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

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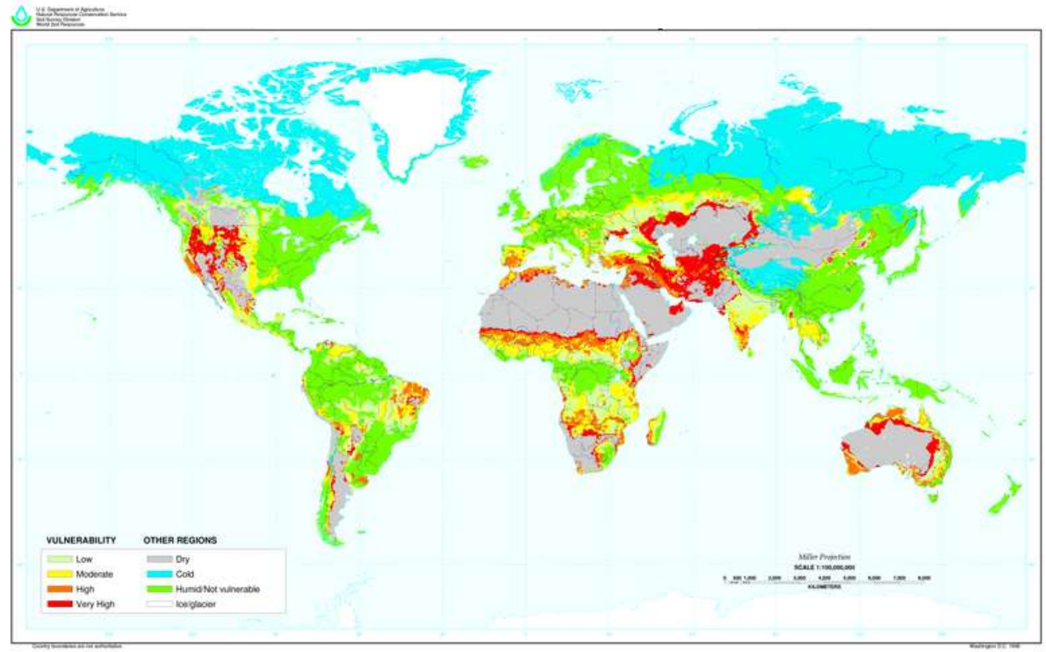
Presentation Outline

