Montana Agricultural Biomass Residual Overview

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Department of Environmental Quality

Renewable Energy and Clean Air Program

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Montana Department of Environmental Quality

DEQ Energy and Pollution Prevention Bureau has had a long relationship with Department of Energy (DOE) Biomass and Bioenergy program. DEQ has worked on biomass and bioenergy development in the state in cooperation with DOE since 1982.

Montana Department of
ENVIRONMENTAL QUALITY

OVERVIEW

- Agricultural Sources of Biomass
- Benefits of Ag Biomass
- Agricultural Residual
- Potential Agricultural Residual Locations
- Biomass Energy Applications
- Conversion Technologies
- Challenges
- Solutions

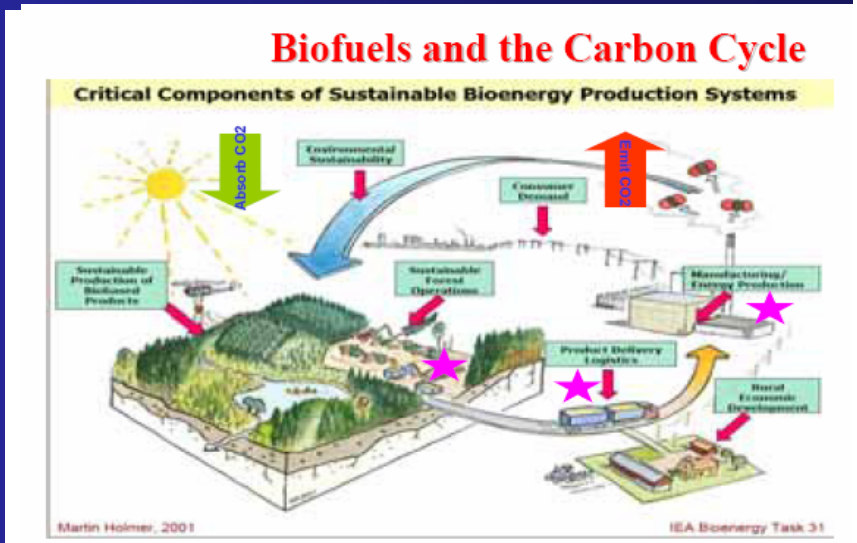
Sources of Agricultural Biomass

- Biomass energy or "bioenergy“ the energy from plants and plant-derived materials.
- Wood is the largest biomass energy resource
- Other agricultural sources of biomass include
  - food crops
  - grassy and woody plants
  - residues from agriculture or forestry
  - organic component of municipal/industrial wastes
  - Manure and landfill gas (60% methane, a natural gas).

Benefits of Using Biomass

Ag Biomass use is favored in rural areas:

1. **Use CO2 when they grow**
2. **Reduce all 3 GHG emissions when used (CO_2, CH_3, N_20)**
3. **Reduce transport energy (regional use)**
4. **Reduces "fossil" CO2 emissions**
5. **Only replacement for "transportation" liquid fuels**



But Starred areas also emit

Source of underlying graphic: Smith, C.T. , L. Biles, D. Cassidy, C.D. Foster, J. Gan, W.G. Hubbard, B.D. Jackson, C. Mayfield and H.M. Rauscher, "Knowledge Products to Inform Rural Communities about Sustainable Forestry for Bioenergy and Biobased Products", IUFRO Conference on *Transfer of Forest Science Knowledge and Technology*, Troutdale, Oregon, 10-13 May 2005

Benefits of Using Biomass

Supports U.S. agricultural and forest-product industries. Main biomass feedstocks are paper mill residue, lumber mill scrap, and municipal waste.

