current NEWBio commercialization ideas and then have a seed-grant opportunity that focuses on commercialization. My experience with commercialization of an educational tool was it took 6 years of development, 3 of which were working with a commercial partner, before going to market. The bulk of
What additional ideas do you have for how NEWBio could be improved in order to renew the northeastern landscape to supply cost-effective, reliable and sustainable woody and warm-season biomass feedstocks that will encourage the production of advanced biofuels, enhanced ecosystem services, and vibrant communities?

Goals and Approaches

• Set clearer, less vague goals. Have flexibility in the budget. Different approaches for different regions within the northeast.
• It appears that team members do not understand the vision for this project and as a result are not engaged and focused on the bigger, broader picture. There is a lot of focus on publishing papers as the primary, and in some cases, only metric for NewBio. Publishing papers alone will not have an impact on the expanding the production of advanced biofuels while enhancing ecosystem services and building communities.
• Scaling down goals. Being flexible in promoting what is working and to drop what is not working. Allowing ideas to evolve at their pace, promoted and hindered by their environment. Following more the entrepreneur’s path than the prescript proposal path.
• Restructure thrusts to maximize outputs.
• Shift from a research-heavy effort to an extension-heavy effort.
• Efficiently motivate team members to produce deliverables; Work closely with stakeholders to solve real-world problems, Better communications...
• Still need to enlist some growers/producers to participate, if only to follow up on our findings.
• I like the idea of including the ecosystem services emphasis.
• Y3 saw several well-done case studies and research summaries completed and posted online. This work a) needs to continue and b) needs a wider audience. Short of a separate marketing arm, not exactly sure how to get the work widely distributed. We definitely need to continue to move our research results beyond peer-reviewed pubs and professional conferences.

Advisory Board and Other Stakeholders

• More clearly involve industry stakeholders in the processes. It is naturally very difficult to create support for an emerging market before it actually exists, which means more focus could be put on creating these markets and show the economic potential.

Cross-Thrust Interactions

• My impression is that the various thrusts hold some misconceptions about what the other trusts can and should be working on. It would seem helpful to clarify this. A discussion about what one thrust would like to see from others would seem fruitful.

Product, Market, and Policy Ideas

• Similar to wood, I think that switchgrass densification in the field or at small regional plants is the key to moving the industry forward. Switchgrass needs to be in a form so it can be handled as a commodity.
• Try to figure out how to get the idea of ‘sustainable advanced biofuels’ from an institutional perspective (land grant university, government agency) to a Google, Apple, Ernst Seeds, Renmatix, or Solazyme perspective. X prize type initiative or DARPA style programs.
• We should drop Miscanthus as a crop.
• Should focus on mine land.
• Should focus on plan to address Cheapeake emissions targets.
• Identify high-income clients willing to pay a very high price for demonstrably renewable liquid fuels. They do not need to use the fuel, they need to pay for it anywhere, and in that way, displace fossil fuels. Hybrid car buyers seem to be an obvious market segment. A tracking system is needed so the purchases can be tracked, e.g. WAWA, or SHEETZ, or SUNOCO, any systems that can monitor purchases. Else, sell conservation value as a package, but I presume this is a low value.
• We need strong state policies for a low-carbon economy. California is a stand-out in this regard.
• There definitely needs to be a future focus on higher value co-products than just energy. This was evident based on other CAP projects presentations and NEWBio should also be looking into alternative areas for products.
• Alignment of NEWBio CAP with other state/federal programs that seek to increase the use of biomass for energy. For example, incentive programs for heating conversions to biomass for residential, school, government facilities.
• Since the market for advanced biofuels-feedstock is fledgling, we should look to the existing end-use (heat) and help prime that pump but within parameters that would translate well to advanced biofuels. In this approach, NEWBio could brainstorm and create ways to be useful to the current market: 1) Be useful to regional growers (or potential growers) of the feedstocks: What chemical, agronomic tests performed by NEWBio researchers could be optimized and performed at low/no cost by NEWBio for growers to improve soil health, feedstock production and feedstock quality? 2) Be useful to regional buyers of the feedstocks: Today there is not a market to sell biomass for advanced biofuels in the northeast, but the feedstock production pipeline could be primed by diverting feedstocks to an alternative market ideal in the northeast: heating. This is not a new concept, but the question may be how can NEWBio be useful to current biomass pelletizers or biomass transportation companies? What are their problems? It seems that a consistent feedstock composition may be important. Are there chemical tests or procedures that could be standardized to “grade” biomass feedstocks for the region? NEWBio could create the industry standard testing procedures or standard results/standard ‘grades’ for what makes a good starting feedstock for 1) heating and for 2) advanced biofuels production. 3) Be useful to end-use consumers (residential and commercial heating applications): What is important to the end users? How heavy the bag is? how consistent the moisture content is? How much dust am I going to have to deal with after loading the hopper? How difficult it is to clean the stove after a certain biomass type is combusted? Create consumer labeling for feedstock lignin content, heat value, moisture content- and DUST content - and any other aspects that would likely eventually apply to chemical/physical feedstock characterization needed for advanced biofuels feedstocks.....refined by practicing on the heating industry segments. What are other ways NEWBio can use biomass heating-biomass-pellets to define the ‘Arabidopsis’ of advanced biofuels feedstocks?

