Feasibility of Large Scale Biofuels: Assessing the One Billion Ton Study

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Overview

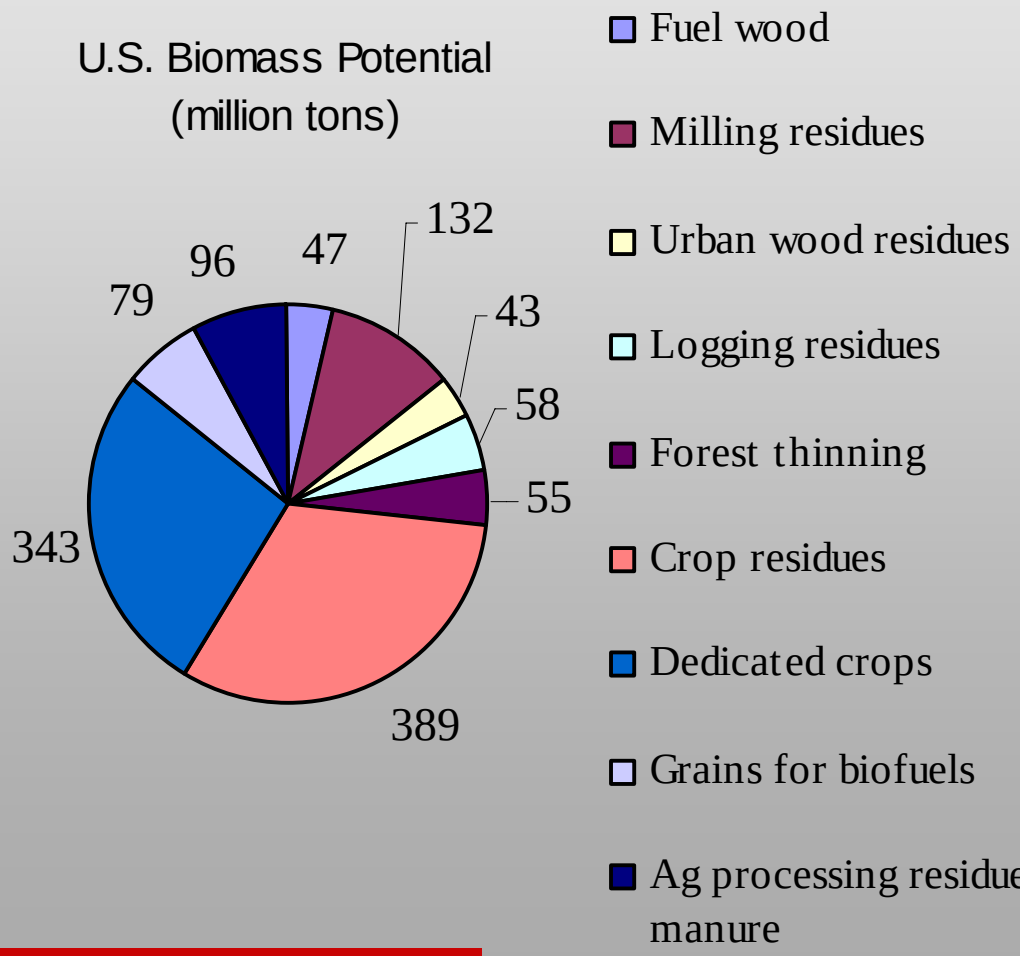
- One billion ton study may be close to having “right answers” (ignore woody biomass)
- But for “wrong reasons”
- 1BT ignores key economic links in market system
- Wrong reasons may lead to adverse EQ and GHG impacts

Overview

- Biomass production technology
- Biomass harvesting, transport, and storage technology
- Biofuel conversion technology
- Ultimately, competitiveness of biomass feedstocks and recognition of opportunity costs

