Beyond Corn and Soybeans: Cellulose Feedstocks

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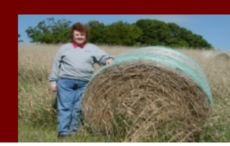
M & E Biomass

Oak Ridge, TN



Presentation Overview

- Quantities
- Distribution
- Economics
  - Collection costs, equivalent profits--added incentives needed to encourage changes in existing practices and are not included
  - Transportation costs not included
- Implications

Renewable Biomass (PL 110-140)

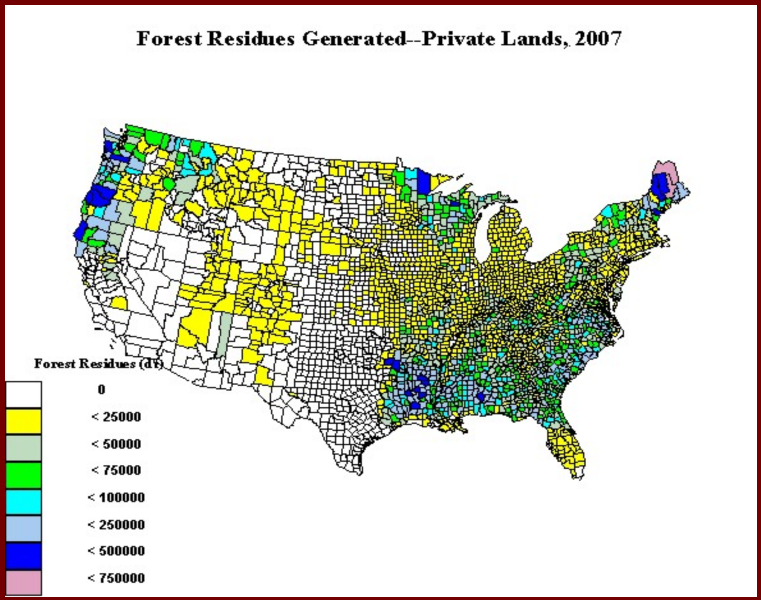
- Planted crops/crop residues from non-forested agricultural land cleared/cultivated/managed prior to passage of bill
- Planted trees/tree residues from actively managed tree plantations
- Slash/pre-commercial thinnings from non-federal forestlands
- Separated yard waste/food wastes
- Biomass from immediate vicinity of occupied buildings at risk from wildfires (wildland-urban interface)
- Animal wastes/byproducts
- Algae

Forestry Residues

Forest Residues Generated, 2007* (million dry tons)				
	National Forests	Other Public	Private	Total
Slash	1.4	3.8	57.9	63.0
Thinnings	0.6	1.6	22.6	24.7
Total	2.0	5.3	80.4	87.8

* Includes chipping costs

Forest Residue Collection Costs (million dry tons)				
	$30/dt	$40/dt	$50/dt	$100/dt
2007	10.5	32.6	41.6	50.5



Fuel treatment resources--100-200 million acres at risk; 124 to 445 total dt in 15 western states with less in wildland-urban interface (areas near buildings). Removal rates of 20-30 dt/ac. Estimated costs are $250-$2500/ac; $35-$62/dt. From 2001-2007, mechanical thinning on 3.77 million WUI acres.