Annual Meeting
• This specific suggestion for the annual meetings doesn’t seem to have a slot in the survey, so I’ll put it here: for the annual meeting’s student poster competition, please create a competition category for the NEWBio summer scholars. With only a short program timeframe, they are otherwise at a strong disadvantage when trying to compete with MS and PhD posters.
• At annual meetings, I would like more time for hearing from teams about findings, and time for working within teams. Less time for somewhat unclear cross thrust meetings and less focus on short presentations with externals audiences. I think it would be valuable to have more time just with researchers since we meet infrequently face to face.
INTERVIEW RESULTS

Description of Participants

A total of 20 individuals were originally invited to participate in interviews. Fourteen interviews were completed: eleven with Leadership Team/Executive Leadership members and three with external stakeholders.

Findings

General Assessment of Progress

The team, as a team, is doing well and making strong progress in building and drawing on its established collaborative capacity. As one researcher notes, the team is “doing well in terms of dealing with the scientific questions and moving things forward successfully.” Some collaborative research had advanced to the point of publication, a notable achievement that sometimes presents a challenge for interdisciplinary teams. What is more challenging – and this comes as no surprise given the complexity involved in transdisciplinary, multi-institutional, solutions oriented projects – is translating this capacity to address the needs of external stakeholders, especially given the current external conditions facing the bioenergy and biofuels context. Overall, there is a noted need to focus on finishing projects and ensure that the project makes a significant contribution to the academic world. The project is progressing strongly in this regard. What is seen as a greater challenge is the project’s ability to deliver on stakeholder needs because of concern about the market for end products. Some even express this as disappointment, but recognize that there are larger influences at play.

Our overall assessment is that the NEWBio team is at an important juncture, a developmental stage that is common to large team efforts like this one. Some see the team as being a little stuck in the current phase of work with less of a broader view toward the future. Some interview participants expressed concern that they are not getting the bioenergy industry going that “we had hoped for. We’re at a juncture.” The key point we want to emphasize is that the team itself is doing well and evolving in a productive way despite many challenges. It is a nimble organization that, as an individual participant describes, “as a whole, is working in the right direction.” One person summarizes: “What we’re going to end up with at the end of the five years is not what we planned, but there are a lot of external reasons for this.” The key point is that the team is achieving results, and the prospect for continuing this trajectory is strong.

Mission and Vision

As NEWBio enters its final two years, we wanted to understand how participants see NEWBio’s current mission and vision. The responses, which we quote below, represent a range of perceptions. It is important to note that not everyone is on the same page with regard to the details of the mission and vision, but there is consistent understanding that the project’s mission focuses on building research and development capacity for biomass in the Northeast. Within this general understanding, there are divergent concepts of the mission and vision.

Some individuals state that the mission and vision have always been clear and have not changed; others see the mission and vision as being in flux; some say they have already changed; and others say they have no understanding of what the mission and vision are. There is a tremendous opportunity to clarify the mission and vision for the whole team. This does not mean that a written and stated mission and vision do not currently exist. Rather, our data suggest that there is a lack of clarity across the team as to what these are and whether they have been cohesive and consistent. Galvanizing the team around a renewed commitment to NEWBio’s mission and vision will help address a number of the key challenges and take advantage of critical opportunities that lay before the team.