Current biomass fuels,

- Corn (for ethanol)
- Wheat and barley (ethanol)
- Soybeans and canola (for biodiesel)

Near Future

- Corn stover (the stalks & husks) and wheat straw

Long-term plans: growing dedicated energy crops on land that will not support intensive food crops


Corn Stover

Montana Agricultural Residuals

A. Grasses from CRP lands

B. Surplus grain straw and low quality hay

C. Sugar Beet Pulp

D. Sileage crops as rotation crop

E. Hybrid poplar/willow trees

F. Feedlots and Dairy (Biofuels)

Montana Agricultural Residual

Grasses planted onto CRP

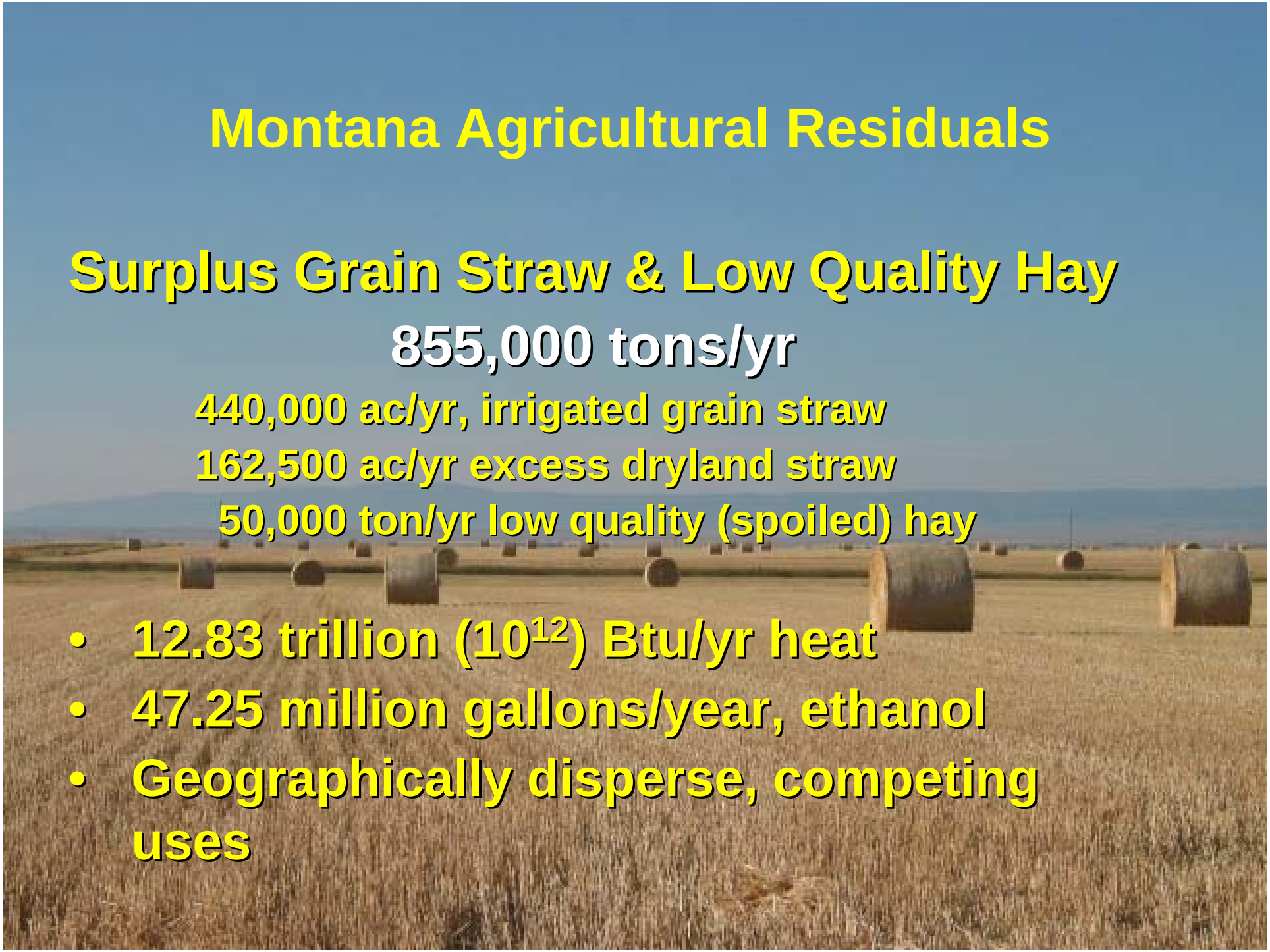
Current Rule (USDA Conservation Reserve Program):
25% of 3.49 million acres ~

