2015 Project Peer Review

Improved Advanced Biomass Logistics Utilizing Woody Feedstocks in the Northeast and Pacific Northwest

SUNY-ESF

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March 27, 2015

Technology Area Review

Goal Statement

- Principal goal is to lower the delivered cost of short rotation woody crops by optimizing a commercial-scale supply system:
  - $80 Dry Ton total cost to throat of conversion reactor
  - $50 Dry Ton for all cumulative logistic costs (excluding grower payments)
- Fits with terrestrial feedstock goals:
  - (1) reducing the delivered cost of sustainably produced feedstock
  - (2) preserving and improving the quality of harvested feedstock to meet the needs of biorefineries and other biomass users

Quad Chart Overview

Timeline

- Start: Anticipated Summer 2015
- End: Summer 2018

Budget

	Total Planned Funding (FY 15-Project End Date
DOE Funded	~$3.0 million
Project Cost Share (Comp.)*	~$936,000

*If there are multiple cost-share partners, separate rows should be used.

Barriers Addressed

- Ft-A. Feedstock Availability and Cost
- Ft-D. Sustainable Harvesting
- Ft-G. Feedstock Quality and Monitoring:
- Ft-H. Biomass Storage Systems:
- Ft-L. Biomass Material Handling and Transportation
- Ft-M. Overall Integration and Scale-Up

Partners

- SUNY ESF
- Case New Holland
- Greenwood Resources
- ORNL – WVU – INL (modeling)
- Applied Biorefinery Sciences
- Celtic Energy – ZeaChem – ReEnergy

1 - Project Overview

- **Previous project (August 2010 to August 2014)**
  - Primary focus was on harvester development for SRWC
- **Previous Achievements**
  - Increased harvester performance
  - Decreased costs by approximately one third
  - Achieved consistent quality from harvester (particularly chip sizes)
  - Improved methodology for tracking harvester performance
    - Better understanding of harvester performance
    - Identified logistics optimization factors including capacity &number of collection vehicles, haul distance, and harvest pattern
- **Unsolved Issues**
  - Harvesting system has not been optimized
  - Changes in feedstock quality through supply system
  - Relate specific crop and site conditions to harvester performance
    - Difficult to make specific recommendations for improving system
    - Can only evaluate inefficiencies in a general way

History - Harvesting Equipment in this Project

- New Holland FB-130 Coppice Header
- Designed to fit New Holland 9000 and Forage Cruiser series of forage harvesters

