Assessment of GHG Mitigation Opportunities in the U.S. Forest

and Agricultural Sectors

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Basic Components of Talk

Project Goals

Last Years Efforts

Key Findings

Directions being Pursued

Project Goals

Examine the portfolio of land based GHG mitigation strategies and identify ones for further scrutiny considering
Afforestation, Forest management, Biofuel, Ag soil, Animals, Fertilization, Rice, Grassland expansion Manure, Crop mix

Look at market and time conditions under which strategies dominate

Educate on needed scope of economic analysis

Bring in a full cost and GHG accounting

Look at market effects and co benefits/ costs

Activities in last year

FASOM-GHG - examines Land based GHG strategies

Strategy	Basic Nature	CO_2	CH_4	N_2O
Afforestation	Sequestration	X		
Existing timberland	Sequestration	X		
Deforestation	Emission	X		
Biofuel Production	Offset	X	X	X
Crop Mix Alteration	Emiss, Seq	X		X
Crop Fertilization Alteration	Emiss, 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
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

Activities in last year

FASOM-GHG - examines Land based GHG strategies

Dissertation by Heng-Chi Lee

Considers saturation characteristics of both soils and forests
(uses 30 years for ag soils, Birdsey for forest soils
and growth/yield characteristics of forests from forest
service)

100 year model

Land exchanges in response to GHG prices, plus all the
agricultural activities by decade

Empirical examinations done in last year

Leakage

International Leakage in ag

Regional project appraisal

Favored regional activity identification

Co-benefits study

Simultaneities with climate change

Improved Non CO2 inventory

Ties to CGE

Major Results

Portfolio

Dynamic role of strategies

Potential measures

Mitigation and Markets

Dynamics and co benefits

Favored regional activity identification

Simultaneities with climate change

Ties to CGE

Portfolio Results

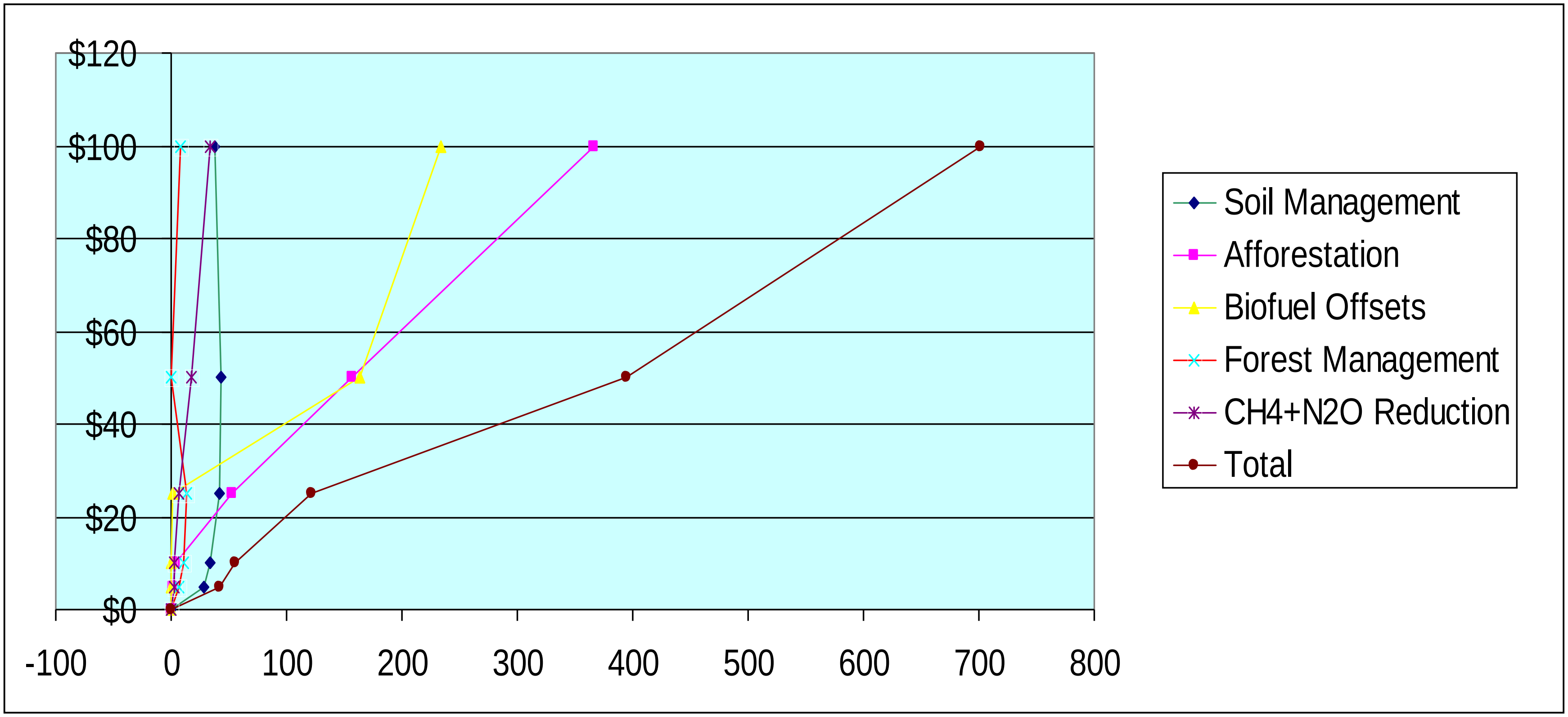
Millions of metric tons sequestered by source at alternative prices

