A web-based Biomass Site Assessment Tool

University of Tennessee
Southeastern Sun Grant Center
Forest Products Center

U.S. Forest Service
Southern Research Station
FIA

Timothy M. Young, PhD – UT
Donald G. Hodges, PhD – UT
Timothy G. Rials, PhD – UT
Robert C. Abt, PhD – NCSU

James H. Perdue – USFS
Andy Hartsell – USFS

3rd Annual Biomass Supply Chain Conference
April 15-16, 2010 Indianapolis, IN
**Problem Definition**

Develop a web-based, economic decision tool for users of cellulose resources with periodic data updates (useful for regional comparisons)

<table>
<thead>
<tr>
<th>Phase I:</th>
<th>woody and ag cellulose, geo-referenced MC (supply) curves….also develop a public domain web-site - <a href="http://www.BioSAT.net">www.BioSAT.net</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase II:</td>
<td>Bayesian logistic regression models for site selection, market constraints, policy constraints, “some sustainability criteria”</td>
</tr>
<tr>
<td>Phase III:</td>
<td>integration with other modeling efforts</td>
</tr>
</tbody>
</table>
Phase 1 Objectives

1. Develop SQL database of resource data
   - Mill Residues – FIA Mill Survey Data
   - Logging Residues – FIA ➔ SRTS
   - Ag Residues – USDA NASS Survey Data
   - Merchantable – FIA

2. Develop wood resource costs
   - Timber Mart South
   - State Price Reports

3. Develop truck transportation cost models

4. Develop harvesting cost models
   - FRCS - logging residues (Dennis Dykstra)
     - Tops and limbs at the landing
     - In-woods non-merchantable biomass
   - AHA - merchantable wood (Dale Greene)
Phase I Objectives

5. Develop web-based system in the public domain (www.BioSAT.net)

6. Update data periodically, e.g.,
   - Diesel prices (US DOE EIA)
   - Resource costs (TMS, State Reports)
   - Road network (MapPoint 2006)
   - Resource data (USFS FIA, SRTS)
   - etc.

Scope: 33 Eastern United States (13 Southern states complete)
Resolution: 24,975 Zip Code Tabulation Areas (ZCTA)
            (9,221 ZCTAs in 13 southern states)
Database Development

- Forest Cover Data
- Economic Data
- Polygon Boundaries (ZCTA)
- Site Locations
- SQL Database

MC Curve

<table>
<thead>
<tr>
<th>Quantity (dry tons) per Year</th>
<th>45.0</th>
<th>50.0</th>
<th>55.0</th>
<th>60.0</th>
<th>65.0</th>
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<tr>
<td>$/dry ton</td>
<td>500000</td>
<td>1000000</td>
<td>1500000</td>
<td>2000000</td>
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</table>
Phase I BioSAT Model

“Woody Residues”

USFS FIA

Mill Residues

Growth/Removals

Logging Residues SRTS

“Econometrics”

Resource Costs (TMS)

Harvesting Costs (FRCS)

ZCTA Allocation (GIS)

Select Demand Point (or State), Indicate Quantity Demanded

Bio-basin Road Networks (MapPoint 2006)

Truck Cost Model

Estimate Total Costs, ATC, MC

“Ag Residues”

USDA NASS

Harvesting Costs (Literature)
# Phase I BioSAT Model

(Woody and Ag Cellulose Categories)

