Biochar and Biofuels: Opportunities and Challenges for Range and Pasturelands.

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Presentation Outline

1) Why bioenergy and biochar?

2) **Bioenergy**
   2a) Technology overview
   2b) Feedstock sourcing
   2c) Conventional thinking
   2d) Range and pastureland scenario

3) **Biochar**
   3a) What is it?
   3b) How is it produced and used?
   3c) What are the implications?
   3d) Climate Change Mitigation
   3e) Range and pastureland scenario
The Need For Bioenergy and Carbon Sequestration

- Global Security (Finite fossil fuels)
- Global Warming (<450 ppm CO2 = - 25% to - 40% below 1990)
- U.S. Energy Independence and Security Act (36 B g/yr by 2022)
- NO U.S. Carbon regulations at present (Feb. 2010)
Bioenergy Overview

- Energy derived from biomass (solar power through photosynthesis)
- Feedstocks: Oil crops, sugar crops, manure, MSW, **cellulose crops**
- Conversion: Thermochemical, Biochemical, Direct Combustion
- Products: Heat, liquid fuels, gaseous fuels, electricity, chemicals
Known Biomass Availability (2005)

- Agricultural residues (crops and animal manure)
- Wood residues (forest, primary mill, secondary mill, urban wood)
- Municipal discards (methane emissions from landfills and wastewater treatment)
- **Dedicated energy crops** (on Conservation Reserve Program and Abandoned Mine Lands)
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Estimates and Projections (2005)

DOE: 1.3 B tons/yr of biomass in US (30% of domestic fuel in 2030)
Assumptions:
- 50% increase in grain yield (emphasis on corn)
- **55 mil. acres of perennial energy crops**
- all manures and residues used (questions of soil sustainability)
- no forest w/o roads or sensitive areas considered
Conventional Production

- Targets mid-west, and south-east
- Corn (9B gal in 2009, 3.7% arable land, 4% gasoline use)
- Feedstock sourcing (50 mile radius)
- Scale (the bigger the cheaper per unit output)
- Change is coming (low-carbon-fuel-standard LCFS.cellulose)

- 22 lbs corn per gal ETOH (Tillman, 06)
- 0.44 gal diesel for 22lbs
- erosion at 12x soil replacement rate

- 280 MMgY Corn Ethanol Facility
- 16,876,712 lbs corn per day
- 1,595 acres of corn per day
  (72 lbs per bushel, 151.1 bushels per acre)
What About Range and Pastureland?

150 million private acres in Intermountain West
Agronomic limitations (water, seasonality, soils)
Competing Land Use (cattle, food, fiber)
Difficult to make generalizations across entire resource
Rangeland Bioenergy Scenario

**CHALLENGES**:
- technical hurdles
- diffuse land resource
- lower productivity per acre than midwest
- costs
- producer adoption
- missing proof of concept model

**FEEDSTOCK**
- Drilled: Switchgrass, Timothy, Wildrye, Big Bluestem

**PROCESSING**
- Modular Processing Unit (think like a ruminant)

**CONSUMPTION**
- Ethanol
- Butanol
- Mixed alcohol
- Synthesis gas
Relevant Research

Very little dedicated to range and pasureland

- David Tillman (U. Minnesota): LIHD grasslands
- Energy Biosciences Institute (Berkeley/Illinois): Perennial grasses
- Oak Ridge National Laboratory: Switchgrass
- Nevada Extension: Switchgrass
- NRCS Meeker, CO field office: Brome
- James Ansley (Texas Extension): Mesquite
- United Kingdom/Israel: *Opuntia* cactus
- Western Governor’s Association: Pine Beetle Kill
- NREL: Process Technology

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What is Biochar?

Biochar is a fine-grained, highly porous charcoal, that is formed by the partial combustion of biomass in an oxygen limited environment. It can be used to enhance the productivity of agricultural soils, and sequester considerable amounts of atmospheric carbon.
What Does Biochar Do?

- Cation Exchange Capacity: 50% Increase (Glaser, 2002)
- Fertilizer Efficiency: 10-30% Increase (Gaunt and Cowie, 2009)
- Liming Agent: 1 Point pH Increase (Lehmann, 2006)
- Soil Moisture Retention: Up to 18% Increase (Tryon, 1948)
- Crop Productivity: 20-120% Increase (Lehman et al., 2006)
- Methane Emissions: 100% Decrease (Rondon et al., 2005)
- Nitrous Oxide Emissions: 50% Decrease (Yanai, 2007; Renner, 2007)
- Reduced Bulk Density: Soil Dependent (Laird, 2008)
- Mycorrhizal Fungi: 40% Increase (Warnock, 2007)
- Biological Nitrogen Fixation: 50-72% Increase (Lehmann et al., 2006)

Biochar is NOT a fertilizer, it is a soil additive
Not All Biochar is The Same

- Parent material and processing method
  - Porosity
  - Surface chemistry
  - pH
  - Particle size
  - Recalcitrance

Dynamotive CQuest Biochar
Home made briquettes
BEST Energies Agrichar

Canadian Soft Woods
Fast Pyrolysis
Cow Manure?
Carbonization
Eucalyptus
Slow Pyrolysis
Climate Change Mitigation Strategy

1 Ton of Biochar

\[ \approx \]

3.67 Tons of CO2
**Rangeland Biochar Scenario**

**FEEDSTOCKS**
- Perennial grasses
- Available biomass

**PROCESSING**
- Biochar Engineering Corporation (BEC)

**APPLICATION**
- Sub-surfers
- Yeomans plow

- **CHALLENGES**: Quality of herbaceous biochars, technology hurdles, no carbon market, need for additional research across many soils, lack of low impact application methods.
- **POTENTIAL**: Increased water holding capacity, soil remediation, yield improvement
Research to Date

Dedicated Biochar Research Efforts in The United States
Flux Farm’s Research

Biochar

Bioenergy

Feedstocks
Process Technology
Application methods
Agronomic impacts

And growing...

Filling in the gaps and connecting the dots
Thank you

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