An Economic Exploration of Biofuel based Greenhouse Gas Emission Mitigation

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Presented at Workshop on

Agriculture as a Producer and Consumer of Energy

Washington D.C.

June 24-25, 2004

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Basic Components of Talk

- Project Goals
- Policy Context
- Project Scope
- Key Findings
- Policy Implications of Results
- Directions Being Pursued

Project Goals

- Examine the portfolio of land based GHG mitigation strategies
- Identify ones for further scrutiny considering Afforestation, Forest management, Biofuels, 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

Paper/Study Objectives

- **Assess the economic potential of U.S. agriculture and forestry to mitigate emissions considering carbon dioxide, nitrous oxide and methane**
- **Focus on the role of Biofuel strategies**
- **Examine the dynamics of mitigation strategies**

Policy Context

- U.S. is outside of the context of Kyoto Protocol
- U.S. has a largely voluntary policy to reduce GHG emission intensity by 18% by 2012. Intensity is emissions divided by GDP. This commitment is 1/6 the size of Kyoto obligation.
- Many U.S. states proceeding unilaterally, Northeast, West Coast, Texas and others.
- Virtually all U.S. companies have climate change offices and emissions are becoming of widespread concern
- Chicago Climate Exchange is emerging but price low.
- I think something will happen, but when?

Background

- Society has concerns about build-up in atmospheric concentrations of greenhouse gases
- Scientific consensus emerging that buildup will affect the global climate, stimulating warming.
- Disturbances caused by GHG concentrations will take a long time to reverse.
- IPPC asserts

  a) centuries for sea level to stop rising
  b) decades for atmospheric GHG to stabilize once emissions stabilize
  c) decades to retrofit/replace equipment and technology causing current emissions.

Background

- Society faces decision
  i) let emission increases continue
  ii) reduce emissions in effort to stabilize atmospheric concentrations.
- Decision involves uncertain future effects of GHG induced climate change
- Implications for many sectors of the economy
- Decision involves whether to insure against possible future deleterious effects by either reducing emissions, creating sinks, or creating offsets.
- Irreversibility dimensions to decision

Mitigation related role of Ag & Forestry

- **Agriculture and forestry can play a role**
- **Small emitters of the most prevalent greenhouse gas (carbon dioxide - CO2),**
- **Other emissions important**
- **U.S. agricultural GHG emissions contribute**
  - **7% of total carbon equivalent emissions**
  - **28% of methane emissions (GWP 21)**
  - **70% of nitrous oxide(GWP 310).**
- **U.S. forests are large but shrinking sink for carbon dioxide 14% of 1997 emissions, 23% in 1990.**

Mitigation related role of Ag & Forestry

- **Agriculture has substantial potential for offsetting emissions**
- **Sink augmenting GHG absorption,**

  changes in tillage

  conversion of ag land to grassland or forest.
- **Increasing production of commodities, which can serve as**

  feedstocks for the production of biofuel or offset GHG emission intensive commodities (steel, concrete)

Finally Biofuels

- **Biofuel production contributes to reduction in net GHG emissions because**

  As plant grows photosynthesis absorbs CO2 from atmosphere concentrating it in the feedstock

  When burned this is released

- **Thus Biofuel use involves recycled carbon.**
- **Offsets net GHG emissions relative to fossil fuels by about 75-95 percent for power use and much less for liquid fuel**

Finally Biofuels

- Never has been an economic proposition.
- In U.S. ethanol subsidies often amount to over 50% of product sale price.
- Bolstered by sugar program
- It likely to remain uneconomic in the near future in absence of subsidies.
- Can climate change contribute a new subsidy source?

