BioEnergy Sorghum, Lifecycle Carbon Footprint, Market Impacts and Leakage

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Topic of the day

Energy Sorghum, Biofuels and GHGs

- Lifecycle analysis
- Leakage
- Food prices, poor and the environment
- Sorguhm as a preferred strategy as affected by GHG prices and Policy

Collaborators

Darius Adams, Oregon State
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Mahmood El-Halwagi, TAMU
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Steve Rose, EPA
Ron Sands, PNNL, Maryland
Thien Muang, TAMU
Michael Shelby, EPA

Uwe Schneider, University of Hamburg
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Francisco de la Chesnaye, EPA
Heng-Chi Lee, Taiwan
Kenneth Szulczyk, TAMU
Sharyn Lie, EPA

Sources of Support

USDA DOE
USEPA
CSiTE

An Aside

From a GHG perspective

Biofuels ≠ Ethanol

Particularly corn or sugar ethanol

GHG offset = a1 * crop ethanol
+ a2 * cell ethanol
+ a3 * biodiesel
+ a4 * bio fueled electricity

Life Cycle Analysis

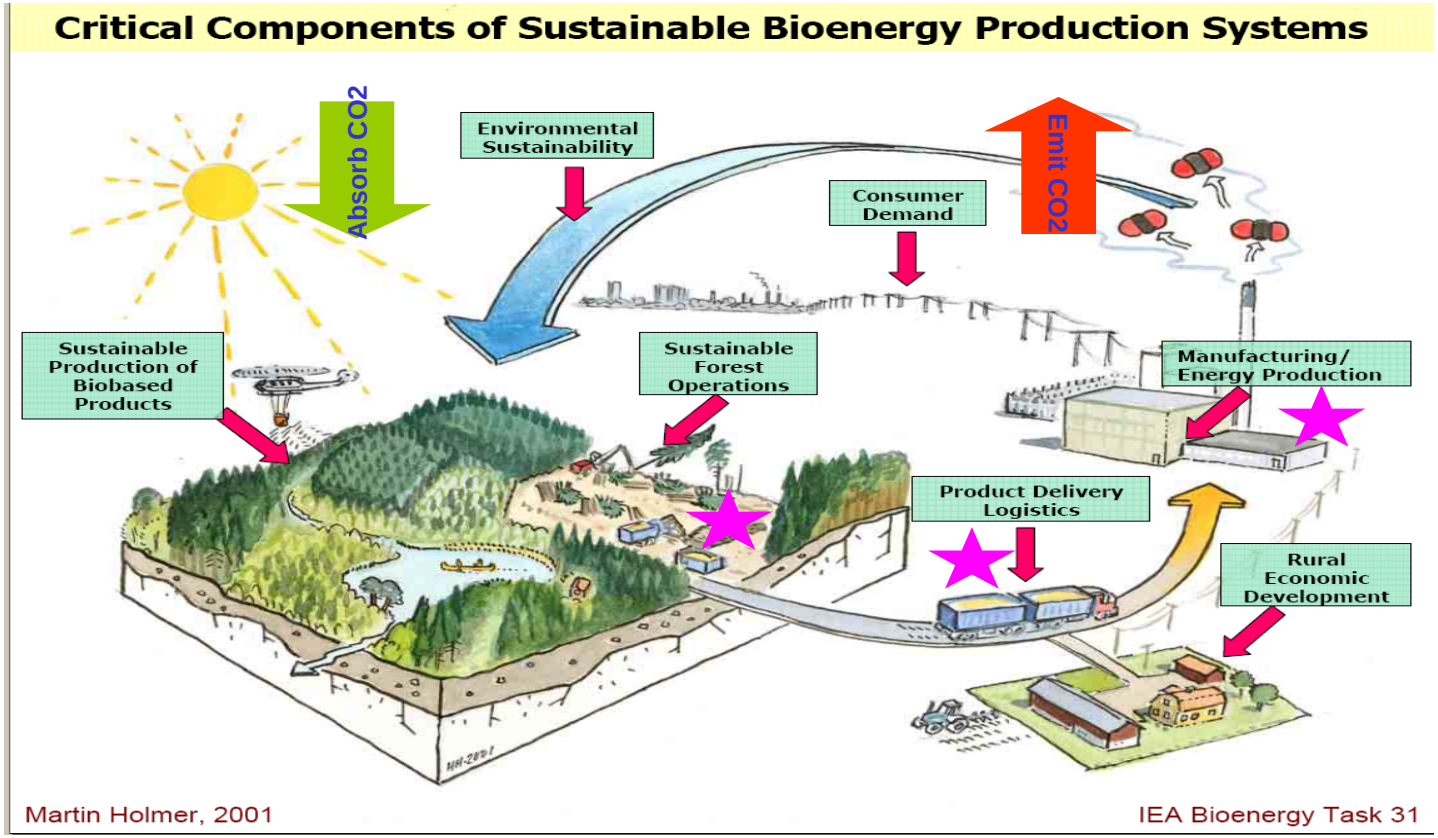
A life cycle assessment (LCA) is the investigation and valuation of the environmental impacts (GHGs for this talk) of a given product

2005 Energy Policy Act required that US gasoline contained a specified volume of “renewable fuel.”

2007 Energy Independence and Security Act (EISA) increased required volumes plus added mandates starting in 2009 for advanced biofuels.

EISA, requires LCA of GHG emissions and a minimum level of LCA based GHG reduction to qualify as an advanced biofuel.

