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# Maine Forest Bioproducts Research Initiative and Green Chemistry: Opportunities for Bioproducts

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# Maine Forest Bioproducts Research Initiative and Green Chemistry: Opportunities for Bioproducts

Northeast Sun Grant Regional Feedstock Summit

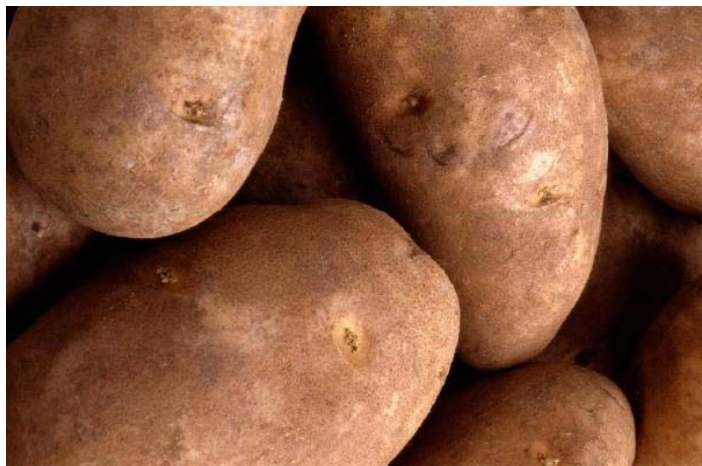
November 11-13, 2007

Jonathan Rubin

# Three Opportunities

- Potatoes-to-Plastics
- Forestry Biorefinery Research Initiative
- Forestry credits under RGGI





# Potatoes-to-Plastics

## Team

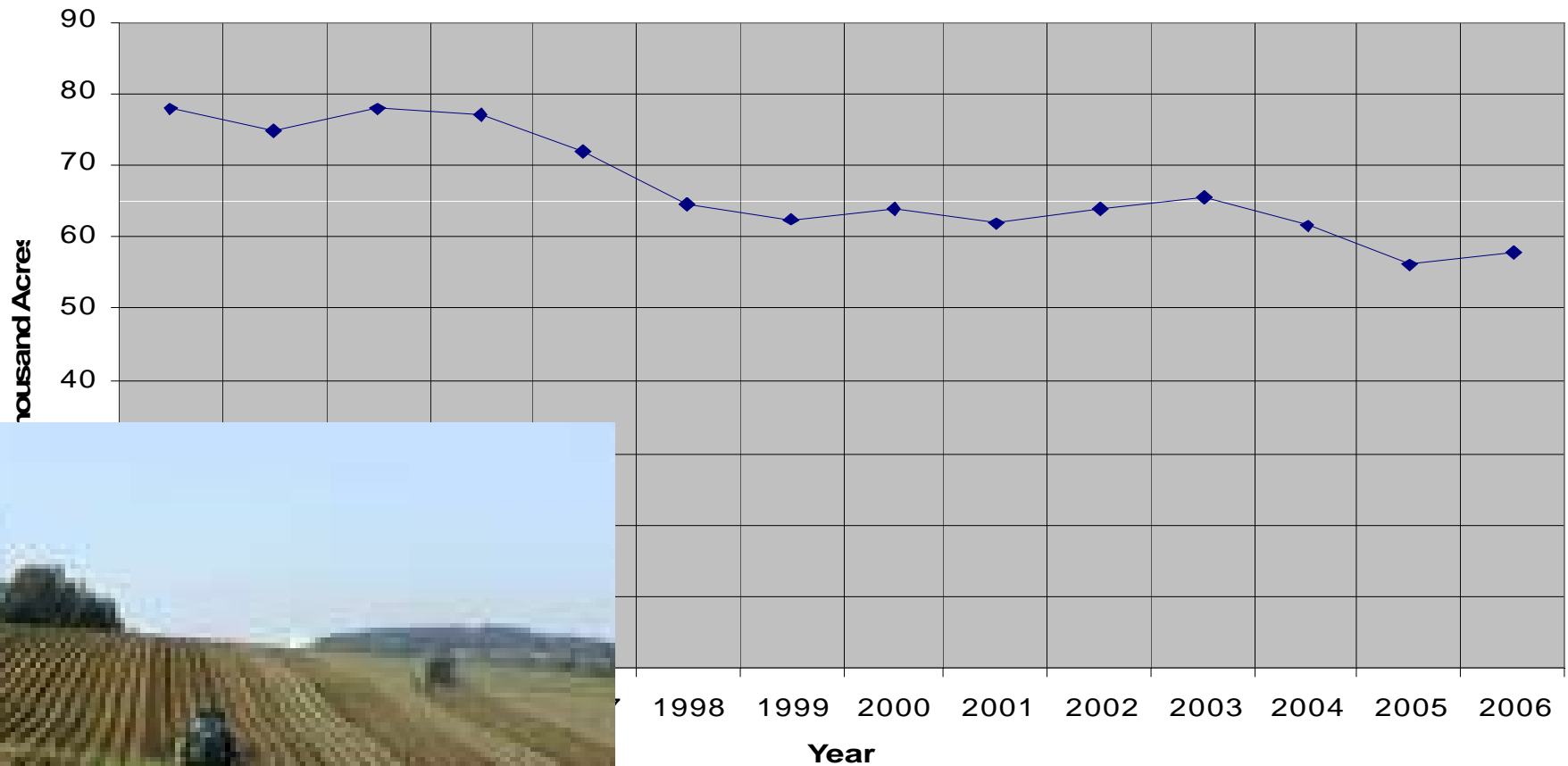
- Kate Dickerson, MCS  
Policy Center
- Maine Technology Institute
- Alliance for a Clean &  
Healthy Maine
- Green Harvest  
Technologies
- InterfaceFABRIC
- Maine Potato Board
- University of Maine
- University of  
Massachusetts, Lowell

