Biomass Opportunities for Feed, Fuel, and Bedding

Working Lands Watershed Restoration Program
Minnesota Board of Water & Soil Resources
Cottage Grove City Hall
April 27, 2017
AURI

• AURI helps discover new uses for agricultural commodities

• AURI was created by the MN Legislature, and its mission is to foster long-term economic benefit through value-added agricultural products.
AURI’s Services

- Applied Research and Development
- Hands-On Scientific Assistance
- Innovation Networking
AURI’s coproducts lab seeks utilization ideas for plant and animal by/coproducts that present *environmental* and *economical* opportunities. The development of value-added agricultural products include:

* fertilizers
* sorbents
* renewable fuels
* soil amendments
* animal feed
* biodegradables
Minnesota Biomass

• Wood and wood residue offer the most available feedstocks as a renewable biomass source in the Midwest

• Agricultural crop residue and coproducts offer a tremendous volume
Value-Added Biomass Opportunities

• Biomass Based Areas of Interest
• New and Existing Product Opportunities
• Project Examples
• Utilizing Biomass for Thermal Requirements
• Alternative Feeds
• What’s on the Horizon?
New & Existing Product Opportunities

- Hydro-seeding mulch development
- Compost blends
- Biofilter media
- Improved erosion control
- Potting soil blends
- Biomass solid fuels
- Focus on local projects
Minnesota Biomass Projects

- Alternative Energy Solutions, Altura, MN
- Mississippi Topsoil, Cold Spring, MN
- Renaissance Fertilizer, Edina, MN
- Mat Inc., Floodwood, MN
- Koda Energy, Shakopee, MN
- MN Lamb and Wool
- Riverview Dairy, Morris, MN
MN Lamb and Wool Association

• “Woolch” development
• Process development
• Performance R&D
• Biobased
• Utilized ag processing coproduct & wool
Riverview Dairy

• Collaborative project with Swanson/U of M-WCROC
• Evaluation of dairy digester solids in plant media
• Focus on nutrient value, water holding capacity, and performance
• Similar to peat
Biobased Materials

- Compost-A-Mats
- Biobased planting materials
- Cost
- Primary materials (peat/PLA/dairy solids)
- Retaining wall construction
- Planter pots
- Erosion control mat stakes
Biofilter Research

• Collaborative project with USDA/ARS Lab and MN Corn Growers Research & Promotion
• Utilizes organic material such as wood chips and ag residue to support microbial growth
• Focus on nitrate removal in subsurface water
Utilizing Biomass for Thermal Requirements

• Viking Company, Albany – Bill Koening
  o On-farm biomass heating system
  o Utilized as a propane replacement for broiler production.
  o Next Gen Funding
  o Start-up in August 2015
  o Focus:
    o Improved bird health
    o Heating economics
    o Biomass ash opportunities
Utilizing Biomass for Thermal Requirements

• Alternative Energy Solutions
  o On-farm biomass pellet manufacture: 500–600 tons pellet/year
  o Utilizes crop residue, native grasses, wood waste
  o Heats 65,000 sq ft of greenhouse
  o Reduces energy costs by about 50%
Utilizing Biomass for Thermal Requirements

- **Koda Energy, Shakopee, MN**
  - Combined heat and power plant (CHP) fueled by biomass
  - Utilizing steam to produce heat and electricity
  - Approximately 75% of biomass fuel comes from Minnesota, Western Wisconsin, Northern Iowa, and North Dakota
Value-Added Research on Alternative Crops and Cover Crops

– Collaboration efforts with the U of M – Forever Green Project.
– Focus on alternative crops, green landscapes and inter-cropping opportunities.
– Targeted vegetation: pennycress, perennial wheat, various flax varieties, Camelina, and more.
– Research aimed at genetic improvements, evaluating oil and feed value, cropping systems and water improvement.
Improving the Nutrient Value of Biomass

- Support Nick Jordan and the U of M MnDrive project focusing on “Modeling and Geo-design Approaches for Multi-Functional Watersheds”.
- Demonstrate immediate potential to create new sources of high-quality animal feeds from underused resources, thus creating profitable, real world, options for farmers who wish to produce agricultural biomass.
Improving the Nutrient Value of Biomass