	GHG Price ($/ton C)					
Activity	$5	$10	$25	$50	$100	$200
Soil Management	28.7	33.7	41.5	43.0	37.8	27.0
Afforestation	1.0	3.8	53.0	156.3	366.2	358.2
Forest Management	7.0	11.2	12.9	-0.6	7.8	62.0
Biofuel Offsets	0.0	0.0	1.5	162.9	233.7	375.1
CH4+N2O Reduction	2.1	2.9	6.1	17.1	34.4	43.0
Other Activities	1.7	2.1	3.9	13.8	18.6	22.4
Total	42.4	55.5	121.7	394.9	700.8	890.7

Sectors can make a difference

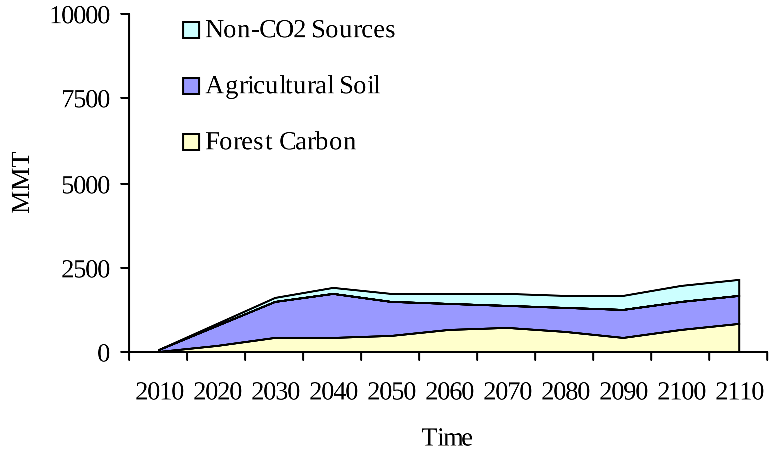
Portfolio Results

MMt arising at an offset price giving $/tonne carbon equiv

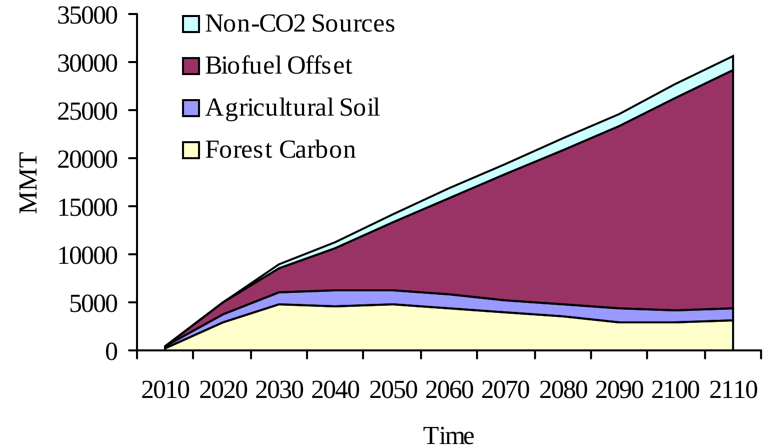


- Small importance of CH4 and N2O
- Different strategies dominate at different price levels

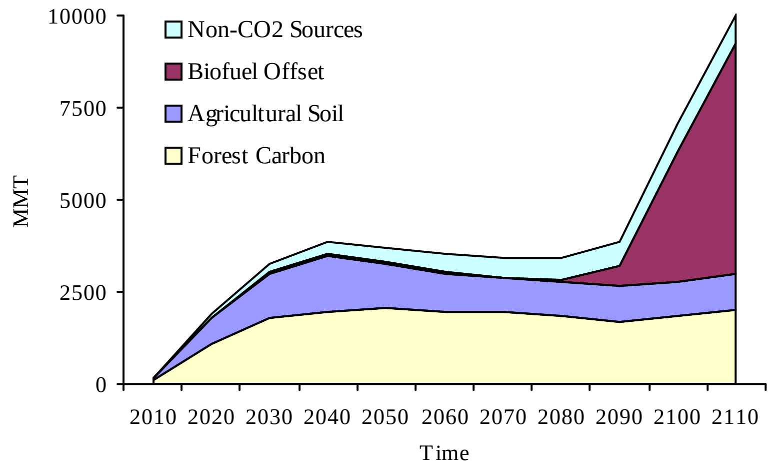
Dynamic role of strategies Results



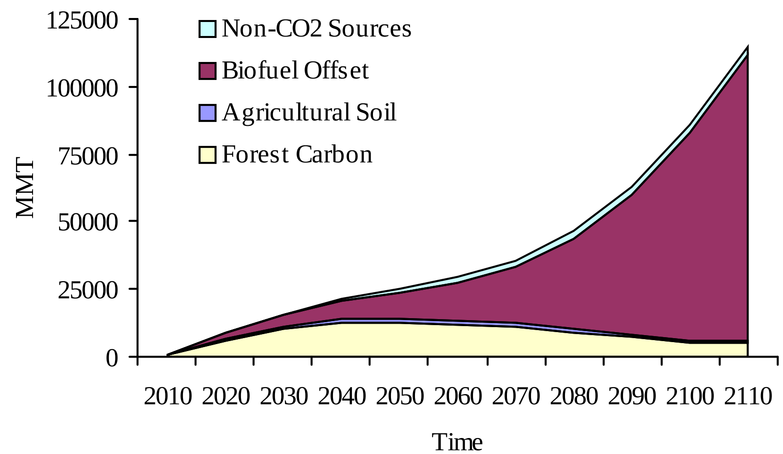
Cumulative Contribution at a $10 Price



Cumulative Contribution at a $50 Price



Cumulative Contribution at a $25 Price



Cumulative Contribution at a $100 Price

Source: Lee, Heng-Chi, **An Economic Investigation of the Dynamic Role for Greenhouse Gas Emission Mitigation by the U.S. Agricultural and Forest Sectors ,** PhD Dissertation, Texas A&M University,December 2002