Report: <http://www.umaine.edu/mcsc/reports/potatoesRpt.pdf>

# Why?

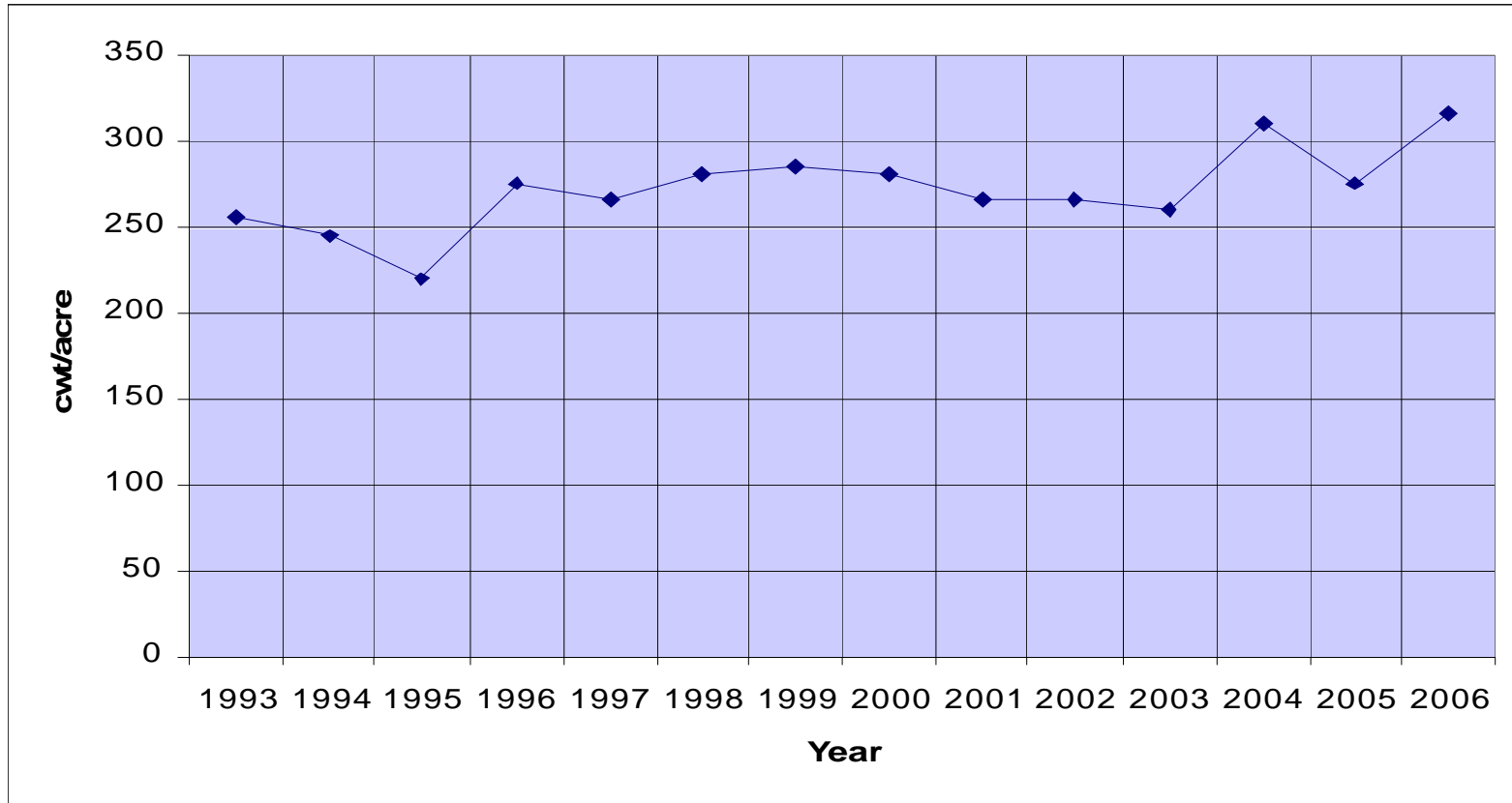
- Petroleum displacement
- Less toxic
- Economic development

