The feedstock contribution to ethanol production cost (FCEPC) is 33% for cellulosic refineries using ag residues or energy crops that require aggregation (Jacques, 2016).

Beyond equipment and operations optimization, field edge (FE) storage has potential to reduce feedstock supply chain cost, roughly $21/ton. Storing bales on the same field as harvested eliminates storage site prep and transportation to storage. (Darr, 2014).

Methods

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Beyond equipment and operations optimization, field edge (FE) storage has potential to reduce feedstock supply chain cost, roughly $21/ton. Storing bales on the same field as harvested eliminates storage site prep and transportation to storage. (Darr, 2014).

Commercial scale field-edge stacks were assembled with large square bales harvested in 2015.

Average bale moisture contents and bale weights were captured during stack assembly and deconstruction to assess moisture migration and determine the percent dry matter loss (DML) in all vertical locations of the stack.

All dry matter loss is assumed to be loss of carbohydrate components of lignocellulose and the FCEPC was used to monetarily compare uncovered FE storage to protected storage.

Table 1: FCEPC cost comparison for uncovered FE storage to protected storage

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Protected Storage</th>
<th>FE Uncovered</th>
<th>FE Uncovered</th>
<th>FE Uncovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>CostHST</td>
<td>$86</td>
<td>$65</td>
<td>$65</td>
<td>$65</td>
</tr>
<tr>
<td>BCC1</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>DML</td>
<td>2.0%</td>
<td>9.5%</td>
<td>21.0%</td>
<td>35.0%</td>
</tr>
<tr>
<td>YieldEthanol</td>
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<td>35%</td>
<td>35%</td>
<td>35%</td>
</tr>
<tr>
<td>Mass to volume</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

Top

2nd From Top

Center

Bottom

Figure 5: Vertical locations of bales & thermistors

Figure 4: Dry matter loss by vertical bale location for uncovered FE storage, one year

Figure 3: Vertical temperature profile for uncovered FE storage, one year

Figure 2: Stack assembly with commercial stacker

Introduction

• The feedstock contribution to ethanol production cost (FCEPC) is 33% for cellulosic refineries using ag residues or energy crops that require aggregation (Jacques, 2016).

• Beyond equipment and operations optimization, field edge (FE) storage has potential to reduce feedstock supply chain cost, roughly $21/ton. Storing bales on the same field as harvested eliminates storage site prep and transportation to storage. (Darr, 2014).

Results – Measured Degradation and Cost Comparison

The influence of FE storage on material degradation and biomass quality is unknown. This research evaluates the level of degradation with lessened protection and assesses the tradeoff in FCEPC (1) between reduced storage cost and increased cost with material degradation for FE storage.

\[
FCEPC = 300 \times (BCC_1 - DML)(Yield_{Ethanol}) \]

where

- FCEPC = feedstock contribution to ethanol production cost ($ gal⁻¹)
- CostHST = cost to harvest, store, and transport one ton of biomass ($ ton⁻¹)
- BCC₁ = initial biomass carbohydrate concentration (fractional)
- DML = dry matter loss (fractional)
- Yield_{Ethanol} = reaction product yield ratio (fractional)

*300 represents a constant conversion of volume to mass (gal ton⁻¹)

• The effect of FE storage on material degradation and biomass quality is unknown. This research evaluates the level of degradation with lessened protection and assesses the tradeoff in FCEPC (1) between reduced storage cost and increased cost with material degradation for FE storage.

Conclusions

• Exposed top and bottom bales absorb significant moisture, experience large amounts of dry matter loss, and loose bale integrity.

• Center bales are relatively stable in storage and should be maximized in number.

• If all material is transported and processed at a biorefinery, uncovered field-edge storage has potential to reduce the FCEPC by $0.18/gal, saving a plant $5.4M annually.

• Limitations in handling and processing of degraded bales at a biorefinery increases the FCEPC of field-edge storage, and makes it more costly than protected storage.

References
