Opportunities and Challenges in the Design and Analysis of Biomass Supply Chain

SANGPIL KO,
Graduate Research Assistant
Michigan Technological University

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Article Authors:

- Pasi T Lautala
- Tuulli Laitinen
- Roger Bittencourt
- Amir Valente
- Michael R Hilliard
- Erin Webb
- Ingrid Busch
- Robert M Handler
- Richard Hess
- Mohammad S Roni
- Jorge Hilbert

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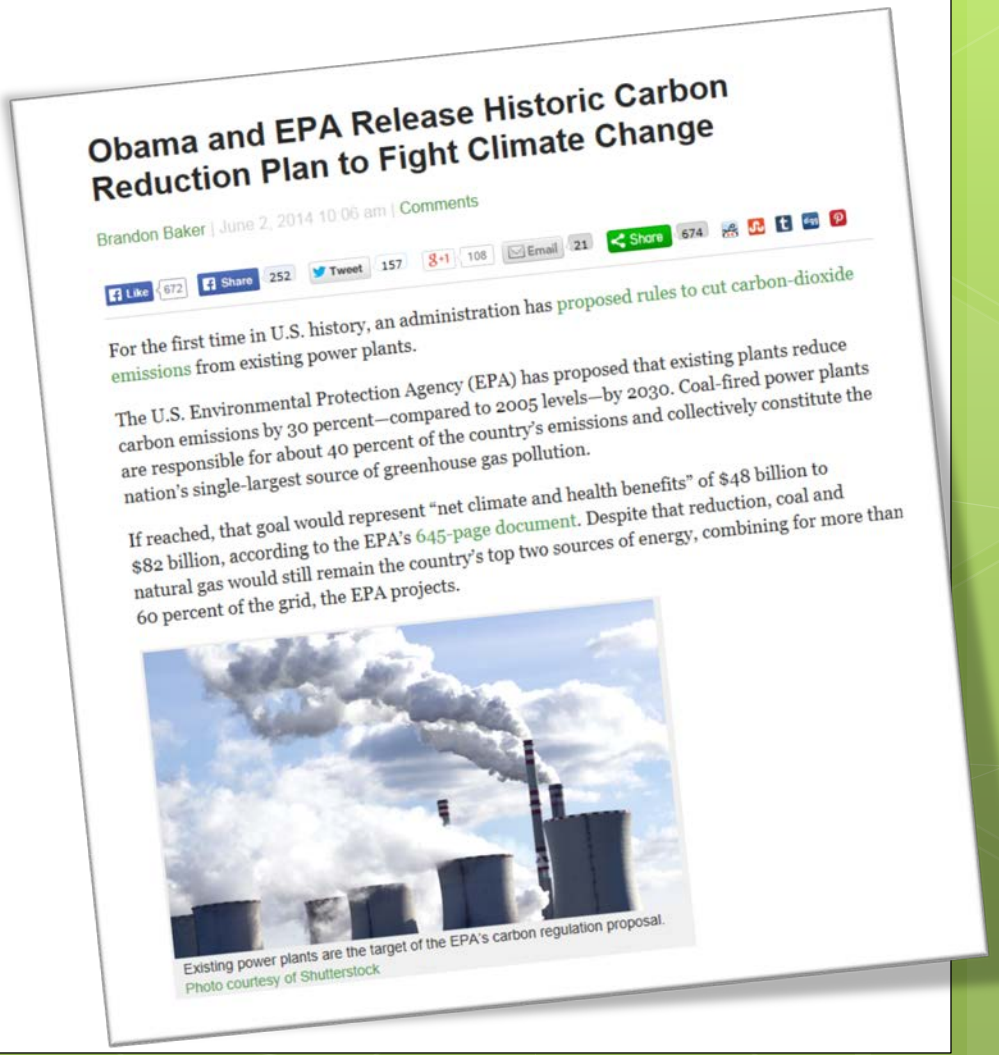
I. Introduction of Biomass Supply Chain

I. Introduction

- The projection of replacing 30% of gasoline consumption by 2030 in the U.S. will require significant infrastructure investments on biomass over the next decades, and effective supply chain management.



Obama and EPA Release Historic Carbon Reduction Plan to Fight Climate Change

Brandon Baker | June 2, 2014 10:06 am | Comments

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For the first time in U.S. history, an administration has proposed rules to cut carbon-dioxide emissions from existing power plants.

The U.S. Environmental Protection Agency (EPA) has proposed that existing plants reduce carbon emissions by 30 percent—compared to 2005 levels—by 2030. Coal-fired power plants are responsible for about 40 percent of the country's emissions and collectively constitute the nation's single-largest source of greenhouse gas pollution.

If reached, that goal would represent "net climate and health benefits" of $48 billion to $82 billion, according to the EPA's 645-page document. Despite that reduction, coal and natural gas would still remain the country's top two sources of energy, combining for more than 60 percent of the grid, the EPA projects.

Existing power plants are the target of the EPA's carbon regulation proposal.
Photo courtesy of Shutterstock