# All Purpose Potatoes Harvested in Maine, 1993-2006



# Maine Potato Yield

hundred weight/acre, 1993-2006



# InterfaceFABRIC: 13M lbs of PLA/yr

<b>PLA Available from Potatoes</b>	
<b>Potato Yield</b>	<b>27,100 lbs potatoes/acre</b>
<b>Percentage of starch in Russet Burbank and Shepody potatoes</b>	<b>14.8 %</b>
<b>Potato starch</b>	<b>4,011 lbs/acre</b>
<b>PLA from Starch (1:0.65)</b>	<b>2,607 lbs/acre</b>
<b>Additional acres for potatoes (in 3-year rotation)</b>	<b>6,667 acres</b>
<b>PLA yield with new acreage</b>	<b>17,380,133 lbs</b>



# Interface FABRIC: 13M lbs of PLA/yr

<b>PLA Available from Potato Wastes</b>		
<b>Potato Harvest</b>	<b>67,000 acres</b>	
<b>Yield</b>	<b>27,100 lbs of potatoes/acre</b>	
<b>Waste Percentage availability</b>	<b>lbs starch available</b>	<b>lbs of PLA</b>
<b>If 10% of production culls and smalls (waste potatoes)</b>	<b>26,872,360</b>	<b>17,467,034</b>
<b>If 50% of production is for fries and 30% waste occurs (potato waste)</b>	<b>40,308,540</b>	<b>26,200,551</b>

# Cost Estimates

- Estimated annual operating costs of a small capacity PLA facility using corn: \$26.6 M/yr
- At such a facility, PLA can be produced at a price of \$1.20/lb
- Using potatoes rather than corn brings an additional cost of \$0.06 per pound of fresh potatoes. Total PLA production cost: \$1.26/lb

# Summary of Findings

- Potential to produce PLA from potato starch will not be limited by the ability of potato growers to provide a viable crop.
- Cost to growers will not be prohibitive for such a project; return will be similar to that for food stock potatoes.
- No current table-ready or processing potatoes need to be taken out of the supply chain.
- The needed increase in the amount of acres planted and harvested can be implemented within one planting season to provide the starch.
- Potato varieties currently grown, in particular the Russet Burbank and/or Shepody potatoes, can be used as the source of starch for PLA manufacturing.