<table>
<thead>
<tr>
<th>&quot;Woody Residues&quot;</th>
<th>&quot;Ag Residues&quot;</th>
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<tr>
<td>o Total Logging Residues</td>
<td>o Barley Straw</td>
</tr>
<tr>
<td>o At the landing</td>
<td>o Corn Stover</td>
</tr>
<tr>
<td>o In the woods</td>
<td>o Oat Straw</td>
</tr>
<tr>
<td>o Total Logging Softwood</td>
<td>o Sorghum Straw</td>
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<tr>
<td>o At the landing</td>
<td>o Wheat Straw (Winter)</td>
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<tr>
<td>o In the woods</td>
<td>o Wheat Straw (All)</td>
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<td>o Total Logging Hardwood</td>
<td></td>
</tr>
<tr>
<td>o At the landing</td>
<td></td>
</tr>
<tr>
<td>o In the woods</td>
<td></td>
</tr>
<tr>
<td>o Total Mill Residues</td>
<td></td>
</tr>
<tr>
<td>o Clean</td>
<td></td>
</tr>
<tr>
<td>o Unclean</td>
<td></td>
</tr>
<tr>
<td>o Total Mill Softwood</td>
<td></td>
</tr>
<tr>
<td>o Clean</td>
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<tr>
<td>o Clean</td>
<td></td>
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<td>o Unclean</td>
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</table>
Phase I BioSAT Model – Results

(Mill Residues)
Phase I BioSAT Model – Results

(Mill Residues – Low Cost)
Phase I BioSAT Model – Results
(Mill Residues – High Cost)
Phase I BioSAT Model - Results

MS – Best Five Demand ZCTAs for Mill Residues
($\leq 1.5$ M Dry Tons per Year)

1. 38916 (Calhoun Co.)
2. 38879 (Lee Co.)
3. 38864 (Pontotoc Co.)
4. 39094 (Leake Co.)
5. 39476 (Perry Co.)
Phase I BioSAT Model - Results

MS – Best Five Demand ZCTAs for Mill Residues
(≤ 1.5 M Dry Tons per Year)
Phase I BioSAT Model - Results

MS – Best Five Demand ZCTAs for Mill Residues
($\leq 1.5$ M Dry Tons per Year)

- 38864
- 38879
- 38916
- 39094
- 39476

<table>
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<th>Mean</th>
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<td>39094 A B</td>
<td>36.285510</td>
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<tr>
<td>38864 A B</td>
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<td>38879 B</td>
<td>35.483049</td>
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<tr>
<td>38916 C</td>
<td>33.635556</td>
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Each Pair
Student's t
0.05
Phase I BioSAT Model - Results

Demand ZCTA 38916 (Calhoun Co.) – Mill Residues
Phase I BioSAT Model - Results

Demand ZCTA 38916 (Calhoun Co.) – Mill Residues
Phase I BioSAT Model - Results

Demand ZCTA 38916 (Calhoun Co.) – Mill Residues

Marginal Cost ($/ton)
- 23 - 27
- 27 - 31
- 31 - 35
- 35 - 39
- 39+

Quantity (dry tons)
Phase I BioSAT Model - Results

Demand ZCTA 38916 (Calhoun Co.) – Mill Residues
Phase I BioSAT Model – Results
Phase I BioSAT Model – Results
# Phase I BioSAT Model – Results

(Low Cost “All” Logging Residues – “at the Landing”)

<table>
<thead>
<tr>
<th>Rank</th>
<th>ZCTA</th>
<th>County</th>
<th>State</th>
<th>City</th>
<th>Annual Quantity Available (dry tons)</th>
<th>Total Cost</th>
<th>Average Total Cost ($/dry ton)</th>
<th>Median MC ($/dry ton)</th>
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<tbody>
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<td>1</td>
<td>27412</td>
<td>Guilford</td>
<td>NC</td>
<td>Greensboro</td>
<td>502,198</td>
<td>$13,599,152</td>
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<td>38501</td>
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<td>TN</td>
<td>Cookeville</td>
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<td>$27.21</td>
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<td>NC</td>
<td>Greensboro</td>
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<td>GA</td>
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<td></td>
<td></td>
<td>Johnsonville</td>
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<td>$13,774,854</td>
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<td>Reevesville</td>
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<td>507,943</td>
<td>$13,800,431</td>
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# Phase I BioSAT Model – Results

(Low Cost “All” Logging Residues – “in the woods”)