Greenhouse Gasses and Biofuels



Please Pretend the growing stuff includes crops

Feedstocks take up CO2 when they grow then CO2 is emitted when feedstocks burned or when energy derivatives burned

But Starred areas also emit

In total they increase emissions but recycled on net

Source of underlying graphic: Smith, C.T. , L. Biles, D. Cassidy, C.D. Foster, J. Gan, W.G. Hubbard, B.D. Jackson, C. Mayfield and H.M. Rauscher, "Knowledge Products to Inform Rural Communities about Sustainable Forestry for Bioenergy and Biobased Products", IUFRO Conference on *Transfer of Forest Science Knowledge and Technology,* Troutdale, Oregon, 10-13 May 2005

Offset Rates Computed Through Lifecycle Analysis

Net Carbon Emission Reduction (%)

	Energy Form				
Commodity	Crop Ethanol	Cellulosic Ethanol	Biodiesel	Electricity Co-Fire 5%	Electricity fire100
Corn	31				
Sorghum	39				
Sugarcane	65				
Corn Residue		73		93	86
Wheat Residue		73		95	91
SwitchGrass		69		94	90
Energy Sorghum		79		98	96
Sweet Sorghum	61				
Sweet Sorghum Ratoon	63				
Soybean Oil			71		
Corn Oil			55		
Bagasse		90		100	100
Lignin				100	100

Crop ethanol<cellulosic<biodiesel<Electricity

Ethanol offsets are in comparison to gasoline Power plants offsets are in comparison to coal.

Lifecycle Analysis

LCA is being expanded as we speak due to international leakage

Last 2 years have shown effect of higher crop prices on international activity

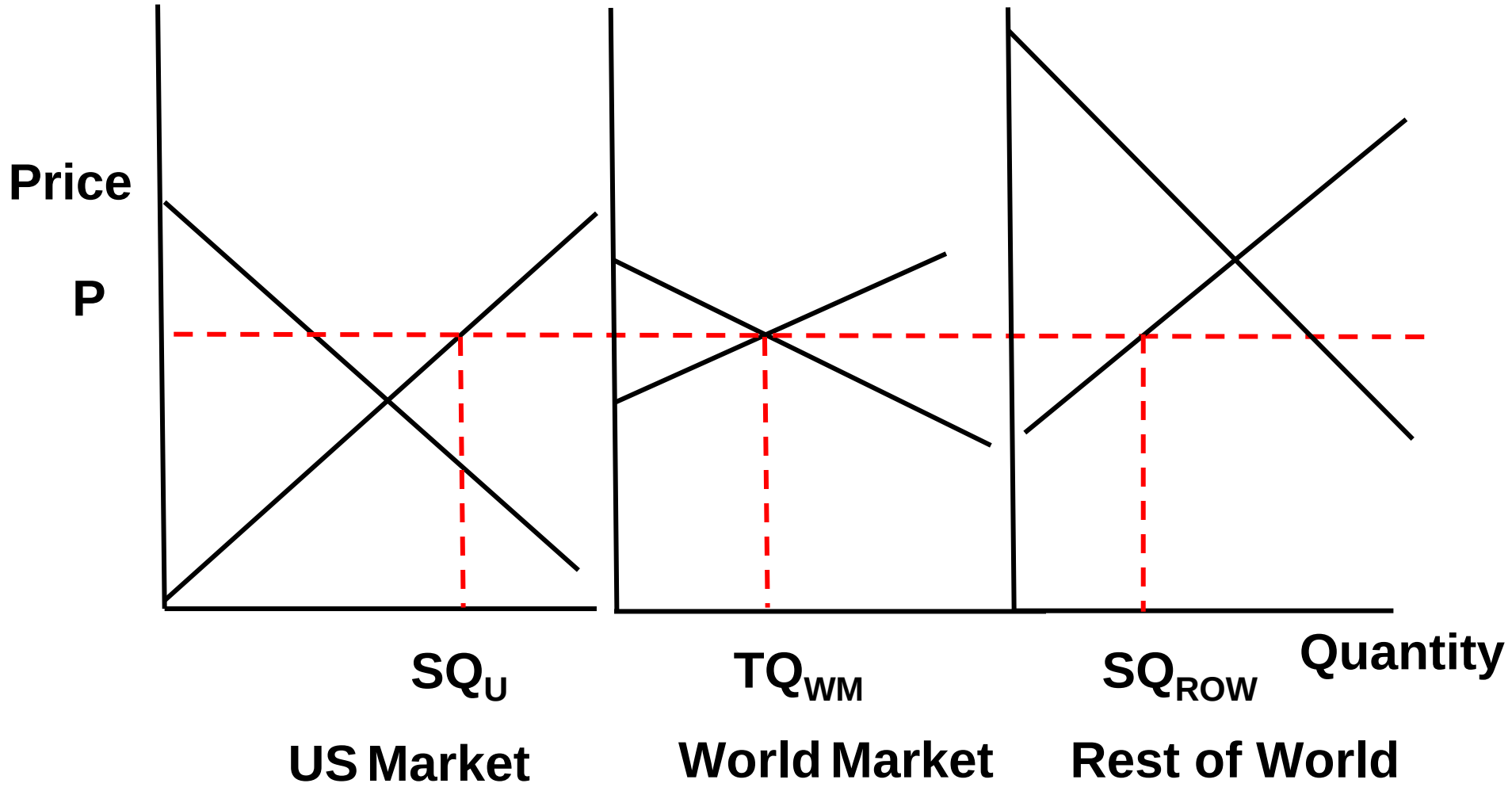
Food Prices, Incomes and Biofuels

- Today food prices have increased quite a lot
  - Corn is up by 2.5
  - Rice has almost tripled but is not a biofuel crop