I. Introduction

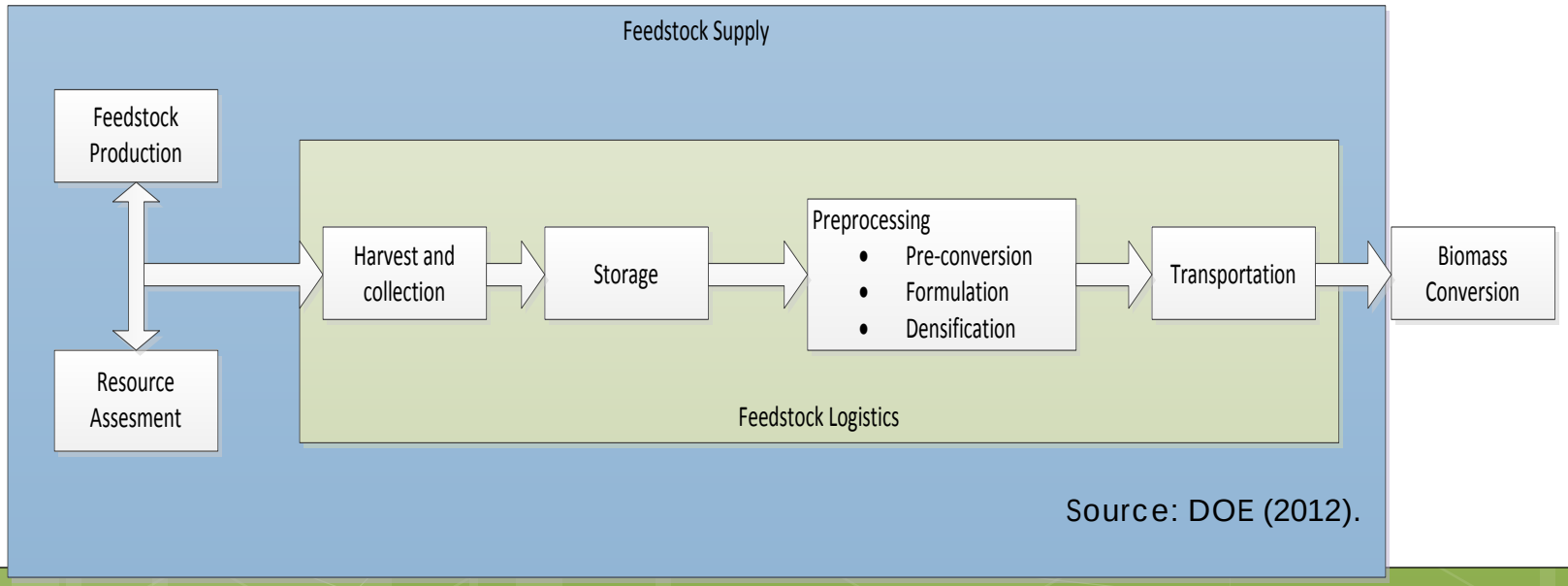
- The Goal of this paper is…

1) To **Introduce key components** of Biomass supply chains.

2) To **Provide examples of modeling applications** available for Biomass supply chain investigations.

I. Introduction

- Biomass Supply Chain Components
  - Biofuel industry is in progress to expand from a primarily sugar-based system to a cellulosic-based system.
  - Most of the feedstock of biomass include a common set of supply chain components.



Source: DOE (2012).

I. Introduction

- Biomass Supply Chain Components

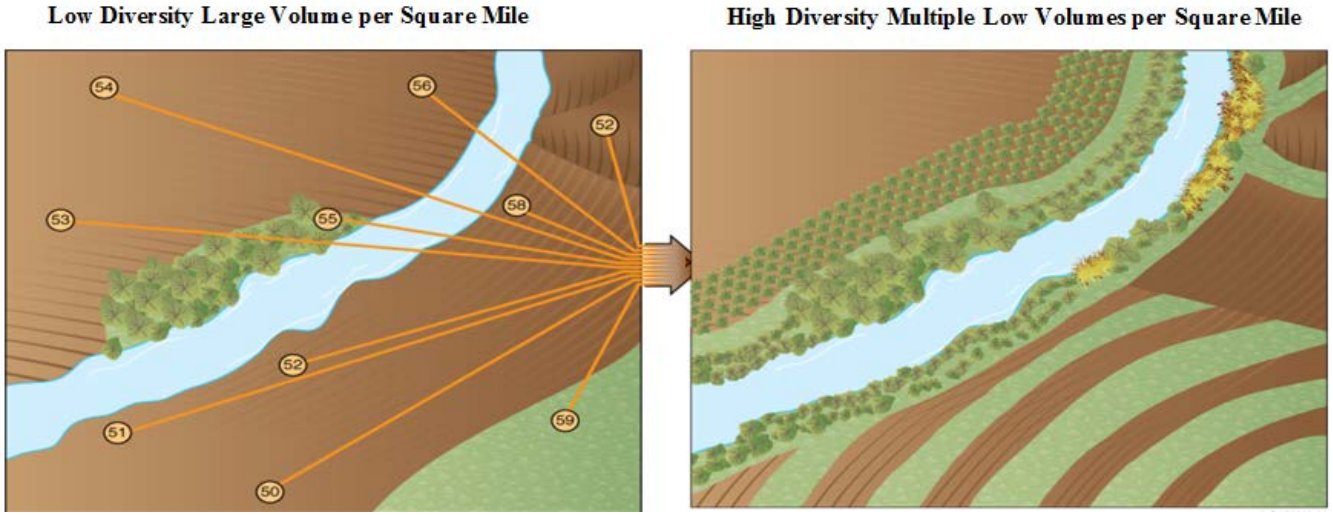
Biomass Cultivation	Naturally regenerated feedstock vs. intense cultivation procedures.
Biomass Harvesting	Removal of biomass from the growing landscape and consolidation for future use.
Biomass Transportation	Logistics of moving feedstock. Often significant cost component.
Biomass Storage	May be necessary at various points of supply chain.
Biomass Processing	Conversion into heat, power, fuel after size reduction or physical processing.
Storage and Final Transport	Direct use (for heat), or distribution for final use via electrical grid or transportation system for liquid products.

II. Advanced Biomass Supply Chain System

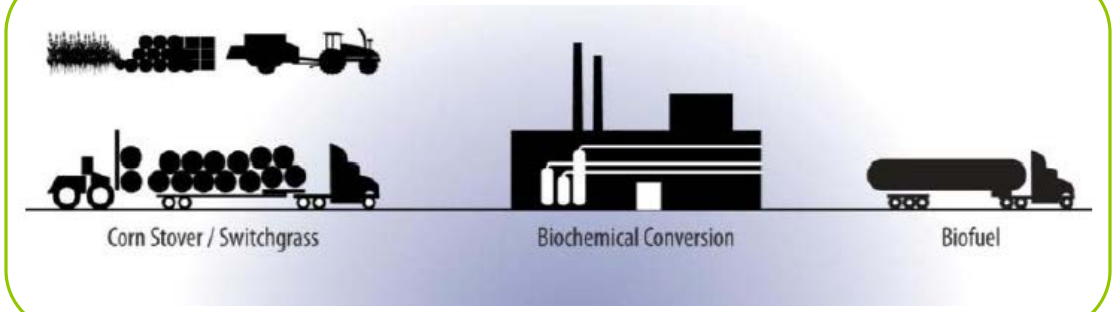
- Integrated Landscape management
- Advanced Biomass Feedstock Supply Chain

II. Advanced Biomass supply chain system

- Integrated Landscape Management
  - A New Concept to improve the biomass supply-demand dynamics and make more biomass available at lower access costs.
  - Traditional cropping system **vs.** Integrated landscape mgmt.