<table>
<thead>
<tr>
<th>Rank</th>
<th>ZCTA</th>
<th>County</th>
<th>State</th>
<th>City</th>
<th>Annual Quantity Available (dry tons)</th>
<th>Total Cost ($/dry ton)</th>
<th>Average Total Cost ($/dry ton)</th>
<th>Median MC ($/dry ton)</th>
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</thead>
<tbody>
<tr>
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<td>31636</td>
<td>Lowndes</td>
<td>GA</td>
<td>Lake Park</td>
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<td>GA</td>
<td>Statenville</td>
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<td>3</td>
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<td>Glynn</td>
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<td>Brunswick</td>
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<td>$260,849,639</td>
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<td>4</td>
<td>31631</td>
<td>Echols</td>
<td>GA</td>
<td>Fargo</td>
<td>1,543,578</td>
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<td>Thomas</td>
<td>GA</td>
<td>Pavo</td>
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<tr>
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<td>GA</td>
<td>Townsend</td>
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<td>$175.27</td>
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<td>GA</td>
<td>Darien</td>
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<td>$177.74</td>
<td>$171.77</td>
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<tr>
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<td></td>
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<td>GA</td>
<td>Savannah</td>
<td>1,527,829</td>
<td>$270,658,985</td>
<td>$179.79</td>
<td>$183.39</td>
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</table>
Results – Ag Residues (Wheat Straw)

Wheat Straw (Wheat All) Residue Quantity By ZCTA5 in the Southeastern United States

Wheat Straw (Wheat All) Harvesting Cost By Z in the Southeastern United States
Results – Ag Residues
(Wheat Straw – Low Cost Demand ZCTAs)
Welcome to BioSAT
Beta Test Site
Phase 1: 13 Southern States

BioSAT Update (Posted 01/27/2010 14:00:00)
Agricultural residue quantity and harvesting cost estimates for the South have been added to the BioSAT residueDB. Residues included are: Barley Straw, Corn Stover, Oat Straw, Sorghum Straw, Wheat (All) Straw, and Wheat

Wheat Straw (Wheat All) Residue Quantity By ZCTAS5 in the Southeastern United States
Wheat Straw (Wheat All) Harvesting Cost By ZCTAS5 in the Southeastern United States

For more information:
James H. Perdue
BioSAT Update (Posted 01/27/2010 14:00:00)

Agricultural residue quantity and harvesting cost estimates for the South have been added to the BioSAT model. Agricultural residues included are: Barley Straw, Corn Stover, Oat Straw, Sorghum Straw, Wheat (All) Straw, and Wheat (Winter) Straw.

Wheat Straw (Wheat All) Residue Quantity by ZCTAS in the Southeastern United States

Note: agricultural residue in the BioSAT model is the plant material remaining. In the BioSAT model, only the above ground portion of agricultural residue is considered. Percent is harvested with forty percent being left in the field for soil fertilization. Annual survey data. The production quantities are converted from bushels of crop and labor cost of harvesting agricultural residues with a hay-baler and soil stubble trailer.

Marginal Cost ($ / dry ton)

The legend shows the marginal cost for different regions.
Energy, its availability and use, is fundamental to a sustainable economy. One of our greatest challenges is balancing the technological, political, environmental and economic forces impacting existing agricultural and forest products markets along with emerging bioenergy markets. Through integrated research relationships we foster a better understanding of global energy influences on the agricultural and forest sector and its continued productive management and use.
### Research Links

<table>
<thead>
<tr>
<th>Links</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative Fuels &amp; Advanced Vehicles Data Center</strong></td>
<td>This comprehensive tool provides detailed information on biomass resources and utilization throughout the United States.</td>
</tr>
<tr>
<td><strong>BFIN (Bioenergy Feedstock Information Network)</strong></td>
<td>The BFIN (Bioenergy Feedstock Information Network) is a gateway to a wealth of biomass feedstock information resources from the U.S. Department of Energy, Oak Ridge National Laboratory, Idaho National Laboratory, National Renewable Energy Laboratory, and other research organizations.</td>
</tr>
<tr>
<td><strong>DSIRE</strong></td>
<td>DSIRE is a comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.</td>
</tr>
</tbody>
</table>

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**For more information:**

- **James H. Perdue**  
  865.946.1123  
  U.S. Forest Service  
  jpcrude@fs.fed.us

- **Dr. Timothy M. Young**  
  865.946.1119  
  University of Tennessee  
  tmyoung1@utk.edu
At BioSAT, we have appropriately integrated assessment tools that can greatly reduce the planning time line, enable continuous forecasting, facilitate rapid visualization, and improve variance analysis.

