Growing Demand for Biomass …

Putting It All Together: The Tennessee Biomass Innovation Park

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RFS2 Requires Aggressive Buildout …

USDA Biofuels Strategic Production Report
June 23, 2010

A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard by 2022

Advanced Biofuel Production from New Capacity (billion gallons)

Region	% of Total Advanced Volume	Advanced biofuels		Total Advanced	Total Advanced
		Ethanol	Biodiesel	Volume	RFS2 Basis (1)
Southeast (2)	49.8	10.45	0.01	10.46	10.47
Central East (3)	43.3	8.83	0.26	9.09	9.22
Northeast (4)	2.0	0.42	0.01	0.42	0.43
Northwest (5)	4.6	0.79	0.18	0.96	1.05
West (6)	<.3	0.06	0.00	0.06	0.06
United States		20.55	0.45	21.00	21.23

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A Southeast Target …

USDA Biofuels Strategic Production Report
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Southeast

Potential Production Capacity. This region could produce 10.5 billion gallons of advanced biofuels per year, at 263 biorefineries producing 40 million gallons by year, costing $320 million per biorefinery. This will take an $83.8 billion cumulative investment, to build the 263 biorefineries with an average capacity of 40 million gallons. USDA estimated that a significant amount of volume, up to 50%, of the advanced biofuels, could come from this region because it has the most robust growing season in the United States that supports the highest gallons-per-acre crops of all biofuels crops. One advanced fuel biorefinery is expected to open in August of 2010 in Louisiana, with expected production of 75 million gallons.

Land Use. In this region there is an acreage base of 83.4 million acres of cropland and cropland pasture and 182.8 million acres of forest land. To produce the biofuels necessary from this region, an advanced biofuel production of 10.5 billion gallons from 9.5 million acres, 11.4% of the available cropland and cropland pasture acreage base, would be required for fuel use.

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Biomass: The Common Denominator

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Tailoring Biomass Supply Chain Solutions

Biochemical Biofuels & Products

- Achieving carbohydrate structure for specific conversion processes
- Blending, if at all, within species for a commodity market like wheat

Thermochemical Biofuels & Heat/Power

- Achieving ash, moisture & rheological property specs
- Blending to produce a commodity market like corn or coal

Petroleum Refinery Markets

- Achieving energy density & feedstock stability
- Blending to produce a stabilized liquid "bio-crude" for a commodity market like petroleum crude

Biomass Selection & Pre-Processing

*While **one size** of feedstock **may fit** all downstream conversion uses*

…

*It **doesn't mean** that one size/type/ source/ spec is necessarily the most **efficient or cost effective** for all downstream conversion uses*

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Feedstock Characteristics

Perennial Energy Crops

- Multi-year production decision
- High up-front establishment costs
- Slow yield ramp after establishment
- Minimal annual production risk post-establishment
- Moderate/high yield

Annual Energy Crops

- Annual production decision
- Full yield harvested in first crop cycle
- Higher annual production risk
- May be part of multi-year rotations
- High yield potential

Ag Residues

- Secondary value stream
- Annual quantity fluctuations
- Higher annual crop yield (production) risk
- Low annual yield potential

Forest Residues

- Secondary value stream
- Quantity limited by primary products
- Potentially high collection cost
- Low annual yield potential

Short Rotation Woody Crops

- Multi-year production decision
- High up-front establishment costs
- Slow yield ramp after establishment
- Moderate yield potential

