

Poplar Production Costs, Opportunity Costs and Economics of Liquid Fuels Production

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- **Economics of unirrigated poplar production**
- **Comparison to economic returns of other crops**
- **Review of cropland acreage and uses**
- **Estimated fuel production economics**

Billion Ton Update

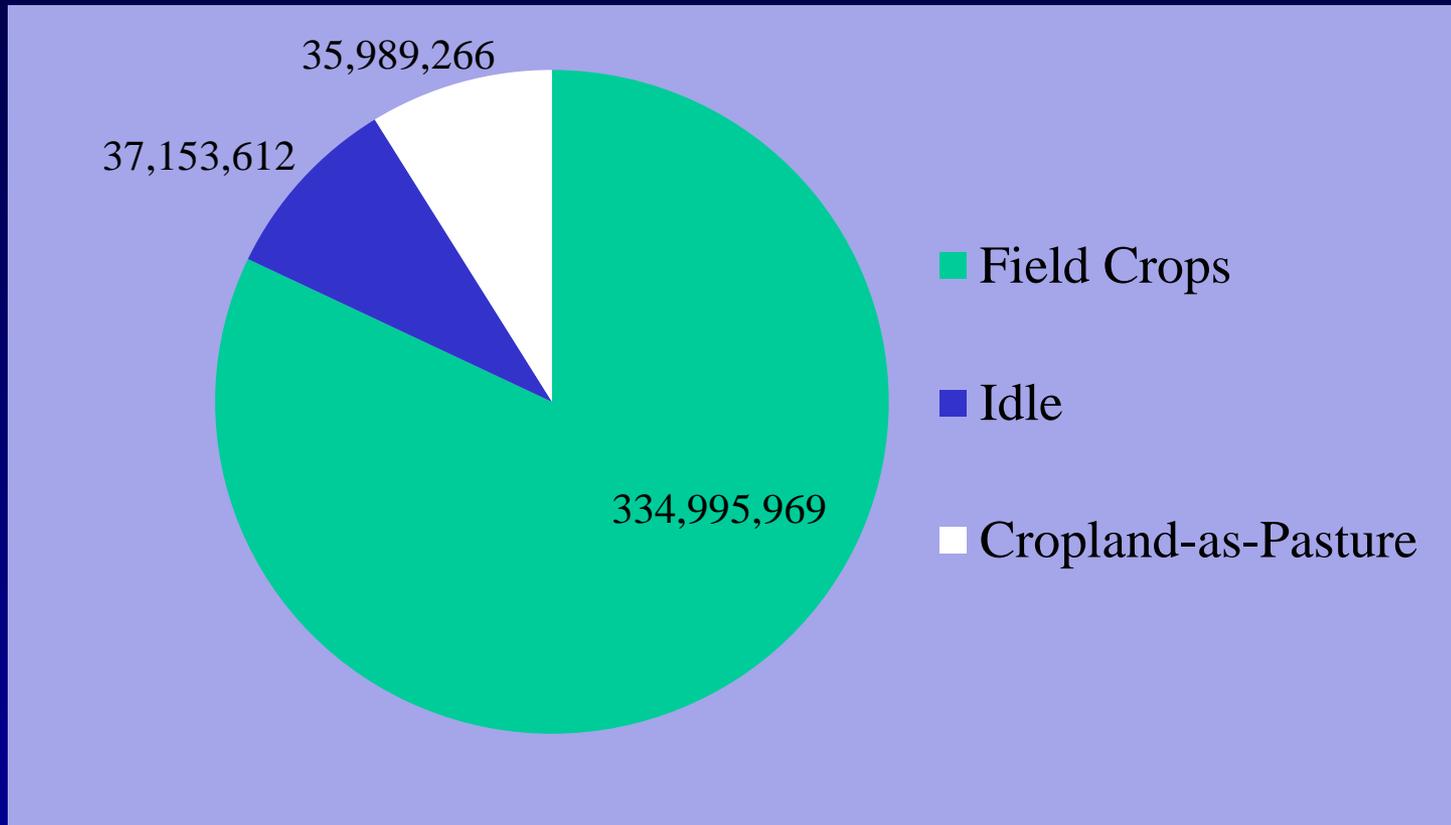


U.S. DOE recently updated the “Billion Ton Study” with estimates of U.S. biomass supply.