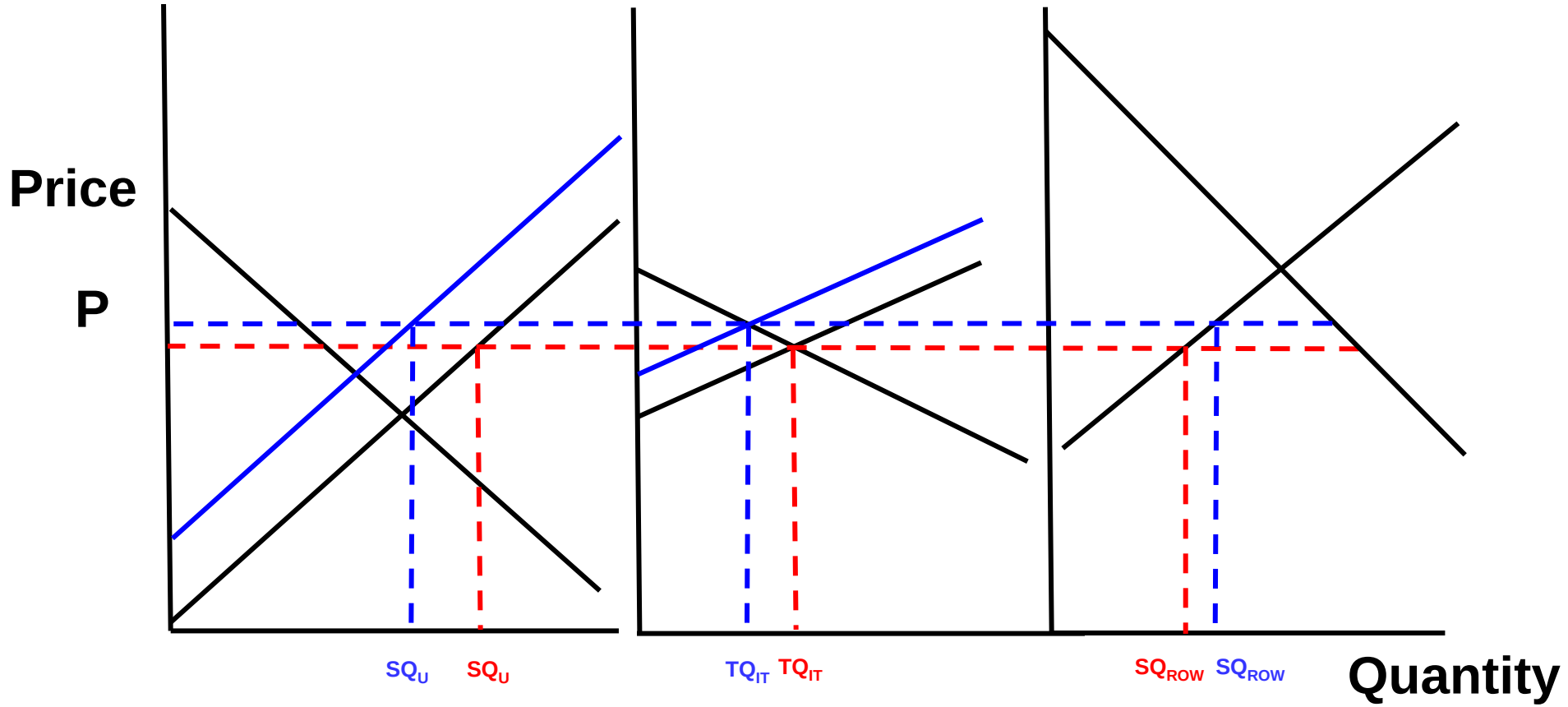
- Why?
  - Land competition – Biofuels
  - Exchange rate
  - Self sufficiency kick
  - Strong export demand
  - Bad yields and weather – climate change influence?
  - Income and population growth
  - Slowing technical progress

  - Will induce technical progress and we will produce our way partially out of this but demand here to stay

Leakage


Price
P
SQ_U
TQ_{WM}
SQ_{ROW}
Quantity
US Market
World Market
Rest of World

Leakage



$$LEAK = 1 - \frac{SQ_{ROW} - SQ_{ROW}}{SQ_U - SQ_U}$$

Leakage

Cout/Cproj	Leak	GHG - Leak Discount
1	45%	55% (Only pay for ½)
2	91%	9% (Only pay for 10%)
0.5	23%	77% (Only pay for 3/4)

Case 1 Emissions per acre of commodity prices = biofuel offset

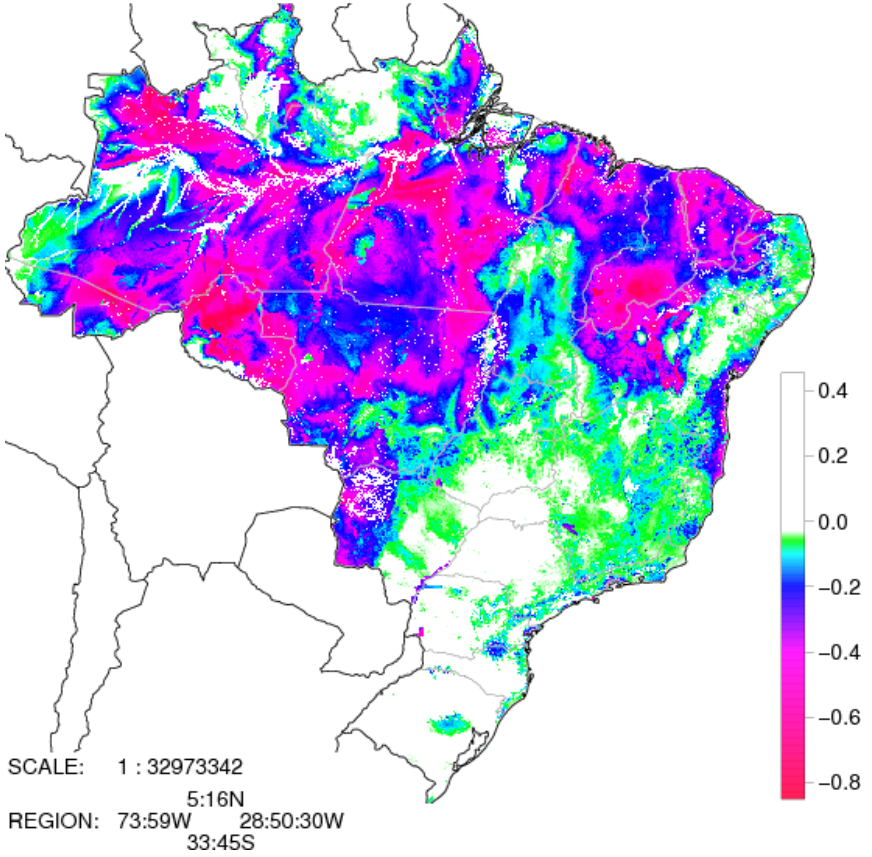
Case 2 Emissions per acre of commodity prices = twice biofuel offset