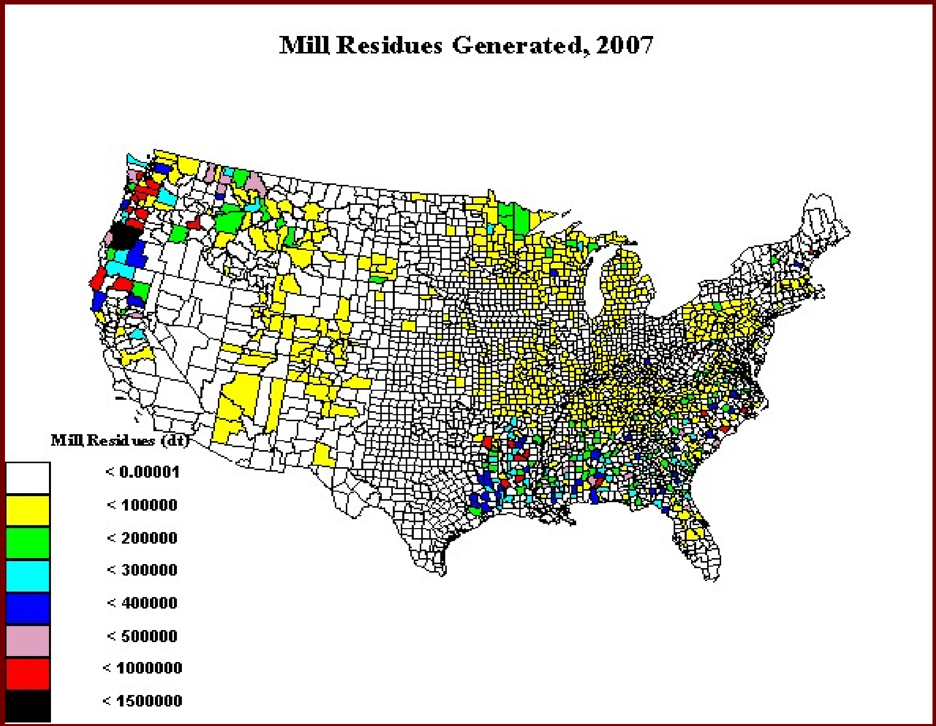
Pine Plantations—30 million acres in SE. Typically thinned once in 20-25 year rotation removing 5-10 dt/ac; about 300,000 acres thinned per year.

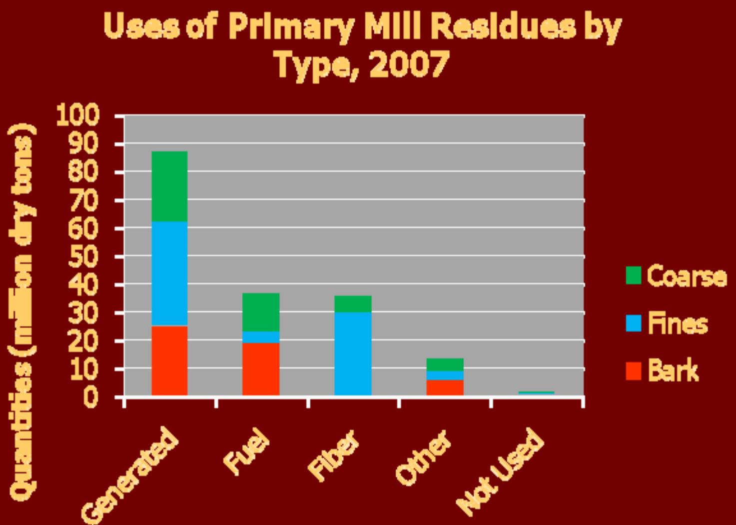
Primary Mill Residues

Mill Residues, 2007 (million dry tons)	
Generated	86.7
Not Used	1.3

Costs of Mill Residues* (million dry tons)				
	$30/dt	$40/dt	$50/dt	$100/dt
2007	6.0	20.1	42.4	51.0

*Cost = Size reduction, estimated value in existing uses





Urban Wood Wastes

Estimated Quantities of Urban Wood Wastes Generated (million dry tons)			
	Generated	Total Clean	Yard Trim Only
2010	50.6	22.7	8.6