Mitigation Assessment

- **Multi-period analysis of ag/forest response**
- **Examines overall and component response at varying carbon equivalent prices**
- **Also observe commodity and factor prices, levels of production, exports and imports, management choices, resource usage, and environmental impacts**
- **Simultaneous across all agricultural GHG mitigation strategies including biofuels**
- **Simultaneous modeling of other agricultural environmental problems**
- **Based on life cycle comparisons**

GHG Activities in FASOMGHG

- **Multiple GHG mitigation strategy setup**
- **Detailed GHG emission accounting**
  - **Forest carbon**
  - **Soil carbon**
  - **N2O**
  - **CH4**
  - **Fuel use carbon emissions**
- **National GHG balance**
- **GWP weighted sum of all GHG accounts**
- **GHG Policy implementation**

FASOMGHG MITIGATION OPTIONS

Strategy	Basic Nature	CO_2	CH_4	N_2O
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
Biofuel Production	Offset	X	X	X
Afforestation	Sequestration	X		
Existing timberland Management	Sequestration	X		
Deforestation	Emission	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

Biomass Option

- **Fast growing trees or switchgrass plus corn**
- **Feedstock for electrical power plants or liquid fuel production**
- **Offsets fossil fuels $\rightarrow$ recycles emissions**
- **Requires land $\rightarrow$ Opportunity cost**
- **Sustainable, verifiable**

Why not just biofuels

We consider biofuel net contribution to GHG emissions considering carbon dioxide, nitrous oxide and methane not biofuels in isolation

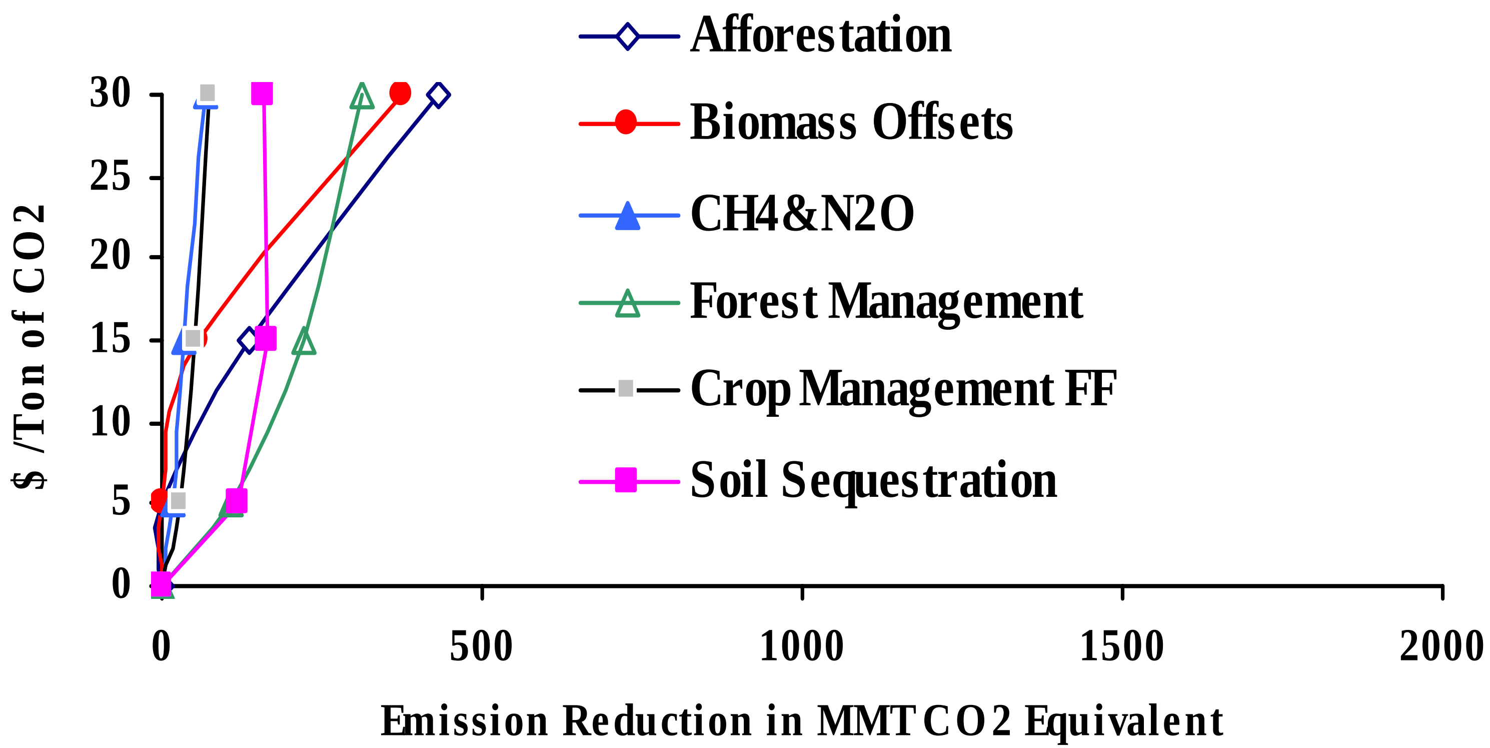
We examine relative desirability as compared to other GHG mitigation strategies

Why?