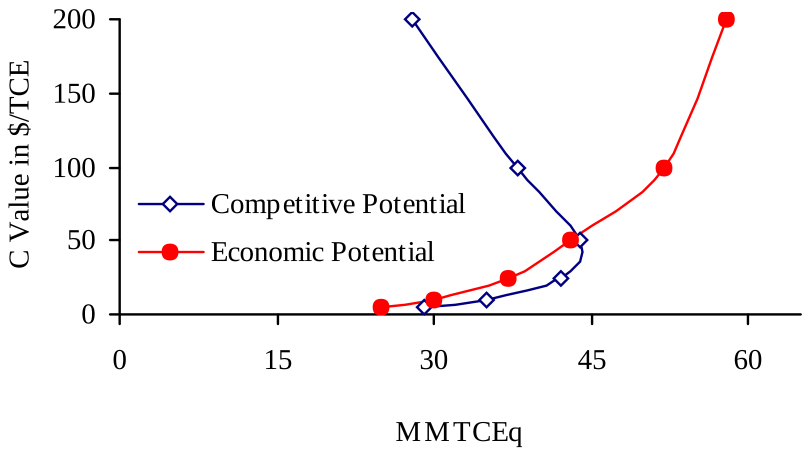
Dynamic role of strategies Results

Time from now		
>30 years	Limited forest and afforest Non co2	Bio fuels Non co2
O to30 years	Ag soils Limited forest and afforest Non co2	Limited Ag soils Forest and afforest Biofuels Non co2
	<$50/metric ton	>$50/metric ton