872,500 acre/yr
1.09 million tons biomass/yr
16.35 trillion Btu/yr
60 million gal/yr of ethanol

Switchgrass

Harvest frequency increased 33.3% ~ 1.16 million acres
1.45 million tons biomass/yr
21.75 trillion Btu/yr (~796 kW annual capacity)
79.75 million gal/yr ethanol

50% harvest rate = 1.7 million acres
2.18 million tons biomass/yr
32.7 trillion Btu/yr, ~263.5 kW nominal annual capacity
120 million gallons/ year ethanol



Montana Agricultural Residuals

Surplus Grain Straw & Low Quality Hay

855,000 tons/yr

440,000 ac/yr, irrigated grain straw

162,500 ac/yr excess dryland straw

50,000 ton/yr low quality (spoiled) hay

- 12.83 trillion (10^{12}) Btu/yr heat
- 47.25 million gallons/year, ethanol
- Geographically disperse, competing uses

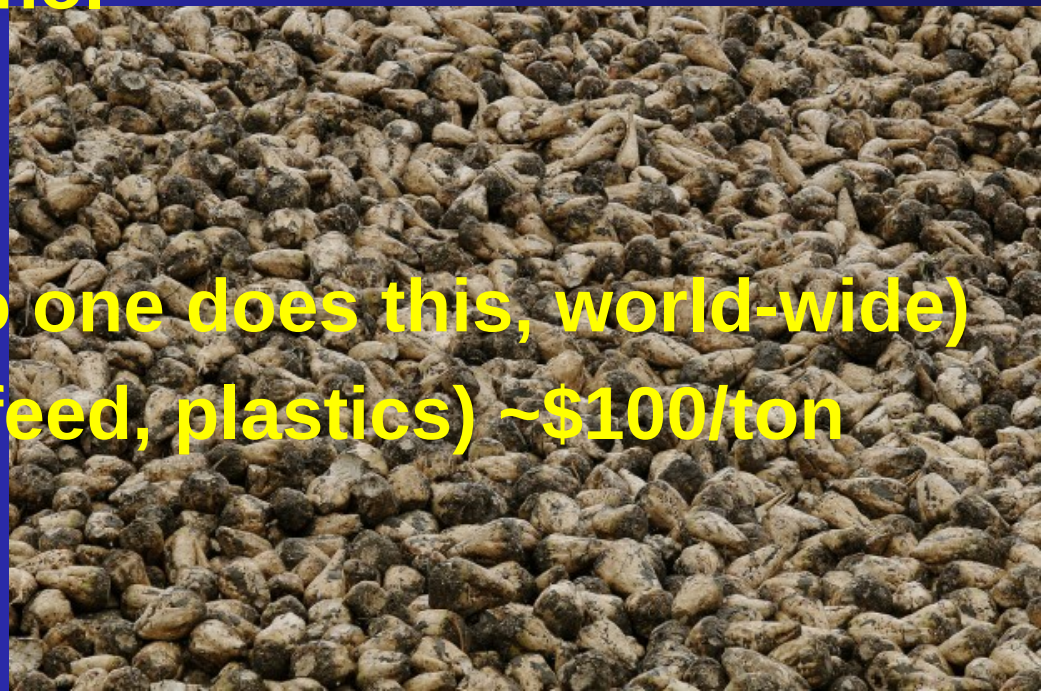
Montana Agricultural Residuals

Sugar Beet Pulp

98,300 tons per year, Billings & Sidney