We present the diverse perspectives on mission and vision below in abbreviated form to show where there is both synergy and dissonance. The voices of different participants (both internal team members and external stakeholders) appear in italics:

26
To develop and create markets for energy crops in the Northeastern US that will provide materials for downstream conversion to fuel materials. [There is talk] about changing to bioproducts – that’s the kind of change we need.

To help establish a biomass base production chain, particularly on our end [...]. I don’t think our piece was to develop the bioproducts.

To grow the bioenergy industry in the region by laying the groundwork for successful growing production and processing of biomass crops.

To promote biomass production and research. It spans both the woody plants – mainly willows and grass biomass, maybe switchgrass, some mixes too. To promote biomass R&D.

The broad vision is to facilitate development and deployment of bioenergy systems in the Northeast.

Showing that demonstration – the supply chain for these three feedstocks – whether [for] drop in fuel for your car, compostable dinnerware – to make sure we can use biomass in a sustainable way for all kinds of different purposes, not just biofuels. [...] The Vision – long term – is [that there will] be a whole new business/economic opportunity for the Northeast.

The mission is to develop and demonstrate from feedstock to product the bioenergy technology that is suitable and sustainable for our region. Vision – original vision was very optimistic, trying to facilitate deployment of 50,000 acres – economic forces working against us in that respect. My vision has become a little more focused on trying to demonstrate to raise these crops on mine lands – that was a minor part of our vision but perhaps is a more important part of the vision as we move forward.

It’s like the other CAP projects – targeted at doing R&D to facilitate development of new bioenergy resources, especially in the Northeast with willow, wood waste, switch grass, and herbaceous species. It’s a very broadly focused effort.

I think it’s to develop markets – they’re interested in developing markets for production of biomass.

Promotion of bioenergy in the Northeast. [...] Necessarily the vision of NEWBio that focuses on these three crops has changed – not focusing on biofuels exclusively –bioproducts. [...] I see it more as the utilization of biologically derived material, especially if it involves these three crops and especially if it involves energy to galvanize economic activity.

If there is a mission and vision statement, I don’t know if I know it – to try to figure out some of the challenges and opportunities for expanding bioenergy economy in the Northeastern US on underutilized agricultural land and other kind of unproductive land, mining land.

The vision has to do with clean energy in total, whether it be a sustainable crop that can be used for heat or used for combined heat and power or ultimately [...] to look at the biofuels side of it and grow that industry, which seems to be – it was a high focus maybe 2-3 years ago on the Penn State side, and I think that has slowed the realization that working with some of these entities doing combined heat & power or just heat are more viable than some of these other projects.

To further research and development on some of these particular feedstocks.

Put together the knowledge and tools and provide the businesses with the information they need to develop sustainable large scale biomass supply chains in the region. Biomass can be a significant part of bioeconomy in the region, can enable new rural economic opportunities and environmental benefits.
Situation Analysis

There have been significant changes that affect the landscape of bioenergy in the U.S. Given that the context has shifted quite dramatically since the project was first conceptualized, we asked participants to provide us with insights into the internal and external conditions and conducted a general SWOT (Strengths, Weaknesses, Opportunities, Strengths) analysis. We summarize these findings below.

Strengths & Opportunities

Strengths refer to internal assets, while opportunities references external assets. When we asked participants about strengths and opportunities, the following responses emerged:

The Team:
Participants emphasize the strength of the team itself. They point to strong researchers and a strong team that covers broad ground, “from breeding, to agronomy, to logistics” This, in and of itself, is recognized as a strong outcome and an important basis for moving bioenergy forward in the Northeast. There is a core structure in place across Cornell, ESF, Penn State, and West Virginia. While there are different levels of engagement, there’s a sense of a team across the Northeast that is engaged together in this work. As one participant notes, this is a “great pool of resources and extensive network that’s potentially out there and could be used to address challenges and move bioenergy systems forth in the Northeast U.S.” We note the use of the word “collegiality,” a critical aspect to the success of any team. There are high degrees of respect and willingness to listen, engage, and integrate across this team. One individual emphasizes this, and we note that this strength represents a model for other teams to follow: “the give & take, the network that holds people together – their ability in polite and functional ways to have that appropriate scientific discussion of things – how would this work, would you move forward here, do you have the data on this – the rapport, give and take in sorting out difficult issues –watching the group, I’m very impressed with the strength of that [capacity].”