Case 3 Emissions per acre of commodity prices = one half biofuel offset

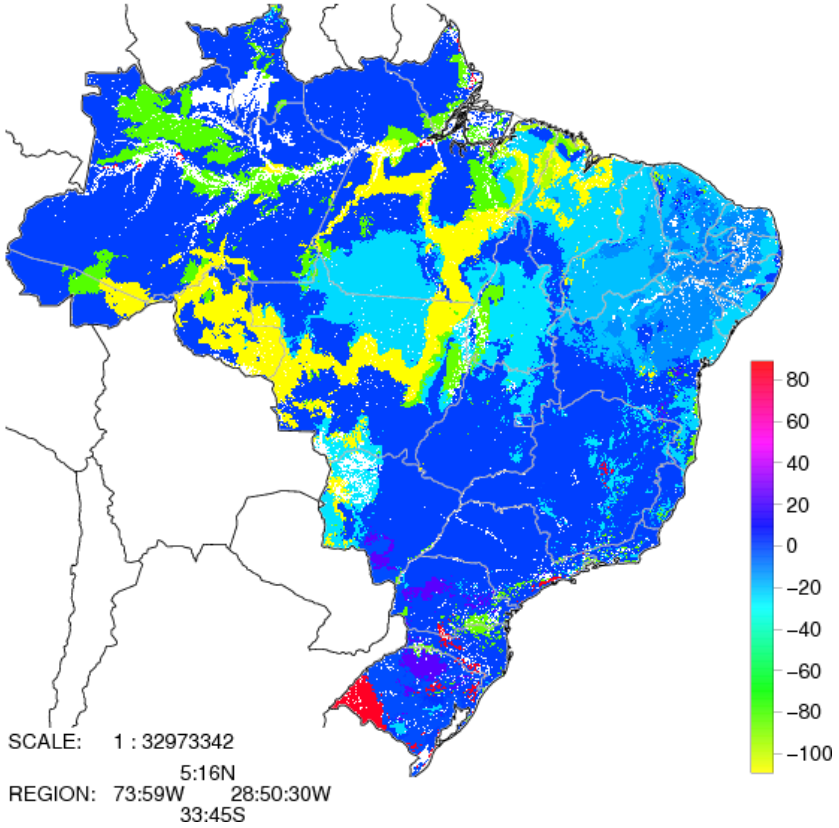
Probably offsets gains for corn

Energy sorghum?

Leakage



Change in probability of forest



Change in Carbon

Source G.C. Nelson and R.D. Robertson, “Green Gold or Green Wash: Environmental Consequences of Biofuels in the Developing World” Paper prepared for ASSA 2008 Invited paper session “Biofuels-Long-Run Implications for Food Security and the Environment”. ASSA Meeting New Orleans, January, 2008 and forthcoming in Review of Agricultural Economics Run for Brazil with a 25 percent increase in the price of maize and a 10 percent increase in the price of sugar at exporting ports.

Food Prices, Incomes and Environment

- Is rain forest deforestation bad?
- What about providing better income potential in northeast Brazil or Rural Indonesia
- Can policy address?
  - May need a compensation policy to reflect our valuation – allow payment for avoided deforestation
  - Allowing prices to transmit through to rural areas in countries with govenrment trading
  - Will economics win?
  - As population and food demand rises can we protect?
  - Looks like US immigration policy