Time Horizon, Risk, Capital Investment, Downstream Processing

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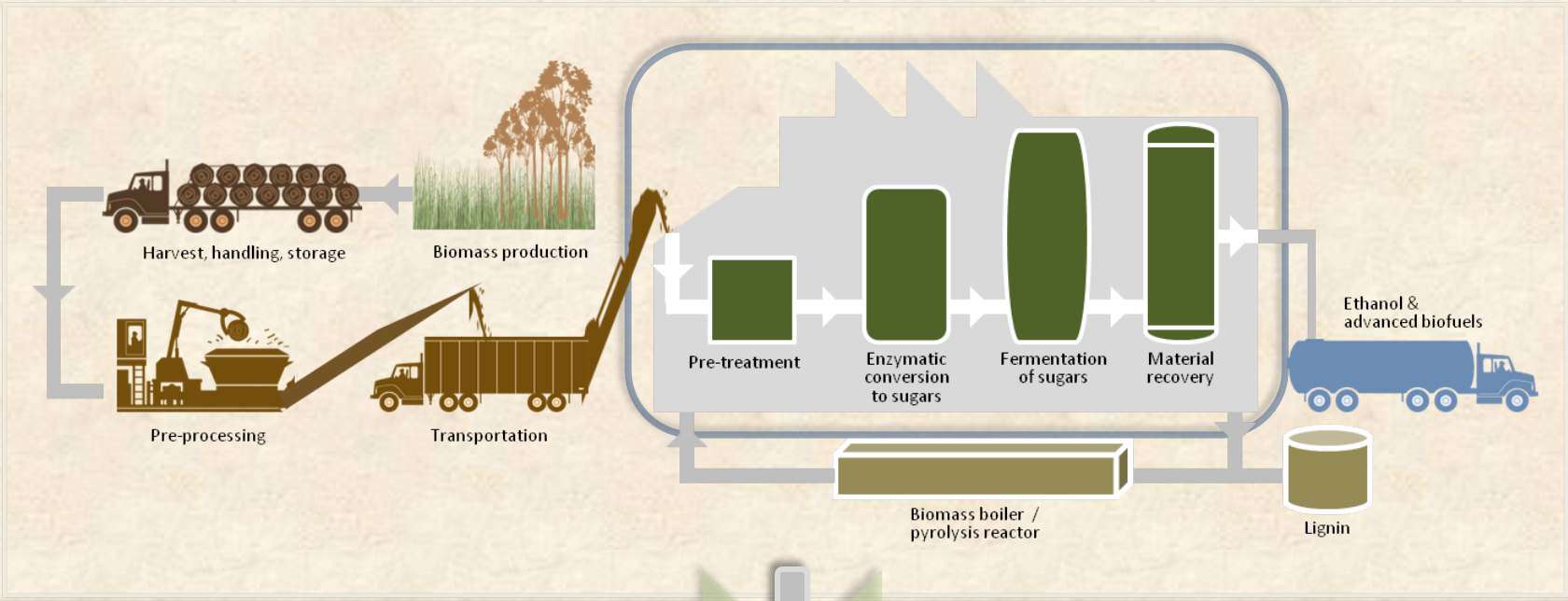
Integrated Industry Value Chain



- Land Management
- Crop Production & Management
- Harvesting/Collection & Aggregation
- Handling & Storage
- Pre-Processing & Densification
- Value-Added Pre-Treatment
- Transportation & Logistics
- Feedstock Delivery

- Feedstock Receiving
- Pre-Processing
- Pre-Treatment
- Saccharification
- Fermentation
- Distillation
- Product Recovery
- Offtake/Marketing

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Tennessee's Comprehensive Approach

BIOFUELS INITIATIVE

Energy Crop Supply Chain

Demonstrate the establishment of a dedicated biomass energy crop supply chain with farmer

AgResearch Extension

Biofuels, Bioproducts R&D

Establish premier RD&D capabilities and capacity in biofuels and bioproducts

BESC BioEnergy Science Center · SunGrant INITIATIVE · Oak Ridge National Laboratory

Commercialization

Develop a viable, sustainable, long-term path to commercialization of cellulosic biofuels in Tennessee

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$70.5 Million
State Commitment

Cellulosic Ethanol Biorefinery

Demonstrate the pre-commercial production of ethanol from switchgrass

DDCE DuPont Danisco Cellulosic Ethanol LLC · Genera energy

Switchgrass as an Energy Crop

- Warm season, native, perennial grass
- Well suited to the Southeast
  - — Currently, ~6-10 tons/acre in TN
  - — Potential for 12+ tons/acre
- Tolerates poor soils, flooding, drought
- Low input use
  - — No irrigation, 60 #/ac N, no P & K, no pesticides or fungicides, minimal herbicides
- 1-2 year establishment
  - — Weed control critical in establishment
- Works with existing infrastructure
- Noninvasive, may be removed, improves soil quality
- UT research focus for 20+ years

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Tennessee Switchgrass Experience

- Since 2008, contracting with local farmers to produce >5,000 acres of switchgrass
  - 1,000 acres improved varieties
- One annual harvest after first killing frost
  - In TN, November-February
- Begin harvest first year
- Averaging about 8 tons/ac by 3rd year
  - Harvesting ~2 tons in year 1
  - ~5 tons in year 2
  - ~8 tons year 3 and beyond
- Builds soil carbon