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

Coal-fired power plant

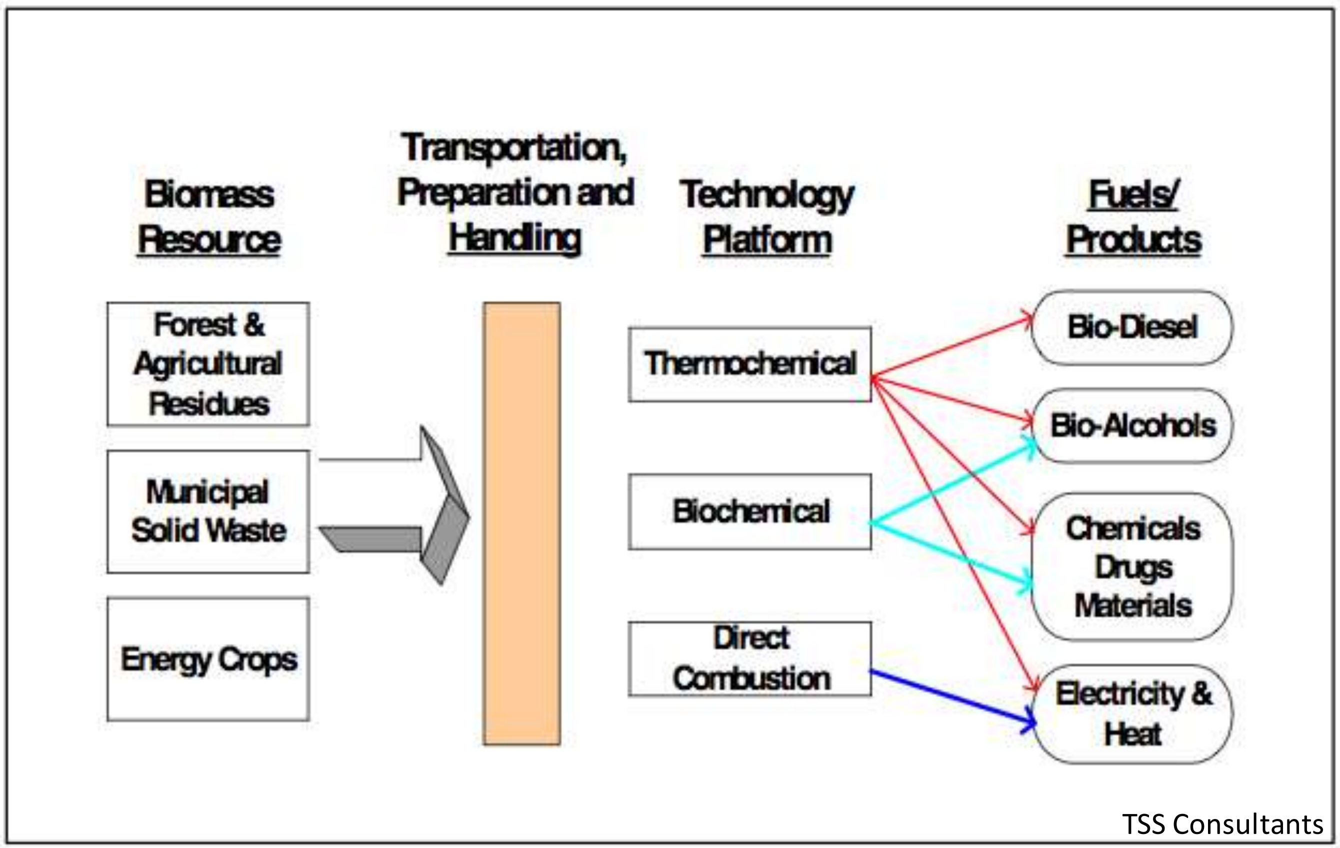


Desertification Vulnerability (USDA)

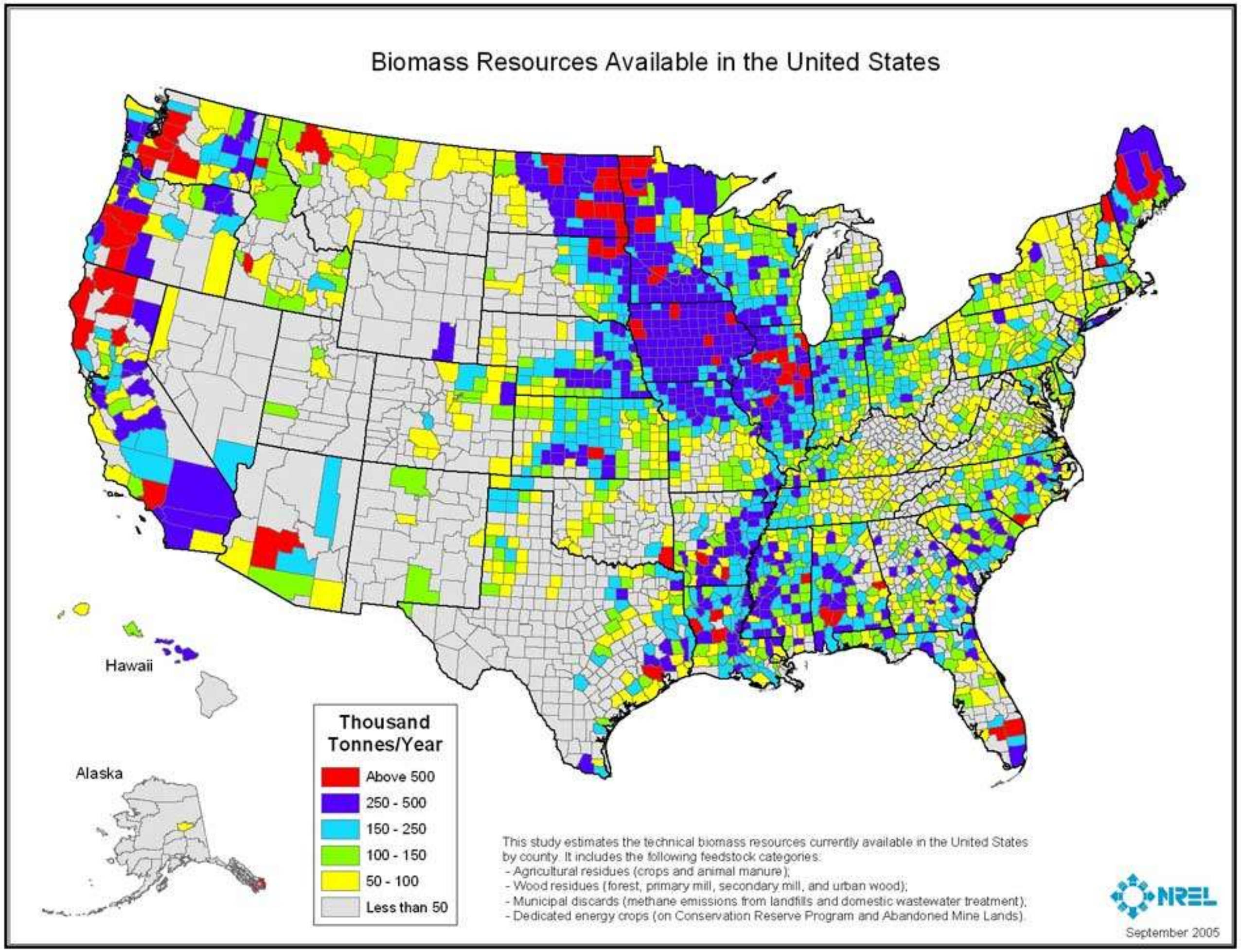
- Global Security (Finite fossil fuels)
- Global Warming (<450 ppm CO_2 = - 25% to - 40% below 1990)
- U.S. Energy Independence and Security Act (36 B g/yr by 2022)
- **NO** U.S. Carbon regulations at present (Feb. 2010)