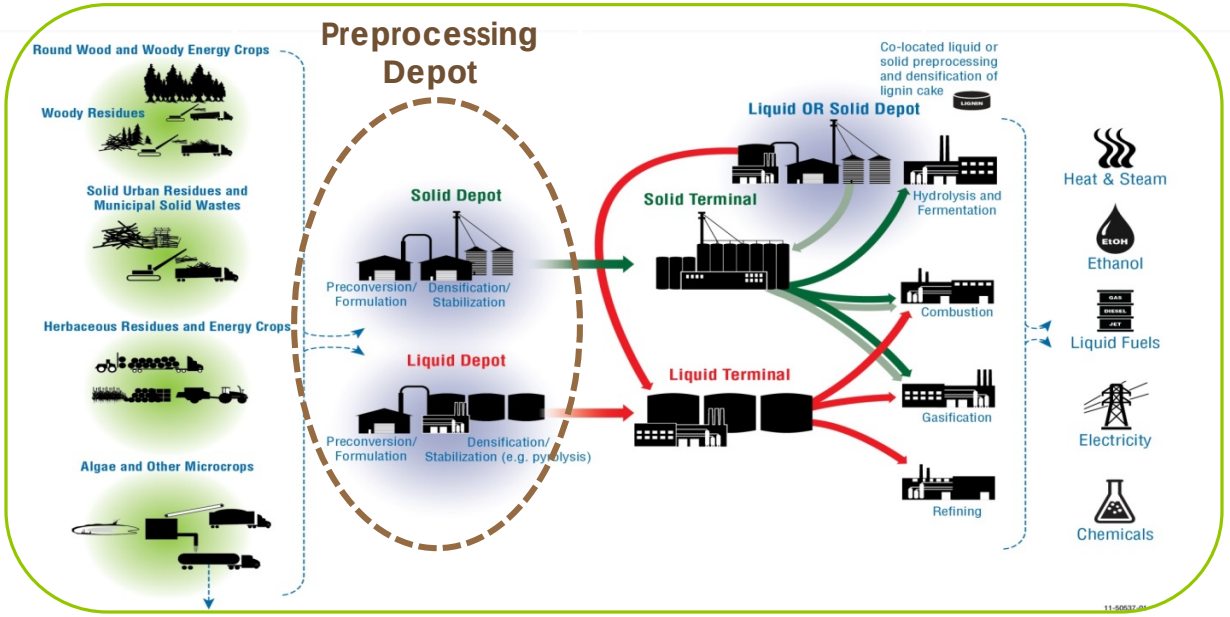


II. Advanced Biomass supply chain system



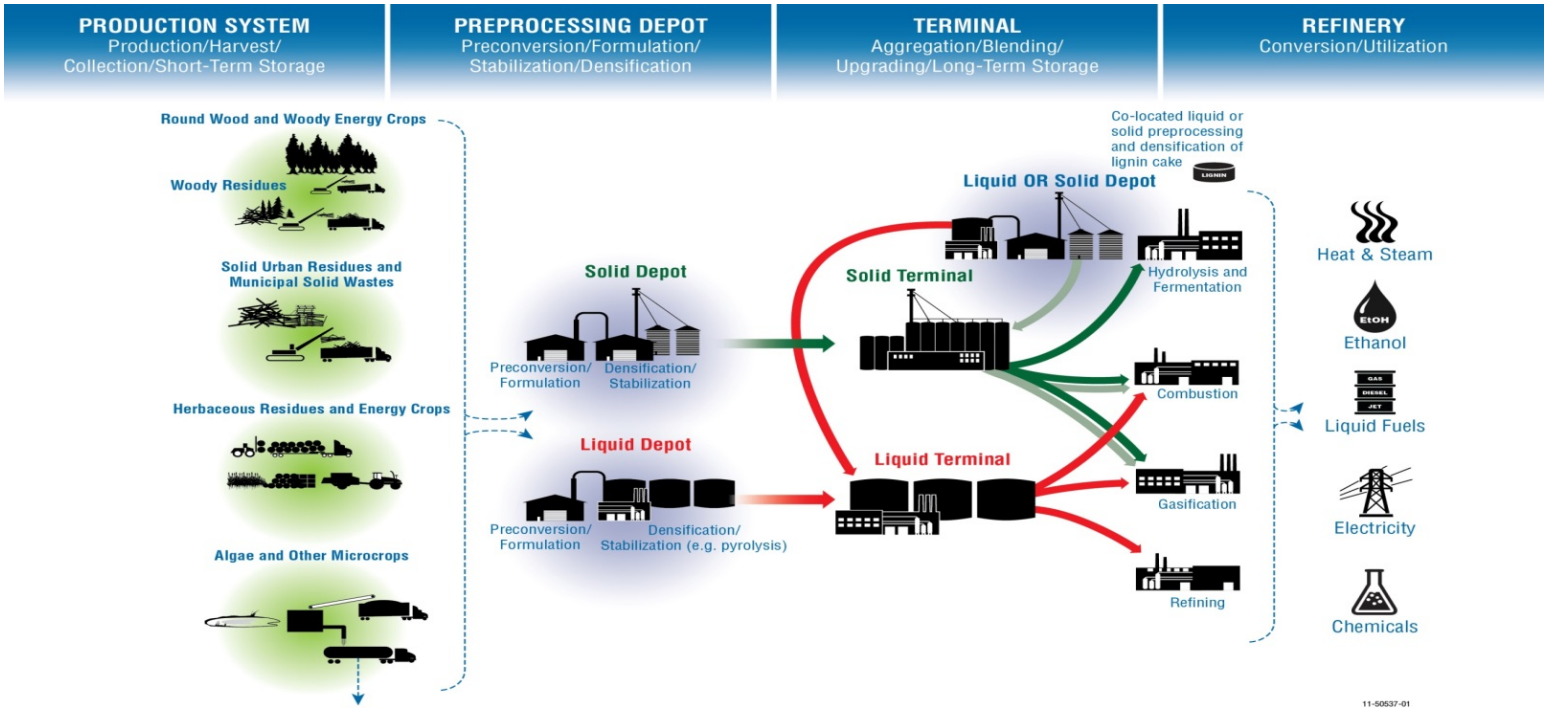
- Existing Biomass Supply Chain

- Advanced Biomass Supply Chain included Preprocessing phase



II. Advanced Biomass supply chain system

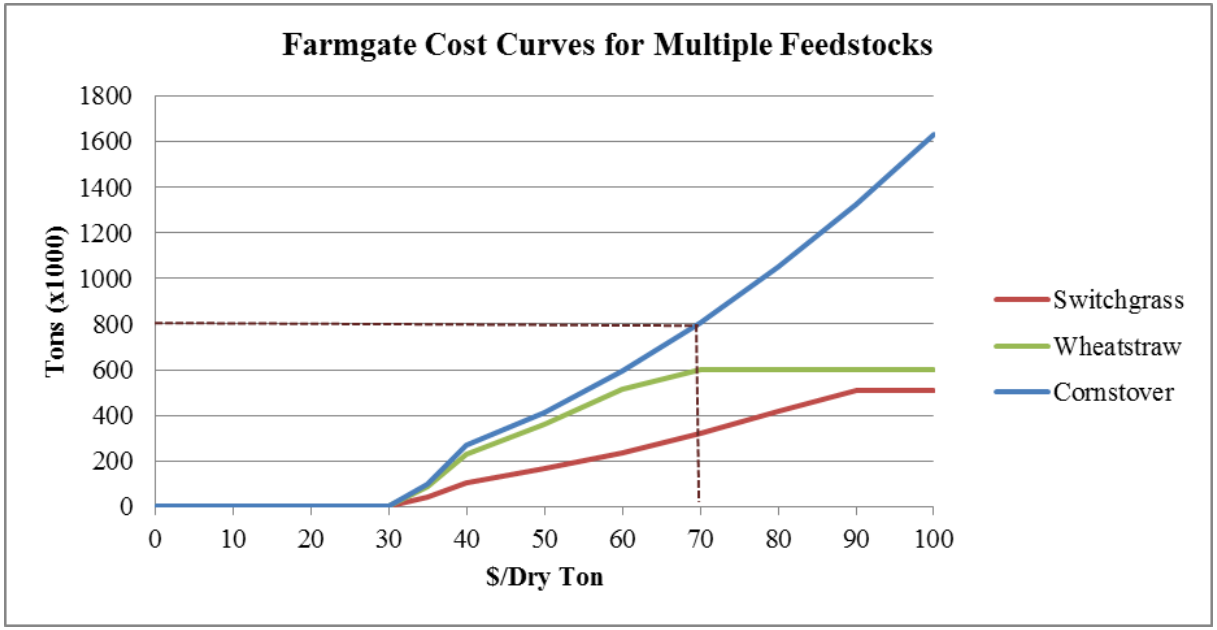
- Advanced biomass feedstock supply chain
  - Advanced feedstock supply chain system is needed to enable sustainable integrated landscape management.



II. Advanced Biomass supply chain system

- Advanced biomass feedstock supply chain
  - Advanced supply chain system has the ability to utilize small quantity of multiple types of biomass produced from the integrated landscape mgmt.

e.g. Required Biorefinery Supply 800,000 tons



III. Biomass Supply Chain Models

