BioEnergy Lifecycle Carbon Footprint, and Leakage

Bruce A. McCarl
Regents Professor of Agricultural Economics
Texas A&M University

Presented at Farm Foundation meeting on
Lifecycle Carbon Footprint of Biofuels

National Press Club, Washington, DC
April 8, 2008

Topic of the day

Biofuels and GHGs

Lifecycle analysis

Leakage

More equilibrium forms of GHG accounting

Portfolio of preferred strategies as affected by GHG prices and Energy Prices

Collaborators

Darius Adams, Oregon State
Gerald Cornforth, TAMU
Brian Murray, Duke
Chi-Chung Chen, TAMU, NTU

Ralph Alig, USDA Forest Service
Greg Latta, Oregon State
Dhazn Gillig, TAMU/AMEX

Mahmood El-Halwagi, TAMU
Ben DeAngelo, EPA
Steve Rose, EPA
Ron Sands, PNNL, Maryland
Thien Muang, TAMU
Michael Shelby, EPA

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

Sources of Support

USDA DOE
USEPA
CSiTE

An Aside

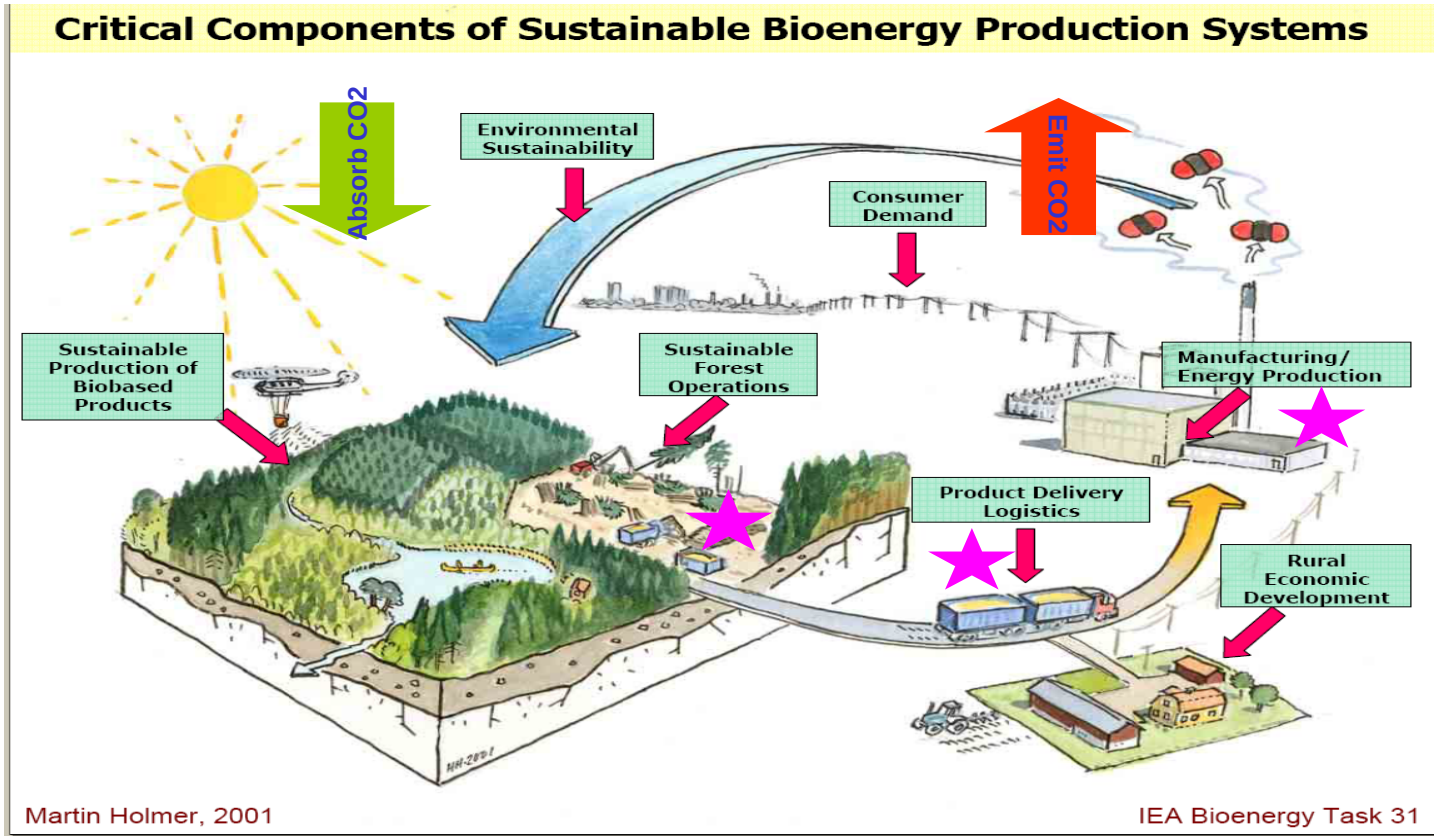
From a GHG perspective

Biofuels ≠ Ethanol

Particularly corn or sugar ethanol

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

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

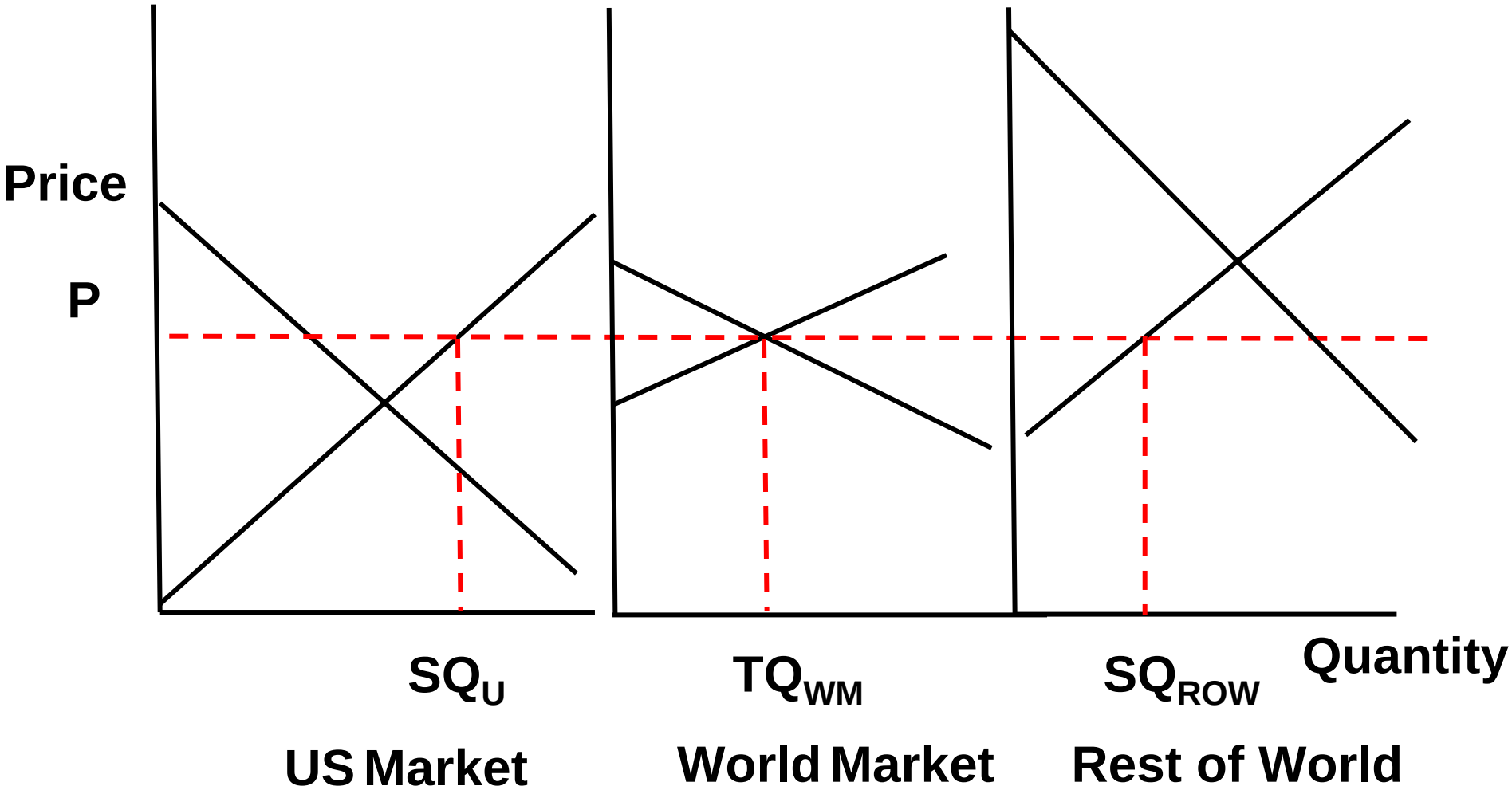
Net Carbon Emission Reduction (%)