Wood in MSW, Yard Trimmings, Construction, Demolition, and Renovation Wastes

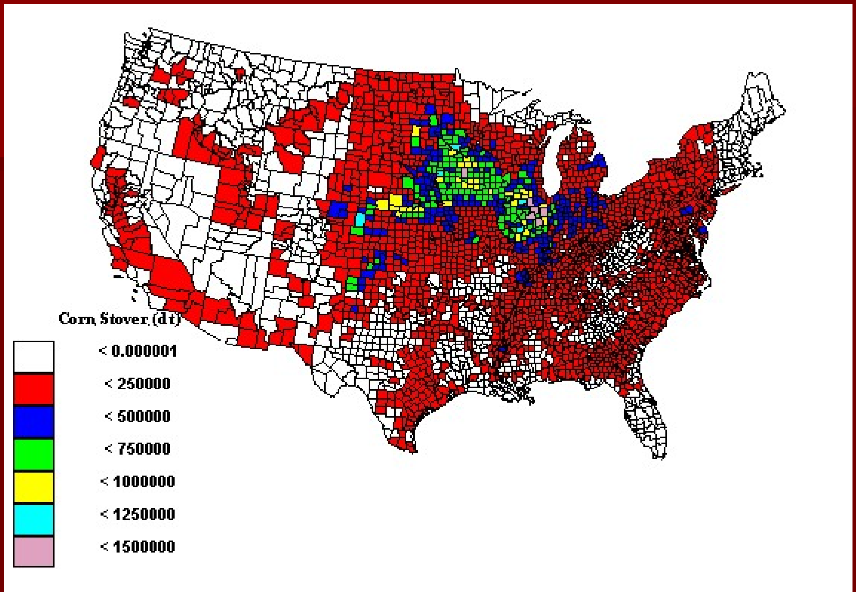
Costs of Yard Trim Wood*					
	$20/dt	$30/dt	$40/dt	$50/dt	$100/dt
2010	2.1	3.4	3.5	4.3	6.4

* Cost = Sort, size reduction, estimated value in existing uses

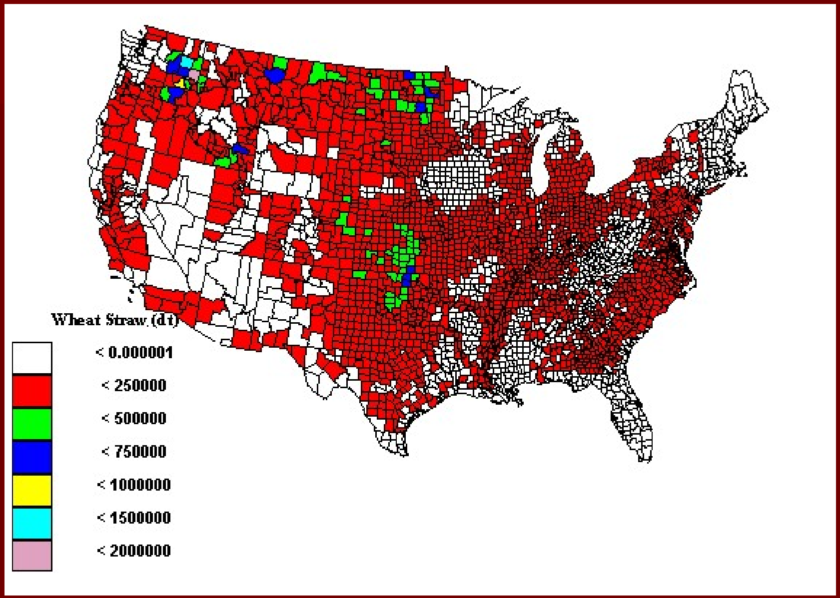
Ubiquitous and everywhere in small quantities and concentrated in metropolitan areas—but not necessarily cheap

Crop Residues (Corn Stover and Wheat Straw)

Corn Stover Generated—2005



Wheat Straw Generated--2005



	Quantities Corn Stover Generated (million dry tons)	Quantities Wheat Straw Generated (million dry tons)
2005	303	92.4

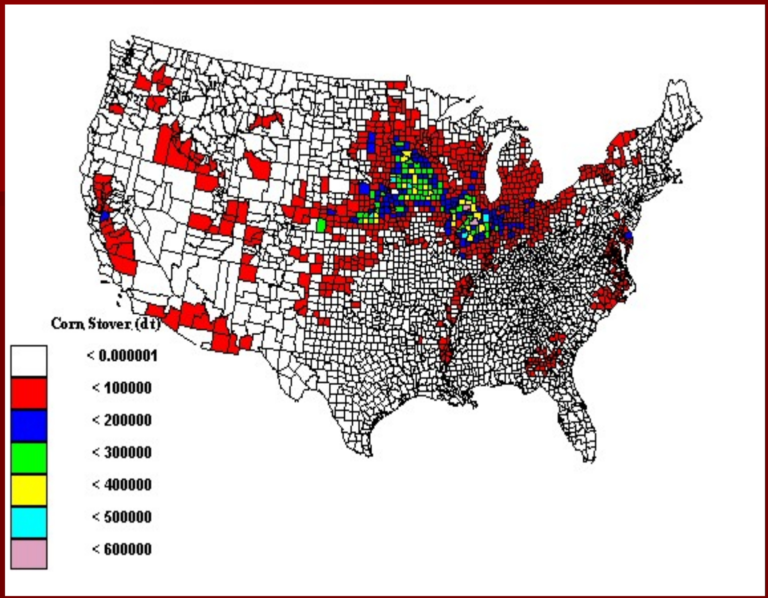
Ag residues play crucial role in controlling erosion and maintaining health and long term productivity of soil