- **incredible interrelatedness of ag economy**
- **opportunity cost of resources**

Land to crops to feed to cattle all involved with GHG

Portfolio Composition



Ag soil goes up fast then plateaus and even comes down

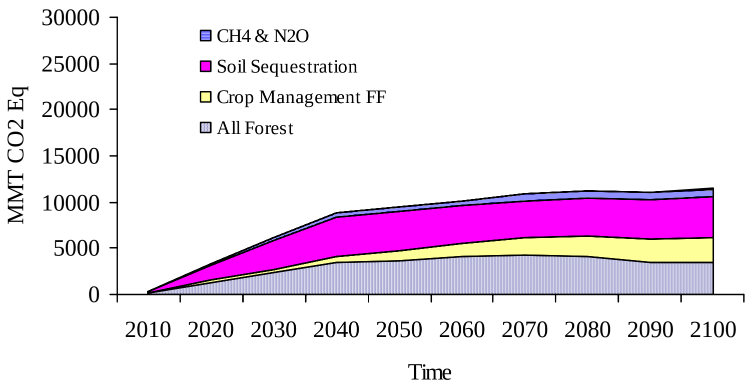
Why – Congruence and partial low cost

Lower per acre rates than higher cost alternatives

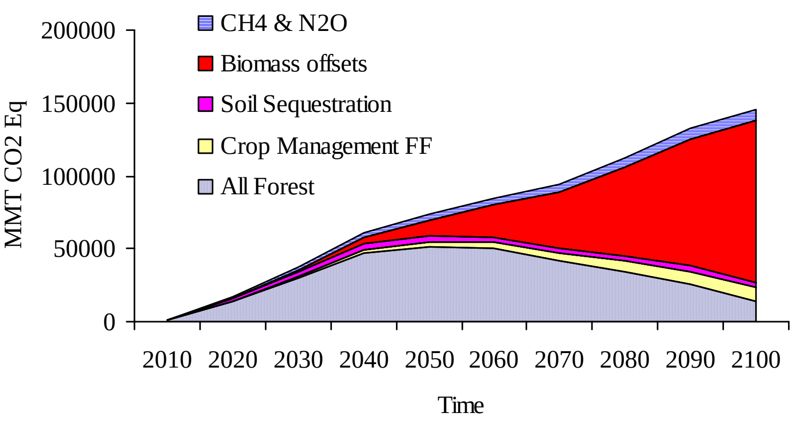
Biofuel takes higher price

No Ethanol

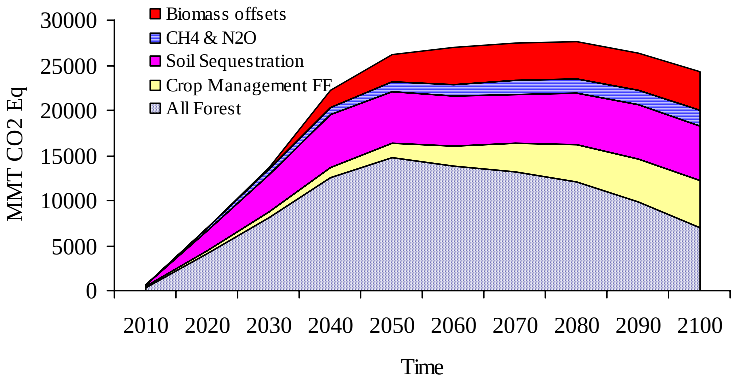
Dynamic Role of Strategies Results



Cumulative Contribution at a $5 per tonne CO2 Price



Cumulative Contribution at a $50 Price



Cumulative Contribution at a $15 Price

Note

Effects of saturation on sequestration
Growing nonco2 and biofuels

Source Lee, H.C., B.A. McCarl and D. Gillig, "The Dynamic Competitiveness of U.S. Agricultural and Forest Carbon Sequestration," 2003.