Participants emphasize that there is frequent communication and high levels of collegiality from different backgrounds and expertise. One describes this as a “willingness to communicate and support one another.” There appears to be good focus within as well as across research thrusts for the most part. Cooperation and collaboration are noted strengths. Compared to other interdisciplinary projects participants have participated in, NEWBio is noted for its ability to keep people apprised of progress.

Leadership:
Participants note the strong role that Tom Richard plays as a leader, and emphasize his communication skills. Others note the “combined brain power, retention of facts, and historical narrative” that the top leaders of the team provide as an important strength. One person notes that a core group of stakeholders is very involved and willing to work with the project.

Opportunity to Build on Strengths:
People recognize that, under changing external conditions, there is an opportunity to change course. One individual elaborates, “There are times I look at the research that is happening and progress, publications, etc. being made, and it seems like, if the consortium were dissolved tomorrow, I think a lot of that would continue, driven by individual PIs who would probably be doing the same research perhaps with other access. They would probably do the same type of research in their academic institution. [...] It makes me wonder, what else could happen with this unique opportunity, because we’re all in this consortium? What can we push more than what we would expect without this?” Focusing on what difference the consortium as a consortium makes is key to the project’s next phase of development.

In the context of opportunities to build on previous investments, individuals mention the ability to develop focus areas with demonstration sites and business development. Brainstorming sessions were noted as a strategy to
help advance this. One participant mentioned that, relative to other CAP projects, there is some economic activity with businesses using biomass in the region happening on NEWBio.

There is an opportunity to encourage landowners and growers/producers to increase acreage, even if this is for other products/biomass uses and parts of the biomass economy. A number of individuals questioned how to encourage the use of marginal lands for willow or switchgrass with the right kinds of amendments. There is an opportunity – and this has certainly been discussed by the project since it began – for alternative markets based on non-fuel products from biomass. One participant provides a strong statement that summarizes others’ perspectives on this theme: “There are not a lot of opportunities to have this much directed interaction between private companies and public entities with academic components. The consortium created opportunities for deep engagement with companies (like Ernst) – built-in opportunities for the kind of collaboration that goes beyond the capacity of one entity – private or federally funded research engaged with the public.” Capitalizing on these opportunities will help focus the project in its final two years of current funding.

NEWBio provides an opportunity for universities to learn how they can “really handle projects that are this big.” As one participant states, “What are the expectations? What are the outcomes? One actual outcome is not just what is the science, what is the process? How did you come up with this black box – what worked, what didn’t – that kind of finding of how do you build a successful $10M project that makes an impact on the world – maybe it’s as important as the rest of this. How do you make sure this happens? It’s an actual impact like XYZ. It’s a critical outcome of this project that’s transportable to other areas.” The opportunity to reflect and share learnings within and beyond the team is significant.

Weaknesses & Threats
Weaknesses refer to internal challenges, while threats references external forces. When we asked participants about internal and external challenges, we received the following responses:

External Conditions: Market and Policy Challenges
The primary concerns noted focus on external conditions. As one individual states, “there is a challenge to delivering biomass at the right price and a question about whether we are walking in the right direction.” Markets for liquid and fuel are not there, with low oil prices and lack of a supportive policy context. One person describes the need to “demonstrate that the system can be viable to a sufficient degree that it would attract venture capital/commercial investment.” Another emphasizes, “Our greatest vulnerability is that there’s a gap between where we are in terms of our science, economic analysis, business capabilities and where we need to be for biofuels to be viable. We’re standing on one side of a ravine, and there’s no bridge to climb over. NEWBio was supposed to be that bridge, and it’s not there.” Some participants emphasize the need to provide a model that demonstrates that this can work. As one participant summarizes, “The area we are lacking in is real-life commercial demonstration.” There is uncertainty in the markets and uncertainty among some of the research team about future prospects.