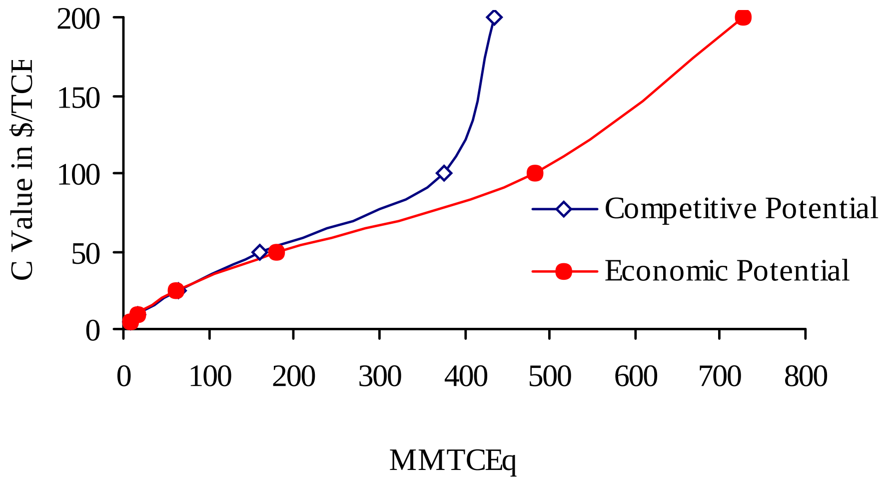
Level of Price

Potential measures Results

Economic vs competitive potential



Annual Soil Carbon Sequestration on Crop Land



Annual Carbon Sequestration in Forest Sector

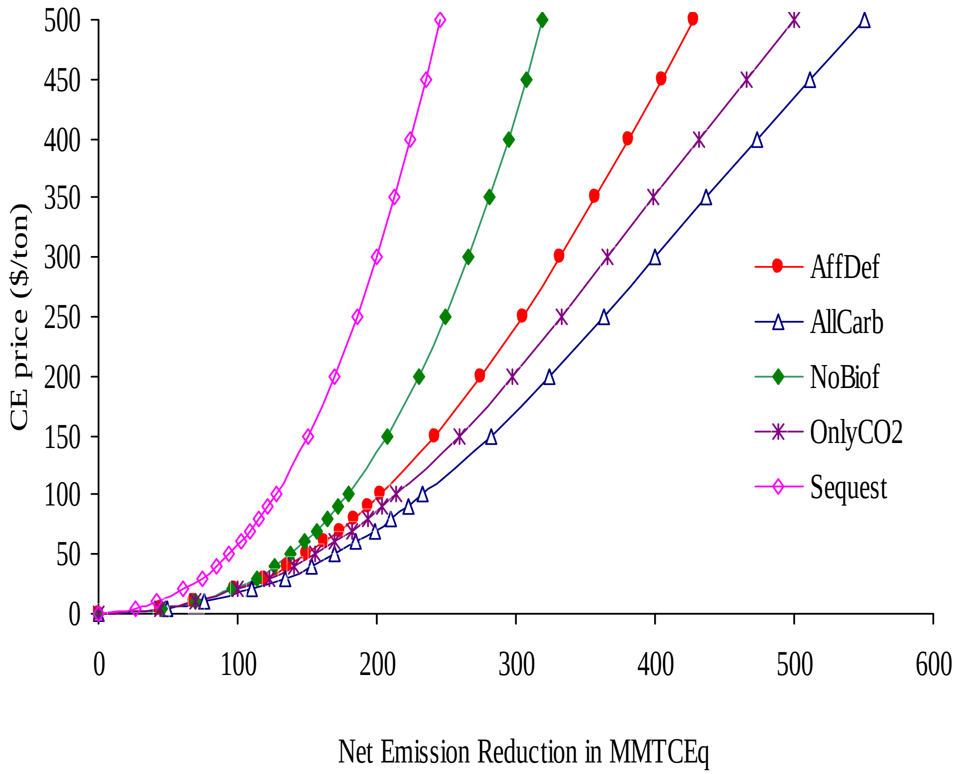