Sectoral Lifecycle Accounting

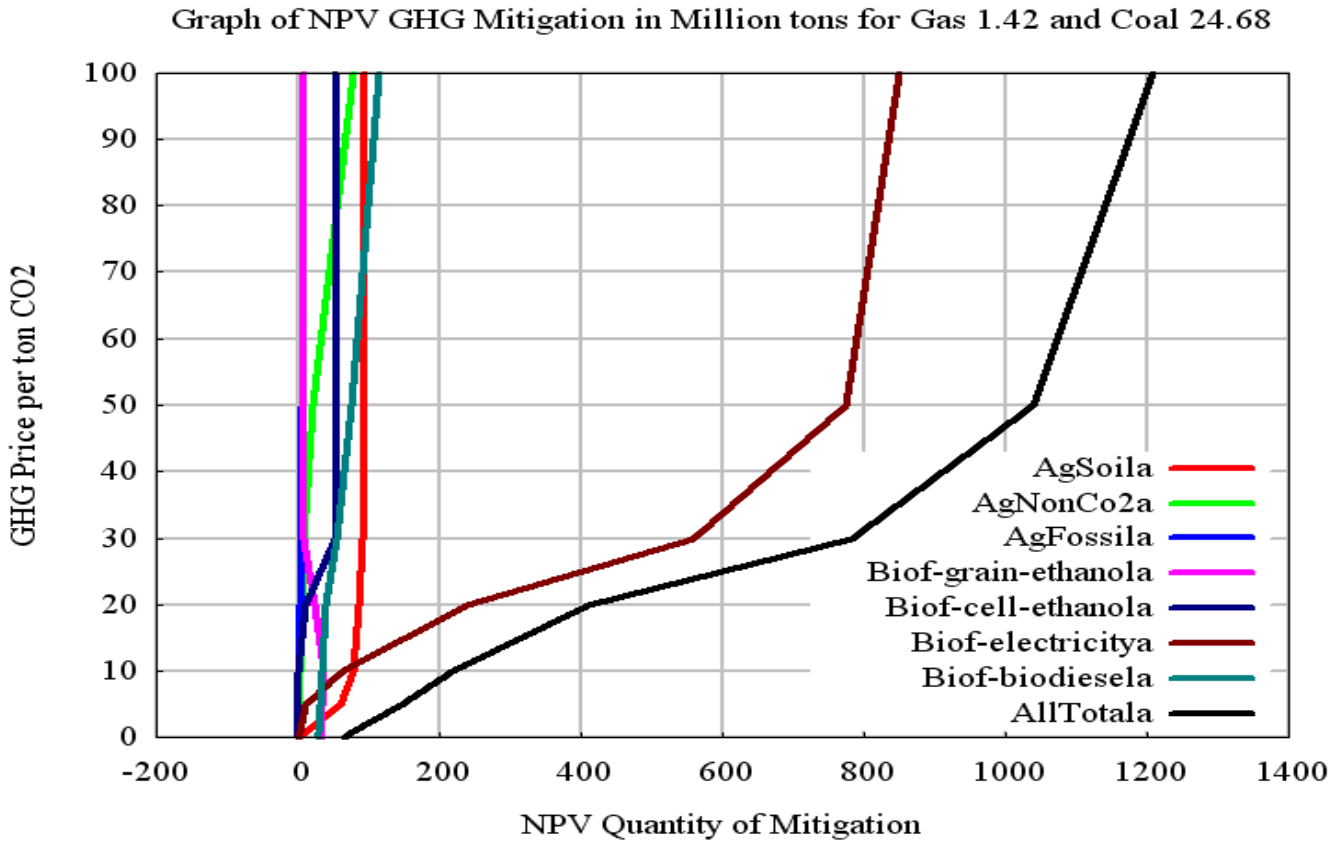
- Corn ethanol from 15 to 18 billion gallons.

Soil carbon sequestration	-7.39
CH4 and N20 from animals	+7.18
CH4 and N20 – from crops	-5.98
Ag CO2 from Fossil fuel use	-3.80
Net offset when making Ethanol from grains	+80.6
Net offset when making Electricity from ag feedstocks	-7.65
Net offset when making Biodiesel from ag feedstocks	-2.55
Other miscellaneous	-0.08

FASOMGHG Mitigation Options

Strategy	Basic Nature	CO2	CH4	N2O
Crop Mix Alteration	Emis, Seq	X		X
Crop Fertilization Alteration	Emis, Seq	X		X
Crop Input Alteration	Emission	X		X
Crop Tillage Alteration	Emission	X		X
Grassland Conversion	Sequestration	X		
Irrigated /Dry land Mix	Emission	X		X
Ferment Ethanol Production	Offset	X	X	X
Cellulosic Ethanol Production	Offset	X	X	X
Biodiesel Production	Offset	X	X	X
Bioelectric Production	Offset	X	X	X
Stocker/Feedlot mix	Emission	X		
Enteric fermentation	Emission	X		
Livestock Herd Size	Emission	X	X	
Livestock System Change	Emission	X	X	
Manure Management	Emission	X	X	
Rice Acreage	Emission	X	X	X
Afforestation	Sequestration	X		
Existing timberland Manage	Sequestration	X		
Deforestation	Emission	X		
Forest Product Choice	Sequestration	X		