Conclusions:

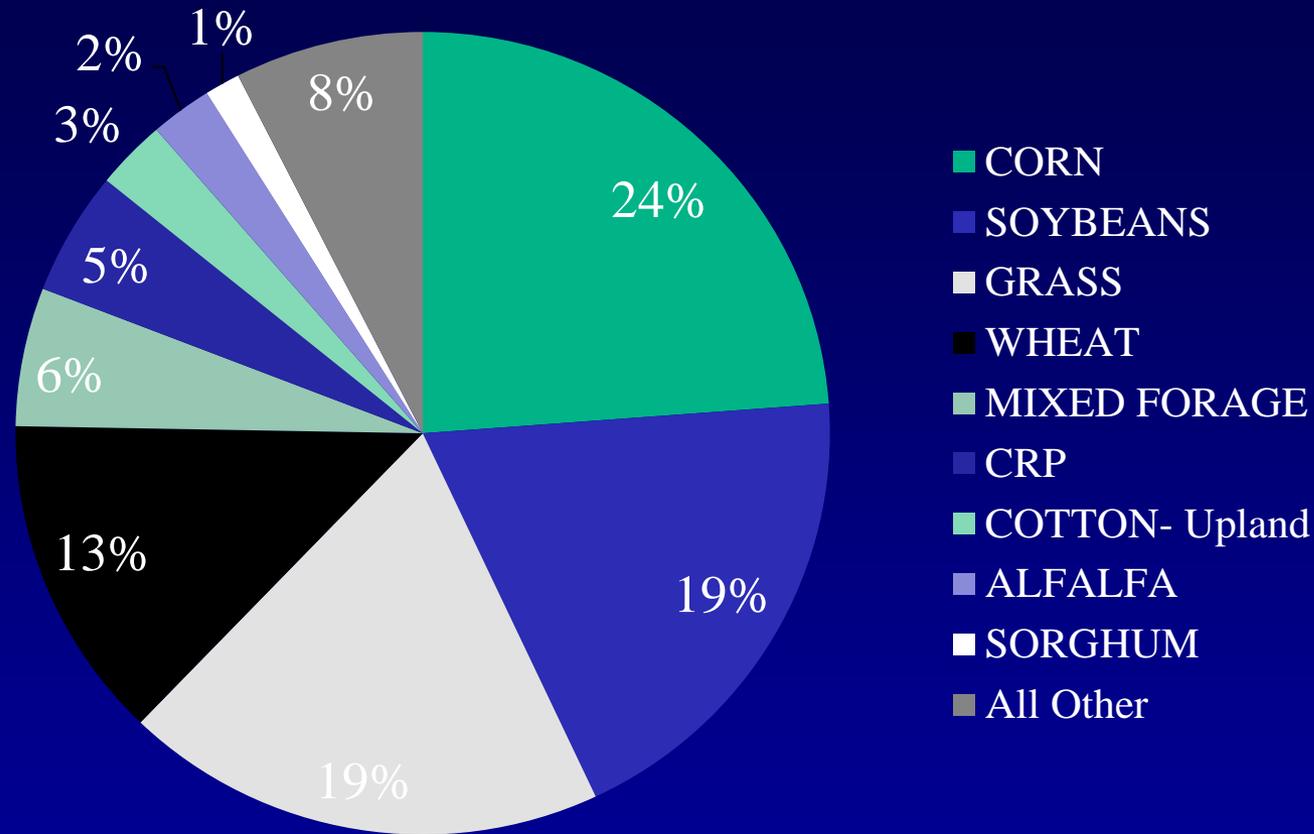
- 1.3 billion tons could be potentially available
- Energy Crops will play a major role in producing this biomass
- High-Yield Scenario – 500 to 800 million dry tons/year by 2030 – 77 million acres

USDA Cropland Acreage



- 408 million total - 334 million in crops, 37 million idle, 36 million cropland-as-pasture
- Energy crops will displace something – lower value land
- Of cropland-as-pasture, roughly 1/3 alfalfa, remaining other hay

Planted Acreage by Crop Type



- Budgets for corn, soybeans, wheat, cotton, alfalfa and other hay
- Land rent (~opportunity cost) tied directly to per-acre returns

Opportunity Costs and Comparison to Major Crops

- Straightforward Questions by Farmers:

What do I grow?

How do I grow it?

How much will I make compared to my current crop?

- Highlight the economics of production of major crops and compare to poplar (or switchgrass)

