Estimating and Comparing Alternative Ethanol Processes and Feedstock Choices

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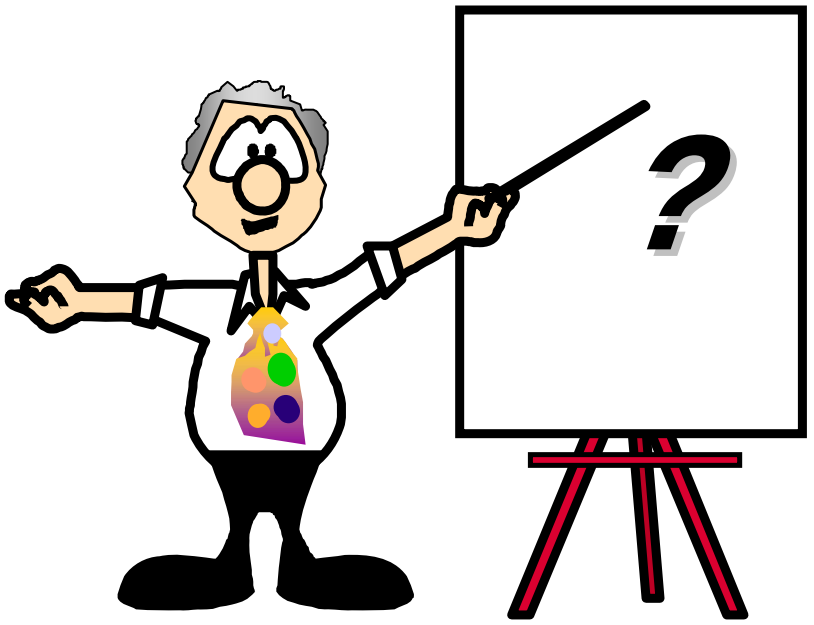
Overview

- Background
- Objectives
- Data & Methods
- Operational Assumptions
- Results & Conclusions



Background

- Grain Based Ethanol – Out of Favor with Some
- Cellulosic Ethanol Feedstocks
  - Non-competitive with food supply chain
  - Sufficient crop density
    - Minimize transportation costs
  - Maximize energy yield
  - Catch 22: most productive cropland is most competitive
    - May be economically prohibitive for biorefinery
  - “Marginal” growing areas may be better suited

Background

- Early Studies Identified Switchgrass
  - Led by Oak Ridge National Laboratory in 1990s
- Subsequent Economic Research Centered Around Switchgrass
  - USDA (De La Torre Ugarte et al, 2003)
  - University of Tennesee (English et al, 2006)
  - Oklahoma Sate University (Mapemba et al, 2007; Epplin et al, 2007)
  - Additional Research: Iowa State, University of Nebraska
- Other Feedstocks: Texas A&M University, University of Florida, Louisiana State University

Objectives

- Estimate Delivered Cost of Alternative Feedstock Mixes
- Estimate the Total Cost of Producing Ethanol Across Alternative Production Processes
  - Grain ethanol process
  - Cellulosic ethanol – MixAlco process
  - Brazilian ethanol process

Data

- Feedstock Production
  - Texas A&M Agronomists
  - Grower Panel
- Ethanol Production Processes
  - Grain process: Bryan & Bryan International
  - Cellulosic MixAlco process: Lau dissertation
  - Brazilian process: Brazilian industry representatives
- Historical Prices
  - NASS, DOE-EIA, FAPRI, Hart Energy
- Price & Inflation Forecasts: FAPRI

Methods

- Feedstock Production Model
  - Partial budget analysis
  - Monte Carlo simulation
  - Estimates delivered cost for alternative feedstock mixes
    - Two stage contract: Fixed minimum contract price per acre & additional per unit payment on actual yield
    - Harvest & transportation cost
- Ethanol Processing Model
  - Biorefinery Monte Carlo simulation
  - Maintains standard accounting relationships to estimate financial performance
  - Estimates total processing cost across alternative production processes and feedstock mixes

Operational Assumptions: Grain Process

Grain Ethanol		
Proposed Capital Cost	$/gallon of ethanol	2.25
Ethanol Processing Costs	$/gallon of ethanol	0.61
Grain Ethanol yield		
Corn	gallons/ bushel	2.75
Sorghum	gallons/ bushel	2.75
DDGs yield	pounds/bushel	18.00
Local Basis		
Corn	$/bushel	0.05
Sorghum	$/bushel	0.15
Denaturant added	fraction	0.05