Quantities that must be left are a function of soil type and topography, climate, crop rotation and management practices, particularly tillage

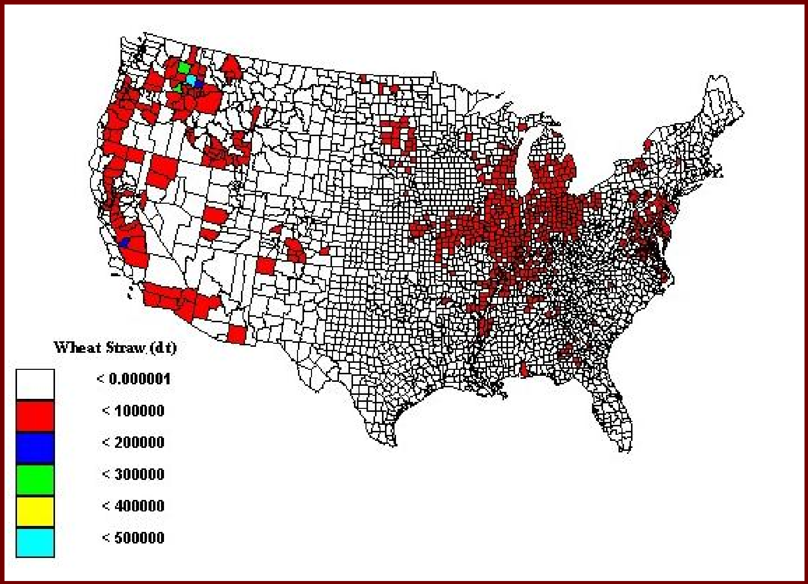
Available Corn Stover Quantities—2005 (million dry tons)		
	100% No-Till	
	Erosion	Erosion/Carbon
Continuous Corn Rotation	228	173
Corn-Soybean Rotation	195	154
	Current Mix of Tillage Practices	
	Erosion	Erosion/Carbon
Continuous Corn Rotation	141	102
Corn-Soybean Rotation	128	80

Crop Residues (Corn Stover and Wheat Straw)