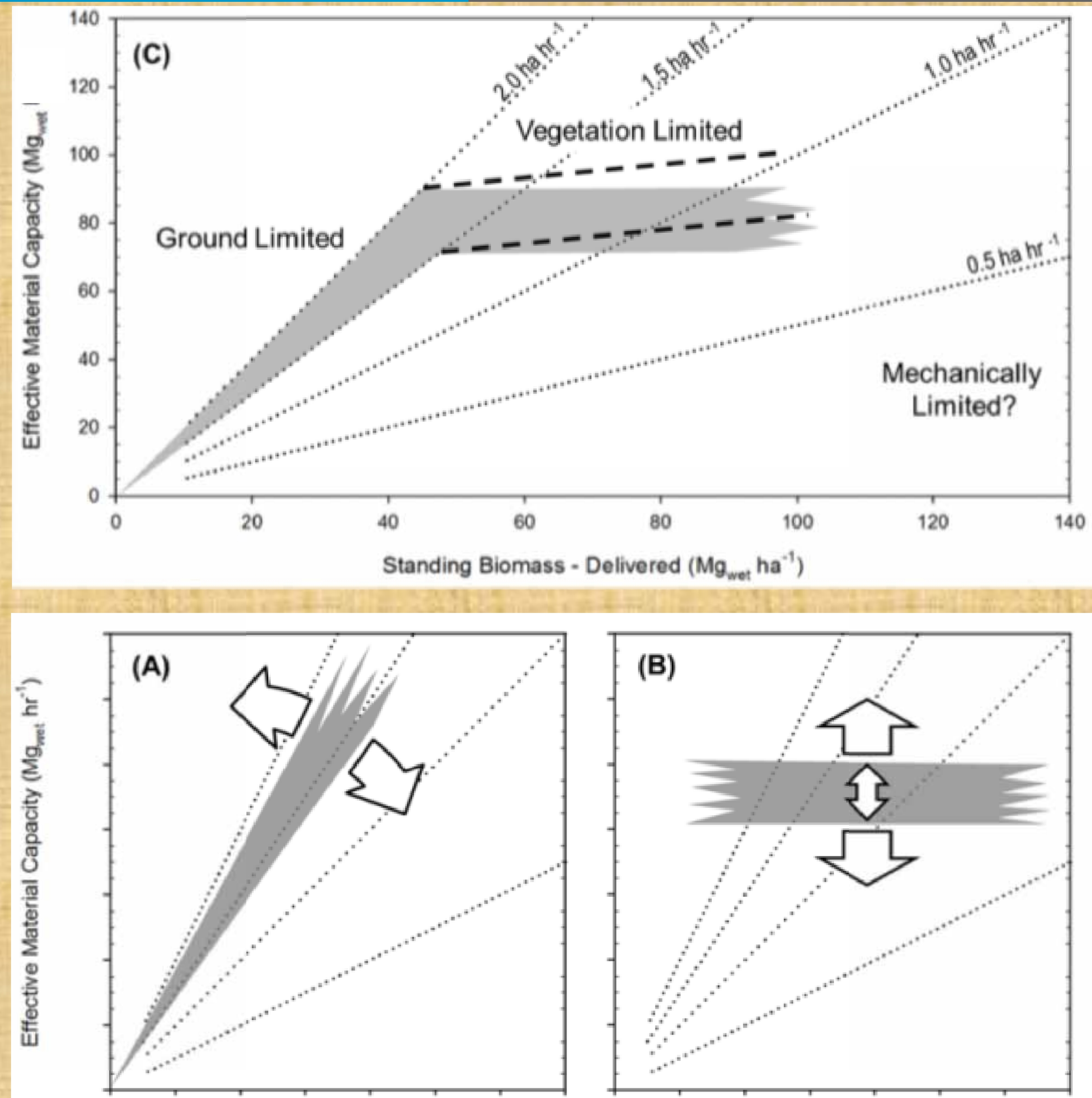
History - Harvester Performance

Factors affecting throughput

(1) Ground Conditions
(2) Vegetation Characteristics
- ✓ Shape and form
- ✓ Planting design
- ✓ Density of material

(3) Mechanical limitations
- ✓ Horsepower
- ✓ Feed rates
- ✓ Flow into throat of harvester

(4) Operator experience



(Eisenbies et al. 2014)