• Treatment of crop residues for improved digestibility has been utilized for decades.
• Although technology is underutilized, it can provide value-added opportunity for livestock producers and processors to capture greater value and performance from crop residues or coproducts produced.
• **Process:** Fibers treated with liquid Calcium Hydroxide obtained from Mississippi Lime and brought up to 50% moisture for a minimum of 7 days.
Improving the Nutrient Value of Biomass

- The NDF represents the indigestible and slowly digestible components in plant cell walls (cellulose, hemicellulose, lignin, and ash).
- IVTOMD24 – digestibility determined by incubation of a ground forage sample with rumen fluid in a beaker or test tube for 24 hours, followed either by the addition of acid and pepsin with further incubation for 24 hours or by boiling in neutral detergent fiber solutions. The greater the resulting number, the more increased digestibility within a rumen after 24 hours.
- NDFD24 – neutral detergent fiber disappearance after 24 hours of rumen fluid exposure. A higher number indicates improved disappearance in the rumen.
- NFC – nonfibrous carbohydrate is an estimate of the rapidly available carbohydrates in forage (primarily starch and sugars). This value is calculated by NFC=100% - (CP%+NDF%+EE%+Ash%).
## Improving the Nutrient Value of Biomass

<table>
<thead>
<tr>
<th>Product Information</th>
<th>Lab Measurements (%DM Basis)</th>
<th>Milk2006 Calc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Process</td>
<td>Treatment</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>Control</td>
<td>---------</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>3% Ca Hydroxide</td>
<td>49.2%</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>Ground 3% Ca Hydroxide</td>
<td>45.5%</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>5% Ca Hydroxide</td>
<td>37.0%</td>
</tr>
<tr>
<td>Corn Stover</td>
<td>Ground 5% Ca Hydroxide</td>
<td>51.1%</td>
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<tr>
<td>Barley Straw</td>
<td>Control</td>
<td>---------</td>
</tr>
<tr>
<td>Barley Straw</td>
<td>Ground 3% Ca Hydroxide</td>
<td>44.6%</td>
</tr>
<tr>
<td>Barley Straw</td>
<td>Ground 5% Ca Hydroxide</td>
<td>46.7%</td>
</tr>
<tr>
<td>Mixed Grass Hay</td>
<td>Control</td>
<td>---------</td>
</tr>
<tr>
<td>Mixed Grass Hay</td>
<td>Ground 5% Ca Hydroxide</td>
<td>52.9%</td>
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</table>
## Improving the Nutrient Value of Biomass