Available Corn Stover



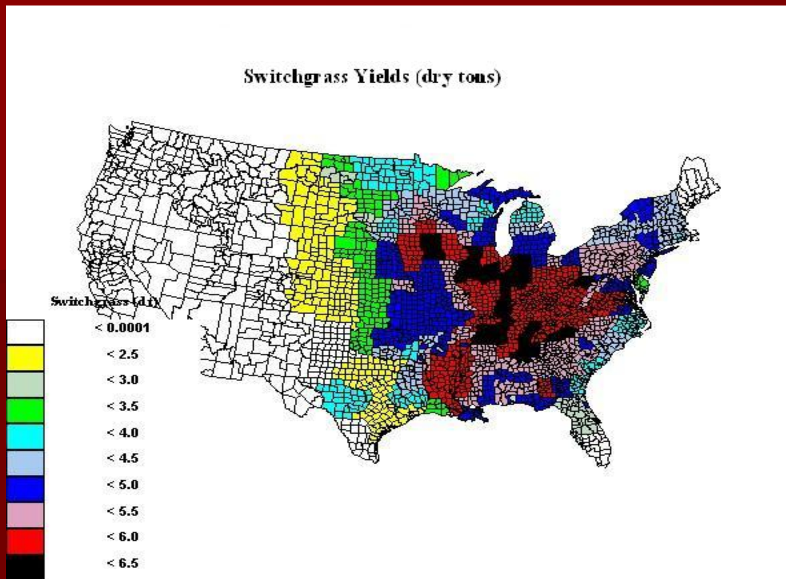
Available Wheat Straw

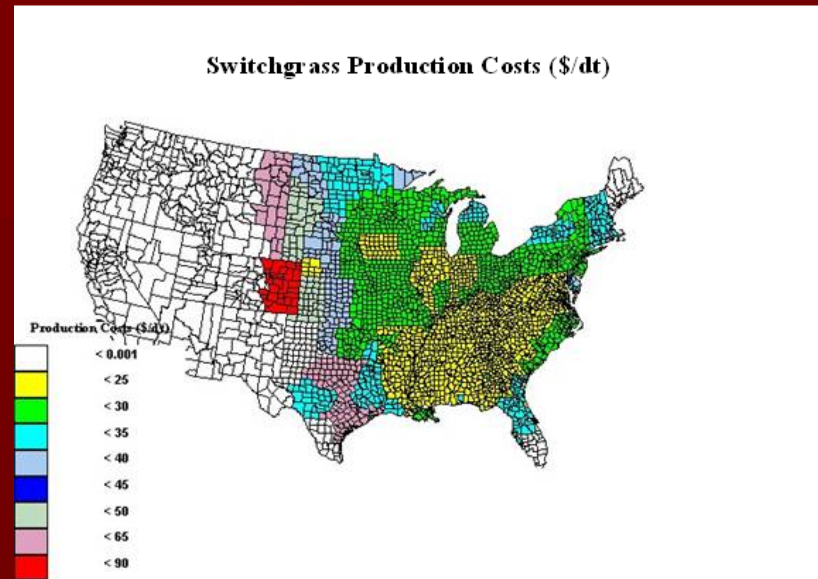


	Costs of Available Crop Residues (million dry tons)* 2010 Management, Technology, Projected Acres & Yields			
	$30/dt	$40/dt	$50/dt	$100/dt
Corn Stover	0.4	76.1	89.8	105.9
Wheat Straw	0.5	1.6	5.2	6.1

