Feedstock Logistics for Aviation Fuel

John Sessions
Oregon State University
November 17, 2016
Feedstock Logistics

Feedstock:
Forest harvest residues are byproducts from commercial timber harvest

Logistics Issues:
What are the most efficient forest harvest residue collection and delivery methods?
Forest Harvest Residues on Non-Federal Forests (Oven Dry Tons)

- Idaho: [VALUE]
- Montana: 464,517
- Washington: [VALUE]
- Oregon: 616,896

Idaho Montana Washington Oregon

[Image of logos: USDA, NIFA, OSU, NARA]
Forest Harvest Residue by Harvest System (%)

### Non-federal Forest

<table>
<thead>
<tr>
<th>State</th>
<th>Ground</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Idaho</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Montana</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Washington</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Oregon</td>
<td>60</td>
<td>40</td>
</tr>
</tbody>
</table>
Where is the biomass?

Steep Terrain: Biomass At Landing

Flat Terrain: Biomass in Field
Cost Factors

– Harvest System
– Large Trailer Access to Landing
– Material Density
– Material Quality
– Transport Time to Plant
Collection vs Transport Costs

Plant Price

Maximum Collection Cost

Comminution + Transport Cost

$/ODT vs miles
**Collection Costs**

- **Marginal cost ($/ODT) to bring forest residues to landing.** Mobilization costs not included (Zamora and Sessions 2016).
Truck Transport Options

Large Trailer to Each Landing – Grind at Each Landing

Small Truck to Each Landing – Grind At Central Landing

Combination of Large and Small Trucks- Grind at Some Landings

Mobile Chipper with Set-out Trailers
Residue Height in Trailer

48-ft trailer, 8.3 ft wide, dry bulk density (hogfuel) = 9.3 pounds per cubic foot.
Biomass Supply Curve
Delivered Residue Cost to Longview, Washington

$69.23
Pulp takes 30%

$63.42
Taking T&L and PL

Oven Dry Tons to Longview, WA

NARA Model pulp takes 30%
NARA Model pulp takes none
Fresh and Aged Forest Harvest Residues

MC = 60% Wet Basis
Bark & Needles = 16.7% of Dry Mass

MC = 15% Wet Basis
Bark & Needles = 6.2% of Dry Mass
Laboratory Analysis

<table>
<thead>
<tr>
<th>Component</th>
<th>Aged Residue (15%)</th>
<th>Fresh Residue (60%)</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polysaccharides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lignin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid-Insoluble (Klason)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extractives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Value Difference Components at Plant

• From Analytical Test: 26% more residues need to be delivered to provide the same amount of sugar from fresh residues.

• The greater the sum of collection + grinding + transportation distance (cost), the greater the cost penalty from the reduced sugar yield
Sugar cost differences by distance

Sugar	Cost	USD	$/kg

One	Way	Distance
to	Conversion	Facility,
km

Sugar Cost USD $/kg

Sugar cost differences by distance

One Way Distance to Conversion Facility, km

- Aged
- Fresh
Field Aged Residues Appear Strongly Positive

- **Collection Costs** - Volume Limited, No Difference
- **Comminution Costs** - Aged Residues Slightly More Expensive
- **Transport** – Aged Residues Much Less Expensive
- **Plant Site** - Aged Residues More Valuable due to Higher Sugar Yield
- **Environmental Considerations** – Needles, if left in forest, have micro and macro nutrients that maintain site productivity
- **Traffic** - Fewer truck loads, less impact on roads
Total above-ground nutrients

Douglas-fir tree, 38 yrs old
dbh=45.6 cm, height =33.5 m, crown length =19.9 m

Mainwaring, Maguire, and Harrison, NARA
Annual Meeting, 2015, Spokane, WA
Questions ?