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)
- **<u>Dedicated energy crops</u>** (on Conservation Reserve Program and Abandoned Mine Lands)

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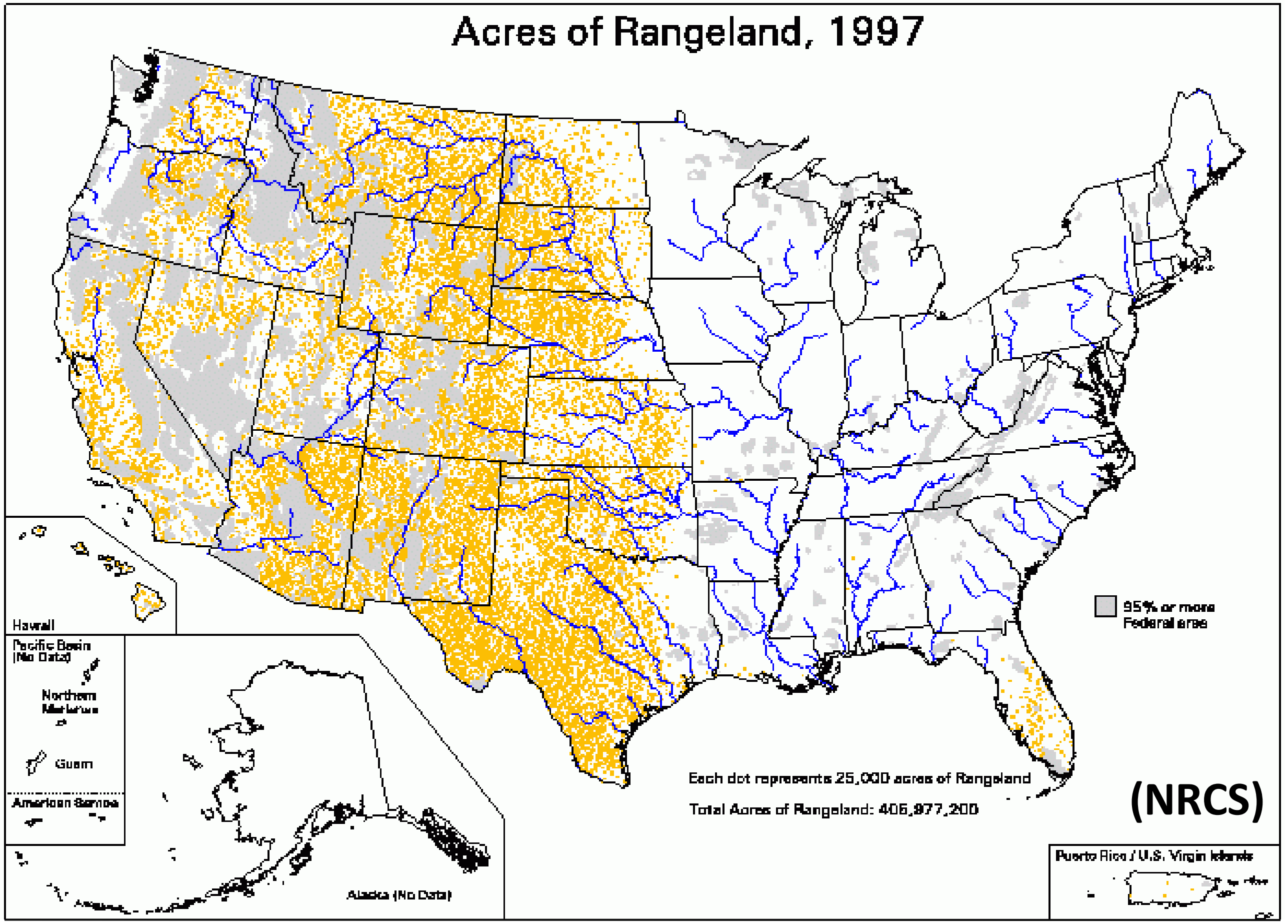