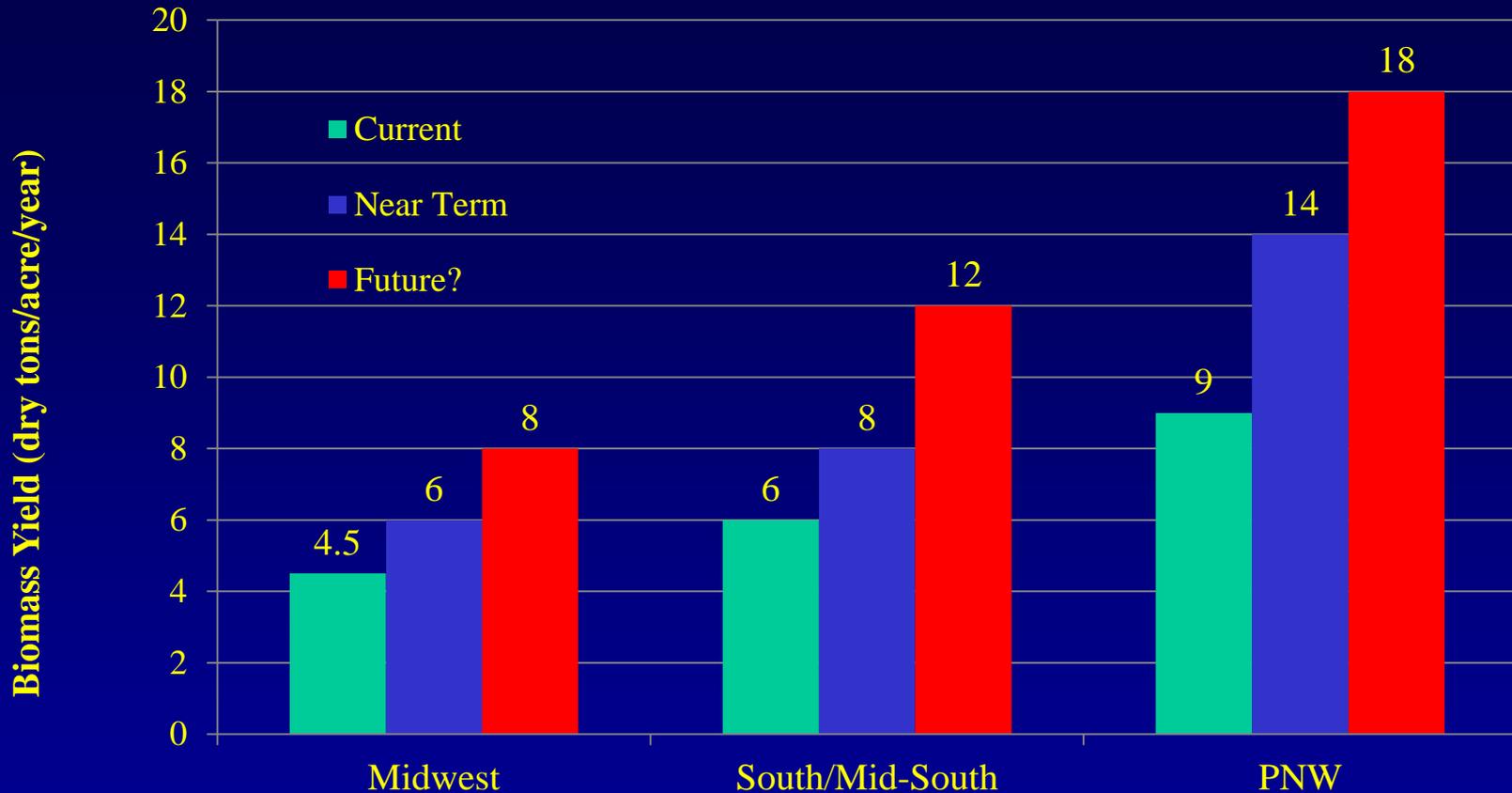
- Crop Enterprise Budgets published by the USDA and major Universities for dominant crops

Production Economics – MN

12 year rotation, 13 total with site prep year

- Cash flow model developed with industrial cooperation (Verso Paper)
- Maintained “arms length” from internal industry numbers
- \$501.00 per acre discounted production cost over a 13 year timeframe (12 year rotation, 1 prep year)
- \$38.59 per acre annualized production cost – benchmark for comparison
- if 3, six-year coppice rotations: \$37.17 annualized cost
- aside: switchgrass in MN is similar at \$156.00/acre/year post-harvest ($\$156/4 = \39.16 per ton, poplar: $\$37.17/4 = \$9.29 + \$25$ harvest = $\$34.29$ – for practical purposes equal)