*Costs = Collection cost (round bales), fertilizer replacement cost

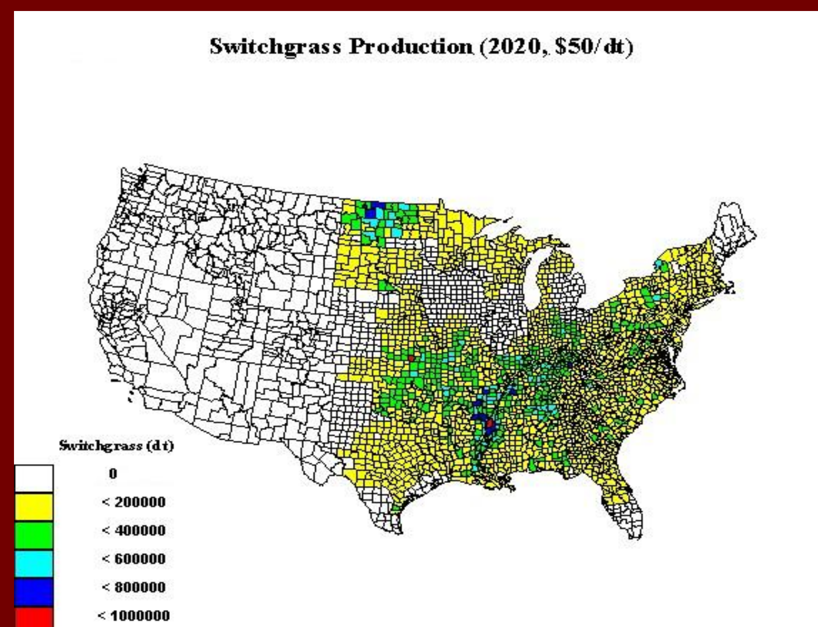
Energy Crops (Switchgrass)--Potential



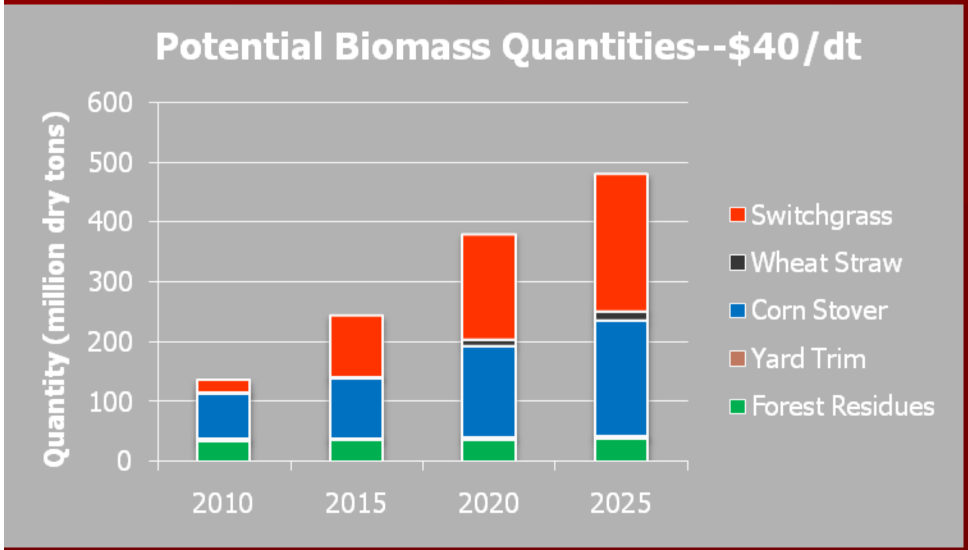


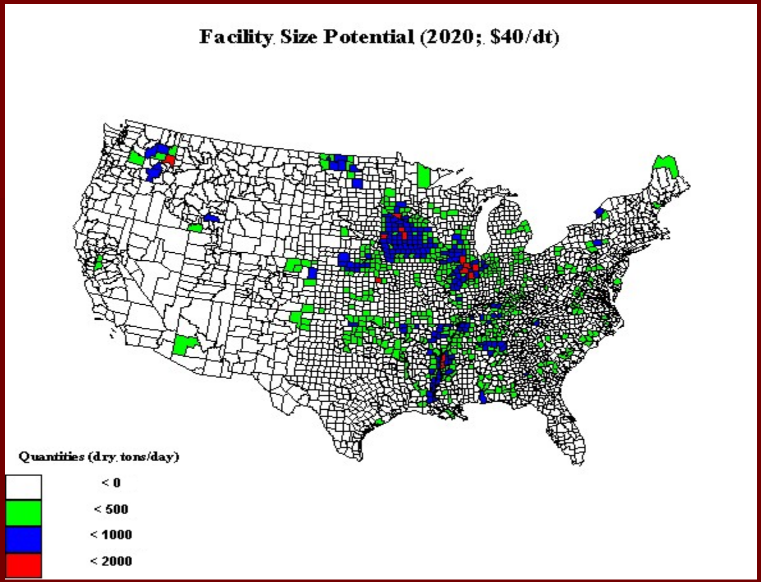
	Costs of Switchgrass* (million dry tons)		
	$30/dt	$40/dt	$50/dt
2010	12.5	20.5	27.4
2020	119.9	176.8	230.8

*Cost based on yields, production costs of switchgrass and profits of existing land use. Uses USDA 2006 Baseline



Meeting the RFS Quantity





Individual counties with sufficient total biomass quantities to support 500, 1000, and 2000 dMt/day Facilities; 2020 technology; $40/dt collection costs; 100% participation

Target Cellulose Ethanol Quantities (billion gallons)			
2010	2015	2020	2022
0.1	3.0	10.5	16.0