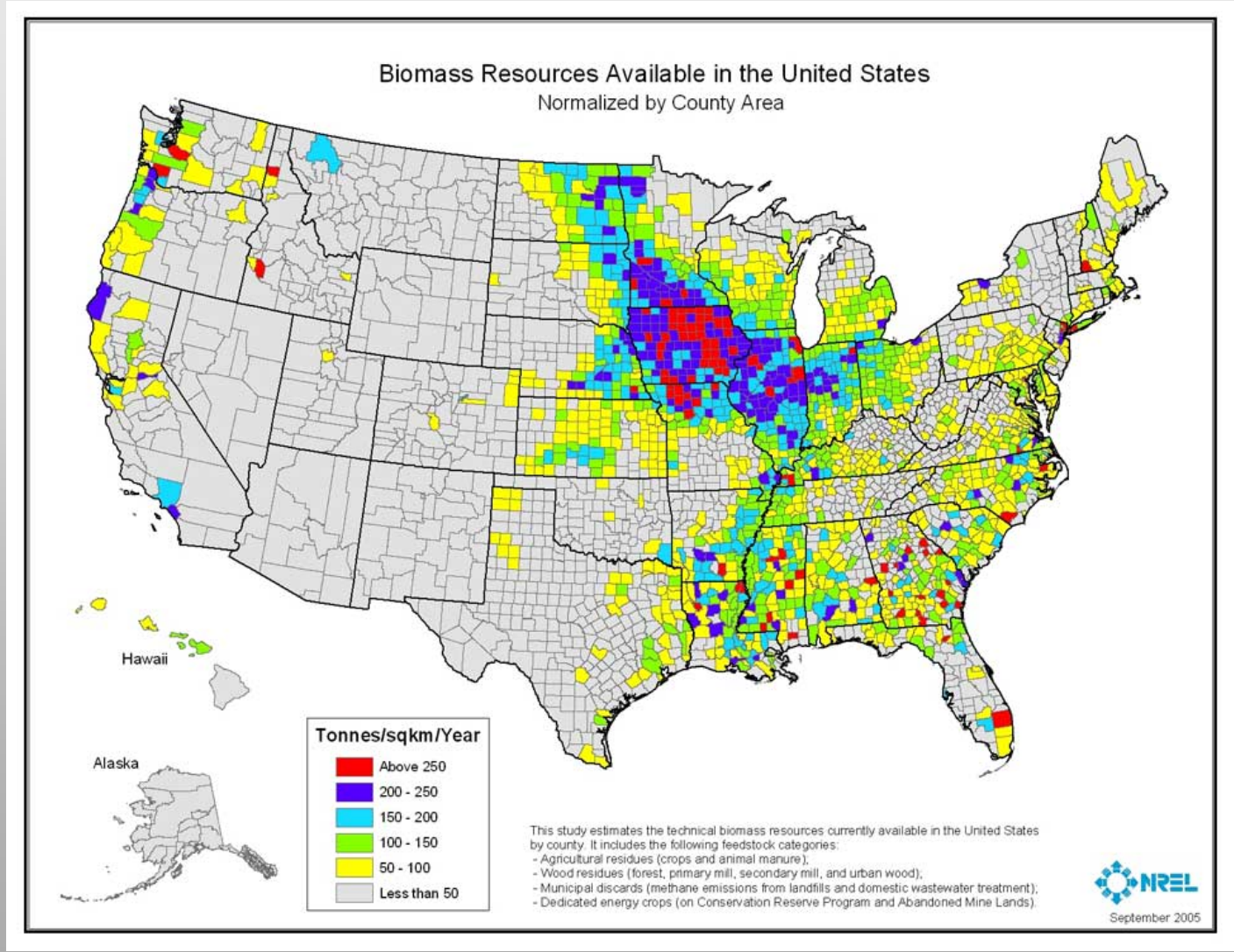
Grains represent only a small fraction of potential U.S. supply of biomass

- Total potential in U.S. is in excess of 1.3 billion tons (about 21 EJ)
- Could replace up to 66% of U.S. gasoline demand
- Grain ethanol represents 7% of biofuels potential



USDA/DOE "Billion Ton Study"

Midwest is the Saudi Arabia of biomass



Source: U.S. DOE

Biomass production technology

- Establishment & Mixed seed approaches
- Yields and locations
- Fertilization
- Erosion & Nutrients
- Research

Biomass harvesting, transport, and storage technology

- May be highest hurdle for biofuels
- $.50/gal within 30 mile radius, simultaneous harvest & no storage; otherwise $.60-.80/gal (ORNL)
- May be $1.00-1.50/gal including storage

Crop form affects transport

Form	Density (dry lb/cu ft)
Cut	3
Field chopped	5
Bales	9
Cubes	30
Shelled corn	38

Turhollow, ORNL

Biofuel conversion technology - options and timeframe

- **Ethanol is not the goal!**
- Biochemical (sugar platform)
  - Starch
  - Cellulose
- Thermochemical
  - Gasification
  - Fast pyrolysis
- Hybrid biochemical/thermochemical
- Commercialization – 2015?