Current, Near-Term and Future Poplar Yields

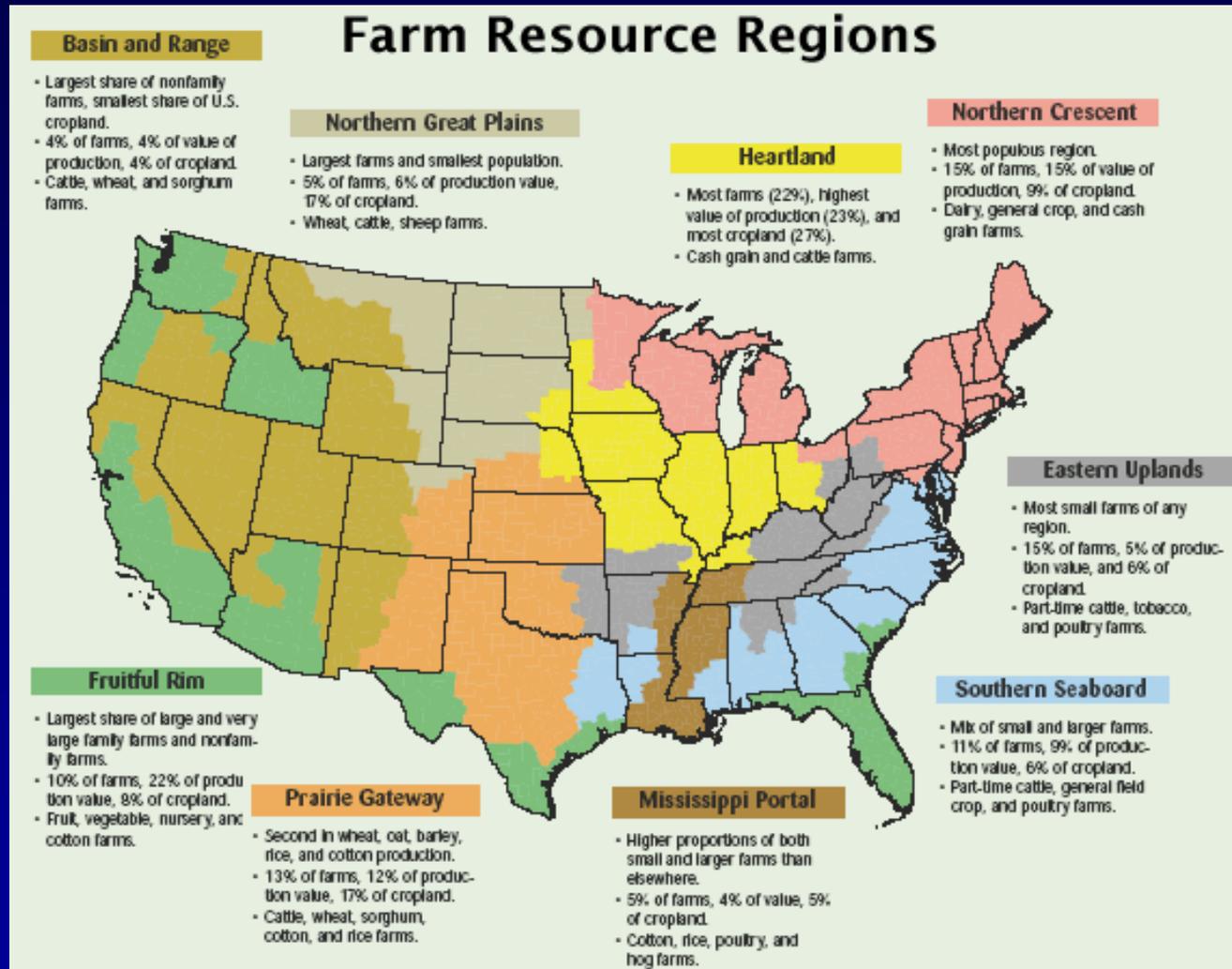


- Near-term: next 10 years with genetic improvement
- Future: traditional genetic improvement and application of genomics
- Midwest and Pacific Northwest – DT, DN, DM crosses
- South/Mid-South – D, DxN, likely hybrid aspens in the mix

Crop Enterprise Budgets

- Summarize all components of production including:
 - **Direct Costs**
 - Site preparation
 - Fertilizer
 - Seed
 - Tillage
 - Crop chemicals
 - All expendables
 - **Indirect Costs**
 - Interest
 - Machinery Depreciation
 - Buildings
 - Land Rent

Data Sources - USDA Economic Research Service



- not state-level reporting of enterprise budgets
- also used FINBIN - Minnesota

Crop Enterprise Budget Summary

	USDA				UM-FINBIN			
	Corn	Soybeans	Cotton	Wheat	Corn	Wheat	Alfalfa	Other Hay
Total Direct and Indirect Cost	\$479	\$262	\$673	\$233	\$601	\$315	\$362	\$39
Commodity Price	\$7.39	\$15.58	\$0.90	\$8.64	\$7.39	\$8.64	\$125.00	\$35.00
Yield	160	44	1000	38	160	46	4.4	1
Gross Revenue	\$1,182	\$686	\$1,100	\$328	\$1,182	\$397	\$550	\$35
Net Revenue	\$703	\$424	\$427	\$95	\$581	\$82	\$188	-\$4
Poplar Yield	5	5	6	4	5	4	4	3
Biomass Price	\$148	\$93	\$78	\$34	\$124	\$30	\$57	\$15
Gross Revenue	\$740	\$465	\$468	\$136	\$620	\$120	\$228	\$45
Annualized Production Cost	\$39	\$39	\$39	\$39	\$39	\$39	\$39	\$39
Net Revenue	\$701	\$426	\$429	\$97	\$581	\$81	\$189	\$6
Assumed Biomass Harvest	\$25	\$25	\$25	\$25	\$25	\$25	\$25	\$25
Transport (50 mile haul)	\$12	\$12	\$12	\$12	\$12	\$12	\$12	\$12
Total Delivered Biomass Cost	\$185	\$130	\$115	\$71	\$161	\$67	\$94	\$52