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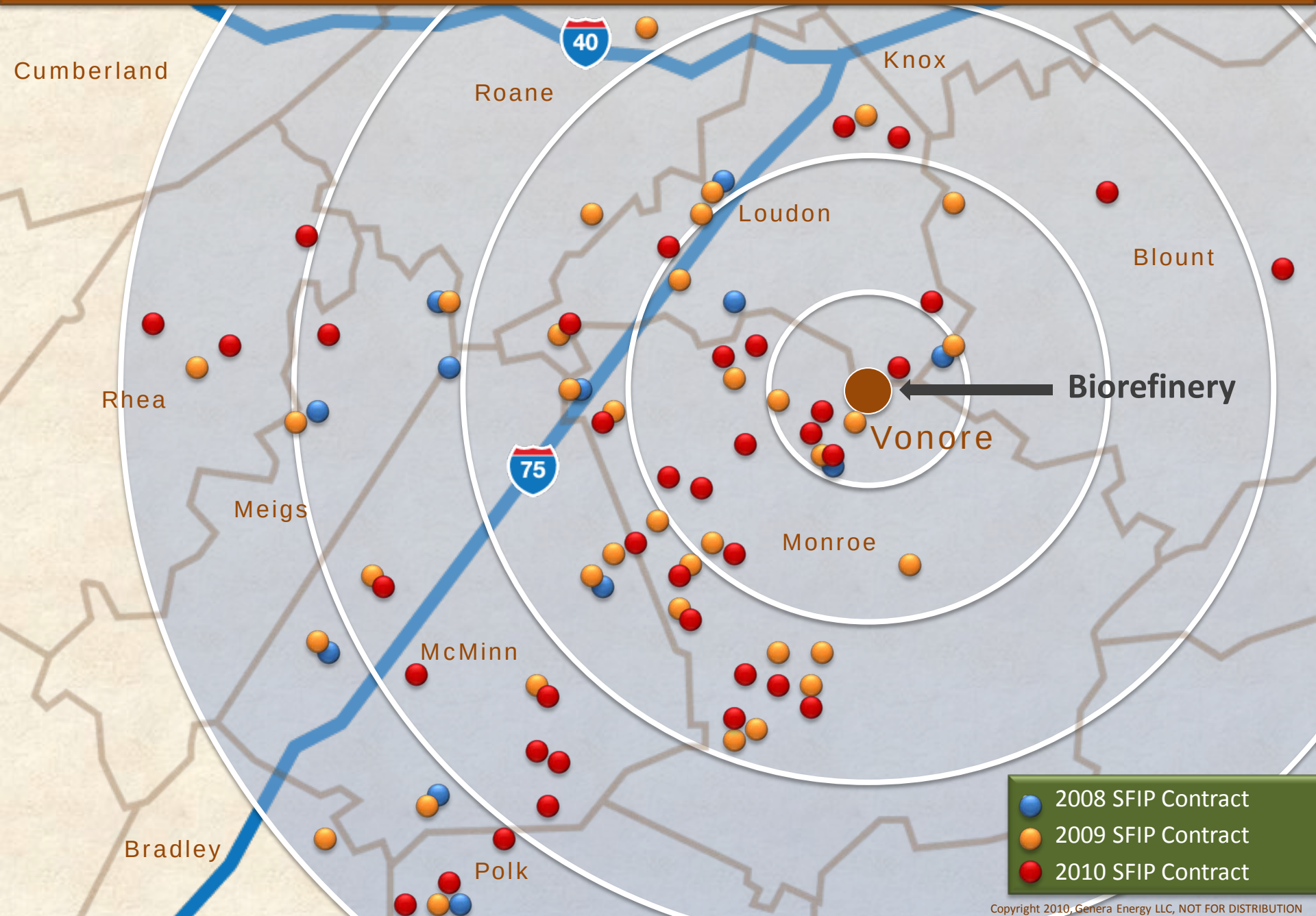
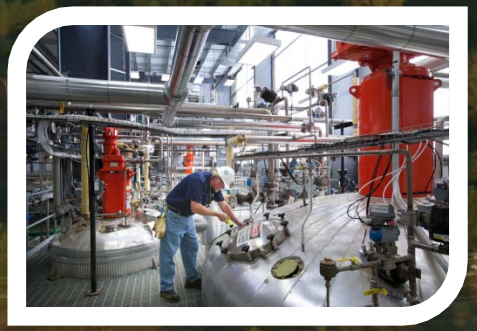
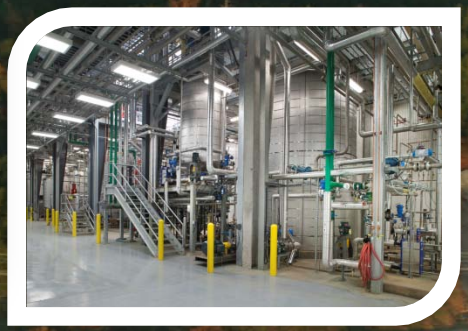
Switchgrass Contract Farms