<table>
<thead>
<tr>
<th>Product</th>
<th>Process</th>
<th>Treatment</th>
<th>DM</th>
<th>CP</th>
<th>NDD-ICP</th>
<th>aNDF</th>
<th>aNDFom</th>
<th>NDFD24</th>
<th>uNDFom 24</th>
<th>EE (fat)</th>
<th>Ash</th>
<th>TDN 1x</th>
<th>TDN 1X</th>
<th>Milk 2013 Calcs</th>
<th>NeL 3X (Mcal/cwtDM)</th>
<th>% Improved from tmnt.</th>
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<tr>
<td>Corn Stover</td>
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<td>86.2%</td>
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<td>78.3</td>
<td>74.9</td>
<td>39.5</td>
<td>45.3</td>
<td>1.4</td>
<td>8.0</td>
<td>55.4</td>
<td>53.4</td>
<td>48.0</td>
<td></td>
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<td></td>
<td>7%</td>
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<td>38.8%</td>
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<td>59.9</td>
<td>55.5</td>
<td>50.3</td>
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<td>17.8</td>
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<td>7.0%</td>
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<tr>
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<td>Treated</td>
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<td>61.8</td>
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<tr>
<td>Mix grass hay</td>
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<td>88.3%</td>
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<td>1.1</td>
<td>66.4</td>
<td>64.8</td>
<td>48.3</td>
<td>33.5</td>
<td>2.9</td>
<td>9.7</td>
<td>53.5</td>
<td>53.2</td>
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</tr>
<tr>
<td></td>
<td>Treated</td>
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<td>45.0%</td>
<td>6.8</td>
<td>1.1</td>
<td>62.6</td>
<td>60.9</td>
<td>50.8</td>
<td>30.0</td>
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<td>16.6</td>
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<td>-7.0%</td>
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<td>71.9</td>
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<td>45.5</td>
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<td>42.6</td>
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<td>27.7%</td>
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<tr>
<td></td>
<td>Treated</td>
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<td>43.0%</td>
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<td>0.8</td>
<td>64.0</td>
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<td>Switch grass</td>
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<td>3.3</td>
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<td>81.0</td>
<td>79.6</td>
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<td>63.7</td>
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<td>4.0</td>
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<td>25.7</td>
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<td>19.2%</td>
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<tr>
<td></td>
<td>Treated</td>
<td></td>
<td>45.5%</td>
<td>3.0</td>
<td>0.5</td>
<td>77.1</td>
<td>75.7</td>
<td>28.0</td>
<td>54.5</td>
<td>1.0</td>
<td>8.4</td>
<td>49.4</td>
<td>30.6</td>
<td>38.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reed Canary grs</td>
<td>Control</td>
<td></td>
<td>88.2%</td>
<td>6.0</td>
<td>1.0</td>
<td>67.2</td>
<td>65.9</td>
<td>38.9</td>
<td>40.3</td>
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<td>6.0</td>
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<tr>
<td></td>
<td>Treated</td>
<td></td>
<td>33.0%</td>
<td>5.0</td>
<td>0.8</td>
<td>60.5</td>
<td>59.2</td>
<td>65.2</td>
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<td>11.6</td>
<td>51.2</td>
<td>62.3</td>
<td>55.8</td>
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<td>28.7%</td>
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</tbody>
</table>
### Improving the Nutrient Value of Biomass

<table>
<thead>
<tr>
<th>Product</th>
<th>Value per ton at EQUAL moisture content</th>
<th>Value per ton at 50% moisture treatment level</th>
<th>Value per ton at EQUAL moisture content</th>
<th>Value per ton at 50% moisture treatment level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn stover</td>
<td>$64.49</td>
<td>$105.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated Corn Stover</td>
<td>+ $2.43</td>
<td>$(25.12)</td>
<td>+ $4.75</td>
<td>$(40.58)</td>
</tr>
<tr>
<td>Oat Straw</td>
<td>$50.44</td>
<td>$76.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated Oat Straw</td>
<td>+ $10.23</td>
<td>$(14.75)</td>
<td>+ $19.94</td>
<td>$(19.71)</td>
</tr>
<tr>
<td>Mixed Grass Hay</td>
<td>$83.30</td>
<td>$124.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated Mixed Hay</td>
<td>$(4.70)</td>
<td>$(37.06)</td>
<td>$(7.55)</td>
<td>$(55.63)</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>$63.96</td>
<td>$96.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated Ryegrass</td>
<td>+ $8.45</td>
<td>$(21.37)</td>
<td>+ $17.54</td>
<td>$(29.54)</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>$39.51</td>
<td>$59.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated Switchgrass</td>
<td>+ $2.28</td>
<td>$(14.93)</td>
<td>+ $6.06</td>
<td>$(20.86)</td>
</tr>
<tr>
<td>Reed Canary grass</td>
<td>$73.19</td>
<td>$110.49</td>
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</tr>
<tr>
<td>Treated Reed Canary grass</td>
<td>+ $5.63</td>
<td>$(26.83)</td>
<td>+ $16.34</td>
<td>$(35.89)</td>
</tr>
</tbody>
</table>
Livestock Bedding Opportunities

- Corn stover
- Wheat straw/Small grain straw
- Corn Cobs
- Flax straw – grinding issues?
- Grass sources – consumption issues?
Livestock Bedding Opportunities

• Wood blends along with corn cobs and soybean straw showed the greatest opportunity for compost dairy bedded barns. AURI does not recommend removal of soybean straw.

• Grass screening indicated potential opportunity to reducing ammonia production in poultry bars.
What’s on the Horizon?

- Torrefaction research – Real world, high volume applications do not currently exist.
- Biochar developments
  - Example: Char Energy, Ada, MN
- Improved Biomass Combustion System
- Biomass Collection and Densification
Thank you!

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