Economic potential is how much one would get if this was the only strategy employed

Competiive potential is how much one gets when other strategies are possible

Technical potential of ag soils is at 140 MMT

Potential measures Results

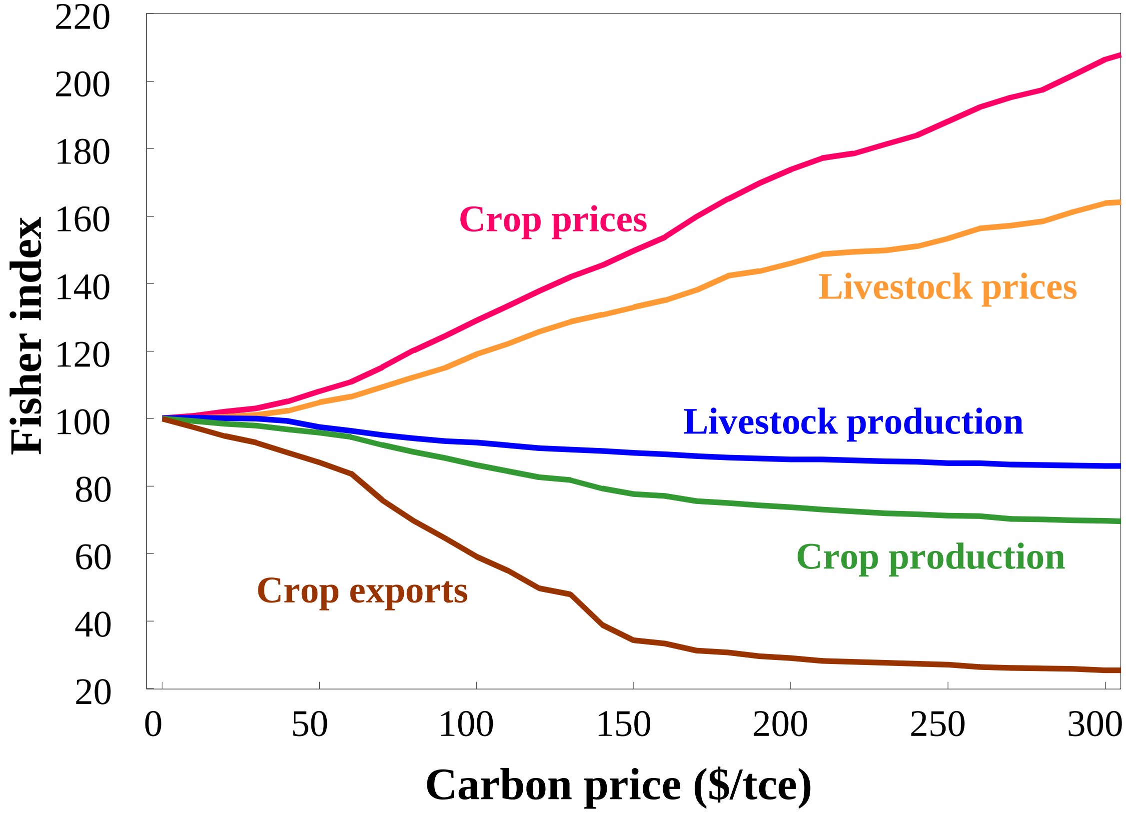
Implementation policy and response (from ASM summary)