note: cotton commodity price includes 1670 lbs/acre of cottonseed @ \$0.12/lb. and 1000 lbs fiber at \$0.90.

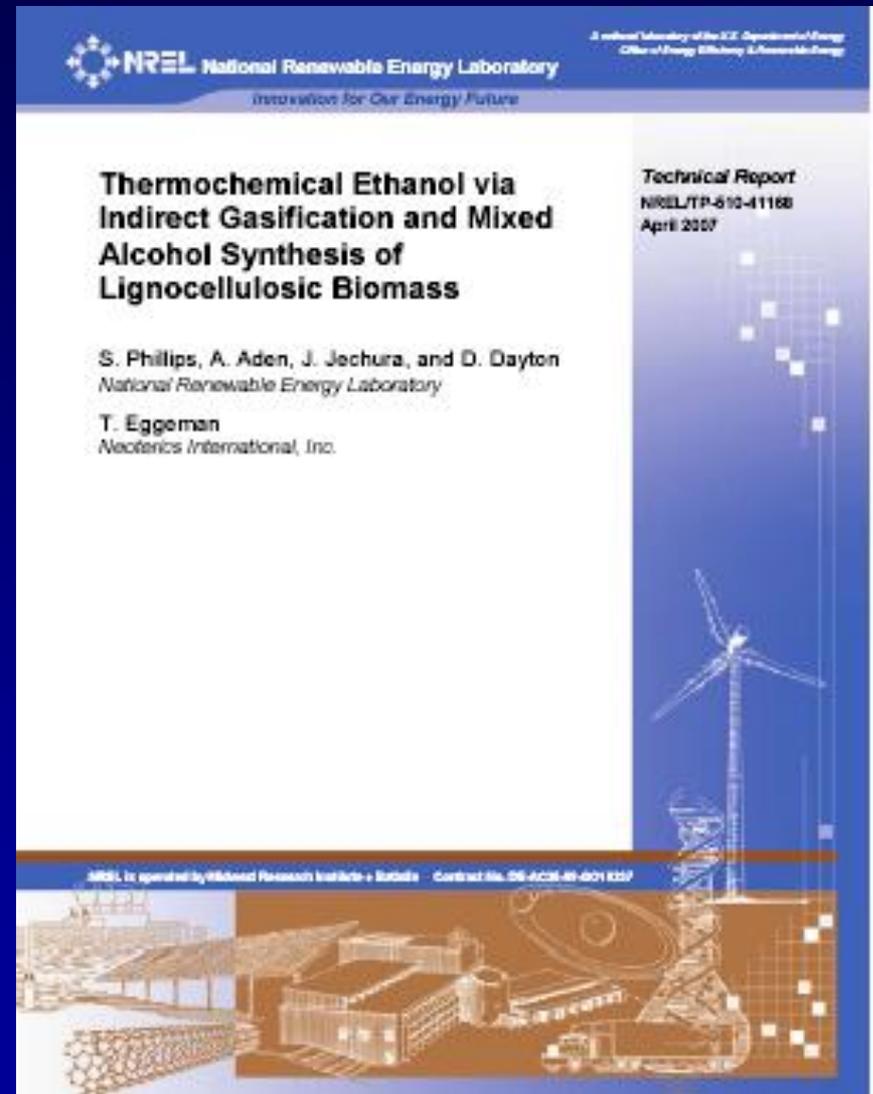
note: of total cropland-as-pasture, 1/3 is alfalfa, rest various pasture grasses and mixes

Note: transport cost based on 50 mile haul and 50% moisture content wood (fresh from field)

Obvious Conclusion: need to target research to determine suitable genotypes and yields on lower productivity sites

Cellulosic Ethanol Economics

- Phillips, et.al. - NREL Study
- Process flow diagrams
- Economic analysis
- Biochemical and thermochemical analyses done with similar breakeven per-gallon price



Assumptions in NREL Analysis

- Etoh yield of 80.1 gallons/dry ton
- Higher-chain alcohols – 14 gallons/ton
- 61.8 million gallon/year plant
- 770,000 dry tons of biomass needed
- Delivered feedstock \$35.00 per dry ton
- \$1.01 per gallon ethanol breakeven price with 10% return

ETOH Adjusted Price for Feedstock Cost

- \$35.00 feedstock in NREL analysis
- 80.1 gallons/ton
- \$0.44 per gallon in feedstock
- \$0.57/gallon capital/operating
- \$1.01/gallon estimated cost of production with 10% return

- \$90/ton feedstock = \$1.12/gal of etoh @80.1
- \$1.12 + \$0.57 = \$1.69/gallon FOB plant

ETOH Adjusted Price (cont.)