- BILT model (USA)
- IBSAL model (USA)
- WISDOM model: Woodshed Analysis (Argentina)

III. Biomass Supply Chain Models

- **BILT** (**B**iofuel **I**nfrastructure, **L**ogistics and **T**ransportation) Model
  - Given a region and a level of biofuel demand, the model creates a biofuel supply chain for the region that minimizes costs under given set of assumptions. Information included in the model include:

1. **Feedstock Production**
   - e.g. Which feedstock?

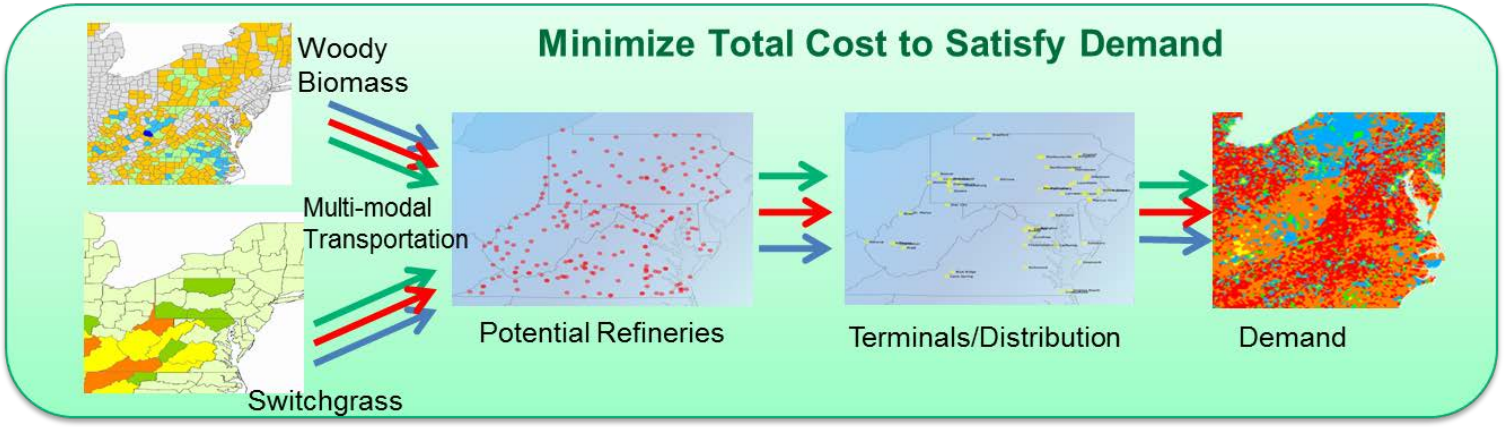
2. **Feedstock Logistics**
   - e.g. How will the biomass be handled, processed and stored on the farm, in transit and before it is used at the refinery?

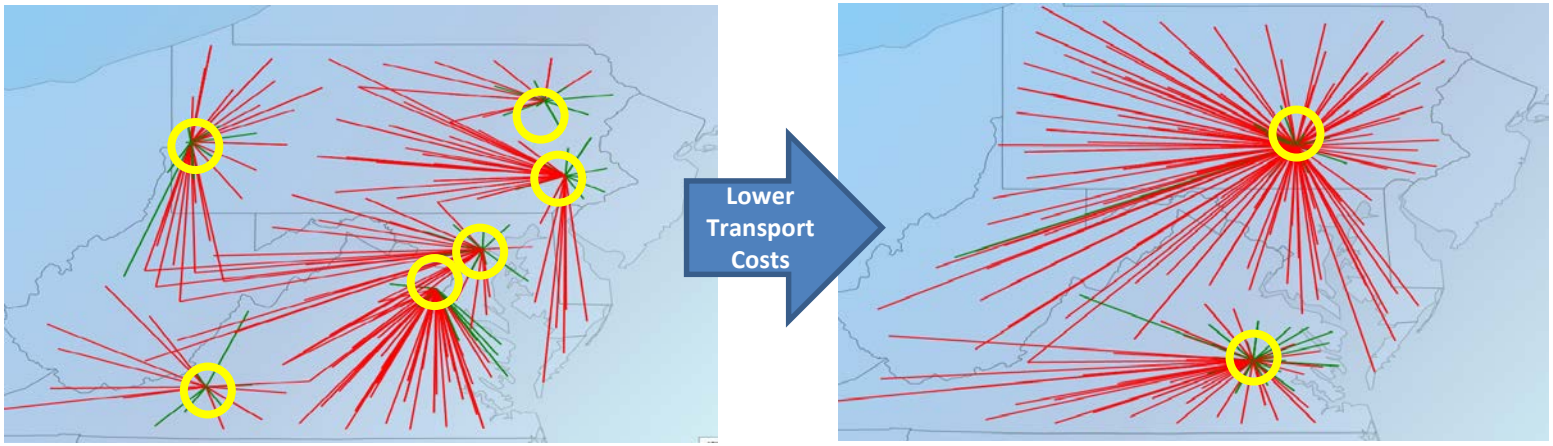
3. **Ethanol Production**
   - e.g. Which bio-refinery technologies will be employed?