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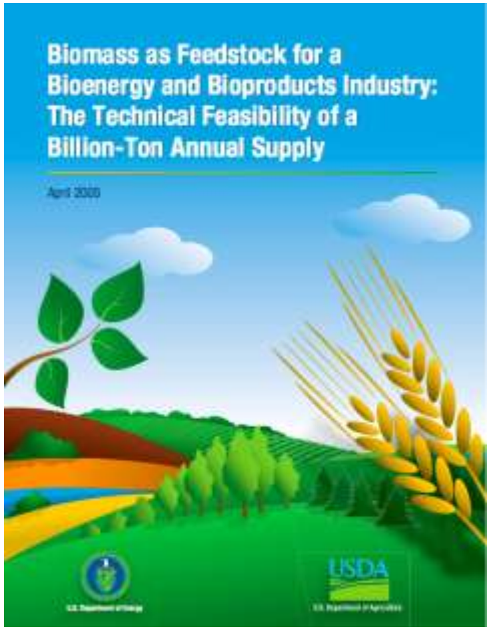
Estimates and Projections (2005)



University of Illinois (*Miscanthus giganteus)*

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

USDA-ARS

Rangeland Bioenergy Scenario

FEEDSTOCK

Drilled: Switchgrass, Timothy, Wildrye, Big Bluestem

Mesquite

Opuntia

PROCESSING

Modular Processing Unit (think like a ruminant)