- \$90/ton feedstock = \$1.12/gal of etoh
- \$1.12 + \$0.57 = \$1.69/gallon FOB plant
- if 15% deduct for mileage, need 1.18 gallons of etoh to equal one gallon of gasoline so equivalent gasoline price would be \$1.99 per gallon gasoline-equivalent.
- comparable benchmark – RBOB gasoline price: \$2.73
- \$120/ton feedstock adds \$0.37 equivalent to \$2.43 per gallon gasoline-equivalent

If 135 gallons/ton yield and \$120/ton feedstock, \$0.88 per gallon and estimated \$1.45/gallon etoh or \$1.71 per gallon gasoline-equivalent

Potentially feasible and depends on technology development and risk (biomass production, price, technology)

Important Considerations

In Minnesota, yields are generally unfertilized yields in long-term trials

Response to nitrogen is highly variable and difficult to predict unless extreme (below 1.5% N in foliage)

Relatively high yields have been noted in northwestern MN on lower quality sites (flood risk) and, conversely, yields on very high quality sites are moderate (4 to 5 tons/acre/year)

Need a better understanding of nitrogen needs and site relationships

Conclusions

Biomass production for liquid fuels not economically unrealistic

Relevant Questions

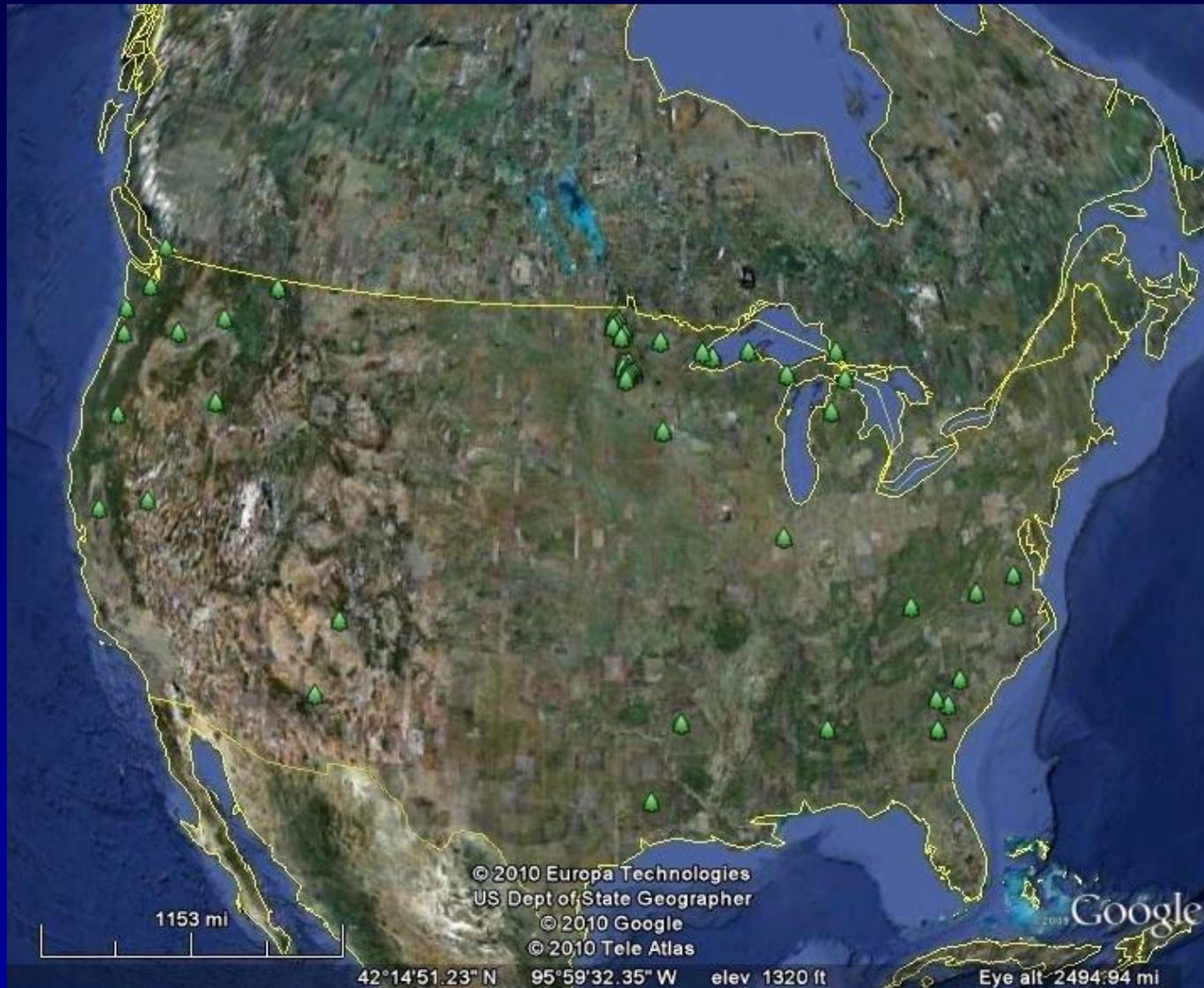
Nitrogen use and site quality relationships