4. **Ethanol Distribution**
   - e.g. How will ethanol be moved to blending facilities, and how will it be distributed between the facilities?

III. Biomass Supply Chain Models

- **BILT** (**B**iofuel **I**nfrastructure, **L**ogistics and **T**ransportation) Model

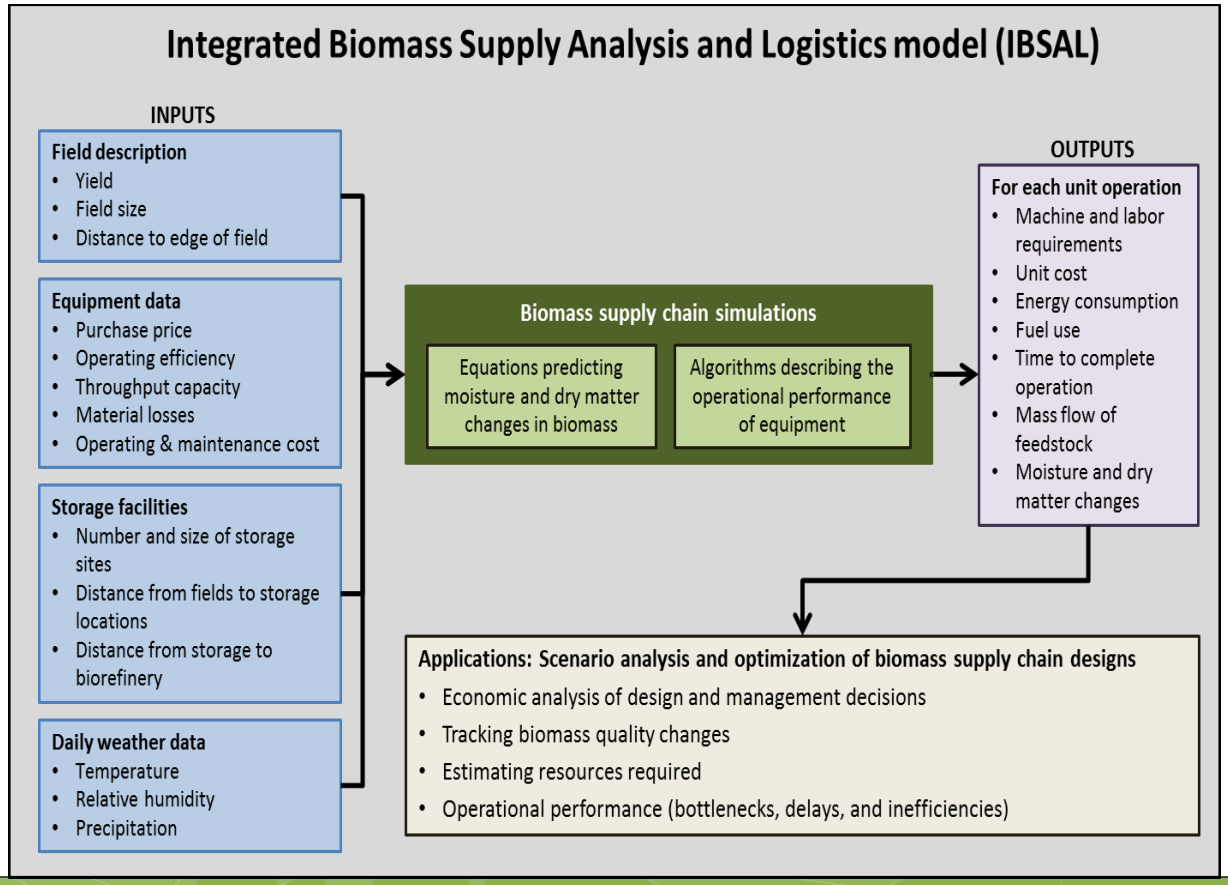




e.g. The six refineries are replaced by two large facilities when transportation costs are decreased.

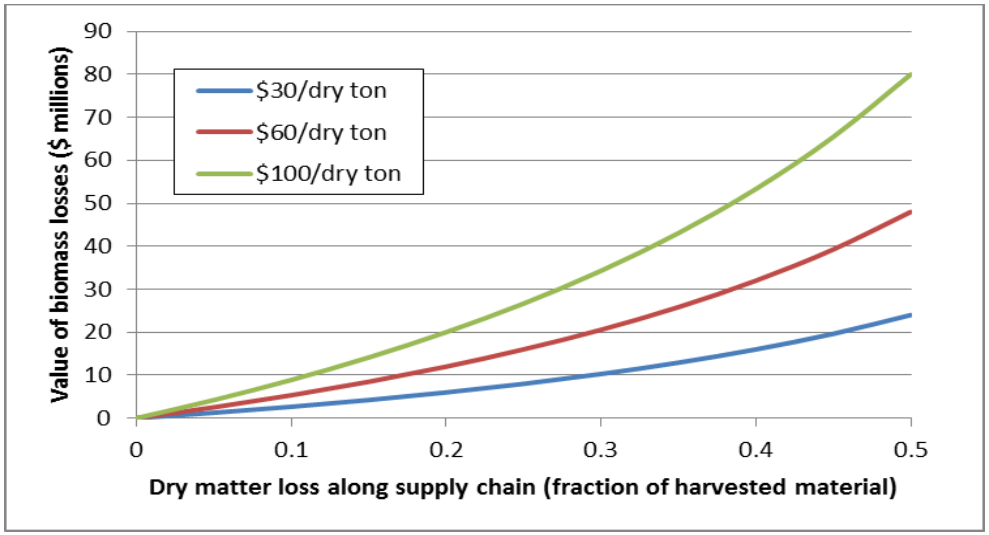
III. Biomass Supply Chain Models

- **IBSAL** (**I**ntegrated **B**iomass **S**upply **A**nalysis and **L**ogistics) Model
  - The objective of this model to simulate biomass movement through the supply chain.