Cellulosic Ethanol Biorefinery





- Vonore, Tennessee: Niles Ferry Industrial Park, Monroe County, 32 acre site
- 250,000 GPY demo plant and Process Development Unit (PDU) pilot plant
- Collaboration between Genera Energy and DuPont Danisco (DDCE)
- Optimized as precursor to commercial facility
- Multiple feedstocks: cob, stover, switchgrass
- Started operations December 2009
- Long-term operation as an RD&D facility

DDCE
DuPont Danisco Cellulosic Ethanol LLC

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Biomass Handling Today…

Integrated Biomass Supply Chain

Biomass Production & Harvest

Handling, Storage, Transportation

Pre-Processing & Densification

Value-Added Pre-Treatment

Industrial Processing

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Tennessee Biomass Innovation Park

- World-class RD&D campus
- Integrates entire biomass supply chain
  - Harvest, handling, storage, densification, logistics
  - Pre-processing
  - High throughput screening and analysis
  - Agronomics, plant genetics, production
  - Intermediate processing and conversion
- Multiple feedstocks
- Site for $5M DOE-funded high tonnage bulk handling demonstration
- Processing operational by summer 2011
- Strategic partnership opportunities
- Template for regional biomass depots

Conceptual Rendering: July 2010

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Biomass Innovation Park Timeline

2010

- Phase I (receiving, storage) to be completed by the end of 2010

2011

- Phases II & III (processing and DOE-funded high-tonnage switchgrass bulk handling system to be completed by Q2 2011

2012

- Working with switchgrass-to-hydrogen technology partner to demonstrate pre-commercial scale unit for power generation
- Potential to develop/demonstrate integration of novel pretreatment

2013

- Seeking grant funding (with UT) to add biomass characterization and analytical laboratories
- Potential to expand footprint to demonstrate gasification, pyrolysis, other conversion technologies or feedstocks