Operational Assumptions: Cellulosic Process

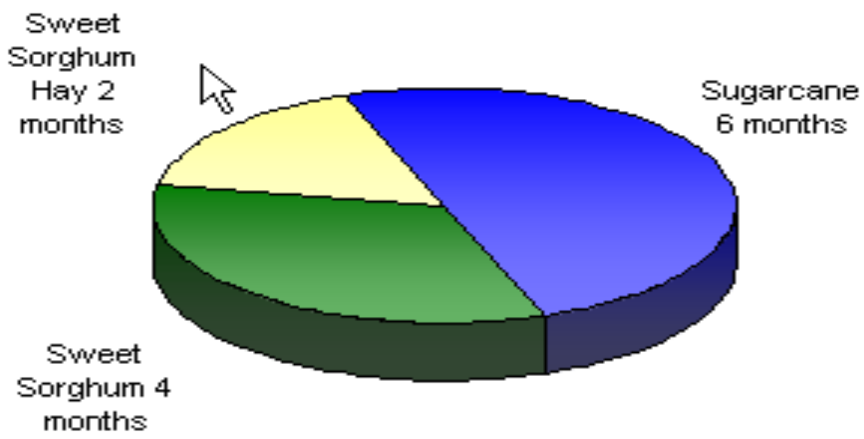
Cellulosic Ethanol		
Proposed Capital Cost	$/gallon of ethanol	0.63
Percent Dry Matter		
Sweet Sorghum	fraction	0.30
Sweet Sorghum Hay	fraction	0.85
Sweet Sorghum HB	fraction	0.40
Sugarcane	fraction	0.33
Ethanol Processing Costs	$/gallon of ethanol	1.25
Cellulosic Ethanol Yield		
Yield for Contracting Acres	gallons/ton of dry matte	90.00
Yield Parameters for Production		
Min	gallons/ton of dry matte	70.00
Med	gallons/ton of dry matte	90.00
Max	gallons/ton of dry matte	110.00
Denaturant added	fraction	0.05

Operational Assumptions: Brazilian Process

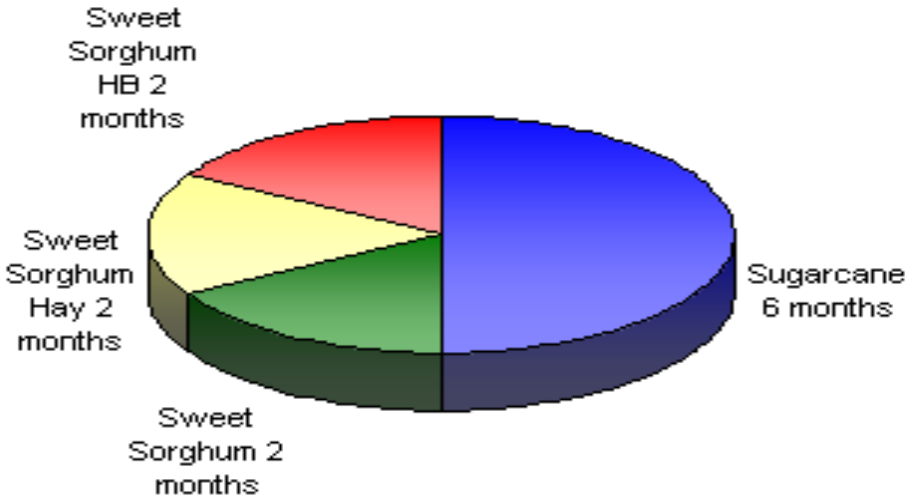
Brazilian Ethanol		
Proposed Capital Cost	$/gallon of ethanol	6.07
Percent Dry Matter		
Sweet Sorghum	fraction	0.30
Sugarcane	fraction	0.33
Brazilian Ethanol Yield		
Sweet Sorghum	gallons/ton of dry matte	49.00
Sugarcane	gallons/ton of dry matte	61.68
Cane Processing Costs	$/gallon of ethanol	0.19
Ethanol processing costs	$/gallon of ethanol	0.38
Grain Ethanol Backup		
Grain Ethanol yield		
Corn	gallons/ bushel	2.75
Sorghum	gallons/ bushel	2.75
DDGs yield	pounds/bushel	18.00
Ethanol processing costs	$/gallon of ethanol	0.61
Denaturant added	fraction	0.05