History – Collection System Performance





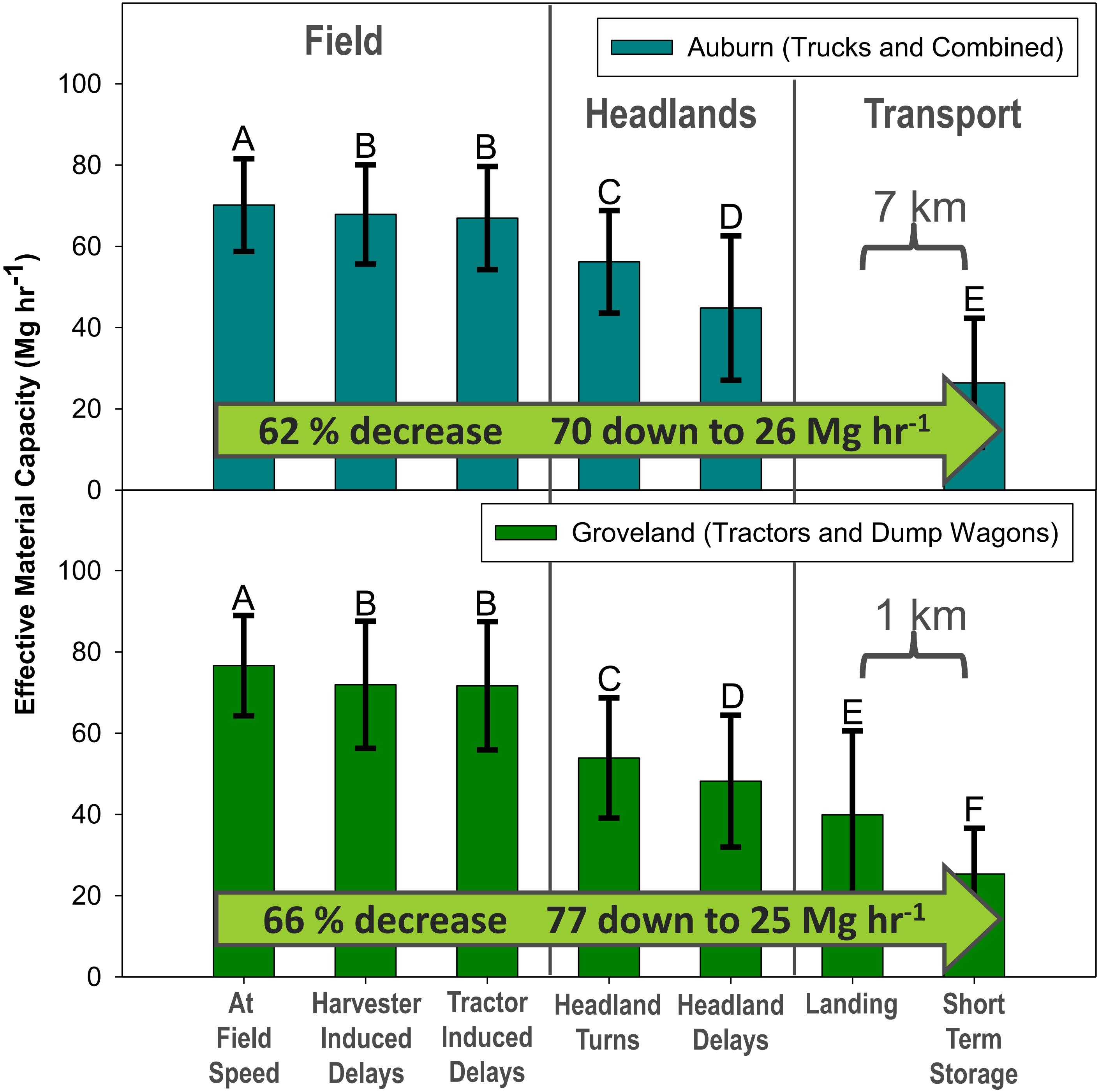

- **A variety of collection vehicles were tried during previous harvesting operations**

History

Collection System Performance

"Out the Spout" to Storage

62-66% loss of efficiency overall



2 – Approach (Technical) Five Task Areas

1. **Harvesting Logistics of SRWC Systems**
   - Expanding the harvesting window (Engineering methods to remove leaves and snow)
   - Iterative process of modeling simulation and field trials to decrease costs
   - Improve data collection to integrate plot-level data with machine performance
2. **Transport and Storage** of SRWC feedstocks
   - Devise methods for tracking feedstock quality in a commercially realistic context
   - Integrating SRWC with existing forest-based biomass systems
3. **Pre-Processing and Blending** with other forest-based biomass to improve feedstock quality
   - Pre-processing methods such as HWE be used to increase feedstock value
   - Pre-processing and screening methods be used to stabilize feedstock quality
4. **Feedstock Characterization** throughout the supply chain
   - Baseline characterization of Willow and Poplar biomass crops
   - Devising high-throughput screening systems for SRWC feedstocks
5. **Logistic and Economic Modeling**
   - Develop advanced logistics and process simulation models and optimize planning and management of new and existing systems (Integrating Tasks 1-4)

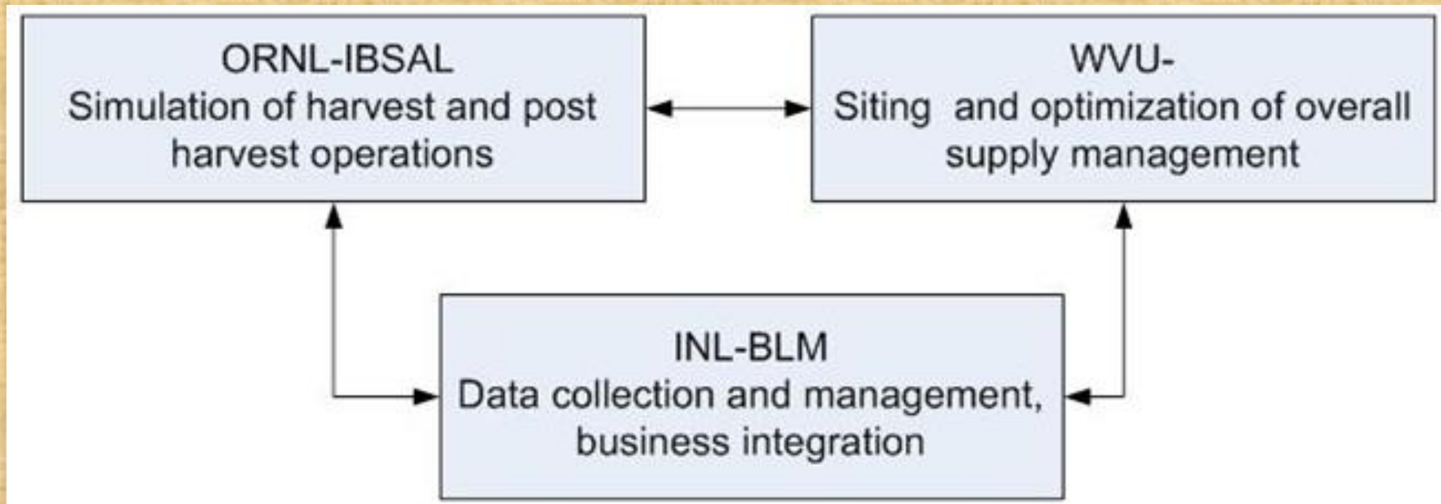
2 – Approach (Management)