The concern about the policy and market conditions is perceived as influencing public perceptions. This creates the concern that “the public isn’t as interested in biomass as we thought they were going to be a few years ago.” To cite a participant, “People lose interest – we have very short memories. The emphasis on alternative fuels, including with farmers, wants. I don’t think we’ve developed the market we need for biomass materials.” This context provides a challenge to communicating with other stakeholders who are not involved in the project and the general public. With forest-based wood being well established as a supply chain in the Northeast, there is a need to “meet people where they are.” Extension team members emphasize the importance of Extension’s role in engaging these external audiences and the challenge of trying to “build quality extension around something we’re theoretically piecing out.”

Internal Challenges: Growing a Big, Cohesive Team
The project has faced challenges it did not anticipate, especially relative to changing external conditions. As evaluators, we are impressed with the fortitude that the project has demonstrated and that things have moved forward as effectively and cohesively as they have. Many projects may have fallen apart or drifted under these
conditions. NEWBio moved forward. Nonetheless, this context challenges some of the internal operations of the project. One of these key challenges is loss of common mission and vision (as reflected in the range of statements cited earlier in this report); a related challenge is project burnout related to mission creep and concerns about externally driven motivation.

Some communication is not functioning as well as other efforts. For example, some state that thrust-to-thrust communication could be strengthened: “Information still doesn’t flow fluidly within the project in some areas.” Mostly, any problems related to coordination are minor, rather than major in nature. Some stakeholder communication is particularly effective (numerous individuals note Ernst as an example), while other stakeholder groups are not as engaged. While communication is generally noted as a strength for the team, sometimes members feel that they are learning about things in small, incremental ways that mask the broader progress. Piecemeal communication can undermine a team’s ability to generate excitement and buy-in for the bigger picture. Here, the whole is genuinely greater than the sum of the projects detailed parts.

There is a need for skilled facilitation at certain meetings, especially the annual all-hands meeting. For people who are not as engaged directly in the thrusts, it can be very confusing to come in, listen, and make sense of the work. The team runs the risk of losing “outsiders” who may want to move inward. Skilled facilitators can help keep a larger frame while attending to the details, and help produce stronger outcomes.

Some participants expressed concern about the interdisciplinary collaboration: “The dream of this fully integrated, collaborative unit pushing forward to a common goal isn’t what I see. I see individuals working on parts of pieces of a bigger picture – maybe this is a good thing.” One participant notes, “we’re sort of sliding back into disciplines and are going to miss the opportunity for synergy in transdisciplinary work. Some groups, especially ecosystems services, are doing that work, but we’re missing opportunities to connect with other groups with similar focus on other issues.” In this regard, the team may be a bit stuck, a phase of “performing” that is quite common to interdisciplinary teams. Some creative recommendations emerged from participants, for example, that “more can be done to shake up the natural tendency of individual researchers to continue what they’re working on – not sure whether carrot or stick – mix it up.”

The time scale at which the project plans provides a challenge in the eyes of some. The project is often focused on solving problems that are six months ahead, rather than thinking long term. This emerges as a natural consequence of regular reporting cycles, but the project leadership can help lift the vision to remind the team of the broader context and opportunities.

The advisory board is seen, with the exception of a few individual board members, as under-engaged and inactive. Some commercial partners have “come and gone,” and, as a participant describes, “I think we have potentially some new commercial partnerships that could replace some of our old original partnerships.” ReEnergy, Ernst, and the Chesapeake Bay Commission are noted as strengths. Working at this broader scale is helping some individuals to find a bigger picture that makes sense despite the policy and market conditions.

With regard to internal team dynamics, a number of participants recognize the emergence of some inertia. Certainly, as one individual states, it’s “hard to change course in the middle of a big project.” Some express concern about the ability to deliver as a whole group. Questions emerged around whether funds are appropriately allocated; if everyone is pulling their weight appropriately; and whether resources are fragmented. Some participants note a concern that not enough progress has been made relative to what was anticipated. This may be rooted in different perceptions of what progress has and has not been made along with a lack of understanding as to how progress is being measured.