	Liquid Fuels			Electricity	
Commodity	Crop Ethanol	Cell Ethanol	Biodiesel	5 %	fire100%
Corn	17.2				
Hard Red Winter Wheat	16.1				
Sugarcane	64.9				
Soybean Oil			95.0		
Corn Oil			39.1		
Switch Grass		56.7		86.3	75.1
Corn Cropping Residue		69.8		89.2	80.1
Wheat Cropping Residue		56.4		93.3	87.2
Manure				99.5	96.4
Bagasse		95.7		98.1	96.5
Lignin				91.3	85.8

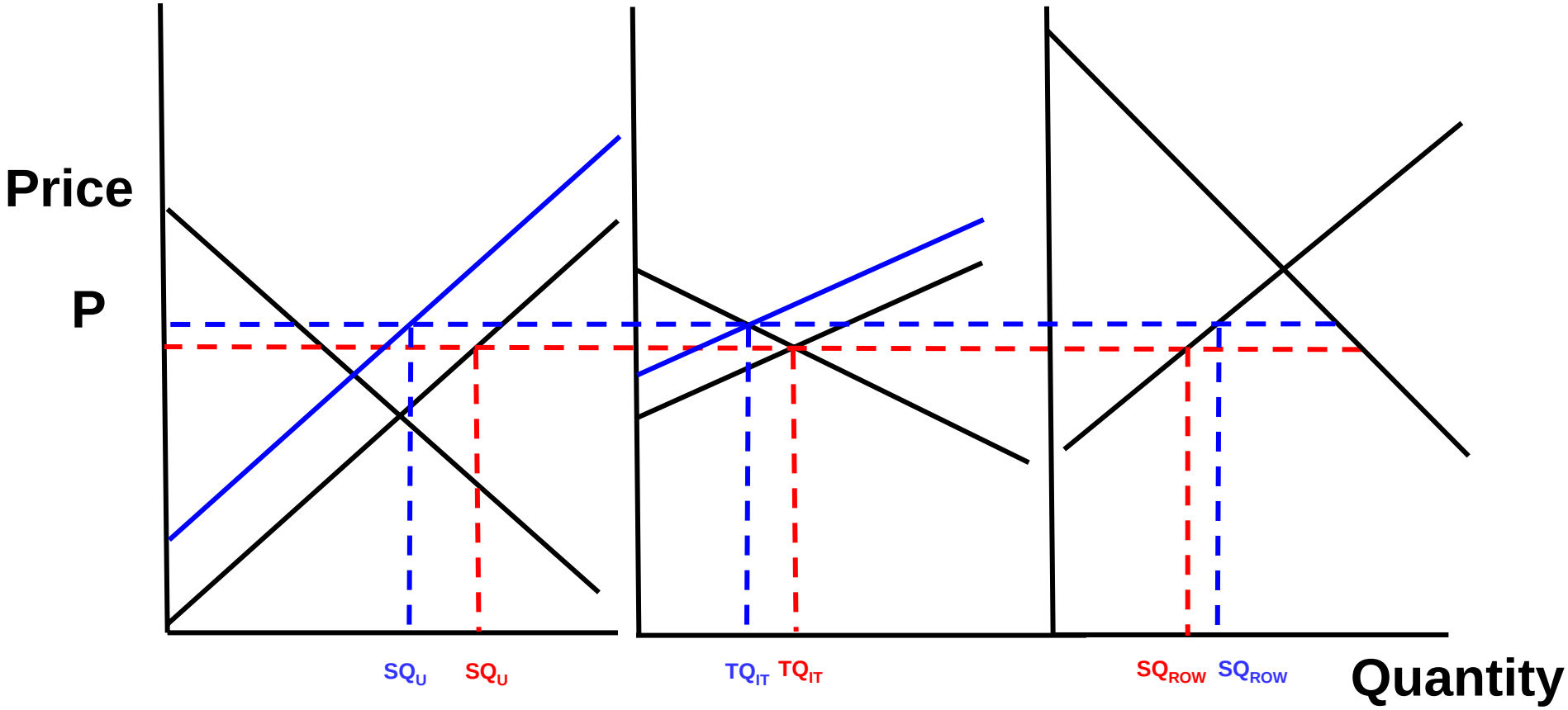
Crop ethanol<cellulosic<biodiesel<Electricity