- **Critical Success Factors**
  - Achieve the $80 and $50 per dry ton costs to meet BETO goals
  - Improve system efficiency
  - Expand harvesting window
  - Developing and implementing system to affordably monitor quality (e.g. moisture content, ash content) in the field
- **Challenges**
  - Working in fields that did not implement recommended planting designs
  - Coordination of multiple independent players along supply chain
    - Coordinating harvesting trials
    - Tracking feedstock quality through supply chain
  - Engineering leaf and snow handling systems
  - Developing models and sampling protocols for measuring quality in the field
- **Structure**
  - Iterative: Model Simulation/Optimization & Harvest Planning ➔ Harvest Trials
  - Monthly phone calls and quarterly assessment of milestones using PMP
  - Annual meetings organized around harvests
  - Go/No-Go meeting midway through project

3– Relevance

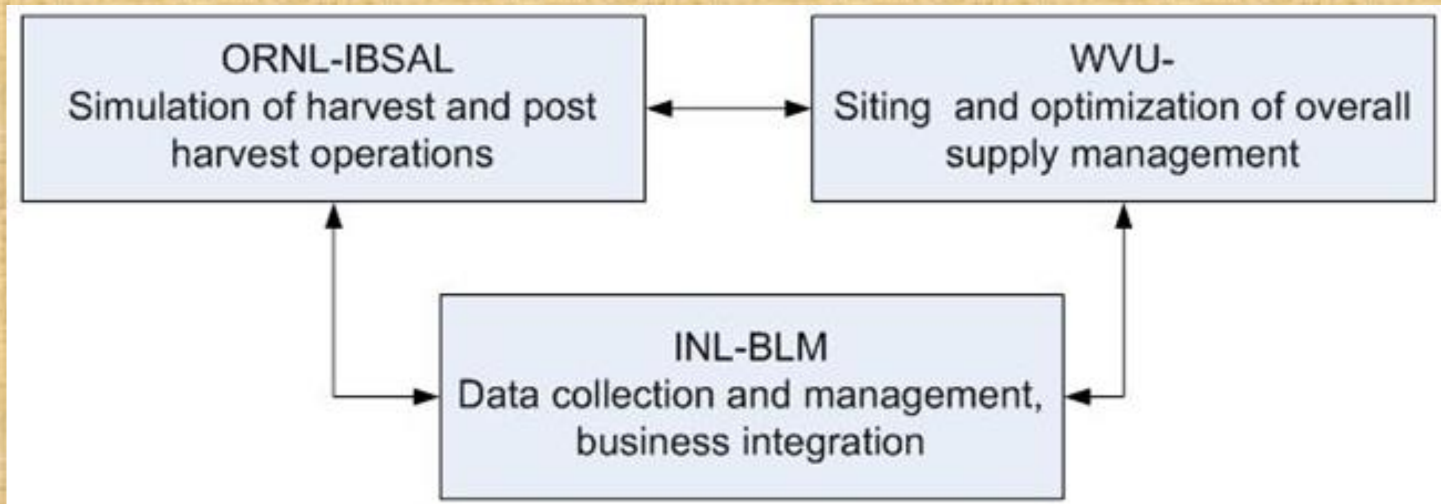
- **BETO Platform Goals and Objectives (MYPP)**
  - Meet the $80 and $50 dry ton objectives
  - Addresses important facets of terrestrial feedstock supply and logistics in the MYPP
    - Biomass production, Harvest and collection, Storage, Transport and Handling, Preprocessing, Quality Characterization and Assessment
  - Addresses important facets of conventional logistic systems and moves SRWC in the direction of advanced logistics systems identified in the MYPP
- **Applications for the emerging bioenergy industry**
  - Working with private growers and end users to optimize the system to meet their needs in two regions.
  - 480 ha of shrub willow in NY
  - ~140 ha of hybrid poplar in Oregon
  - Ensure that quality is maintained and/or identify quality challenges throughout supply chain to meet/preserve end user specifications
  - Supply samples and quality data to INL feedstock library
- **Advance the state of technology**
  - Document and develop best practices for harvesting and establishment in conjunction with commercial growers and end users
  - Developing and implementing system to affordably monitor quality (e.g. moisture content, ash content) in the field