Perceptions of Leadership

The NEWBio Project is at an important juncture, as articulated by numerous project participants. We were interested in hearing what ideas participants had about the kind of leadership that could and should support the project in its next phase. Most comments focused on the current leadership structure, and fewer ideas emerged
about what kinds of leadership could emerge. We note this before entering into the details of our analysis because we encourage some thoughtful discussions about what other models might emerge for leadership within and beyond the project.

Overall, strong leadership is provided by Tom, who is described as “a good leader.” Some participants discussed that leadership may not filter down to the next level beneath the Leadership Team: “those channels could use some work.” There’s a recognition that the project has and needs hierarchy, but some creative thinking might help energize people’s understanding of their own stakes in the greater project through novel approaches to leadership. There is recognition that faculty, students, and postdocs are taking on more responsibility for getting important work done.

Leadership, as one individual describes, might focus on specific areas, for example, helping identify the three to four large impact scientific papers that will help NEWBio convey its accomplishments. Furthermore, leadership should start projecting more into the future and advance strategic thinking about where things might go. The Leadership Team should explicitly have a conversation about what the future leadership will be. At the individual level, leadership is important to help encourage people to focus. One participant states, “Big speeches at monthly meetings not as valuable as one on one sitting down with key people to work together or adjust what they’re doing or focus on a critical area of need.” Similarly, one participant talks about “creating those moments, that environment where the necessary synergies can grow – whether that’s – like the annual meeting – the value didn’t come from the speeches and updates. Sounded a lot like the ones from last year – the value came in the little interactions during the coffee break, or in the van travelling from tour site to tour site. Maybe leadership in the form of trying to make sure that those moments occur somewhere or other might be the kind of thing that can yield a bountiful nature.” What these comments reflect is a culture of leadership that has already demonstrated success. The suggestion is to invest more in this type of culture, which has proven important for NEWBio’s strengths. This includes efforts to hold people accountable for deadlines, without coming across as top-down. It is worthwhile, as one participant explains, to experiment with some decentralization of leadership to the next tier down, which may help people become “a little more invested.” This participant recognizes the trade-offs involved in decentralization: “I think there’s kind of a tension for needing someone who has a top down tight ship approach versus really trying to get more people engaged in leading other parts of it.” Thoughtful conversations about what leadership could look like can engender a greater sense of belonging and responsibility.

An important theme that emerged in the discussion of leadership reflects information we gathered in the SWOT analysis: Leadership needs to help create the bigger picture and paint the context in which people can recognize their individual parts. Instead of lectures and presentations, All Hands annual and monthly meetings might focus on conversations that remind people of context. This is, as one participant noted, especially important for graduate students on the project, as they may not have the bigger picture. Leadership was also noted as important to the project’s bigger goal of “packaging our work at a flashy demo project.” There is recognition that the challenging external context creates complexity for the leadership within NEWBio.

Involvement of Stakeholders

Because external stakeholders are so critical to the broader success of NEWBio’s vision, we specifically asked about how stakeholders are currently being engaged and encouraged participants to share ideas for new forms of involvement.

Some note that they have not seen much progress and that the project has yet to be deeply successful in engaging stakeholders, but that stakeholders are facing the same external issues as the project. One even described stakeholder engagement as having taken “a bit of a step backwards.” A number of people stress the need to engage different types of stakeholders, for example more in the environmental realm. The lack of participation by some stakeholders in the Annual Meeting was noted.

An important reminder articulated by one participant stresses that the NEWBio Consortium is not necessarily set up to “solve the private problems of our partners.” Yet, there’s an opportunity to ask stakeholders what
unanswered questions and unmet needs they have. As one team member states, engaging stakeholders requires “working up some significant commercial demand and motivating small businesses and supply chains to pull together.” This links, in turn, to the broader perceptions of bioenergy.

Some have the perception that stakeholder interaction is largely in the hands of the Leadership Team, who gets input and support from them. This is not necessarily seen as negative, but rather represents more of a diagnosis. Some see progress made with particular stakeholders but not others, and a few participants voiced concern about stakeholder fatigue. The definition of who is a stakeholder continues to confuse some participants. One asks, for example, “Who, exactly, is the end user?” Some participants see progress, for example, in involving additional stakeholders in school districts (Terra Green). There was a recommendation to help conversion partners become more involved. Furthermore, some participants asked if Human Dimensions research and researchers can help make recommendations for new stakeholders based on their research. A critical reminder to all with regard to stakeholder engagement was voiced eloquently by one participant: “There has been more progress than we show. We know more than we knew before.” Focusing on what has been achieved to build out the next two years will help leverage successes and address concerns.