III. Biomass Supply Chain Models

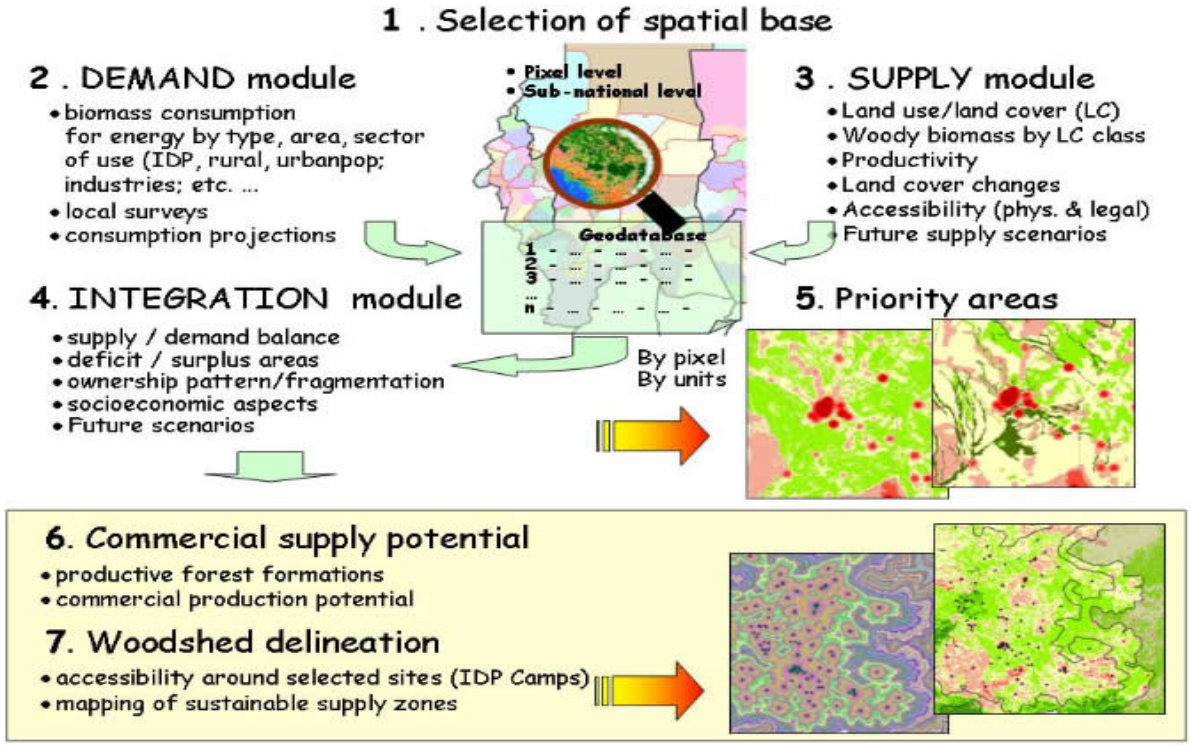
- **IBSAL** (**I**ntegrated **B**iomass **S**upply **A**nalysis and **L**ogistics) Model
  - Simulation results are highly dependent on the quality and accuracy of data. For example, the cost of dry matter loss varies based on quantity lost and unit cost



  - Not properly accounting for losses along the supply chain results in inaccurate cost estimates.

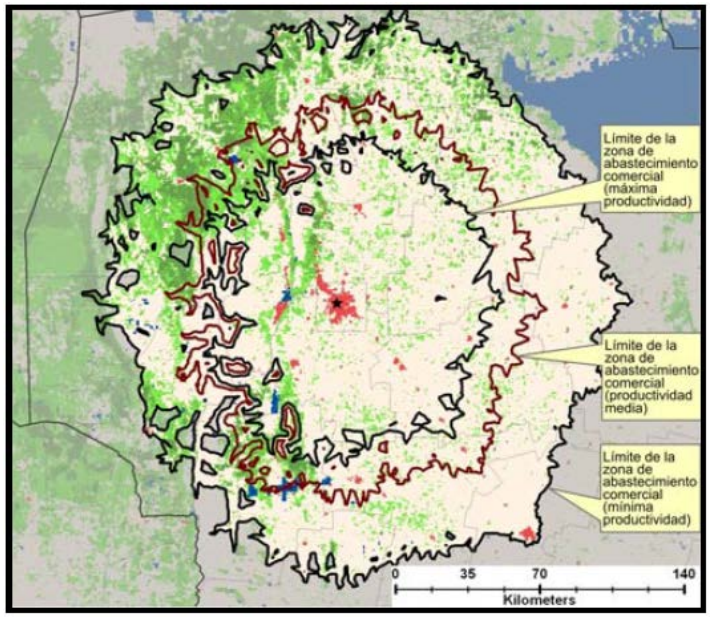
III. Biomass Supply Chain Models

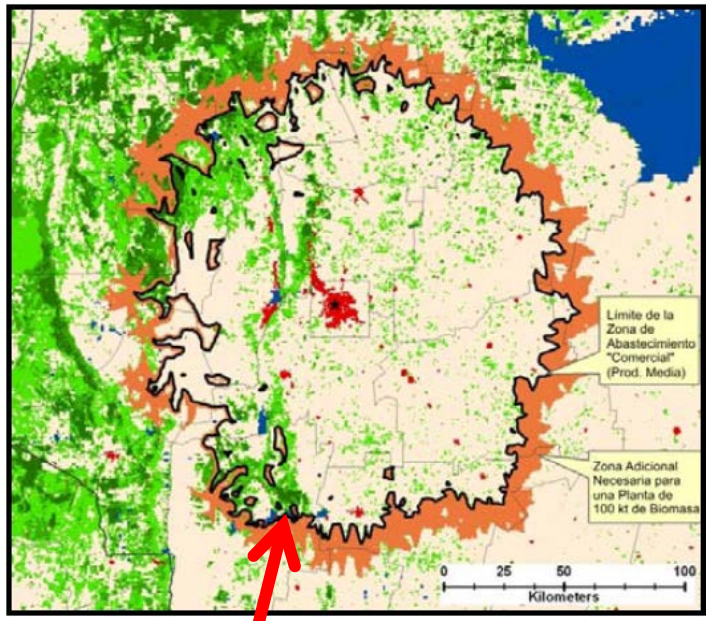
- **WISDOM** (**W**oodfuel **I**ntegrated **S**upply/**D**emand **O**verview **M**apping)
  - Woodshed Analysis: the second phase analysis of WISDOM
  - Mapping of sustainable and probable supply for woodshed delineation.