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

Leakage


Price
P
Quantity
SQ_U
TQ_{WM}
SQ_{ROW}
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)

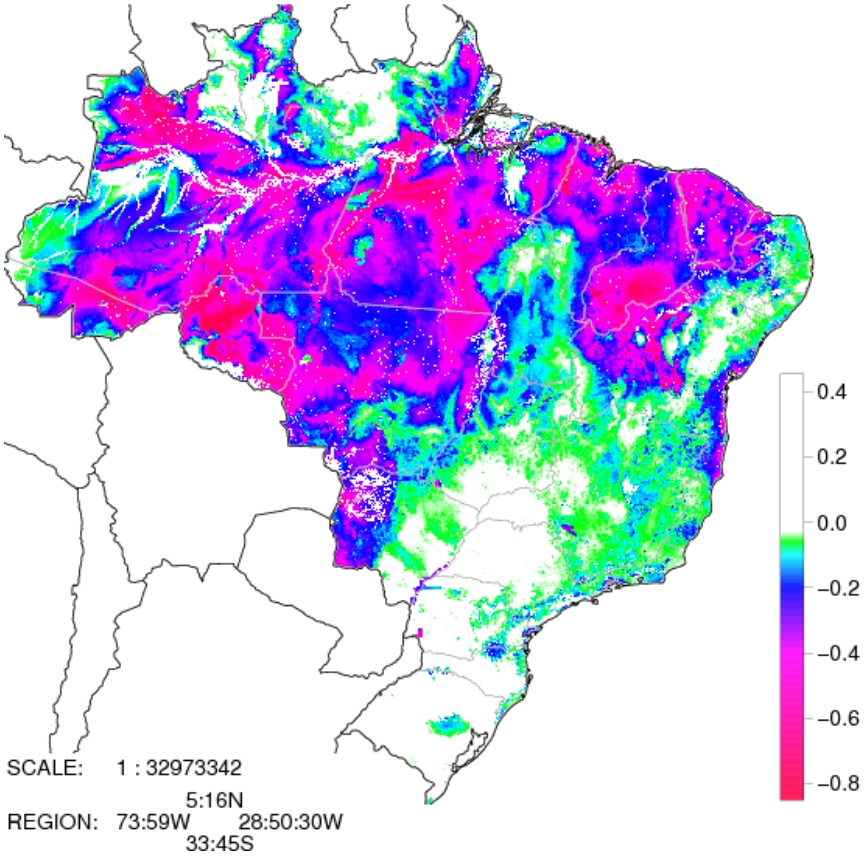
Case 1 Emissions per acre of commodity prices = biofuel offset

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

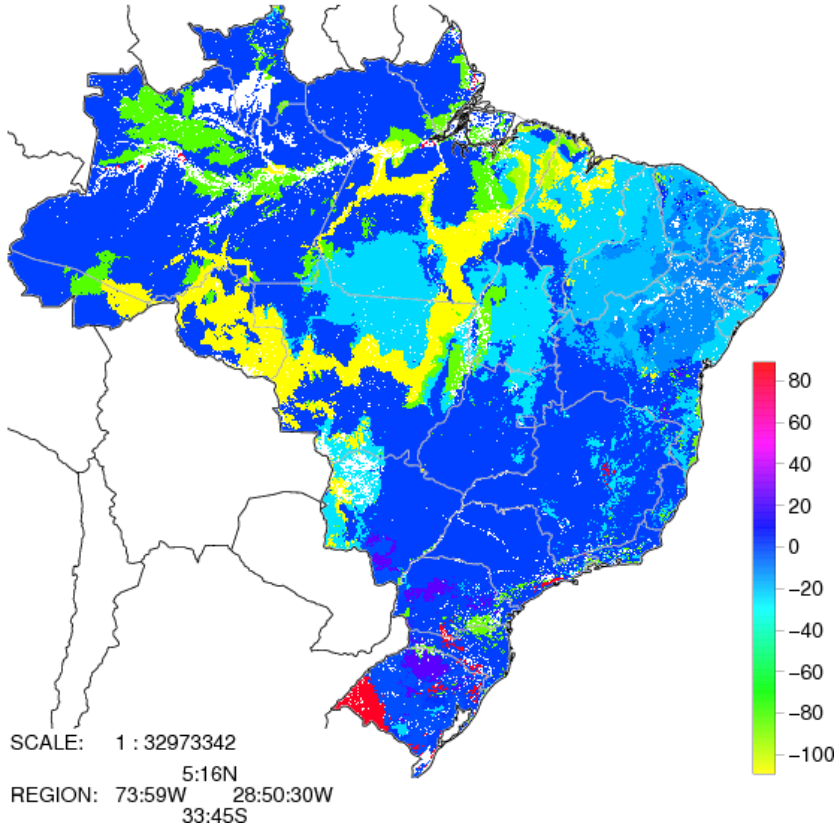
Case 3 Emissions per acre of commodity prices = one half biofuel offset