# Next Steps: Build Industry-University Research Cluster

- R&D of specific performance characteristics required
  - Fiber for textile manufacturing
  - Bottles and containers for food consumption
  - Resins for composite building products
- Conduct the research to determine the location and technical specifications for a PLA facility in Maine
- Examine the potential contribution of waste potatoes and processed starch to support a PLA facility
- Examine potential for new more cost effective and environmentally sustainable potato varieties which can be grown specifically for the PLA market
- Market research for products and product characteristic



# FBRI

**FOREST BIOPRODUCTS  
RESEARCH INITIATIVE**

**Discovering**  
a Sustainable Bio-Economy



# FBRI's Core Research

From the forest floor to the factory floor, researchers, students, and project partners' goals are to:

**Promote**

Forest Health for a  
Stable Bio-Economy

**Understand**

and Separate  
Wood Components

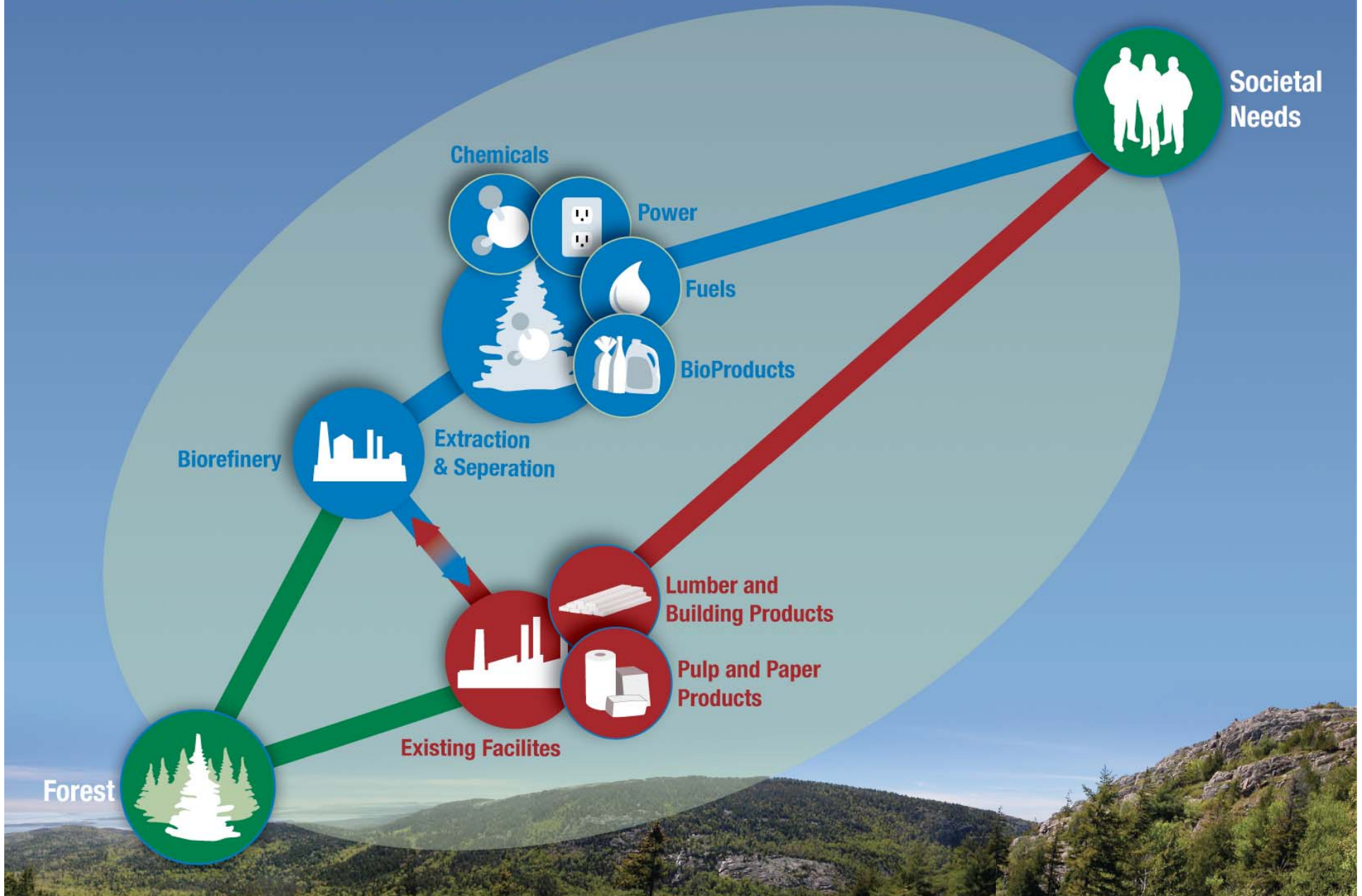
**Create**

and Commercialize  
New Bioproducts





# FOREST BIOPRODUCTS RESEARCH INITIATIVE

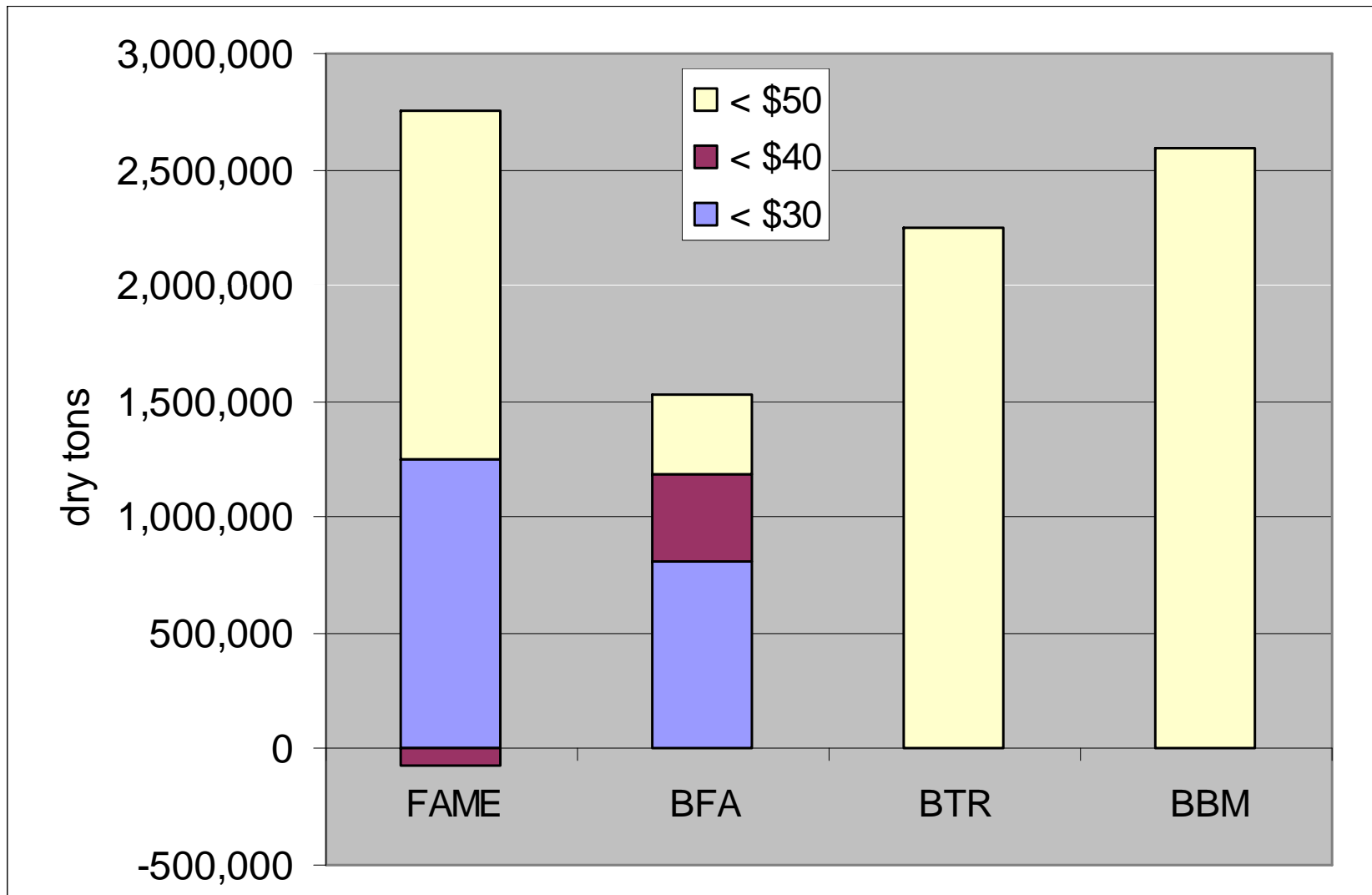


# FBRI's CORE RESEARCH AREAS

- **Promote Forest Health for a Sustainable Bio-Economy**
- **Understand and Separate Wood Components**
- **Create and Commercialize New Bioproducts**



