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School of Forest Resources
Pinchot Institute For Conservation
September 17-19, 2007

www.forestbioproducts.umaine.edu
Forest BioProducts Research Initiative

• Formed April 2006

• $10.4 million

$6.9 million, National Science Foundation EPSCoR Grant

$3.5 million, Maine Economic Improvement Fund
Goal

To advance understanding about the scientific underpinnings, system behavior, and policy implications for the production of forest-based bioproducts that meet societal needs for materials, chemicals and fuels in an economically and ecologically sustainable manner.
FBRI Research Themes

Theme 1
Natural Resource Sustainability

Theme 2
Extraction & Residual Solids Control

Theme 3
Separation & Conversion to New Products
Theme 3 – Separation & Conversion to New Products

Key Questions:

- What biological processes can be used to efficiently convert wood to desired bioproducts while reducing energy input and chemical activity?
- Can we develop a process to produce biopolymers that when combined with natural fibers replace inorganic and petroleum based consumer and building products?
- How would we design a flexible production system that can easily make different bioproducts depending upon consumer demands and market opportunities?
1. Unmarketable Biomass

2. Hog Fuel Chips to Heat & Power

3. Sawdust

4. Wood Strands to OSB plant

5. Wood Chips to Pulp Mill

New carbohydrate feedstock

Pyrolysis Liquid

Syngas

Mixed Sugars

Wood Logs to Saw Mill

Direct Conversion Products
Forest Biorefinery Platform

- Oil
- Natural Gas
- Biomass

Host Option A
Combined Heat & Power Plant

- Syngas
- Steam
- Pyrolysis Oil

Syngas & Pyrolysis Oil Conversion

Integrati**ed Biorefinery Facility**

Sugar Conversion

Sludge, Wood Waste, Hemi Extract

Host Option B
Saw Mill, OSB Plant, Pulp Mill

- Electricity
- Fuels
- Chemicals
- Polymers
- Fiber Product
Theme 3 – Needs addressed

- Need to optimize extraction for downstream processing options
  - Byproducts recovery
  - Suitability for bioconversion
  - Energy efficiency
  - Water integration

- Need to collaborate
  - Enzymatic processes
  - Separations technologies
  - New woodfiber based products
Theme 3 - Personnel

- Hemant Pendse (Theme Leader)
- Adriaan van Heiningen –
  - Extract processing
- Mike Bilodeau –
  - Wood fiber product opportunities
- Joe Genco –
  - Process Simulations
- Peter van Walsum
  - Bioprocessing
- Nan Kravit
  - Bioprospecting
- Clay Wheeler, Brian Fredrick, Bill DeSisto, A. van H.
  - Thermal Conversion
- Doug Bousfield
  - Micro-Fibrilated Cellulose
Theme 2 – Extraction & Residual Solids Control

Key Questions:

- How do we change the wood so that we can simultaneously make building and paper products as well as bioproducts?
- How will using different portions of a tree affect the amount, quality, and cost to produce bioproducts?
- Can advanced scientific tools explore the molecular structure of woody materials, allowing us to develop new processes and bioproducts?
- Can cellulose nanofibers be used to improve coatings and plastics?
Theme 2 - Objectives

- To generate new knowledge needed for selective and controlled extraction of hemicellulose from forest biomass
- To understand the effect of extraction on wood properties and resultant wood products, in addition to downstream pulp, fuels, chemicals and biomaterials
Theme 2 - Ongoing Projects

- Hemicellulose Extraction of Hardwoods with Pure Water
- Kinetics of Degradation of Lignin-Carbohydrate Model Compounds
- Adsorption of Extracted and Modified Hemicelluloses on Pulps
- Influence of Hot Water Extraction on OSB Behavior
- Biomodification of Wood Identification of Forest Bio-Products through Near-Infrared Spectroscopy
- Surface Modification of WPCs for Enhanced Adhesion
- Fabrication and Testing of Biobased and Synthetic Sheet Molding Compound
- Chemistry of Hemicelluloses
- SFS of the Model Cellulose & Lignin Substrates
Theme 1: Forest BioProducts Sustainability
Maine’s forest bioproducts need to come from a predictable and sustainable resource base.
Key Questions

- What is the character and composition of the future sustainable supply of biomass and other wood products from Maine’s forest?
- What impact will demand for bioproducts have on Maine’s future forest?
- What effect will sprawl and public opinion have on the social acceptability of a future forest bioproducts economy?
Key Questions

- What is our logging capacity and are there improvements to be made with current biomass harvesting technologies?
- Does forest bioproducts industry make economic sense for Maine and the Northeast?
- How does the life cycle (energy, waste, carbon footprint, etc.) of forest bioproducts compare to alternative products?
How much is there on timberland?

Biomass of all standing trees
(above/belowground; live/dead; saplings)
(Million Tons, Dry Weight)

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<th>State</th>
<th>Biomass</th>
<th>Percentage</th>
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Source: Ken Laustsen, Maine Forest Service
Twice as much standing forest inventory today than in 1930.
Maine Wood Harvest Trends

Sustainable harvest level

Data Source: Maine Forest Service

Maine Forestland Advantages for BioProducts Industry

- Good standing forest inventory
- Excellent residue potential
- Diverse and integrated industry with history and infrastructure in biomass harvesting
- Nearly all private land
- Largest block of contiguous commercial forestland in US
- A strong market for poor and low quality material would improve forest conditions
- Good road access
- History of university research support and collaboration
Challenges & Uncertainties
Maine Forestland Ownership Changes

5 million acres (45%) changed hands from 1994-2004

Sprawl Projections in Eastern U.S.

Changing Harvest Patterns

Maine Harvest Area By Method as % (1988-2003)

Area harvested (%)

Year

Selection / Partial cutting
Shelterwood
Clearcut
Maine Partial Cutting
Unintended Consequences?


- Area harvested (x1000 acres)
- Wood volume
- Harvested area

Year:
- 1988
- 1989
- 1990
- 1991
- 1992
- 1993
- 1994
- 1995
- 1996
- 1997
- 1998
- 1999
- 2000
- 2001
- 2002
- 2003

Wood volume harvested (million cords)
Implications of Partial Cutting?

Good?

Bad?

Future?
Theme 1 - Interdisciplinary Working Group

- Kathleen Bell
  - Natural resource economics
  - Spatial modeling (GIS)
- Jeff Benjamin
  - Forest operations and wood science
- Darrell Donahue
  - Risk assessment modeling
  - Life cycle analysis
- Ken Laustsen
  - Forest growth and yield
  - Wood supply modeling
- Jessica Leahy
  - Environmental education & policy
- Rob Lilieholm
  - Forest economics and policy
- Greg Norris
  - Life cycle inventory analysis
- Terry Porter
  - Environmental business & policy
- Russell Read
  - Economics & investments
- Jonathan Rubin
  - Economics of alternative fuels
  - Environmental policy
- Bob Wagner (Working Group Chair)
  - Silviculture
  - Forest ecology
- Jeremy Wilson
  - Forest management
  - Landscape analysis
Thank You