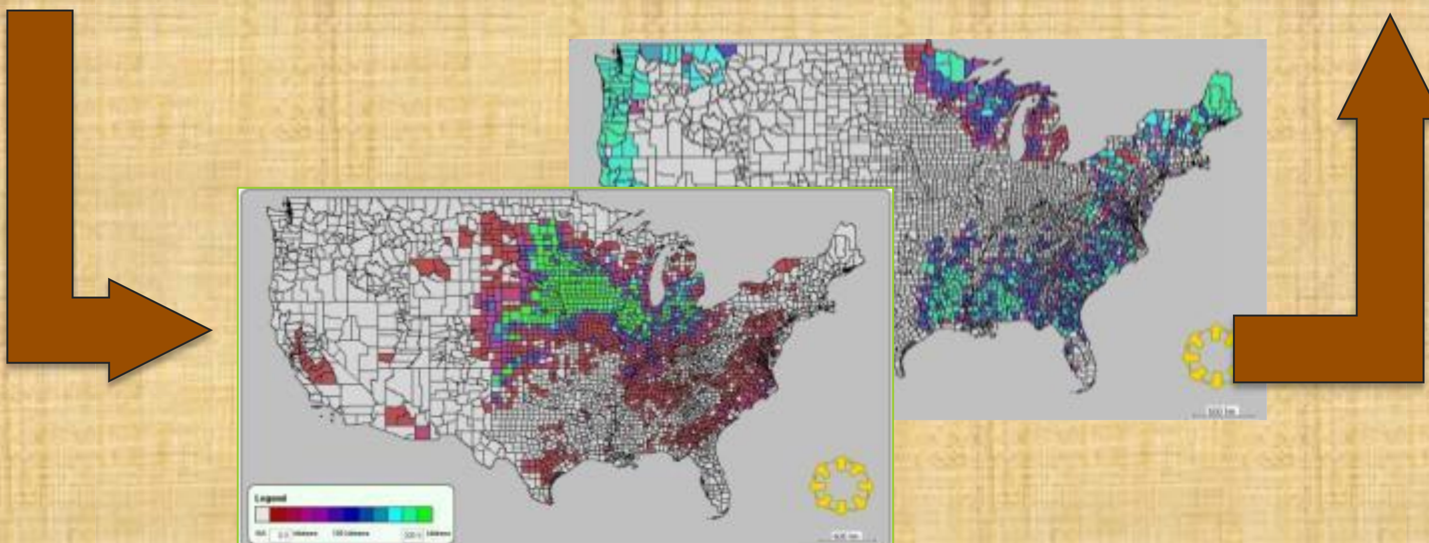
Summary - Modeling Effort



IBSAL: Simulation & Harvest Plans ➔ Harvesting Trials

Summary - Modeling Effort

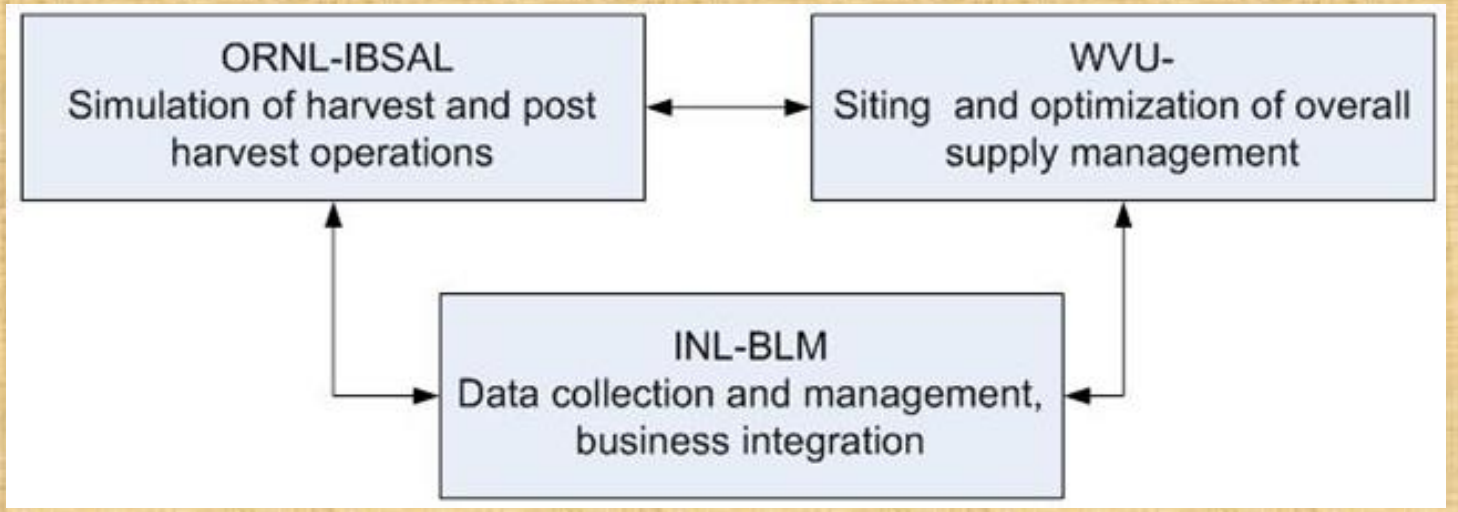




INL Example: Resource Availability for Woody Crops and Corn Stover

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Summary - Modeling Effort