CONSUMPTION

- Ethanol
- Butanol
- Mixed alcohol
- Synthesis gas

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

Relevant Research

<u>Very little dedicated to range and pasureland</u>

-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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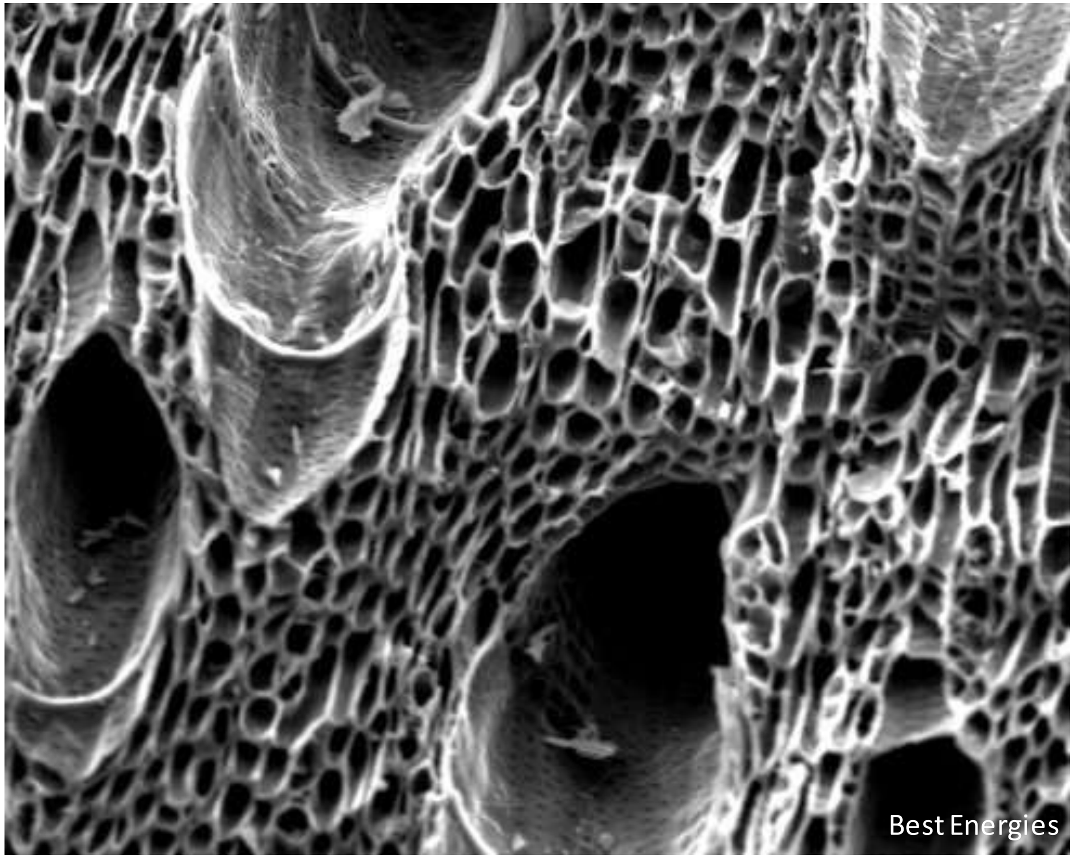
What is Biochar?