Affdef -- afforestation and deforestation only
Allcarb -- all forestry and ag
Nobiof -- no biofuels
OnlyC02 -- no non co2 gasses
Sequest -- ag soils only

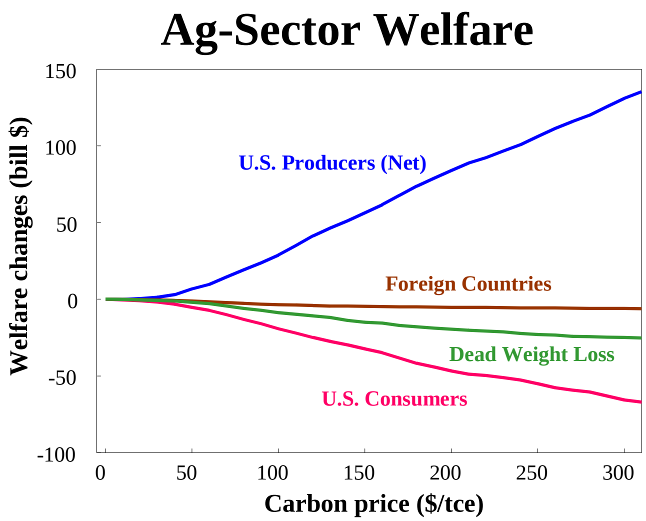
Mitigation and markets results

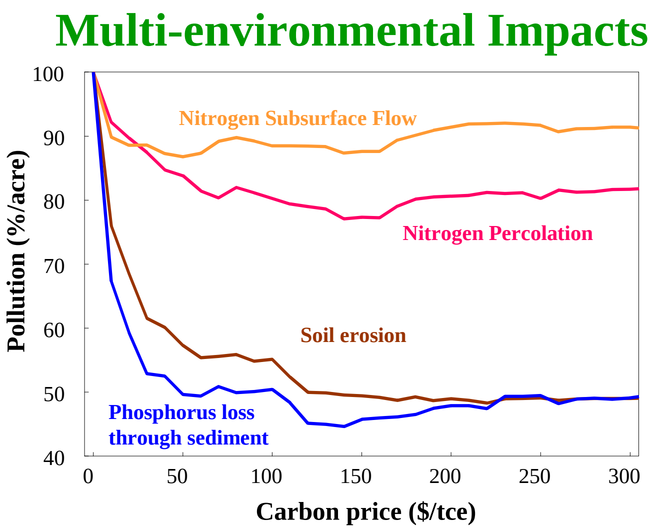
GHG Mitigation and Ag-Markets



From ASMGHG

Dynamics and co benefits results





High prices erode co benefits due to intensification

Producers gain

Consumers lose

Exports reduced

Some co benefits do not saturate over time but continue to be accrued (erosion, runoff, farm income). Ecosystem gains in habitat may saturate