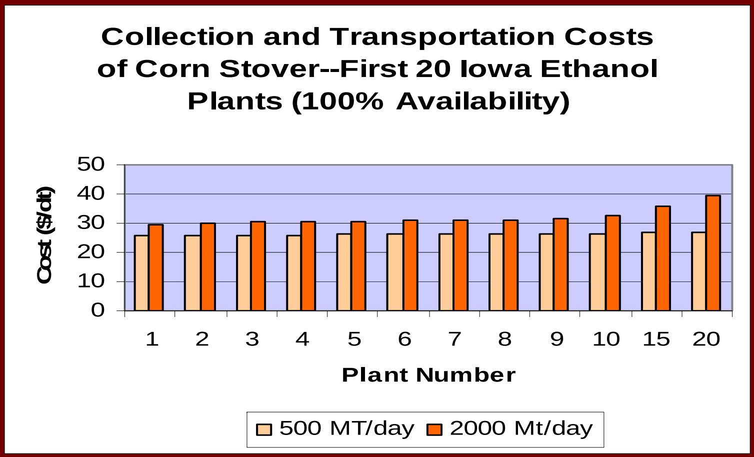
Potential Cellulose ETOH Quantities—100% Participation; $40/dt (billion gallons)									
	Year 2010			Year 2015			Year 2020		
Gal/dt	60	80	100	60	80	100	60	80	100
Residues	7.0	9.3	11.7	8.6	11.4	14.3	12.2	16.3	20.4
Switchgras	1.2	1.6	2.1	6.1	8.1	10.2	10.6	14.1	17.7
Total	8.2	11.0	13.7	14.6	19.5	24.4	22.8	30.4	38.1

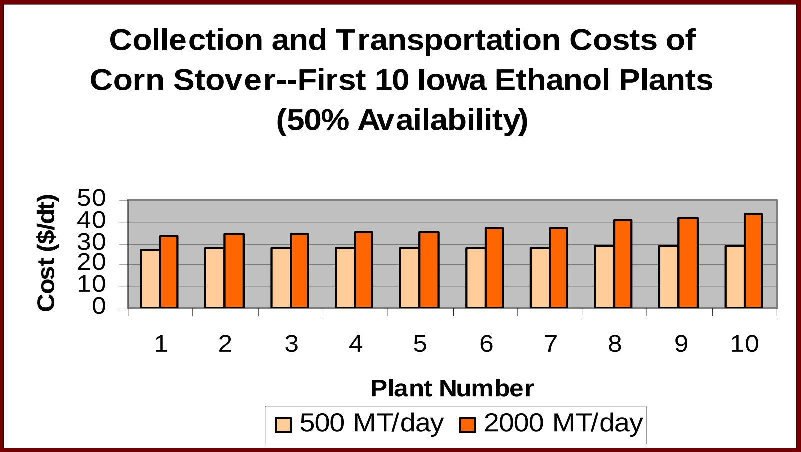
RFS Cellulose Feedstock Definition

- Relatively restrictive
  - Feedstocks that don't meet the definition
  - Not all feedstocks meeting definition are accounted for in this analysis
- Significant cellulose feedstock quantities
  - Not as much nor as cheap as some think
- Feedstock type differs by geographic region
  - Supply logistics will vary due to differences in farm scale, ownership, infrastructure, regulatory and tax considerations, etc.
- Available ***residue*** quantities marginal for existing RFA and may be insufficient to support higher demand levels
  - Energy crops
  - Expanded role for forestry?

Feedstock Distribution

- Under existing conditions, concentration of feedstocks in many areas is insufficient to economically support large facilities (> 2000 dMt/day), especially when feedstock supply variability, supplier participation levels, infrastructure, and order of plant construction (1st vs. 10th) are considered





Feedstock Distribution

- Change the feedstock-increase investments
- Develop smaller scale conversion processes (<1000 dMt/day)
  - Small distributed vs. large centralized systems
    - Less pressure on feedstocks and other resources
    - Energy security (terrorism)
    - Production reliability (Hurricane Katrina)
    - Economic development (higher with more small plants)
- Develop processes to use multiple feedstocks
  - Synergies on the feedstock side that might offset higher conversion costs
  - Reduce costs during supply shortfalls
  - Flexibility/adaptability in a highly uncertain and volatile environment

Near Term Needs

- Develop infrastructure to permit rapid scale-up of energy crop production
- Develop minimal guidelines for residue removal
- Conduct analysis that recognizes not only food, feed, and fiber needs, but also the simultaneous development of multiple biofuels, biopower, and bioproducts using multiple feedstocks
  - Geographically disaggregated
  - Systems approach
  - Stochastic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