With corn at 20% and rainforest??

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.

Sectoral Lifecycle Accounting

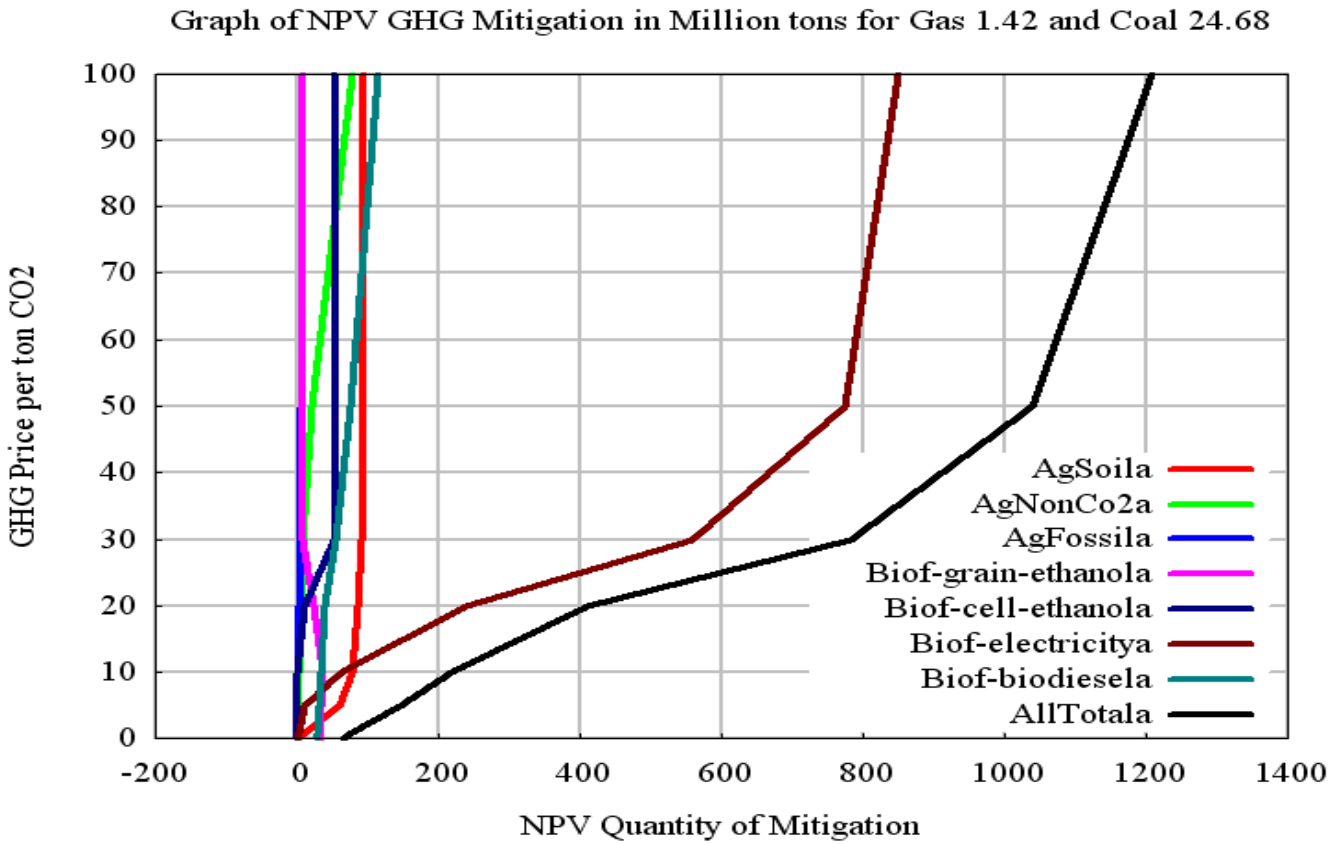
- Corn ethanol from 15 to 18 billion gallons.