What is the value added for agricultural products (corn/soy/wheat) versus fuels?

Jobs created per ton and economic impact?

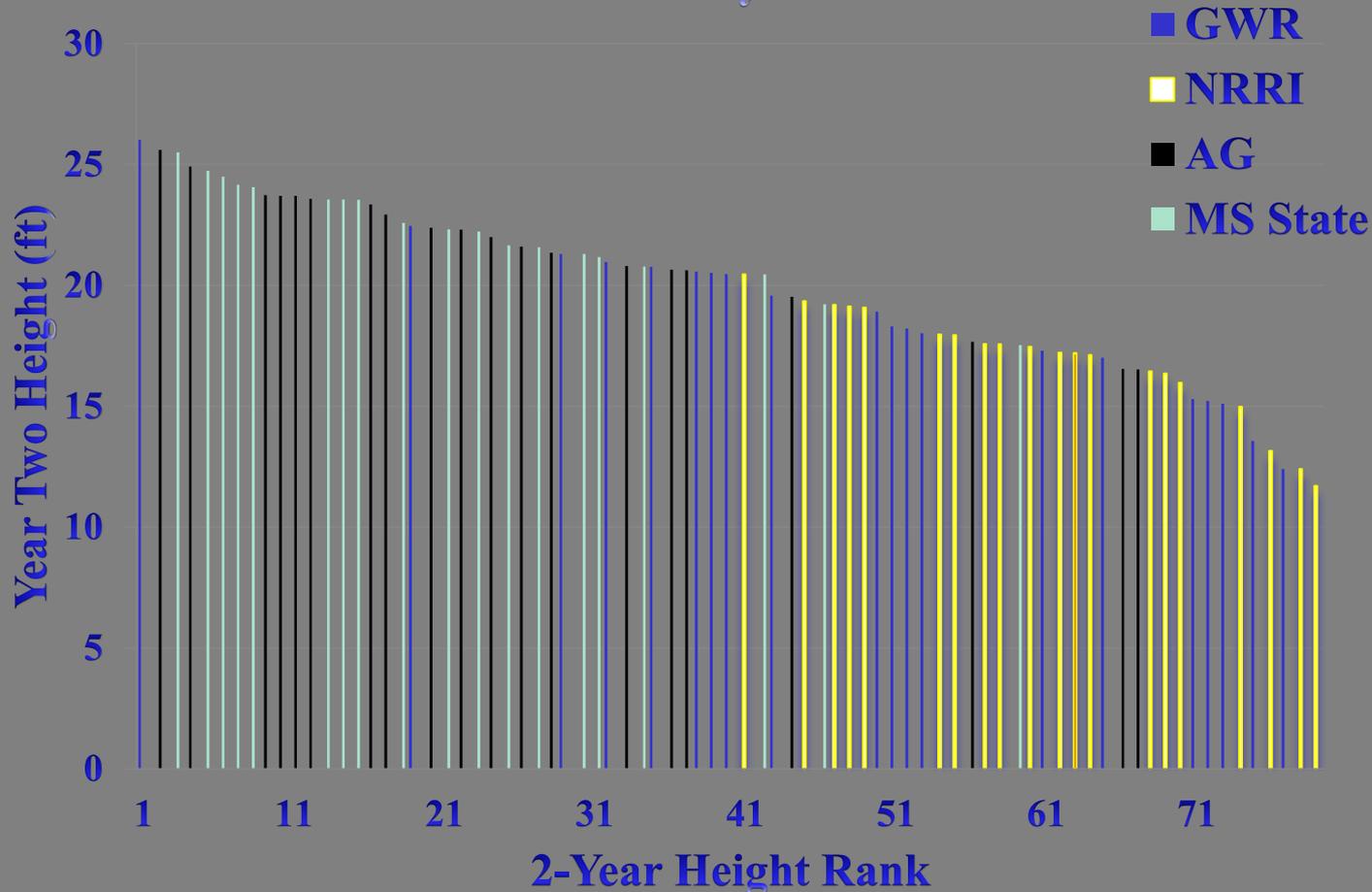
Yields are implied – refinement of genetics in Midwest and South