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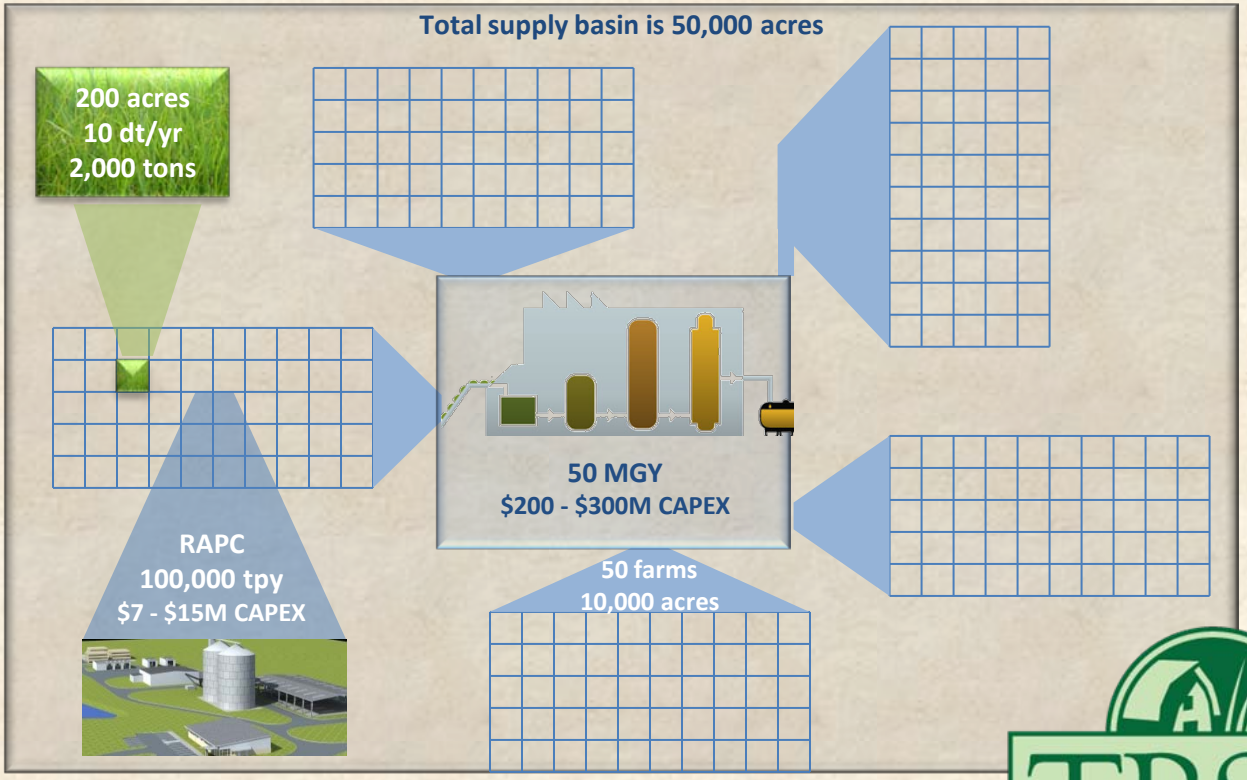
RAPC – Regional Aggregation & Processing Cooperatives



Hub & spoke supply system (RAPC) for supplying, aggregating, storing, processing, marketing biomass is a natural fit for a value-added farmer processing cooperative

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Challenges to Industry Buildout

- Feedstock supply risk to biorefinery
  - Real or perceived
- Availability of, access to financing
  - Conversion facility
  - Biomass supply
- Policy uncertainty
- Maintaining momentum

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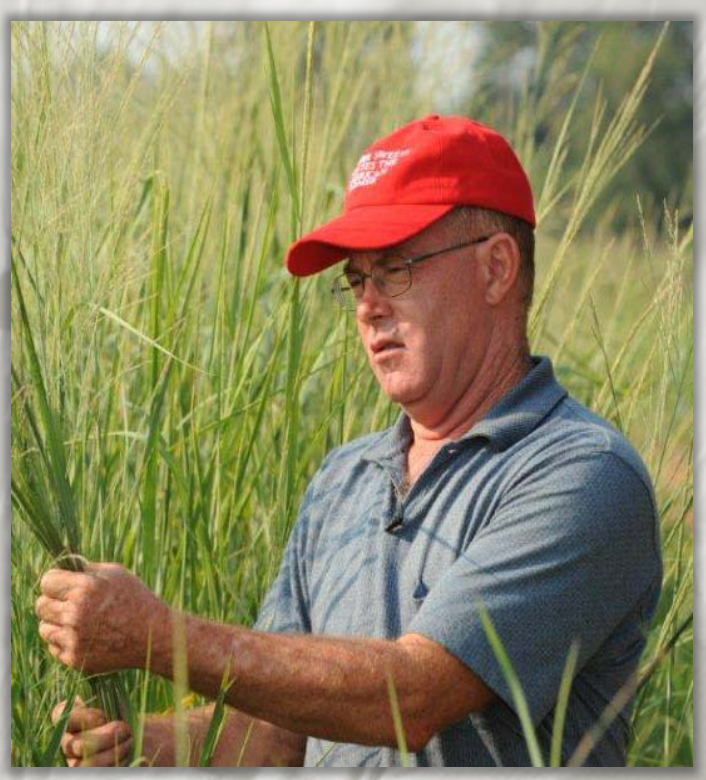
Biomass Supply Chain Structure Drivers

- Required length for supply agreements
  - Matching conversion facility time horizon with crop cycles
  - Perennial crops
  - 20 years?
- Technology treadmill
  - Technology improvement curves
- Managing cash flow
  - Particularly before plant start-up
- Quality control



Points to end-to-end solutions across entire value chain

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Tennessee Leading by Example

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