**How to use the BioSAT Dashboard:**

Login into the Dashboard and select one of the two interactive tools offered.
Marginal Cost Analysis for one Zip Code Tabulation Area (ZCTA)

Zip Code: 37922
Biomass Type: Logging Residues (At Landing, Hardwood)
Travel Distance: 40 Miles (one way)

Bioshed Map  Marginal Cost Data  Marginal Cost Curve
Marginal Cost Analysis for a Specified Census Tract (ZCTA)
Marginal Cost Analysis for one Zip Code Tabulation Area (ZCTA)

Zip Code: 37922
Biomass Type: Logging Residues (At Landing, Hardwood) (one way)
Travel Distance: 160 Miles

Bioshed Map Data Marginal Cost Curve
### BioSAT.net Biomass Cost Calculator

**Zip Code:** 37922  
**Biomass Type:** Total Mill Residues  
**Travel Distance:** 160 Miles (one way)

**Buttons:** Bioshed Map, Marginal Cost Data, Marginal Cost Curve

---

<table>
<thead>
<tr>
<th>ZCTA</th>
<th>Quantity</th>
<th>Distance</th>
<th>Resource Cost</th>
<th>Trucking Cost</th>
<th>Harvesting Cost</th>
<th>Total Cost</th>
<th>Cumulative Qty</th>
<th>Marginal Cost</th>
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<td>37701</td>
<td>188.50</td>
<td>27.280</td>
<td>21.00</td>
<td>5.88</td>
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<td>2010.27</td>
<td>25166.20</td>
<td>29.65</td>
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* 'Distance' below shows Round Trip Distance.
Marginal Cost Curve for ZCTA: 37922

Biomass Type: Total Mill Residues
Travel Distance: 160 miles

Cumulative Quantity (Dry Tons)
<table>
<thead>
<tr>
<th>Biomass Type</th>
<th>Travel Distance</th>
<th>Transportation</th>
<th>Biomass Supply Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mill Residues</td>
<td>160 Miles</td>
<td>Truck - Dry Van</td>
<td>1.5 Million Ton/Year</td>
</tr>
</tbody>
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### States

- Alabama
- Maine
- Ohio
- Arkansas
- Maryland
- Oklahoma
- Connecticut
- Massachusetts
- Pennsylvania
- Delaware
- Michigan
- Rhode Island
- Florida
- Minnesota
- South Carolina
- Georgia
- Mississippi
- Tennessee
- Illinois
- Missouri
- Texas
- Indiana
- New Hampshire
- Vermont
- Iowa
- New Jersey
- Virginia
- Kentucky
- New York
- Wisconsin
- Louisiana
- North Carolina
<table>
<thead>
<tr>
<th>ZCTA</th>
<th>Total Cost</th>
<th>Average Total Cost</th>
<th>Marginal Total Cost</th>
<th>State</th>
<th>County</th>
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<tr>
<td>38664</td>
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<td>MS</td>
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Summary

- [www.BioSAT.net](http://www.BioSAT.net) version 1.0 provides decision tool for identifying least cost woody and ag residues (useful for regional comparisons)
  - mill residues, logging residues, and ag residues
  - resource costs, transportation costs, harvesting costs
- Validation is on-going
- BioSAT (South) – currently in beta-test
Regional Comparative Advantage for Woody Biofuels Production

US Department of Transportation
Southeastern Sun Grant Center
Research Project Final Report

December 20, 2009
Future Research

- Merchantable wood costing
- Railroad networks and intra-modal transfer points
- Water availability
- Competition
- Bayesian logistic regression models for site selection
- Policy influence
- “Some” sustainability criteria
  - Population data, climatology data, fragmentation, etc.
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Questions & Discussion

“All models are wrong, some are useful”

George E.P. Box – Statistician (U of Wisconsin)