Portfolio Composition



Energy prices increases with CO2 price

Ag soil goes up fast then plateaus and even comes down

Why – Congruence and partial low cost

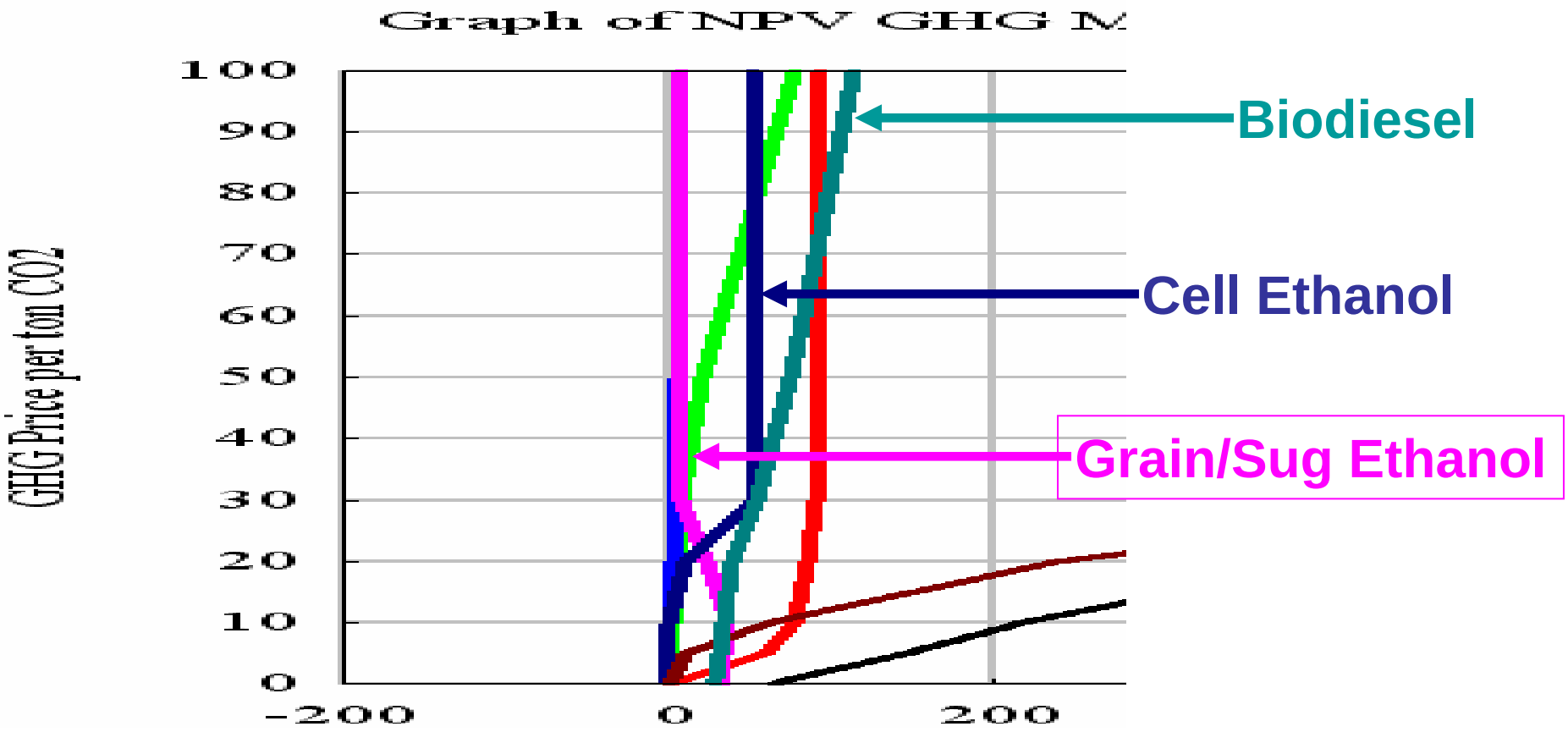
Lower per acre rates than higher cost alternatives

Biofuel takes higher price but takes off

Electricity gives big numbers due to plant expansion

Other small and slowly increasing

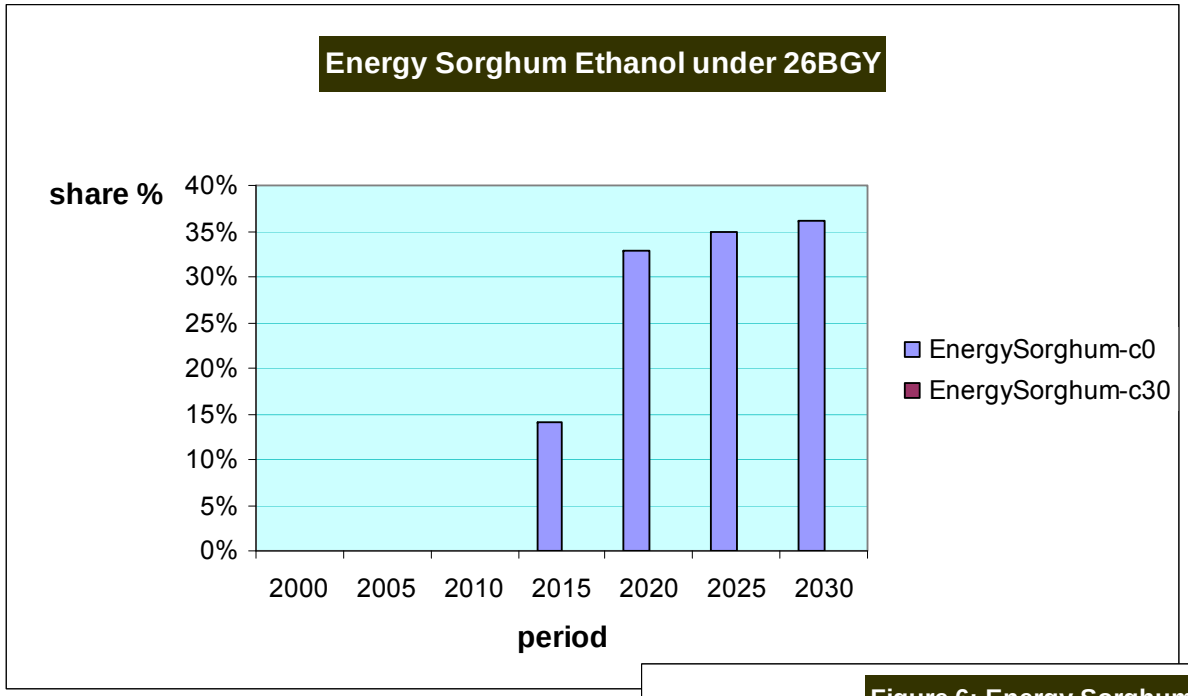
Liquid Portfolio Composition



Energy Sorghum in the US Mix

Crop Acres	26BGY	26BGY+$30 CO2
Cotton	7,378	7,440
Corn	90,861	90,343
Soybeans	69,598	70,506
DurhamWheat	1,746	1,777
HardRedSpringWheat	12,832	12,975
HardRedWinterWheat	26,419	26,586
SoftWhiteWheat	2,315	2,243
Sorghum	5,020	5,070
SweetSorghum	275	274
Rice	3,261	2,662
Oats	2,160	2,150
Barley	4,239	4,234
Silage	6,300	6,279
Hay	54,673	54,514
EnergySorghum	15,670	15,675
SwitchGrass	0	172