A key suggestion to push work to the “finish line so we can present it” would serve the purpose of helping stakeholders understand progress while encouraging the team to see a light at the end of the tunnel. “People shouldn’t be discouraged,” one participant emphasized.

Overall, the team would benefit from some other pathways – both formal and informal – to engage people both externally (stakeholders) and internally. Making sure that researchers value stakeholder input is important so they see how it fits with the bigger vision. One researcher summarizes this concisely, “my sense is that sometimes we get input and people can’t see how it fits into their research agenda, therefore it’s not that important [to them]. In my opinion, our research should be feeding into the stakeholders’ agenda to move the research forward.”

Stakeholder Perspectives

We interviewed a group of stakeholders who are not members of NEWBio’s Advisory Board. It was challenging to get individuals to participate in interviews. We invited ten and were able to engage three individuals in interviews. We recognize that this is a small number that may not represent the broader interests and perspectives of the project’s stakeholders. We share feedback and perspectives from this smaller group as “food for thought” for NEWBio. We encourage the team to consider the small sample size when prioritizing recommendations and interpreting feedback, especially given the more robust data we collected from team members. There appeared to be a range of interpersonal connections and levels of communication with stakeholders. The range of knowledge about the project varied, as did people’s investment in and commitment to the project.

We received feedback that the team should focus more on producing cellulosic ethanol in an economically feasible way than to focus on growing more raw material. One person encourages the project to focus on the biochemical aspect of developing enzymes to create biofuels and then to pair this effort with economic analysis. The project should “crack the code on cellulosic bioenergy so it would benefit landowners.” There was some frustration expressed in this comment, in part because of the downturn in market conditions for biofuels.

A suggestion was made that NEWBio should be more inclusive of stakeholders other than “university people.” This should extend to industry and conservation agencies. The suggestion was made that NEWBio could and should extend its reach more broadly and avoid reinventing the wheel of a knowledge base that had already been attained by others.

The team’s broad interdisciplinary capacity was well recognized, as one stakeholder states, “it’s a very broad regional coalition involving some really strong partners.” Some stakeholders were able to name multiple researchers on the team and spoke highly of their activities. We suspect that where the project has strong connections with stakeholders, knowledge about the project’s activities, vision, scope, and achievements is higher. Some of the stakeholders mentioned the importance of the Chesapeake Bay watershed work and encouraged the team to continue down this path, consistent with the feedback we received from many of the project participants.
We interviewed. One participant stressed an opportunity to align with the CREP program in Pennsylvania that focuses on plantings along stream banks, mentioning hybrid willow as an ideal crop for stream restoration that could also be harvested for biomass. This is a potential opportunity for legislation.

The stakeholders we interviewed clearly understand the external conditions and pointed to the importance of communicating with industry and policymakers. One provided recommendations similar to what we heard from team members: “to the maximum extent possible, I think that the project should seek to collaborate with companies and projects that are making headway and seek to support those efforts.” Even small operations can help advance clear goals and support strong “wins” for NEWBio. Further advice included not “to put all your eggs in one company’s basket, and they go belly up or move out of the area [...] but rather to spread your collaboration across a number of different partners – that would be a healthy approach.”

Stakeholders, when asked, had different information requirements. One, for example, is looking for information and would prefer to participate in webinars, while another, for example, might prefer face-to-face communication. The key here is that stakeholders have diverse needs, and ask them specifically what they want and do not want can help to streamline communication and enhance NEWBio’s transdisciplinary capacity.

One clear recommendation from the stakeholders we interviewed is the development of a centralized, readily accessible repository of project research: a virtually accessible site or database where published papers, summaries of research, etc. could be accessed. One stakeholder mentioned how helpful it would be to have a centralized repository of all CAP-produced research. We recognize that this is not under the control of NEWBio, but provide the feedback because it illustrates a clear need.

**Recommendations**

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.

*Squash 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.
NEWBio’s vision is to build robust, scalable and sustainable value chains for biomass energy in the Northeast United States.

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