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

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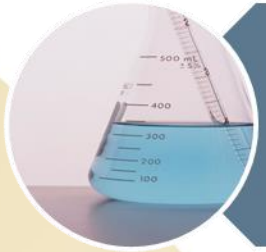
Agricultural Utilization Research Institute

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

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Coproduct Utilization Lab Mission

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**

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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?

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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**
  - On-farm biomass heating system
  - Utilized as a propane replacement for broil production.
  - Next Gen Funding
  - Start-up in August 2015
  - Focus:
    - Improved bird health
    - Heating economics
    - Biomass ash opportunities

Utilizing Biomass for Thermal Requirements

- **Alternative Energy Solutions**
  - On-farm biomass pellet manufacture: 500–600 tons pellet/year
  - Utilizes crop residue, native grasses, wood waste
  - Heats 65,000 sq ft of greenhouse
  - 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 product 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

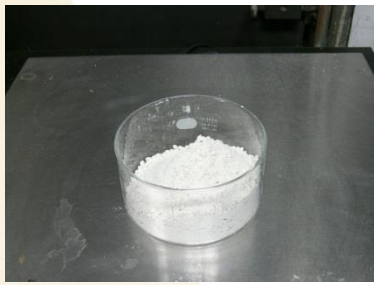
- Support Nick Jordan and the U of M MnDrive project focusing on “Modeling and Geo-design Approaches for Multi-Functional Watersheds”.
- Demonstrate immediate potential to create new sources of high-quality animal feeds from underused resources, thus creating profitable, real world, options for farmers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

Product Information			Lab Measurements (%DM Basis)							Milk2006 Calc	
Product	Process	Treatment	DM	CP	aNDFom	IVTODM24	NDFD24	Ash	EE (fat)	NFC	TDN1x
Corn Stover	Control	----------	87.7%	3.2	74.2	41.5	21.2	6.9	0.9	14.8	33.2
Corn Stover	3%	Ca Hydroxide	49.2%	2.9	68.1	51.6	28.9	8.6	0.3	20.2	55.4
Corn Stover	Ground 3%	Ca Hydroxide	45.5%	3.8	68.0	40.5	12.4	11.1	1.0	16.4	53.7
Corn Stover	5%	Ca Hydroxide	37.0%	4.1	57.4	56.3	24.0	24.1	0.8	13.7	43.6
Corn Stover	Ground 5%	Ca Hydroxide	51.1%	3.5	62.2	44.3	10.4	18.0	0.8	15.8	48.3
Barley Straw	Control	----------	85.9%	2.9	76.7	35.7	16.1	6.7	1.5	12.2	32.3
Barley Straw	Ground 3%	Ca Hydroxide	44.6%	3.0	70.2	43.5	19.6	8.5	0.9	17.5	50.7
Barley Straw	Ground 5%	Ca Hydroxide	46.7%	2.9	65.9	52.5	28.0	11.3	1.3	18.8	49.8
Mixed Grass Hay	Control	----------	88.3%	3.3	67.8	32.6	0.6	8.3	1.2	19.5	52.0
Mixed Grass Hay	Ground 5%	Ca Hydroxide	52.9%	2.9	64.3	35.7	Negative #	10.6	1.1	21.2	50.6

Improving the Nutrient Value of Biomass

Calcium Hydroxide Treatment of Biomass

Product Information			Lab Measurements (%DM Basis)									OARDC	Milk 2013 Calcs		
Product	Process	Treatment	DM	CP	NDD-ICP	aNDF	aNDFom	NDFD24	uNDFom 24	EE (fat)	Ash	TDN1x	TDN 1X	NeL 3X (Mcal/cwt DM)	% Improved from trmt.
Corn Stover	Control		88.2%	3.8	0.6	78.3	74.9	39.5	45.3	1.4	8.0	55.4	53.4	48.0	
Corn Stover	7%		38.8%	7.2	1.2	59.9	55.5	50.3	27.6	1.0	17.8	55.5	56.1	46.0	5.1%
Oat straw	Control		90.8%	4.1	0.7	78.7	76.7	32.6	51.6	1.0	8.7	48.9	33.6	39.0	
Oat straw	Treated		50.0%	4.1	0.7	63.9	61.8	50.7	30.4	1.8	18.4	44.5	46.2	42.4	37.5%
Mix grass hay	Control		88.3%	7.1	1.1	66.4	64.8	48.3	33.5	2.9	9.7	53.5	53.2	53.4	
Mix grass hay	Treated		45.0%	6.8	1.1	62.6	60.9	50.8	30.0	2.6	16.6	47.6	49.5	46.9	-7.0%
Ryegrass	Control		86.6%	5.2	0.8	71.9	70.8	35.8	45.5	1.4	6.2	53.4	42.6	47.9	
Ryegrass	Treated		43.0%	5.0	0.8	64.0	62.9	54.2	28.8	1.0	10.9	50.6	54.4	51.4	27.7%
Switch grass	Control		89.5%	3.3	0.5	81.0	79.6	20.0	63.7	1.2	4.0	52.9	25.7	38.9	
Switch grass	Treated		45.5%	3.0	0.5	77.1	75.7	28.0	54.5	1.0	8.4	49.4	30.63	38.3	19.2%
Reed Canary grs	Control		88.2%	6.0	1.0	67.2	65.9	38.9	40.3	1.8	6.0	55.4	48.4	53.0	
Reed Canary grs	Treated		33.0%	5.0	0.8	60.5	59.2	65.2	20.6	1.1	11.6	51.2	62.3	55.8	28.7%

Improving the Nutrient Value of Biomass

Product	$3.50/bu. corn & $350/ton SBM		$5.00/bu. corn & $425/ton SBM	
	Value per ton at EQUAL moisture content	Value per ton at 50% moisture treatment level	Value per ton at EQUAL moisture content	Value per ton at 50% moisture treatment level
Corn stover	$64.49		$105.33	
Treated Corn Stover	+ $2.43	$(25.12)	+ $4.75	$(40.58)
Oat Straw	$50.44		$76.34	
Treated Oat Straw	+ $10.23	$(14.75)	+ $19.94	$(19.71)
Mixed Grass Hay	$83.30		$124.31	
Treated Mixed Hay	$(4.70)	$(37.06)	$(7.55)	$(55.63)
Ryegrass	$63.96		$96.79	
Treated Ryegrass	+ $8.45	$(21.37)	+ $17.54	$(29.54)
Switchgrass	$39.51		$59.32	
Treated Switchgrass	+ $2.28	$(14.93)	+ $6.06	$(20.86)
Reed Canary grass	$73.19		$110.49	
Treated Reed Canary grass	+ $5.63	$(26.83)	+ $16.34	$(35.89)

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.
  - http://www.auri.org/wp-content/assets/legacy/research/Compost%20Bedding%20Report.pdf

- 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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