Current SunGrant Poplar Field Trial Network



74 sites, genetics, yield tests, nurseries

New Madrid 2010 Consolidated Clone Trial 2-year data

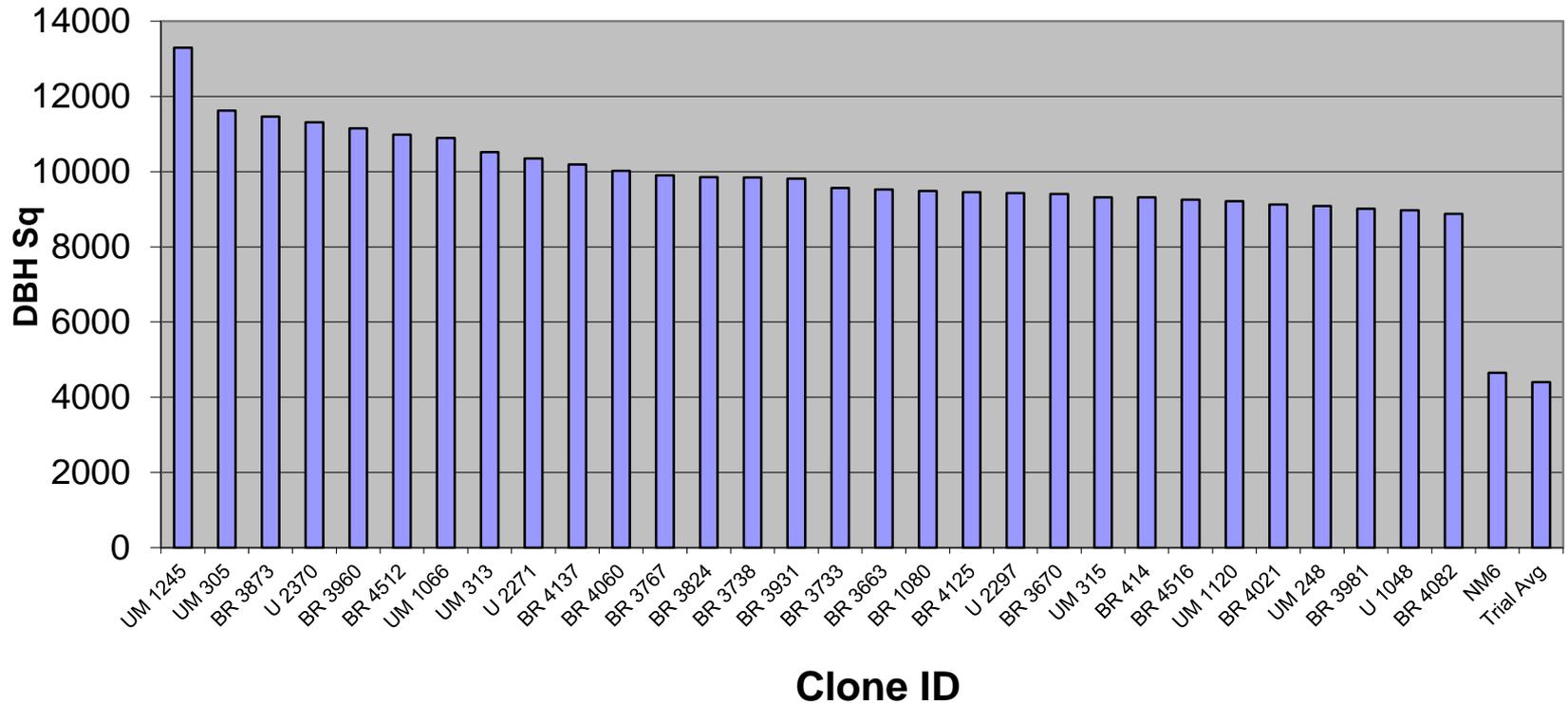


Average ht: 19.8 ft at New Madrid, MO, 11.0 Pototoc, MS, 9.3 - Belle River, MN
Fastest early grower has maximowiczii (DM hybrids) – Septoria susceptible?
Within-source variation high – GWR Source – Rank from 1 to 77
Dominated by pure-deltoides from South/Mid-South – AG and MS State

Age 4 Large Scale Genetics Trial – MN

677 clones total

Central MN – Shultz Site - 2007 Family Field Trial



Ratio of top 30 clones : NM6 = 2.21