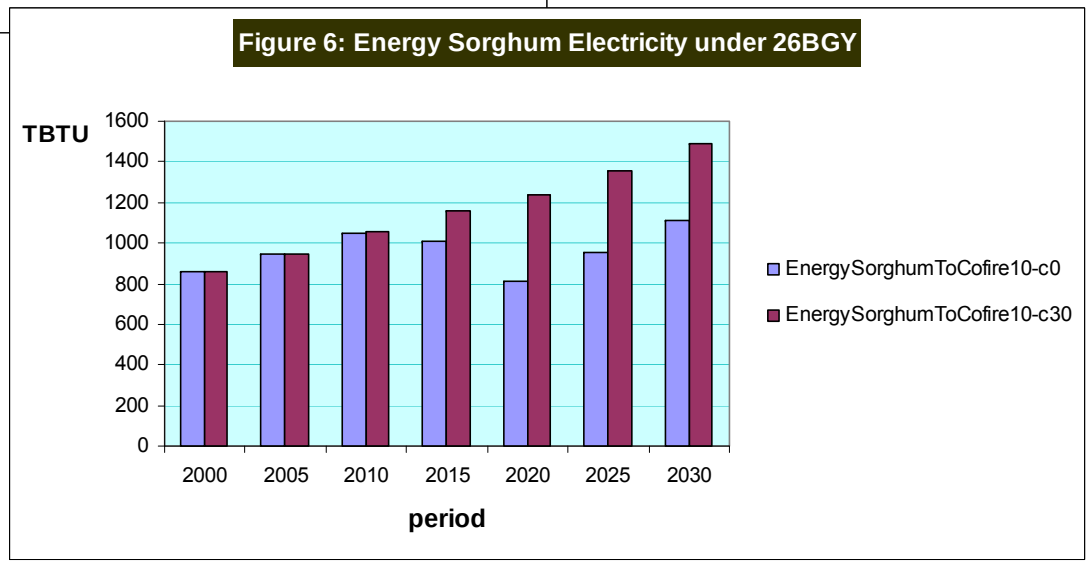
Energy Sorghum in the US Mix



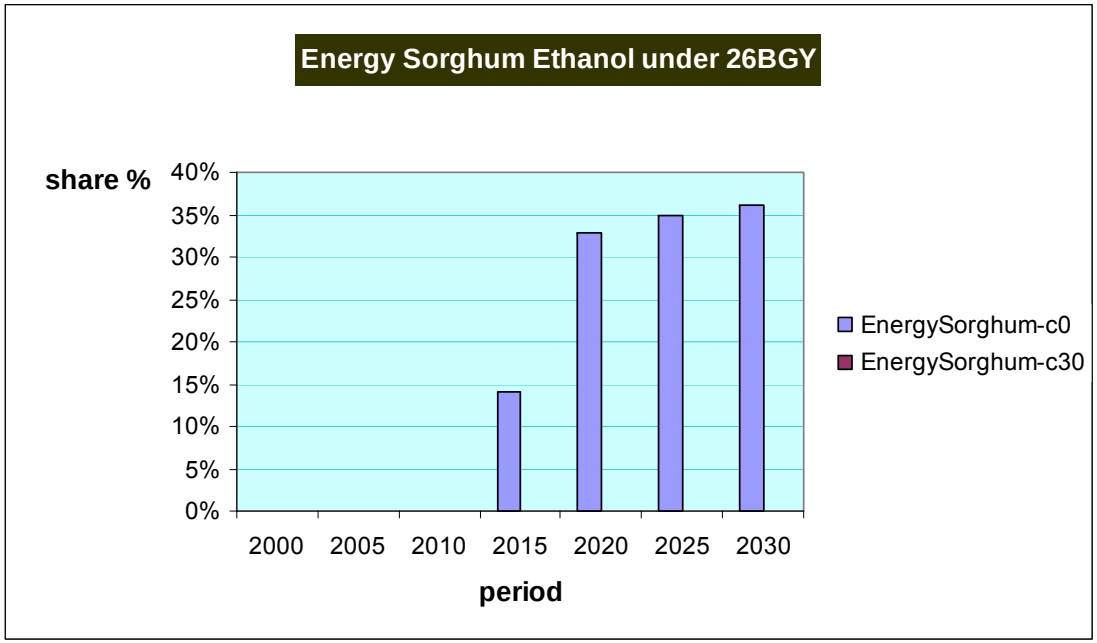
Immediately goes to electricity (10% cofire)