Site locating using a multi-objective decision model

- Suitability indices using a fuzzy-logic model
- Optimize feedstock mixes and logistics

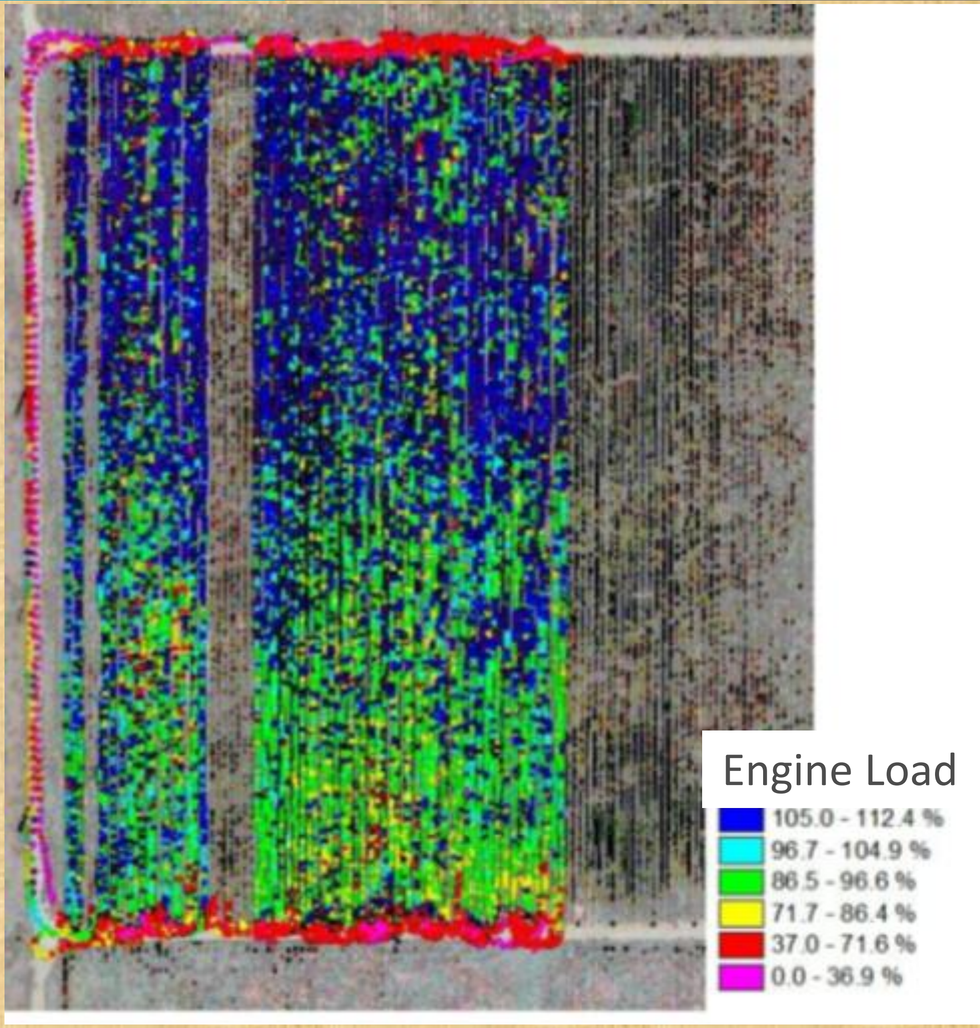
Two-Stage modeling process

- Examine site suitability indices (economic, environmental, infrastructure, societal
- Evaluate and entail the ranking of potential locations