III. Biomass Supply Chain Models

- **WISDOM** (**W**oodfuel **I**ntegrated **S**upply/**D**emand **O**verview **M**apping)
  - Based on commercial balance surplus, an example of bio-shed analysis was carried out for the city of Cordoba considering minimum, medium and maximum productivity levels as follow maps:





Sustainable Commercial Supply Zone

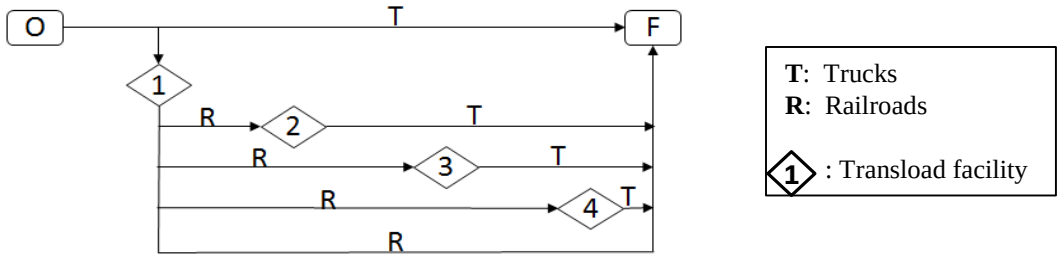
IV. Biomass Transportation Models

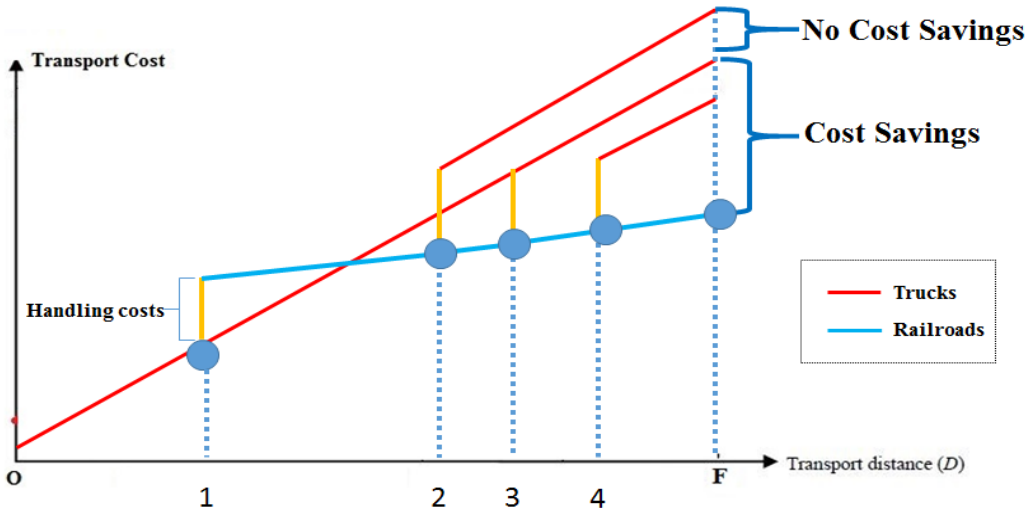
- MMLT model (USA)
- PrevFretes model (Brazil)

IV. Biomass Transportation Models

Transportation Options

- Most biomass transported by trucks
- Main Decision Criteria for Multi-Modal Selection: Cost Efficiency





IV. Biomass Transportation Models

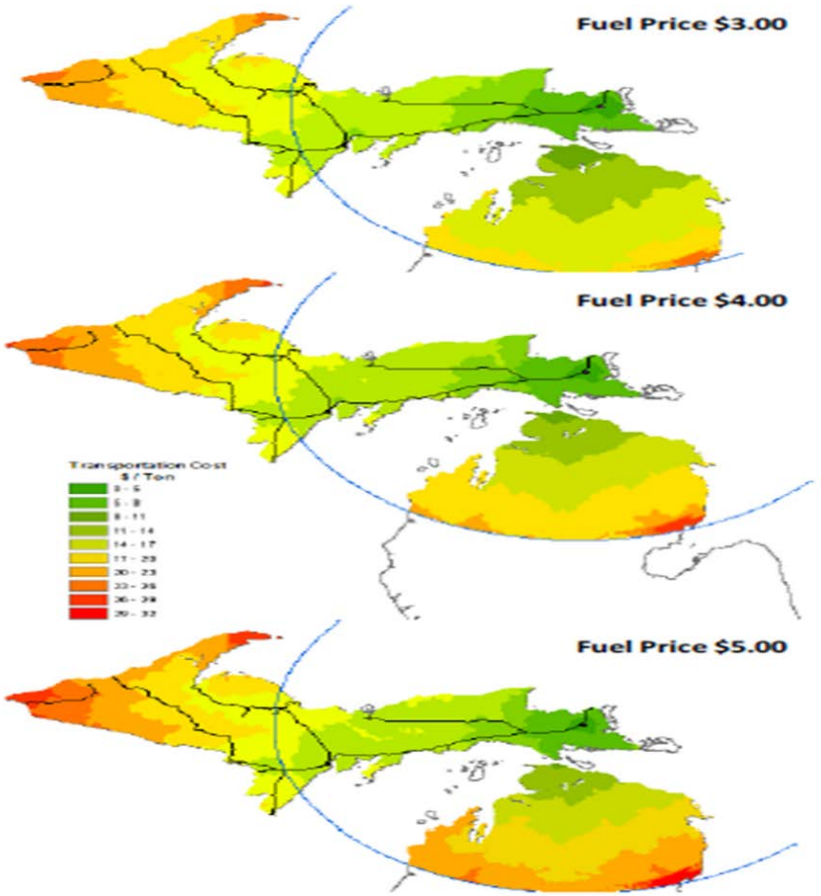
- **MMLT** (**M**ulti-**M**odal **L**og **T**ransportation) Model
  - Regional modeling tool to compare the cost of truck transportation with multi-modal (Truck/Rail) option.
  - This model used loop optimization logic to investigate a data set of 100,000 actual log industry truck trips.
  - Included evaluation of fuel price sensitivity