1.475 trillion Btu/y ~11.9 kW annual capacity

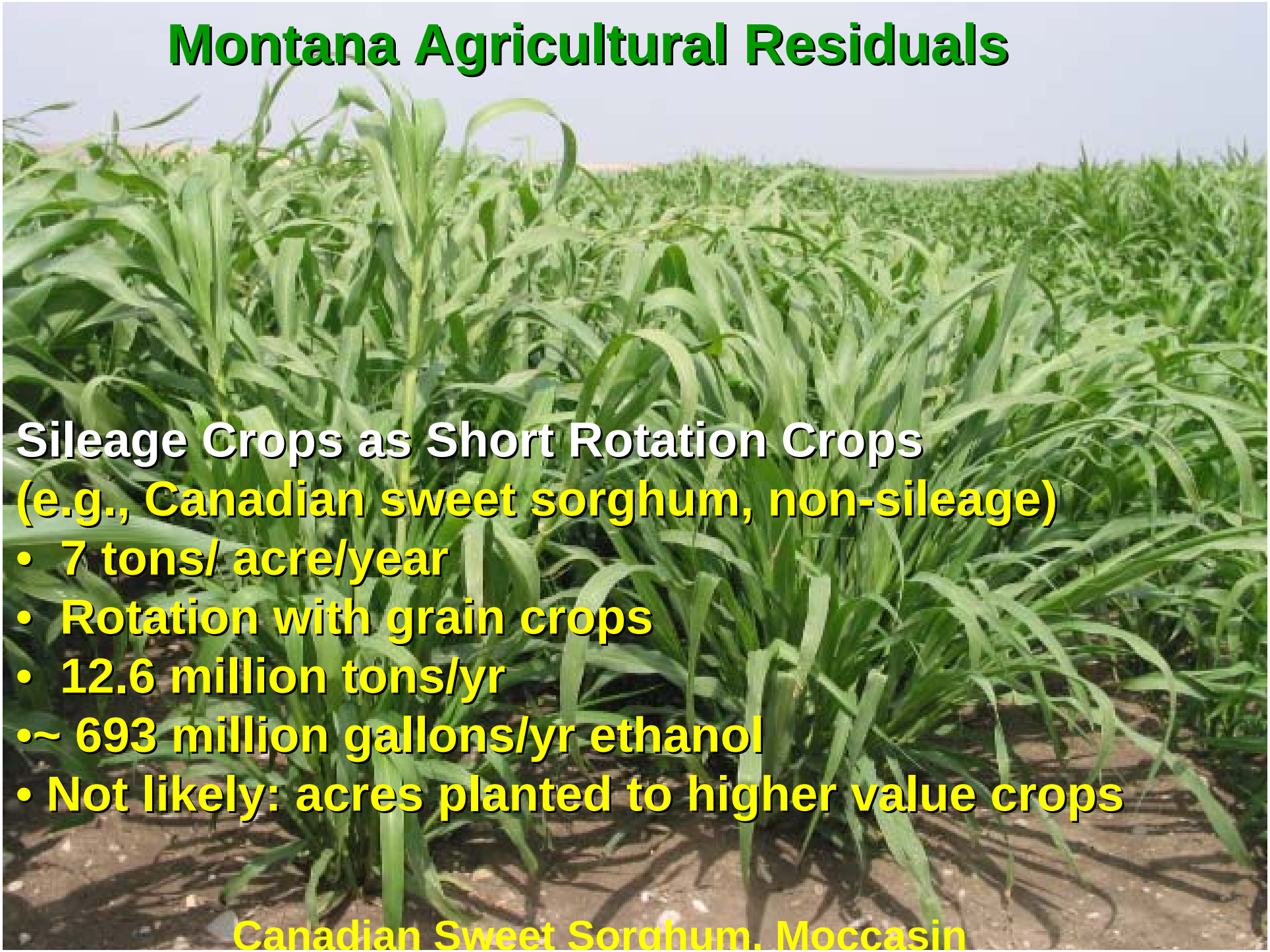
5 million gal/yr of ethanol



Not particularly likely:

- **Technical issues (no one does this, world-wide)**
- **Competing market (feed, plastics) ~$100/ton**

Montana Agricultural Residuals



Sileage Crops as Short Rotation Crops
(e.g., Canadian sweet sorghum, non-sileage)

- 7 tons/ acre/year
- Rotation with grain crops
- 12.6 million tons/yr
- ~ 693 million gallons/yr ethanol
- Not likely: acres planted to higher value crops

Canadian Sweet Sorghum, Moccasin

Montana Agricultural Residuals

Oilseed Straw – location dependent

- 80,000 tons per year (current average)
- 720,000 tons/yr in rotation with grain crops
  (1.8 MM ac/yr ~74 MM gal biodiesel)
- 1.2 to 10.8 trillion Btu/yr

Peggy Lamb, NARC, 2004

Montana Agricultural Residuals

Hybrid Poplar (willows)

