Updates on Biomass Harvest, Preprocessing and Logistics

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Presentation Outline

• What we have accomplished
• What we have delivered
• What we are planning to do
HPL Thrust Tasks

- Task 3.1: Significantly reduce harvesting cost of feedstocks (Wang, Volk, and Liu)
- Task 3.2: Quantify the role of preprocessing on transportation and storage (Boateng, Richard, Ciolkosz, Volk)
- Task 3.3: Assess storage requirements and the effects of long term storage on feedstocks (Volk and Richard)
- Task 3.4: Conduct techno-economic analysis, cost engineering and life cycle analysis (Searcy, Wang, Boateng, McAloon, Spatari)
## Optimize SRWC Harvester

<table>
<thead>
<tr>
<th>Harvester Material Capacities (Mg\text{wet} hr^{-1})</th>
<th>Delivered Material Capacities (Mg\text{wet} hr^{-1})</th>
<th>Down Time (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 ~ 20</td>
<td>9</td>
<td>74</td>
</tr>
<tr>
<td>2011 25 – 53</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>2012 50 – 80 +</td>
<td>35 – 40</td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>

Case New Holland (CNH) started development of the NH 130 FB coppice header in 2007

Customer requirements:
- Harvest 1 or 2 rows
- Rated at 1.6 to 2 ha hr^{-1} (4 - 5 ac hr^{-1})
- Capacity to cut and chip stems 100 to 120-mm (4 - 5 in) in diameter
- No changes to feed rolls and chopper drum on base forage harvester
- Chip length of 10 – 45mm (0.4 - 1.8 in)

(Source: Eisenbies, M. et al. 2013. Improvements in Harvesting Short Rotation Woody Crops Using a New Holland Forage Harvester and SRC Woody Crop Header. DOE BETO, Washington, DC. Also supported by DOE Biomass Program and NYSERDA.)
SRWC Harvest Results

- Analyzed moisture content of chips from fall/winter harvests

Harvester efficiency (the ability of the harvester to produce chips) versus collection system efficiency (the ability of the system to deliver chips to short-term storage)
Cost Effective Harvesting of Grasses

• Negotiated an agreement with Case-New Holland to provide mowers and bailers for fall Miscanthus harvests.
• Performed compression test on small square bales from fall 2012.
• Designed a cutting mechanism that simulates bale cutting for laboratory testing.
Preprocessing Effect on Transport and Conversion

• Obtained preliminary results of biomass properties for pyrolysis.
• Completed analytical pyrolysis of willow samples
• Processed torrefied samples for analysis
Development of Storage Systems

• Collected initial data on dry matter loss of Miscanthus during storage
• Developed analytical and statistical protocols for quantifying dry matter loss in Miscanthus
• Initiated bench-top storage trial with willow to quantify dry matter loss and effect of storage on quality
• Established willow chip piles with temperature monitoring
Cost Engineering of Satellite Processing and Storage

- Gathered results on the techno-economics of densification processes
- Completed two preliminary studies:
  - Pelletization of wood
  - Pelletization of grasses
- Life cycle analysis
Integrated Supply Chain Modeling

• Developed base models of integrated supply chains for willow and Miscanthus

• Incorporated LCA into INL’s Biomass Logistics Model

• Modularized base model to facilitate better understanding of feedstock properties throughout the supply chain

• Integrated datasets from storage studies into feedstock supply chain models
Optimization Modeling

• Developed a preliminary optimization model of the biomass supply chain

\[
MAX \pi = \sum_{p=1}^{P} P_p \cdot Q_p - \sum_{m=1}^{M} \sum_{s=1}^{S} HC_m \cdot X_{1sm} - \sum_{i=1}^{I} \sum_{m=1}^{M} \sum_{s=1}^{S} TC_{ims} \cdot X_{2ims} - \\
\sum_{j=1}^{J} \sum_{m=1}^{M} \sum_{s=1}^{S} TC_{jms} \cdot X_{3jms} - \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{p=1}^{P} TC_{ijp} \cdot X_{4ijp} - \\
\sum_{d=1}^{D} \sum_{j=1}^{J} \sum_{p=1}^{P} TC_{djp} \cdot X_{5djp} - \sum_{d=1}^{D} \sum_{i=1}^{I} \sum_{p=1}^{P} TC_{dip} \cdot X_{6dip}
\]
Optimization Modeling

- Constraints
  - Biomass availability
  - Biomass handling system
  - General storage system balance
  - Storage constraints for bundling system
  - Woody biomass demand
  - Number of plants requiring woody biomass
  - Infrastructures
  - ....

The average delivered cost of woody biomass ranged from $36.54 to $53.75 per dry ton excluding the harvesting.

What we have delivered

• Publications: 1
• Res. Presentations: 11
• Ext. Presentations: 3
• Proposals: 1
What we are planning to do

- Matrix of Benchmarks
- Samples from the different phases of the supply chain
- More detailed data and robust analysis
- Logistic optimization of the supply chains
- Data management, INL’s data library and ORNL’s KDF
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