Optimization Results - Fuel Price $2.89 (Average 2007)					
Mode	Ton-Miles	Tons	Avg Trip Miles	Total Cost	Avg Cost / Ton
Non - Optimized					
Single Mode Trip: Truck	282,887,505.33	3,171,611.15	89.19	$ 37,912,725.50	$ 11.95
Optimized					
Single Mode Trip: Truck	206,206,174.60	2,675,989.03	77.06	$ 29,004,106.67	
Bi-Modal Trip: Rail Segment	62,532,744.09	495,622.12	126.17	$ 3,199,767.83	
Bi-Modal Trip: Truck Segment	14,148,586.65	495,622.12	28.55	$ 4,287,556.68	
Total Cost				$ 36,491,431.17	$ 11.51
Optimized Truck Totals	220,354,761.24	3,171,611.15	69.48		
Savings				$ 1,421,294.33	$ 0.45
Savings Percent				3.75%	

IV. Biomass Transportation Models

MMLT (Multi-Modal Log Transportation) Model

- The same model was used to develop 'cost gradient maps' to represent the cost efficient supply radius for a planned cellulosic ethanol plant.

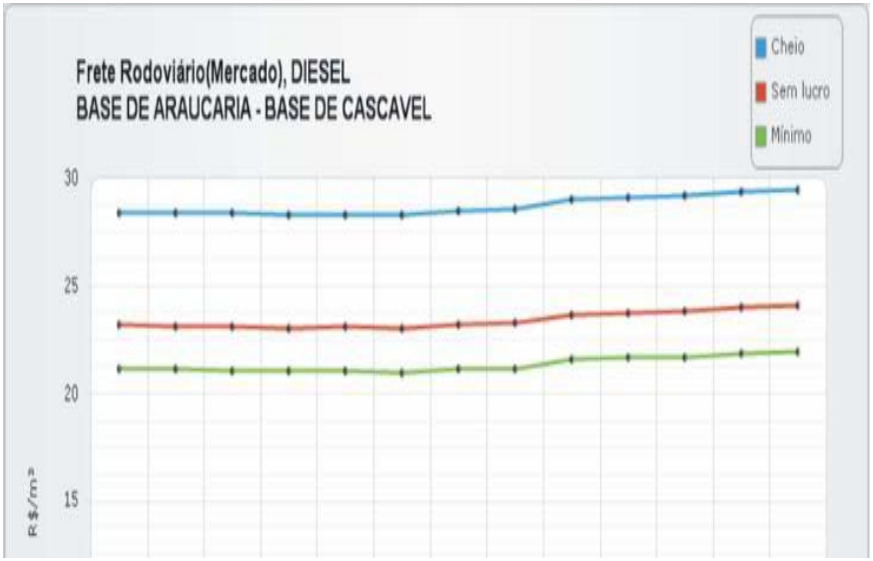


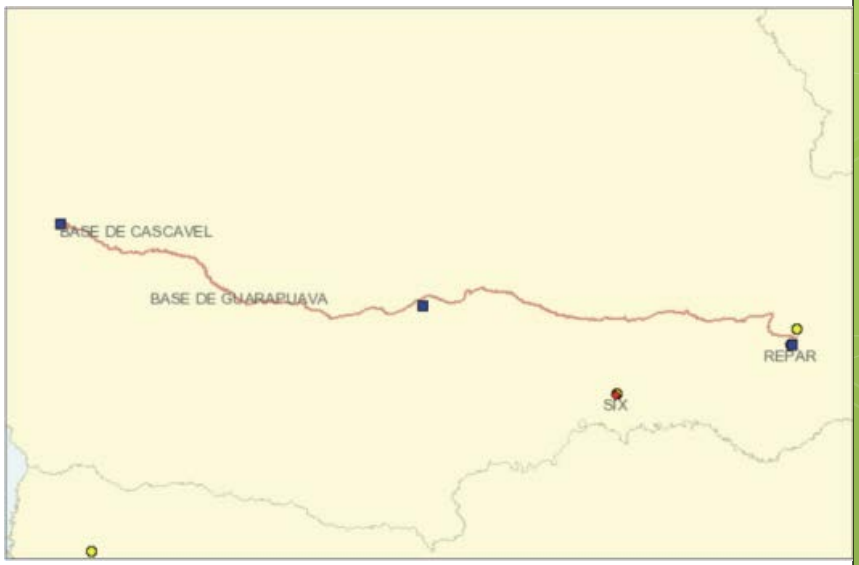
- Blue circle indicates 150mile distance from proposed facility.

IV. Biomass Transportation Models

PrevFretes, Freight Forecasting Model

- Freight Projection Cost for fuel and Oil byproducts. (Petrobras)
- Up to 5 Year Forecasting (Road, Rail, and Water way)
- Correlation Update every 4 month: Market value by Phone survey
- Decision Making Tool: Carrier, Logistics Operators, and Strategic Planners





IV. Biomass Transportation Models

- **PrevFretes**, Freight Forecasting Model

  - Parameters

    - Different Modal Scenarios
    - Type of Service: Transfer or Distribution of Goods
    - Correlation Update every 4 month: Market Value by Phone Survey
    - Type / Material of Trailer or Boat

  - Results

    - Ideal vs. Market Value
    - Net Profit
    - Fees and Direct Taxes
    - Net and Gross Freight Fee

V. Challenges and Research Recommendations

- Challenges
- Recommendations

V. Challenges and Research Recommendations

- **Some of the most prevalent Challenges include:**

  - **Availability and quality of data** to analyze the various components of the supply chain.
  - Lack of a common **framework for sustainability indicators**.
  - Deficiency in integrated analysis when developing the supply chains and individual components.
  - Lack of **national or international policies** and standardization.
  - Lack of understanding the **effect of international energy markets** on sustainable bioenergy production.
  - Need to find shortcomings of current cellulosic conversion processes.

V. Challenges and Research Recommendations

- **Recommendations for Future Research:**

  - A **common framework** should be established that would allow comparison of potential implementation, or the impact of actual implementation.
  - More realistic representation of the biofuel supply chain requires **expanding the analysis of different logistics frameworks** and incorporating the temporal sequencing of infrastructure construction.
  - Advanced supply systems are essential to implement more sustainable biomass production schemes.
  - **The economics of the international energy markets** should be incorporated in the analysis.

Q & A

Thank you!