Sun Grant Western Regional Center
Oregon State University

Hybrid Poplar as a Regional Ethanol Feedstock

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OVERVIEW

Hybrid poplar is a well-known biomass feedstock in the Western U.S. and has a number of advantages over other feedstocks: fast-growing, widely adaptable to various soils and climates, and requires low energy inputs to grow. The goal of this research project is to couple hybrid poplar production with end-use ethanol production. Dr. Swanson, working in collaboration with industrial partners, will analyze feedstock taken from selected hybrid poplar clones to develop ethanol yield data, with will then be used to determine breeding and selecting criteria of hybrid poplar with specific feedstock characteristics. The team will also conduct an economic analysis of the process using the yield data. At project completion, the best performing hybrid poplar varieties, along with economic feasibility and planting recommendations, will be shared through a project website maintained by Washington State University.

Progress to Date

Objective 1. *Indentify clones suitable for regional deployment*:

- Maintained eleven of twelve varietal site trials through 2009.
- Completed analysis of stem diameter measurement data from the varietal site trials that had completed their five year test rotation.
- Completed destructive sampling and NIR wood sampling in seven of eight selected trials.

Case/New Holland biomass harvester operating at the Lower Columbia Tree Farm.

Objective 2. *Determine optimum crop density to increase productivity*:

- Quantified the light environment at different spacings.
- Analysis of spacing showed that the two narrowest spacings (0.9 and 1.2 m) produced significantly smaller trees than the wider spacings (2.4, 3.7, and 6.1 m). However, the range of spacings tested was insufficient to identify a maximum production level.

Objective 3a. *Develop a method to rapidly screen feedstock composition*:

- Samples from multiple hybrid taxa were used to verify NIRS regression models developed in 2008. These studies indicated that our regression models performed poorly. Further investigation revealed that the method of sample preparation, the method of chemical analysis, and small variations in the NIR spectral signature specific to each hybrid taxa contributed to poor model predictions.
- Chemometric models were developed to predict the S/G ratio using 40 core samples from *P. trichocarpa*.

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Progress to Date (cont.)

- In order to produce more robust chemometric models, we have harvested an additional 122 core samples across 7 hybrid poplar taxa. Principal component analysis of the NIR spectra of these samples confirms that small taxa-specific differences exist, but they are not large enough to warrant a classification into spectral groups prior to prediction.

Objective 3b. *Develop and optimize cellulosic biomass conversion technology and determine how feedstock components impact conversion yield*:

- Completed experimental method for wood hydrolysis based on 2-stage dilute sulfuric acid hydrolysis.
- Built an overall process model for wood to ethanol based on the ZeaChem process based on Aspen HYSYS material and energy balance and extracted ethanol yield results
- Determined the target hydrolysis yield for a range of overall ethanol yield targets
- Applied current lab results to the model for hydrolysis and each subsequent stage of the process to determine current projected yield of ethanol; developed work plan to determine which samples to screen.

Objective 4. *Conduct proof-of-concept breeding using parents with a range of wood characteristics*:

In total, 37 cross pollinations were attempted during 2009.

Objective 5. *Economic feasibility of feedstock production:*

GreenWood's Discounted Cash Flow model was modified with updated assumptions from the field for growing poplar biomass for ZeaChem for ethanol production using a yield of 28.0 BDT (Bone Dry Ton) per acre, the number of acres needed to purchase, and harvest, for each planned production stage of the ZeaChem plant. The final ZeaChem production goal is 100,000,000 gallons of ethanol per year. During its beginning production phase, ZeaChem will require one BDT for every 135 gallons of ethanol produced, or 185,185 BDTs per year, to produce 25 million gallons. As the updated biomass yield per acre was determined to be 28.0 BDT per acre, GreenWood would harvest 6,605 acres per year to supply the initial biomass. For a three year coppice cycle, a total of 19,816 acres would be required.

Collaborators

Co-PI: Jeff Kallestad, Washington State University, Puyallup Research and Extension Center;

Brian Stanton, GreenWood Resources, Portland, OR; Dan Verser, ZeaChem, Menlo Park, CA; Mick O'Neill and Robert Heyduck, New Mexico State University, Farmington, NM; Andritz Corporation, CH2MHill, Case/New Holland Corporation

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