- Black Alder, hybrid poplars best suited to Montana (DNRC Energy Div, WSU, P Moore, 1987)
- 1980s: 7-yr rotation, Est 10-15 ton/yr avg growth
- ~ 70 to 105 tons per acre harvested, 10,000 ac/yr
- State lands and near wastewater ponds/lagoons
- ~700,000-1,050,000 ton/yr
- 10.5 - 15.75 trillion Btu/yr
- 39-58 million gal/yr ethanol

Animal Manure: Feedlots, Dairies Biofuels

Biogas from anaerobic digestion of hog, chicken, dairy & feedlot manure

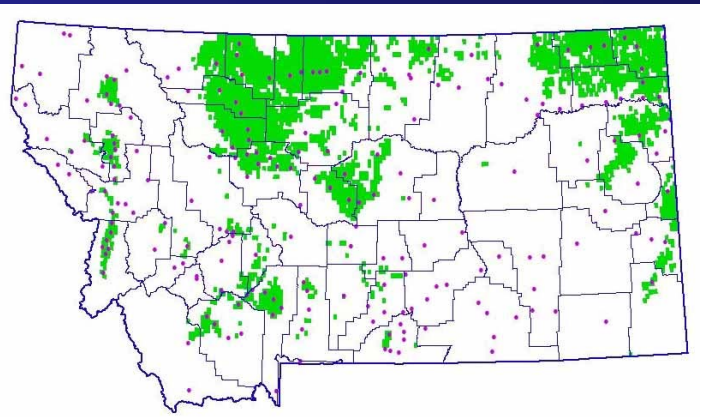
- Huls Dairy, Corvallis, 400 cows
  50 kW, 350,000 Btu/hr
- Leaves “fertilizer” co-product
- Limited by net-metering
- Limits being lowered for herd size (50 head in MN)

Stirling Engine, Helena MT

Potential Montana Agricultural Residues: Locations

- Montana has 2-3 major agricultural regions
  - Golden Triangle (45% of actively farmed Montana land)
  - Northeastern corner (29% of farmed land)
  - Area around Billings (shipping and processing)
  - Elevator & milling waste

    (50 million gal/yr ethanol)