# Maine Forest Residue Estimates



# Forest Capacity for Fuel Production

- **Forest residues**
  - Ethanol could replace 18% of Maine gasoline
  - Fischer-Tropsch diesel could replace 39% of Maine's petro-diesel
- **Roundwood & residues**
  - 77% of Maine transportation fuels
  - 8% of New England's gasoline consumption
- **Modified Billion Tons methodology and better, more recent data**
  - Refined estimates on the way

Sustainable Annual Harvests

Report available: [http://www.umaine.edu/mcsc/reports/Biomass\\_and\\_Biofuels\\_in\\_ME.pdf](http://www.umaine.edu/mcsc/reports/Biomass_and_Biofuels_in_ME.pdf)

# Woody Biomass Availability After Harvesting

- Determine additional biomass availability after traditional harvests and through pre-commercial thinning
- Evaluate the potential impact of additional biomass removals on future stand conditions
- Approach
  - Post-harvest stand conditions measured to determine amount of woody biomass available using current harvest methods
  - Assess amount of biomass available from precommercial thinning
  - Project future stand conditions in to determine the long-term impact of biomass harvests on future stand conditions.

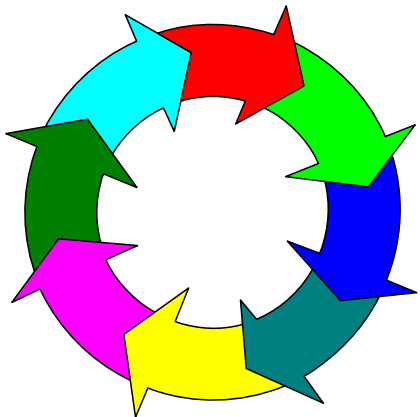
# FBRI's CORE RESEARCH AREAS

## **Promote Forest Health for a Sustainable Bio-Economy**

- Public perceptions emerging forest bioproducts industry
  - Determine potential social challenges of a forest bioproducts economy
  - Quantify social acceptability using social network maps of the forestry community
- What is the market for eco-branded ethanol and diesel?
  - Can we use regional marketing to differentiate our fuel from corn-based ethanol?
  - What fuel/community forestry aspects will consumers pay a premium for?

# Life Cycle Analysis of Forest Bioproducts

- Advance the practice of LCA in application to bio-products
  - Use LCA to help advance sustainable bio-product design and evaluation
  - Develop and demonstrate new methods for LCI, including linkages to forest and economic modeling
  - Develop and demonstrate new methods for LCIA, including addressing land use impacts of forestry and agriculture



# FBRI's CORE RESEARCH AREAS

## **Understand and Separate Wood Components**

- How do we change the wood to make 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?

# FBRI's CORE RESEARCH AREAS

## **Create and Commercialize New Bioproducts**

- What biological processes can be used to efficiently convert wood to desired bioproducts?
- Can we develop a process to produce biopolymers that when combined with natural fibers replace petroleum products?
- How do we design a flexible production system to easily make different bioproducts depending on market opportunities?

# Regional Greenhouse Gas Initiative (RGGI)



- Regional Cap-and-Trade
  - Maine, New Hampshire, Vermont, Connecticut, New Jersey, New York, Delaware, Massachusetts, Rhode Island

“The Regional Greenhouse Gas Initiative,” *Environment*, 49(2) 2007



# New Market Opportunity: Offsets

- Capturing methane gas
  - Landfills
  - Agriculture
- Capturing sulfur hexafluoride (SF<sub>6</sub> )
- **Afforestation**
- Improving “end use” efficiency
  - E.g., Home heating and hot water, etc.
- Reducing methane emissions from natural gas transmission and distribution.
- **Other** offset agreed to by RGGI states

Offset prices of between **\$8 and \$10** per tCO<sub>2</sub>e is approximately equivalent to current CRP rates of \$44 per acre in the RGGI region (The Sampson Group, Inc, 2004)