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

Canadian Soft Woods
Fast Pyrolysis

Home made briquettes

Cow Manure?
Carbonization

BEST Energies Agrichar

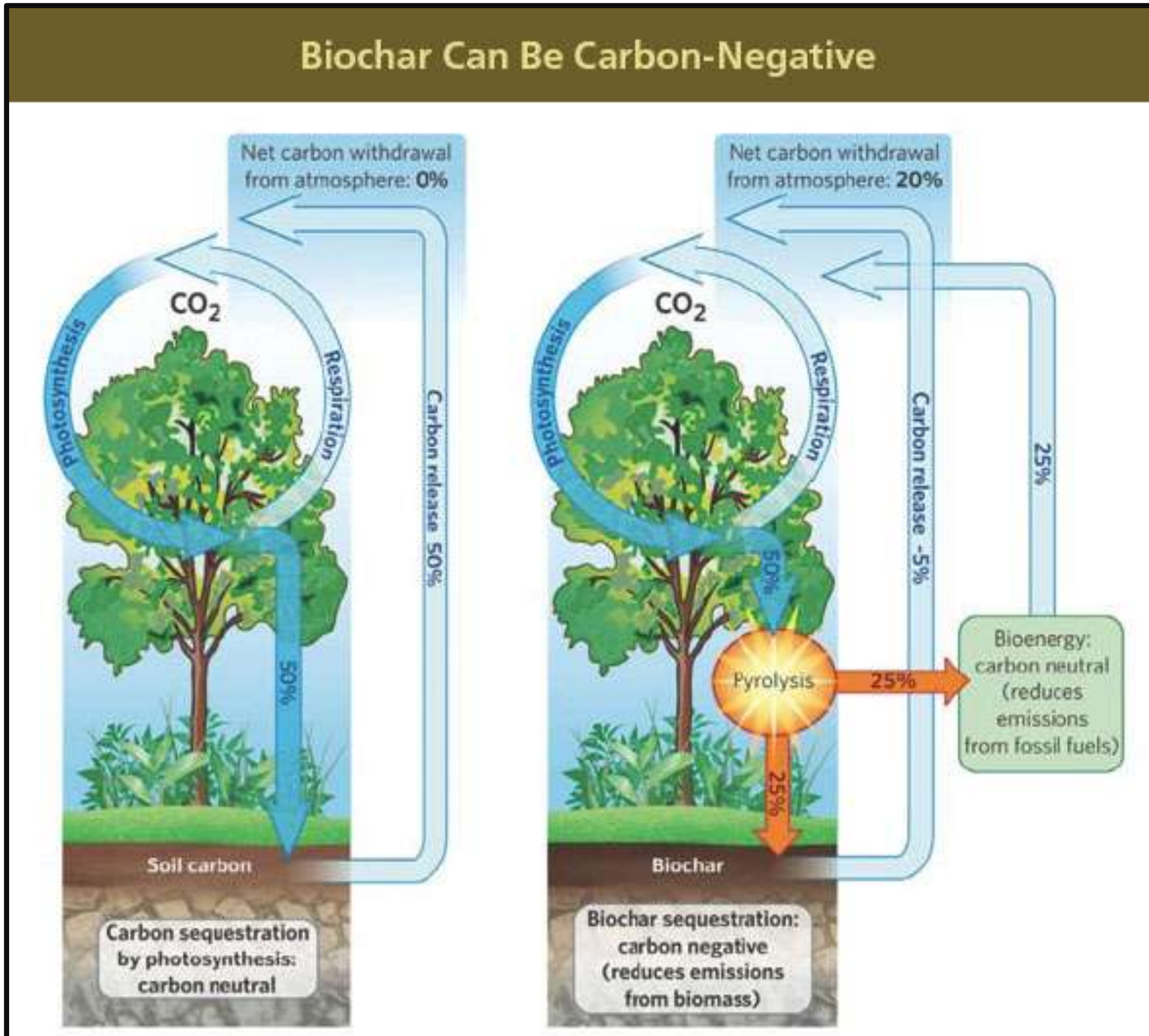
Eucalyptus
Slow Pyrolysis

Climate Change Mitigation Strategy

1 Ton of Biochar

≅

3.67 Tons of CO2



International Biochar Initiative (IBI)

Rangeland Biochar Scenario

FEEDSTOCKS

Perennial grasses

Available biomass

PROCESSING

Biochar Engineering Corporation (BEC)