In future as cellulosic capacity energy sorghum a major player

But if carbon price exists stays in cofire

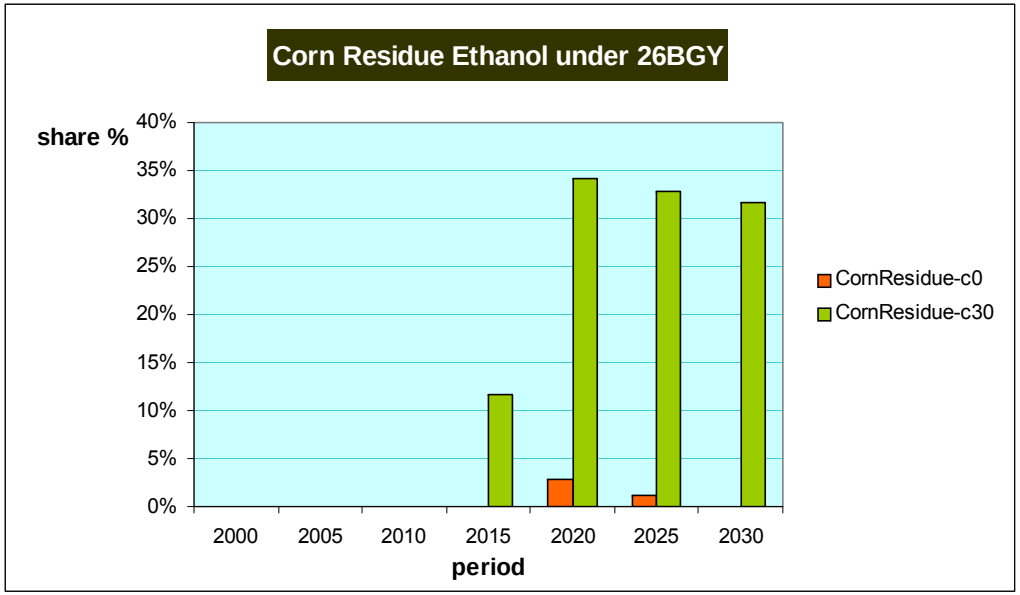


Energy Sorghum in the US Mix

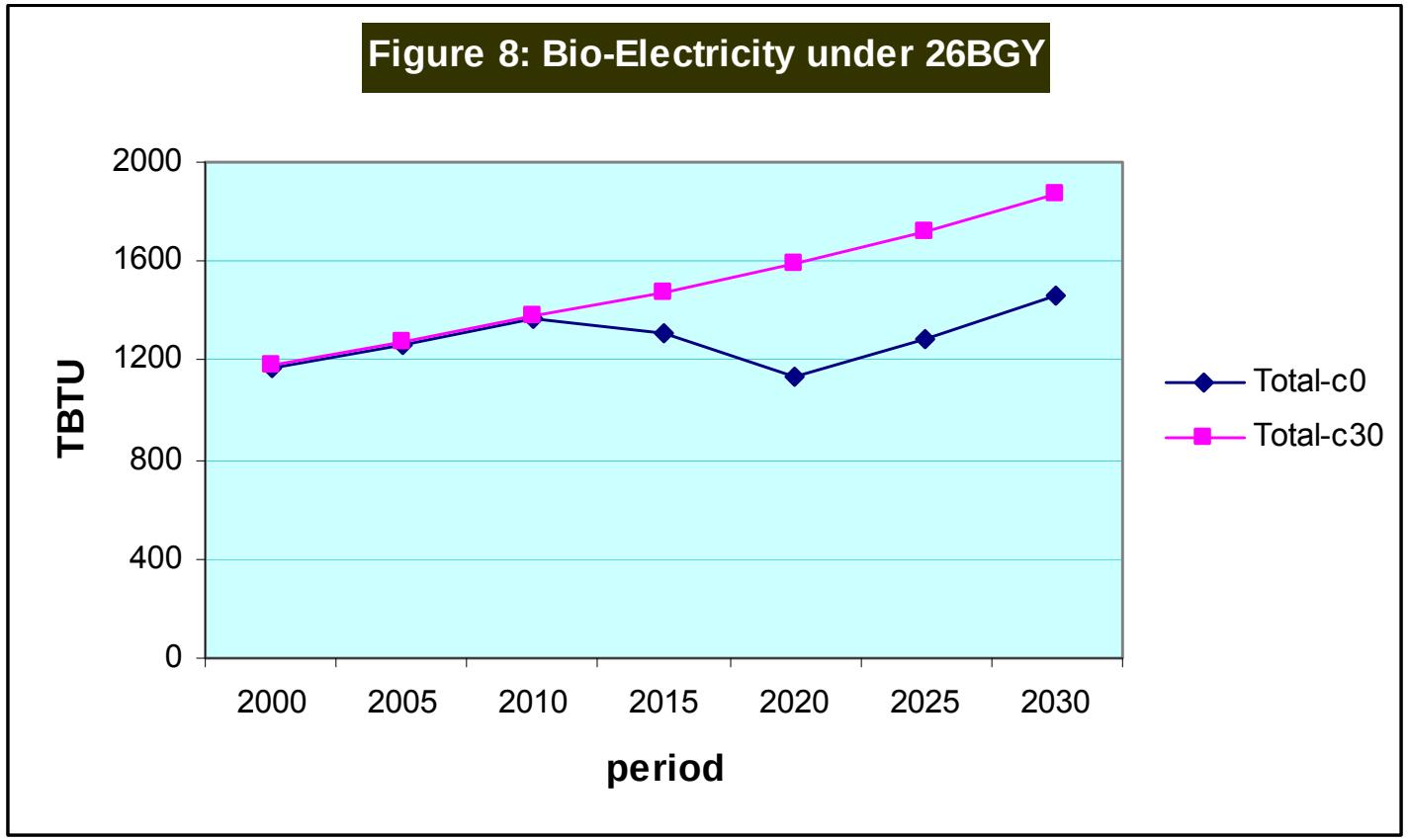


Displaces corn residue in cellulosic 26bgy

But if carbon price exists stays in cofire and residue comes in



Energy Sorghum in the US Mix



If we have a carbon price total market size increases

Findings

- Biofuels and sorghum possible important part in GHG mitigating world
- One size des not fit all – different activities have different LCA rates
- Leakage is a factor need global accounting and more than what lifecycle does
- At low fuel and carbon prices opportunity cost of resources exceeds value of feedstocks generated.
- GHG prices move us away from current ethanols
- Strong move toward electricity

Big questions

- Will society choose to reward biofuel carbon recycling?
- Will energy prices remain high in short run?
- Will ethanol and biodiesel subsidies persist?
- When will cellulosic ethanol be producible at scale?
- Can we increase energy recovery efficiency from biofeedstocks?
- Will food technical progress remain high?
- Will we think about this as we plot future of energy?
- Will the science community expand the definition of biofuels away from corn ethanol?
- Can we withstand current food price pressures?
- Can we find a way to compensate for rainforest preservation?

For more information

http://agecon2.tamu.edu/people/faculty/mccarl-bruce/biomass.html