From ASMGHG

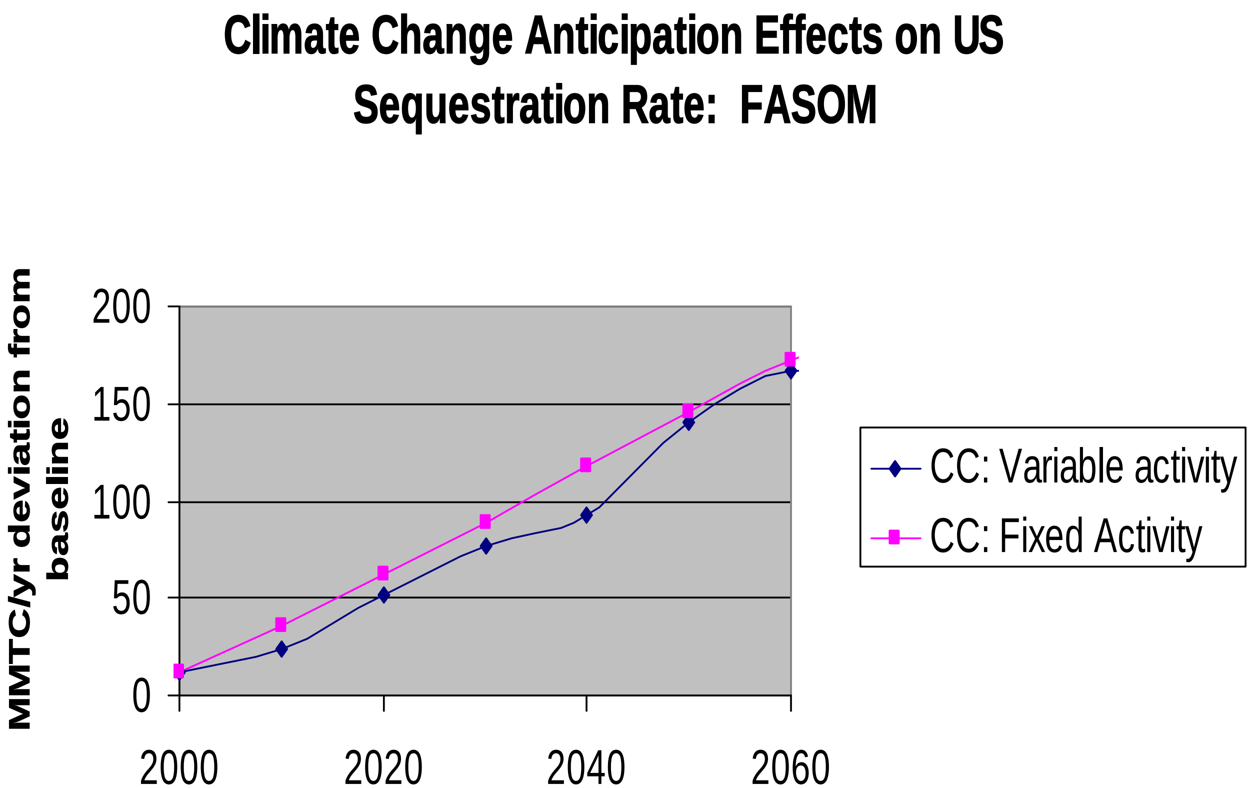
Regional Strategy Results

Largest opportunities by region and type

Region/Type	$5	$10	$25	$50	$100	$200
CB-Soil Management	1	1	3	7	10	
SC-Forest Management	2	2	2	6	7	9
LS-Soil Management	3	4	8			
GP-Soil Management	4	3	6	9		
RM-Soil Management	5	5	9			
CB-Afforestation Activities	6	8	1	3	1	1
SE-Forest Management	7	7	7		9	
RM-CH4+N2O	8					
SW-Soil Management	9	9				
NE-Soil Management	10					
SC-Afforestation Activities		6	4	5	5	6
PNWE-Soil Management		10				
NE-Afforestation Activities			5	4	8	
SE-Afforestation Activities			10	10		
SC-Biofuel Offsets				1	2	2
SE-Biofuel Offsets				2	4	4
LS-Afforestation Activities				8	3	7
NE-Biofuel Offsets					6	8
LS-Biofuel Offsets						3
CB-Biofuel Offsets						5
RM-Afforestation Activities						10