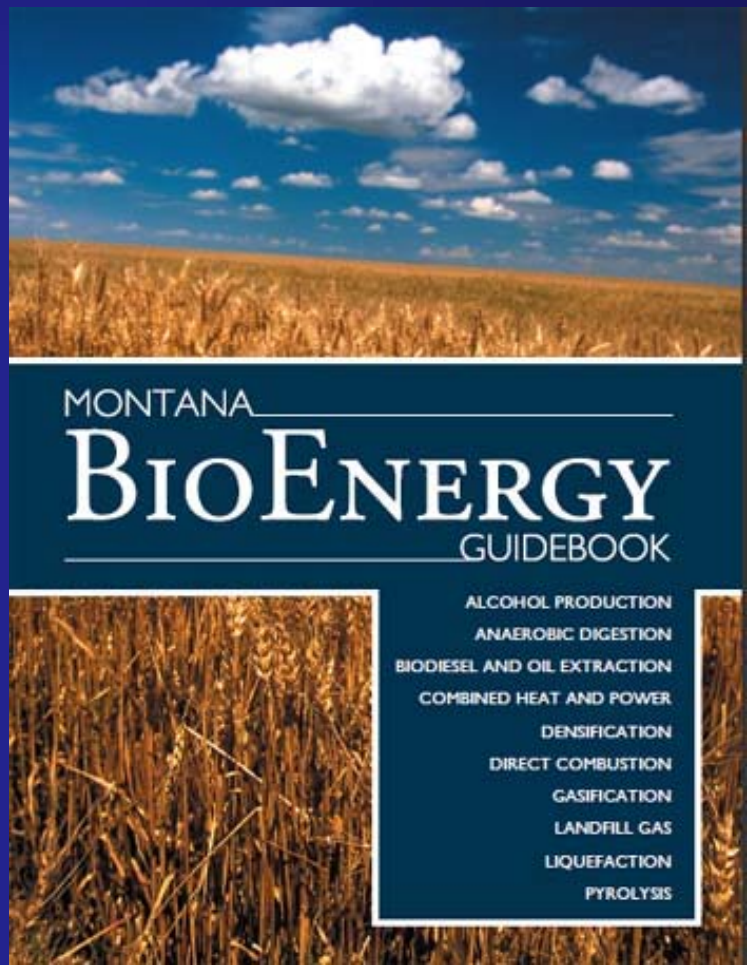


Biomass Energy Applications

- Biofuels — Converting biomass into liquid fuels for transportation
- Biopower, Bioheat — Burning biomass directly, or converting it into gaseous or liquid fuels that burn more efficiently, to generate electricity
- Bioproducts — Converting biomass into chemicals for making plastics and other products that typically are made from petroleum

Conversion Technologies

- Direct Combustion
- Gasification
- Pyrolysis
- Cellulosic Ethanol
- Biorefinery



Direct Combustion

- Boilers and furnaces can be used for heat, steam and power.
- Direct combustion creates hot gases to produce steam in a boiler - the most common use of biomass as in Fuels for Schools Projects.
- Combined heat and power (CHP), also known as cogeneration, is the combined generation of thermal and mechanical energy, usually heat and electricity. CHP systems can have efficiencies over 80% fuel to useful energy.
- e.g., Smurfit Stone, Hall's Wood Processing

Gasification

- **Gasification: heating hydrocarbon material (biomass) in an oxygen-starved environment to produce synthesis gas, or water gas (CO+H2O).**
- **“Close coupled” gasifiers combust these gases cleanly with addition of air (Thompson Falls, Kalispell, Dillon Fuels for Schools gasifier & boiler).**
- **“Indirect” gasifier gases combined with a catalyst can produce liquid and gaseous fuels (like the North Dakota Coal Gasifier making methane)**

Pyrolysis

- Pyrolysis and gasification are related processes, heating hydrocarbons with limited oxygen.
- Pyrolysis, however, is generally a process that includes virtually no oxygen, hopefully to produce a cleaner burning fuel: they are commercial e.g., “Liquid Smoke” for barbeques
- Biochar is a porous charcoal-like substance remaining after pyrolysis. It can store carbon to improve soil fertility in non-alkaline soils

Cellulosic Ethanol

Cellulose is a way plants and trees store food (sugar)

Cellulose + H_2O ~ starch, Starch + H_2O = sugar

Wood and grasses use lignin to protect the cellulose
lignin must be broken down to access the cellulose for ethanol.