WVU: Integrating Supply Chains at the Regional Scale

Summary – Couple conditions to performance

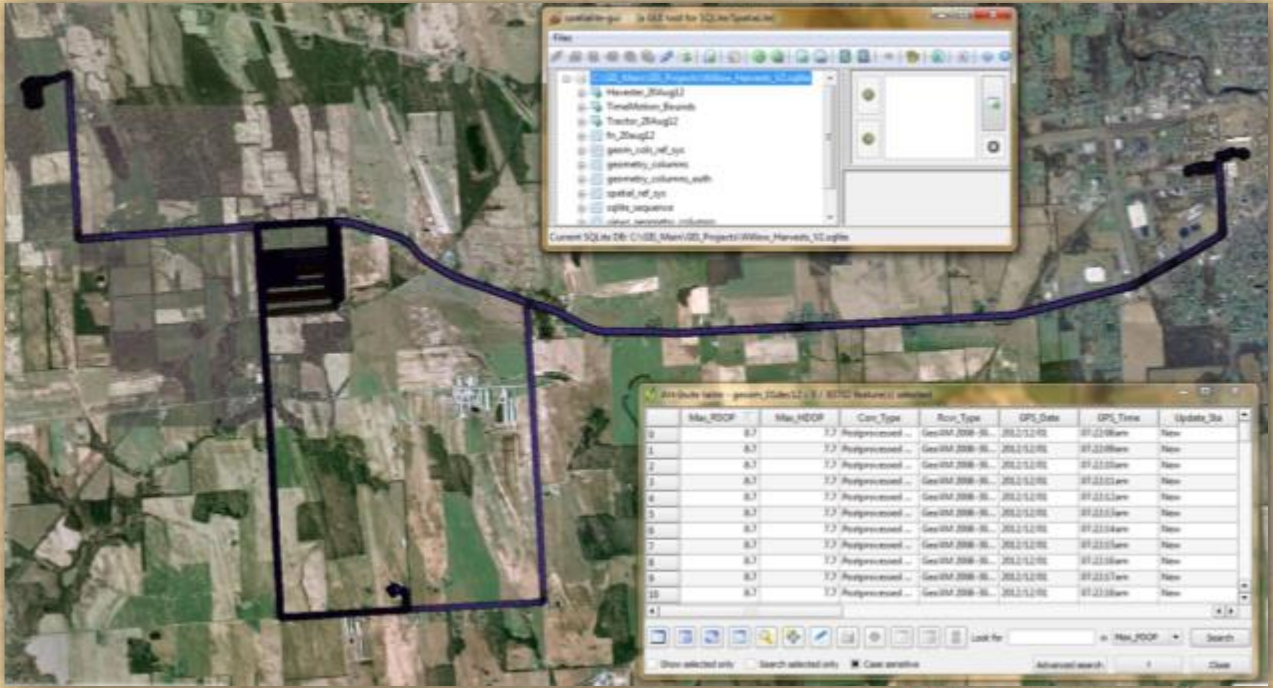
- In previous project, machine performance was assessed on a load basis (i.e. row or part of row with 8-12 tons of biomass)
- Now, we plan to evaluate machine performance relative to crop and field conditions at a much finer scale
  - Crop yield
  - Stemform
  - Soil conditions
  - Engine load
  - Fuel consumption



Distribution of engine load for New Holland Harvester in coppice hybrid poplar energy crops

Summary - Expand the harvesting window

Summary - Improve Harvesting Logistics (IBSAL)



Summary – Rapid Feedstock Assessment

Near Infrared Spectroscopy (NIR)
- Fast (20 seconds)
- Nondestructive
- Small sample requirements

Calibration required to compare lab/field NIR equipment

Most reliable calibrations
- Same species
- Same particle sizes

Quality Attributes
Moisture, Cellulose, HemiC, Lignin, Ash, and possibly "extractives"