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

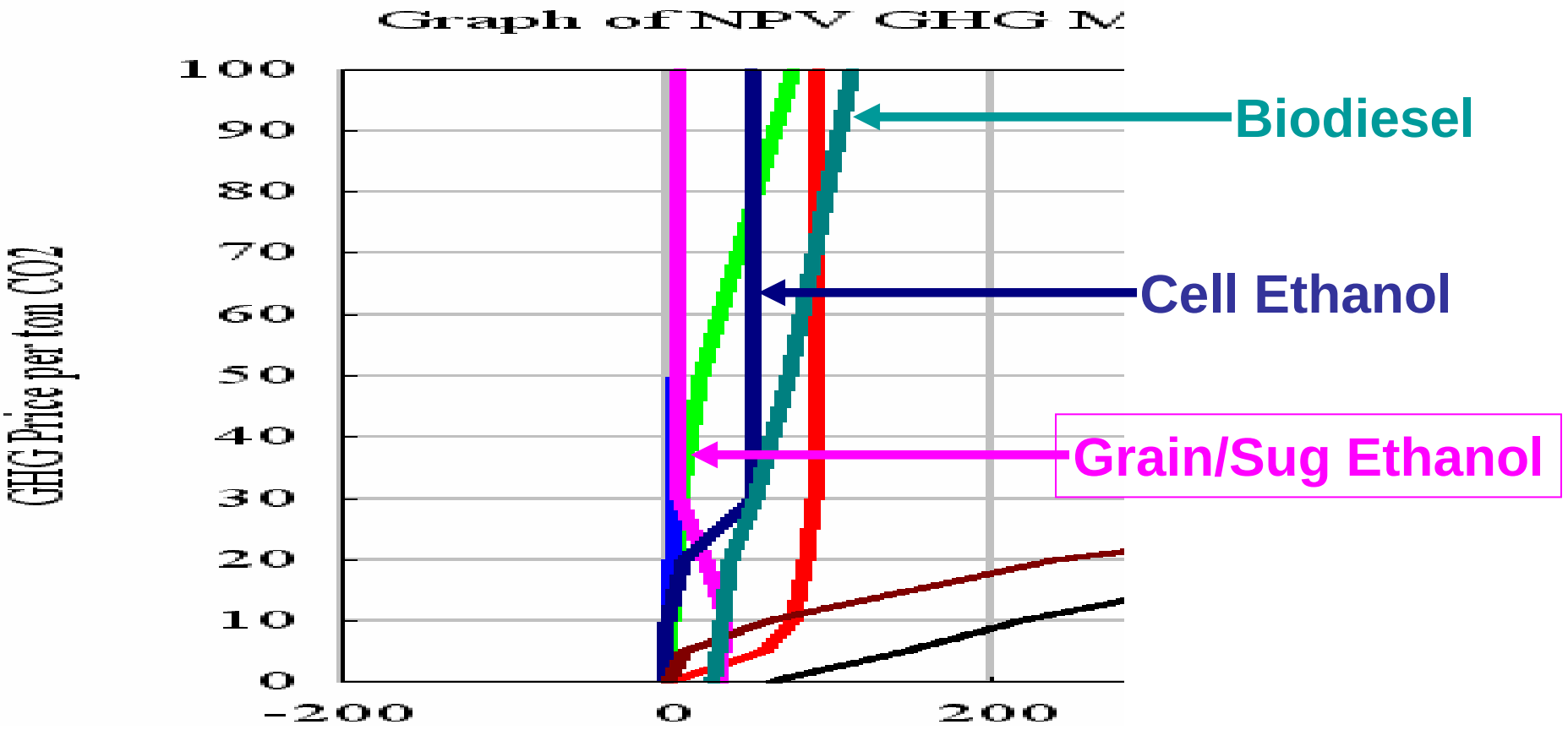
Lower per acre rates than higher cost alternatives

Biofuel takes higher price but takes off

Electricity gives big numbers due to plant expansion

Other small and slowly increasing

Liquid Portfolio Composition



Findings

- Biofuels possible important part in GHG mitigating world
- One size des not fit all – different activities have different 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 biofuel feedstock yields?
- Can we increase energy recovery efficiency from biofeedstocks?
- Will we switch farm subsidies to energy or carbon subsidies?
- 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?

For more information

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