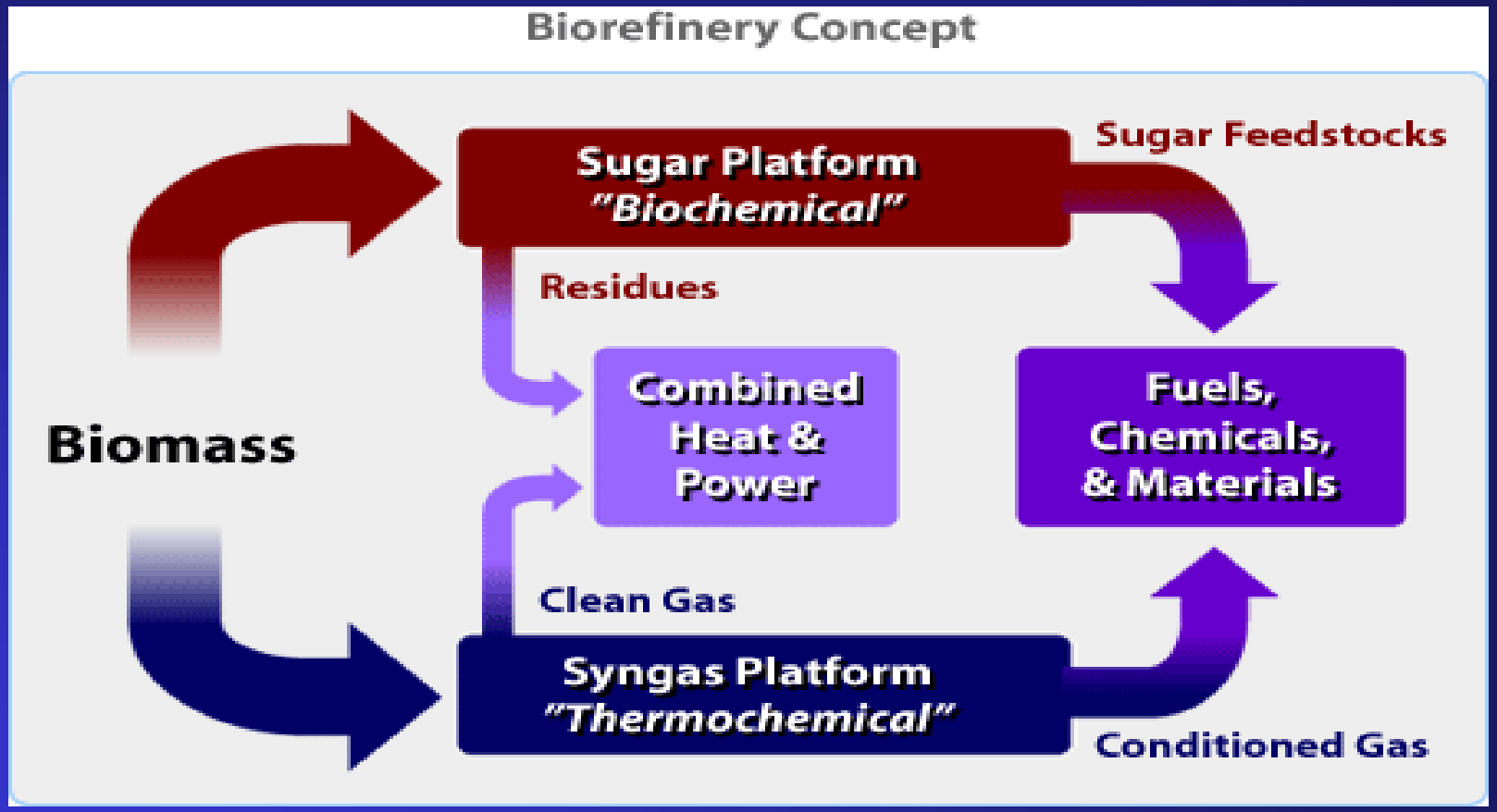
3 methods (sometimes in combination)

- enzymes
- acids or
- heat and pressure

Biorefinery

DOE vision is to develop technology for biorefineries that will convert biomass into a range of valuable fuels, chemicals, materials, and products - much like oil refineries and petrochemical plants do.

Biorefinery



Challenges

- Energy crops must compete with traditional crops. May not be as profitable
- Montana has a shortage of precipitation (relative to other areas) and limited growing season
- Biomass is bulky and geographically dispersed, long hauling distances
- Need research on cost effective collection systems

Possible Solutions

- Smaller, geographically diverse production facilities with regional markets for co-products; Local & regional plants to reduce transportation and initial cost (EF Biofuels, Chester)
- Cost effective collection systems
- Educate the public on the benefits of biomass energy

The End.

Thanks for Listening, Questions?

Montana Department of Environmental Quality

Biofuels Net Energy

Fuel	Energy units in	To Produce units of energy out
Biodiesel	**1**	**4.56**
Biomass derived D2	**1**	**15-60**
Ethanol (corn)	**1**	**1.67-2.12**
Ethanol, cellulosic	**1**	**4.0-7.0+**
Petroleum gasoline, diesel	**1**	**0.88**

Biodiesel Use (variable, depends on cost)

State FY	MGY blend	Gal B-100
2004	0.345	70,000
2005	0.347	71,000
2006	0.348	71,149
2007 (thru Nov)	nya	336,180**
2008		946,328
2009 (19,120 In State)		808,838

RFS – 1

- 2022: 74 MGY (1.8 million acres/year)

Ethanol Use

State FY	MGY blend	MGY ethanol
2004	17	2.4
2005	30	3.1
2006	30	3.0
2007 (thru Mar)	12.6+export	3.1
2008 (thru May)	37.2+ lo Blend & export	
2009	168.911	16.891

RFS-1 Ethanol Production Goals

- 2022: 250 MGY starch, 50 MGY cellulosic