Bruker MPA FT-NIR
Lab/Benchtop NIR

ASD QualitySpec Trek
Handheld Portable NIR

Deere and Zeiss
Harvest Lab Sensor
Inline NIR

Summary – Hot Water Extraction

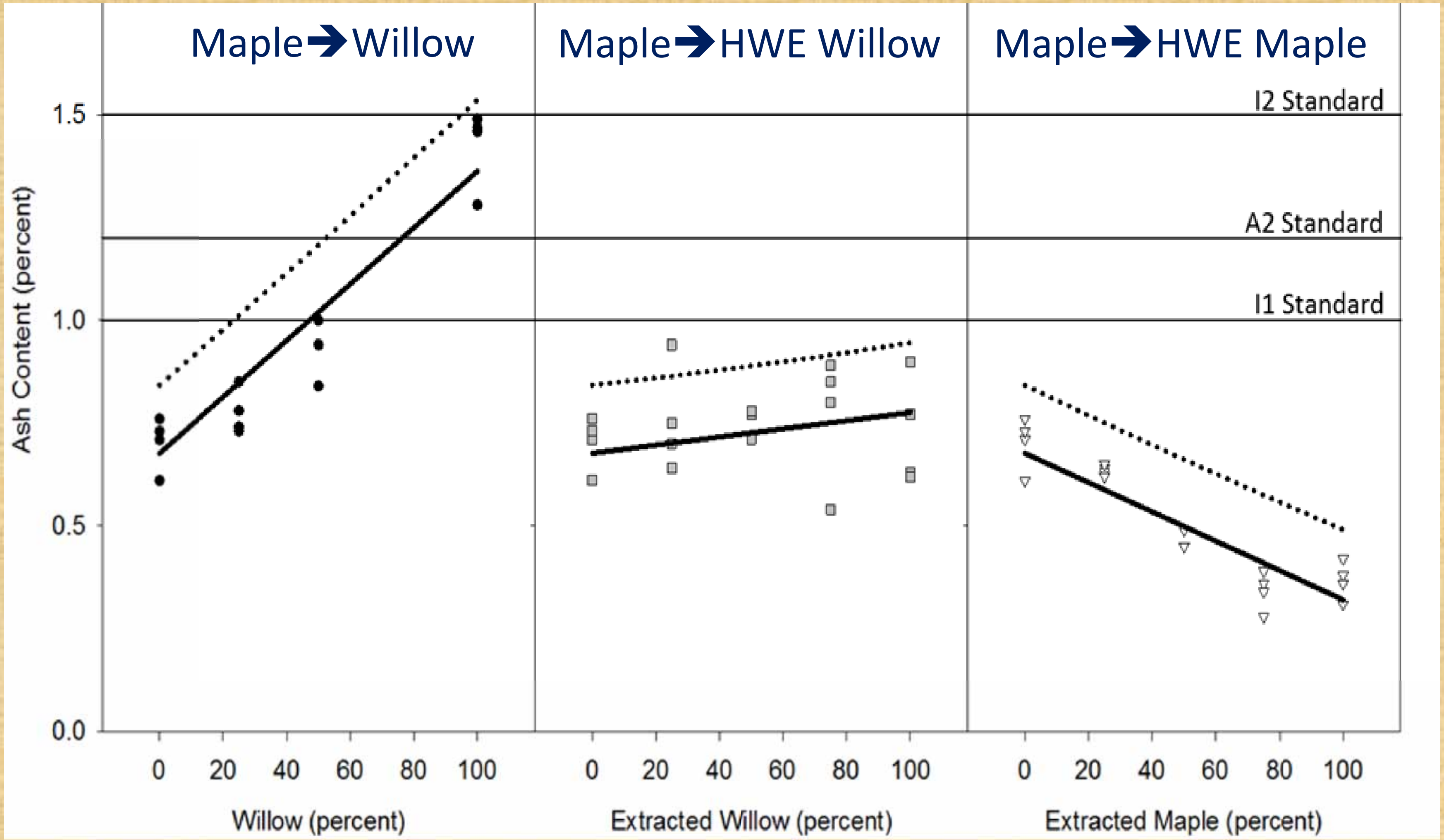
Applied Biorefinery Sciences (ABS) Approach

- Hot-water based
- Incremental deconstruction
- Membrane technology
- Fermentation
- Product recovery

A means to improve feedstock quality while creating additional revenue streams

Membrane Separation

Summary - Pre-Processing and Blending



Ash content of blended pellets comprised of maple with willow, HWE willow, and HWE maple

Summary - Relevance

- Develop advanced logistics and process simulation models to optimize planning and management of the new and existing systems (Integrating Tasks 1-4)
- Anticipate improved reliability and efficiency of a SRWC that will improve economics and advance these systems in two regions
- ReEnergy Holdings have signed contracts to purchase all the willow biomass from 1,200 acres in northern NY
- US Army has signed 20-yr power purchase agreement with ReEnergy
- ReEnergy is interested in increasing the proportion of willow in their feedstock supply
- Advanced Bioenergy Sciences is developing scale-up plans and pellet producers are interested in residual material
- Hybrid poplar biomass crops are being expanded to supply ZeaChem

Questions