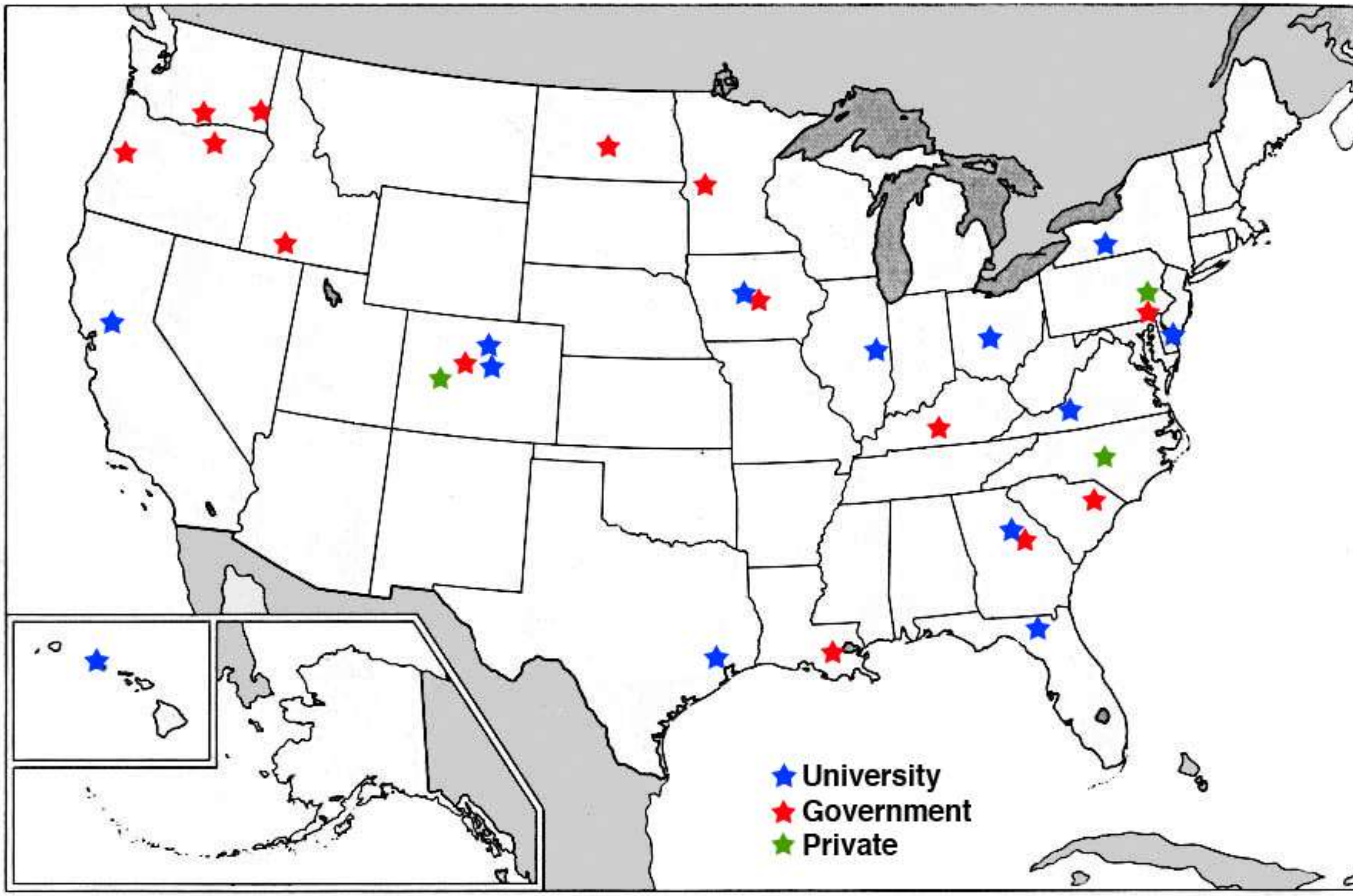
APPLICATION

Sub-surfer

Yeomans plow

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

Research to Date



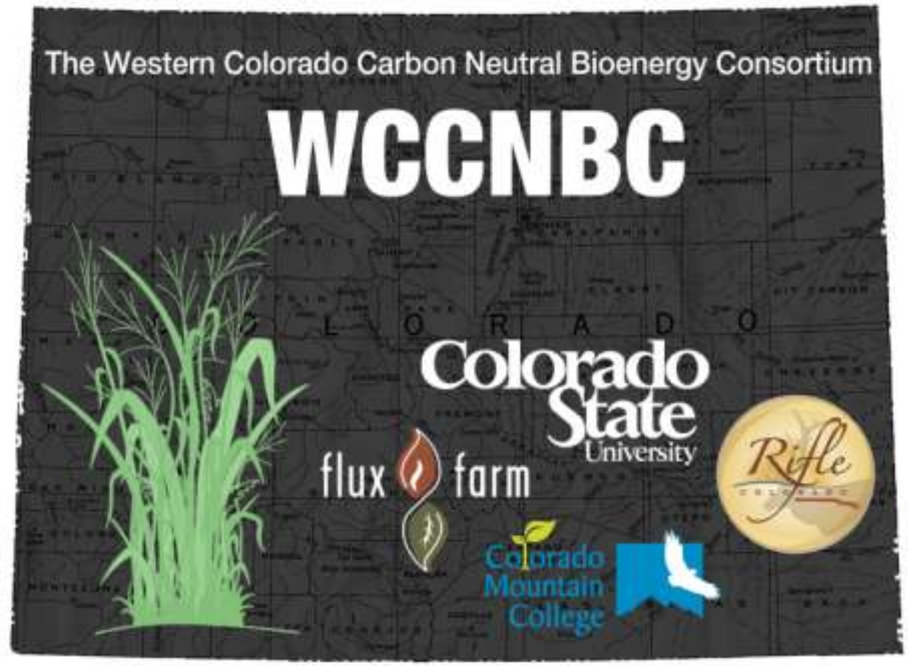
Dedicated Biochar Research Efforts in The United States

Flux Farm's Research

Biochar

Feedstocks
Process Technology
Application methods
Agronomic impacts

Bioenergy



And growing…

Filling in the gaps and connecting the dots

Thank you

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www.fluxfarm.com