One billion ton study close to having "right answers" but for wrong reasons

Break-even corn price model provides useful starting point – what can processors pay for feedstock and breakeven?

Corn price/bu = 3 x ((price of gasoline*0.667) + tax credit + octane credit) + DDG price – cost of capital – operating cost

Key Assumptions & Results

- $60 per gallon price of crude oil translates into $2.07/gallon price of gasoline.
- Break-even corn price is $4.05/bushel
- Exogenous demand shock to ethanol consumption in the U.S. to bring corn price up to $4.05/bushel
- Use FAPRI Model to trace through domestic and international market adjustments

Implications

- Corn price/bu = $4.05 (CARD, September 2006)

- Long run equilibrium ethanol production is about 30B gallons of ethanol from corn grain without major market disruptions!

One billion ton study ignores market linkages and opportunity cost of cropland

- Substitutes biomass and woody crops for grains and oilseeds
- But expect crop returns drive cropping patterns
  - Corn and soybeans dominate in Midwest due to their returns over variable costs
- New energy crops will have to compete for acreage
  - Need returns above variable costs and annualized establishment costs, on par with existing crops

Projected Returns

- For the next five years, returns from corn and soybeans are projected to average $250/acre

- New energy crops will need returns at or above $250/acre to pull acreage away from corn and soybeans

Switchgrass Costs

- Estimated annual cost of producing switchgrass
  - $187/acre with a 4 ton/acre yield - $47/ton
  - $241/acre with a 6 ton/acre yield – $40/ton
  - Includes baling, but not transporting or storing the bales off-farm
  - Broin estimates $100/ton for delivering corn on cob

Moving to Switchgrass

- Given costs and average returns for corn, farmers would consider shifting at a price of:
  - $110/ton with yield = 4 tons/acre
  - $82/ton with yield = 6 tons/acre

Breakeven price of switchgrass?

- $P_{stover} = 70 \times (P_g \times 0.667 + \text{tax credit} - C_k + \text{byproduct credit} - C_v - C_o)$

- Breakeven price for stover is $42-77/ton!

Environmental Worries

- CRP supporters believe that high corn prices will reduce CRP acres
- Livestock producers believe reduced CRP and increased corn acres will reduce corn prices
- Increased corn acreage will increase nutrient and soil losses

Wrong reasons may lead to adverse EQ and GHG impacts - cropping effects on water quality

- Three very stylized scenarios
- Single watershed in Iowa
- Much is unknown about how these crops would actually be grown and harvested
- Results only suggestive and preliminary

Maquoketa River Watershed

- Major contributor of sediments and nutrients to Mississippi River
- Dominant land uses - Baseline
  - Cropland (corn and soybeans) 55%
  - Grassland (pasture) 32%
  - Forest 10%
  - Urban 3%

Maquoketa River Watershed

Kling, et al, CARD

Scenarios

- Meant to illustrate extremes
- Three land use scenarios
  - Convert all potential cropland and CRP to switchgrass w/ fertilization
  - Convert all potential cropland to continuous corn, remove 50% biomass
  - Mixed strategy: switchgrass on HEL, continuous corn elsewhere
- Compare each to Baseline

Summary Findings

Description	*Streamflow (mm)*	*Sediment Yield (Tons)*	*Nitrate (Tons)*	*Total N (Tons)*	*Total P (Tons)*
Baseline	**250**	**146,652**	**8,380**	**10,030**	**360**
1. All Switchgrass	**255**	**22,780**	**4,673**	**4,697**	**65**
2. All Corn (remove 50% biomass)	**257**	**180,054**	**20,738**	**25,067**	**857**
3. Mixed (corn HEL<8)	**254**	**119,135**	**12,382**	**13,201**	**206**

Summary Thoughts

- Move towards continuous corn and biomass removal likely worsen water quality
- Switchgrass relatively water quality friendly
- Targeting switchgrass to highly erodible land dampens water quality problems, but still N problem
- Illustrates potential sensitivity of 1BT Study assumptions

Background information on these slides

- PowerPoints in support of this presentation are available at: http://www.extension.iastate.edu/bioeconomy/

- To view the program, please enter this address, www.extension.iastate.edu/webcast/bioenergy/ in your Web browser.