Regionally dominating strategies

Simultaneities with climate change Results



- Projected climate change could substantially enhance C sequestration rates
- Strong synergies between climate change and C prices
- Need to consider feedback effects between sequestration, GHG concentrations, and climate change

Ties to CGE Results

Developed response functions from ASMGHG sector model

To do this ran ASMGHG sectoral model multiple times under alternative levels for

- carbon equivalent price,
- agricultural commod. demand - domestic & export
- fuel price

Yielding data on simultaneous production of

- GHG offsets
- AF commodity price and quantity
- AF sectoral performance

Then we fit functions to those data to encapsulate the results

Ties to CGE Results

Estimation data

405 systematic scenarios of independent variables

15 alternative carbon eq. prices $1, $5, $10, $20, $30, $40, $50, $60, $70, $80, $90, $100, $200, $300, and $400 per ton

3 levels of fuel prices	80%, 100%, 120% of base
3 levels of domestic demand	80%, 100%, 120% of base
3 levels of export demand	80%, 100%, 120% of base

another 100 random scenarios from the ranges above for each of the 4 items to build degrees of freedom

Ties to CGE Results

Estimated functions

Quantity of GHG emissions and sinks.

Emissions of CO_2, CH_4, and N_2O (broken out to avoid double counting)

Sinks for CO_2 (did CH_4 but should not use?)

Ag Production, exports, imports and price

Fisher index tot ag production, exports, imports and price changes

Biofuel production

Land Use, allocation and valuation.

Acres crops, biofuels, pasture and forest, and choice of tillage practices.

Welfare distribution.

consumers' producers' and foreign interests.

Levels of environmentally related items -

use of crop land, irrig. water; nitrogen, phosphorus, potassium, pesticides, fossil fuels, water and wind erosion.

Ties to CGE Results

Functional form

$$Y_k = A_k \prod_{i} x_i^{\;ki} \pounds_k$$

where

A_k is the intercept term associated with the *k*th response function

β_{ik} is a vector of parameters associated the vector **x** of signals.

The base functions with all of the independent variables held at the base level

1 for carbon price , 100 for the others

That depicts the ASMGHG output under a

zero carbon price

1997 energy price,

1997 domestic demand,

1997 export demand levels.

Ties to CGE Results

Dependent Variables	Intercept	Carbon Price	Agriculture Demand	Exports	Fuel Price	R^2
GHG Accounts:						
CO2 source emissions [a]	19.6450	-0.1725	0.1844	-0.0322*	0.0904	0.879
CO2 nonag emissions [b]	0.603	-0.076	0.395	0.245	0.236	0.901
CH4 source emissions	85.3070	-0.0742	0.0303*	-0.0252*	-0.0428	0.785
N2Osource emissions	9.9328	-0.0653	0.1477	0.0886	0.0975	0.763
CO2 sinks [c]	7.6185	0.5122	-0.1824	0.0866*	0.2752	0.918
CO2 offsets from biofuel	0.00001	3.4568	-0.9853*	-1.2428*	0.2849	0.733
Agricultural Prices and Production:						
Price	12.9690	0.1309	0.1208	0.1365	0.1086	0.685
Production	72.1472	-0.0642	0.0810	0.0106*	0.0147*	0.732
Exports	2.4464	-0.1826	-0.2640	1.2012	-0.0194*	0.589
Imports	18.2478	0.0197	0.3122	0.0129*	0.0324	0.603

* Marks insignificant coefficients

Directions being Pursued

Other Costs of Strategies
Discounts for leakage, saturation, uncertainty additionality
Dynamic response functions from FASOM
Better ag carbon – Century, EPIC
Better forest carbon – Century, EPIC
Better non CO2
Improved animal emission accounting and management
Updated forest inventory and growth
CGE