Cellulosic Feedstock Mixes

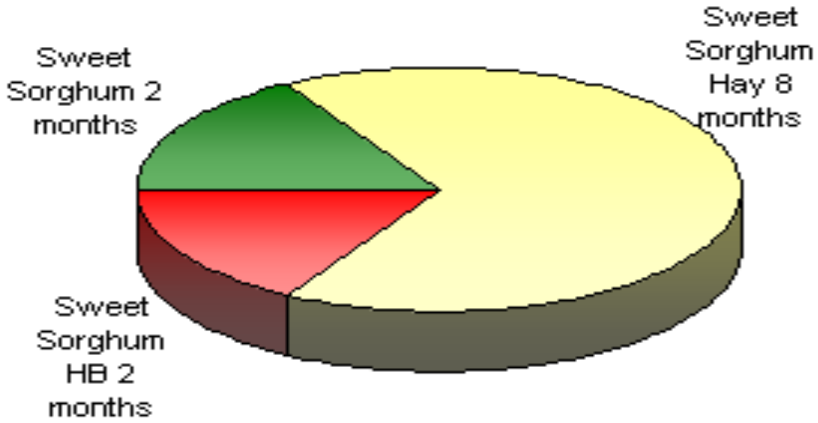
Feedstock Mix 1



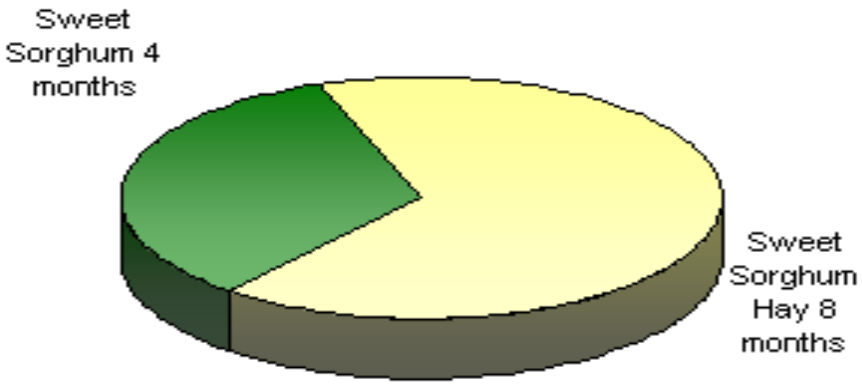
Feedstock Mix 2



Feedstock Mix 3

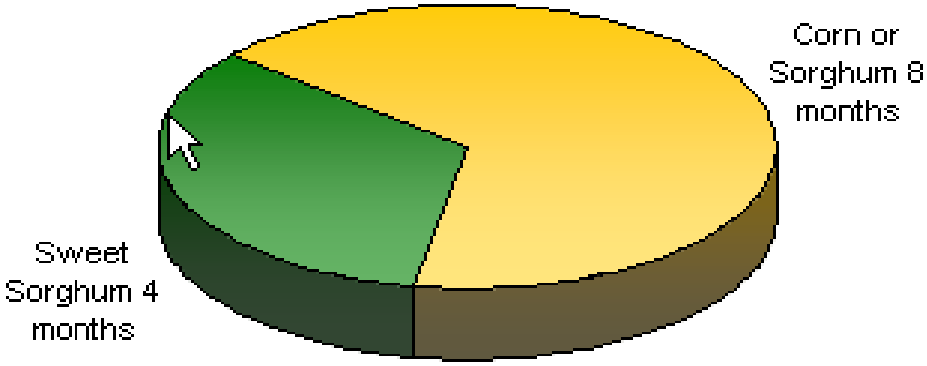


Feedstock Mix 4

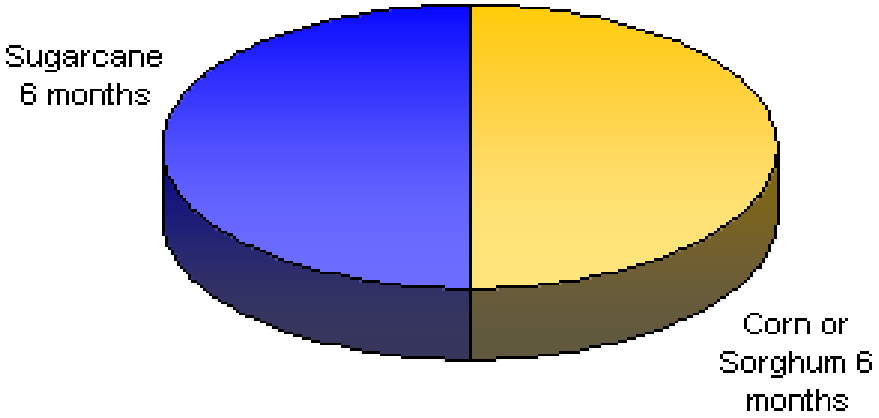


Brazilian Feedstock Mixes

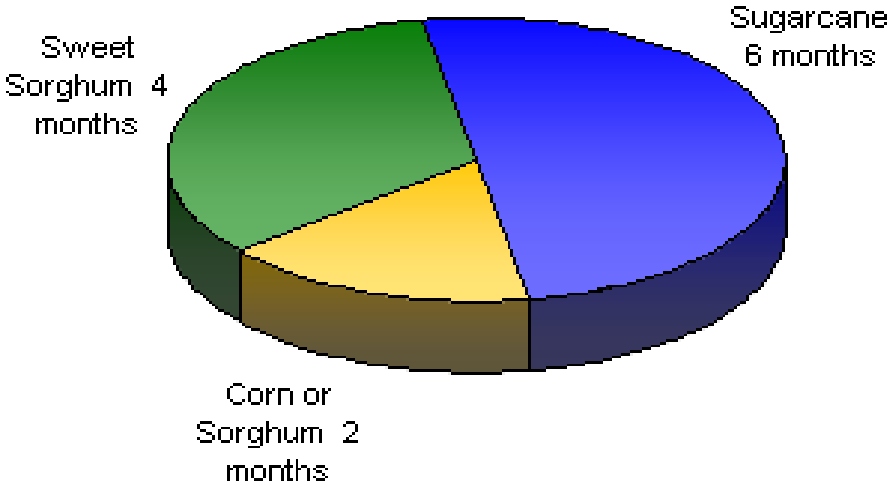
Feedstock Mix 1



Feedstock Mix 2



Feedstock Mix 3



Delivered Feedstock Cost

		Feedstock Mix			
		1	2	3	4
Grain					
Corn	$/bu	3.34			
Sorghum	$/bu	3.18			
Cellulosic					
Sweet Sorghum	$/ton dry matter	87	85	85	87
Sweet Sorghum Hay	$/ton dry matter	116	116	121	121
Sweet Sorghum HB	$/ton dry matter	-	75	75	-
Sugarcane	$/ton dry matter	88	88	-	-
Brazilian					
Sweet Sorghum Billet	$/ton dry matter	89	-	89	
Sugarcane Billet	$/ton dry matter	-	89	89	

Estimated Total Cost of Ethanol Production

	Year 1
Grain	**1.99**
Corn	2.02
Sorghum	1.96
Cellulosic	**2.56**
Feedstock Mix 1	2.46
Feedstock Mix 2	2.44
Feedstock Mix 3	2.65
Feedstock Mix 4	2.67
Brazilian	**2.41**
Feedstock Mix 1	2.37
Feedstock Mix 2	2.32
Feedstock Mix 3	2.54

Grain Ethanol Sensitivity

Total Cost of Ethanol Production

		Grain Price, FOB				
	$/bu	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**
Corn	$/gallon	2.27	2.35	2.44	2.53	2.61
Sorghum	$/gallon	2.30	2.39	2.48	2.56	2.65

- Cellulosic process average: $2.56
- Brazilian process average: $2.41

Conclusions

- Delivered Prices of Non-Grain Feedstocks are Economically Prohibitive versus Baseline Price Estimates for Grain
- Of the Alternative Ethanol Processing Scenarios Analyzed, Grain Ethanol Remains the Most Economically Feasible
- The Brazilian Ethanol Process Ranks Second, Yet Becomes Competitive at $4.50 Grain Prices
- If the MixAlco Cellulosic Process Becomes Commercially Viable, it Becomes Competitive at $4.75-$5.00 Grain Prices

Thank You