Dynamic Role of Strategies Results

Time from now	<$15/metric ton	>$15/metric ton
>30 years	Limited forest and afforest Non co2	Bio fuels Non co2
O to30 years	Ag soils Forest management Non co2	Limited Ag soils Forest and afforest Biofuels Non co2

Level of Price

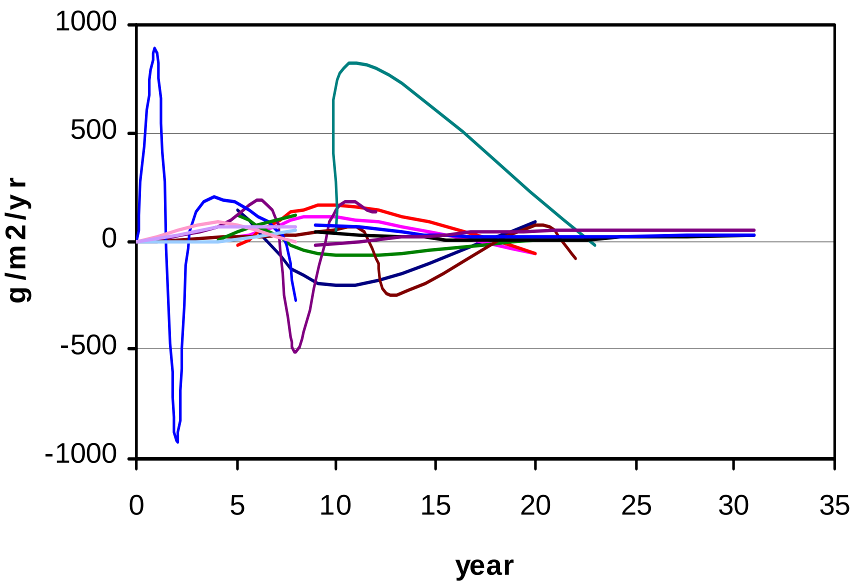
Source Lee, H.C., B.A. McCarl and D. Gillig, "The Dynamic Competitiveness of U.S. Agricultural and Forest Carbon Sequestration," 2003.

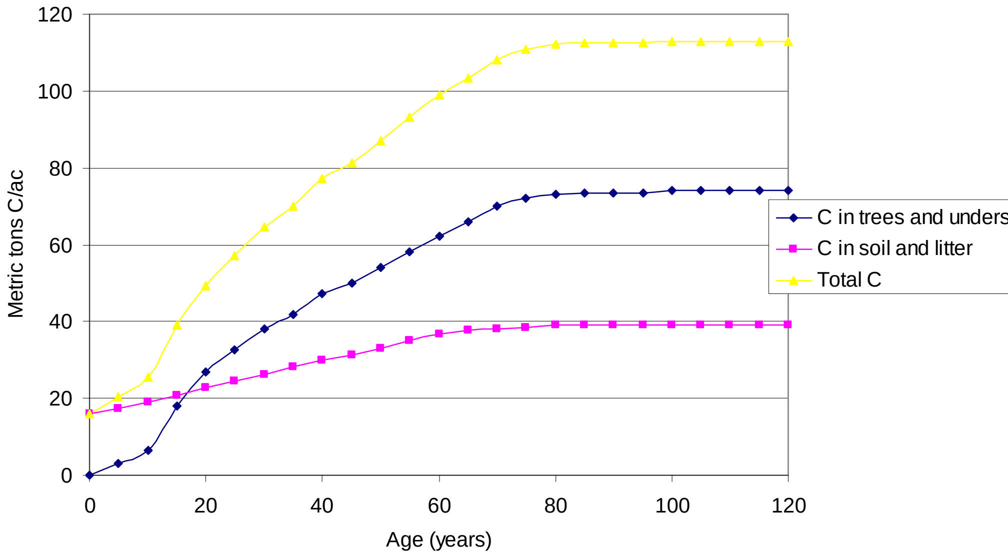
Dynamic Role of Strategies Results

Saturation of Sequestration Ag Soils and Forests

Results – C accumulation vs. time with change from conventional till to no-till

Figure 2. Cumulative Carbon sequestration in a Southeastern U.S. pine plantation
Source: Data Drawn form Birdsey (1996)





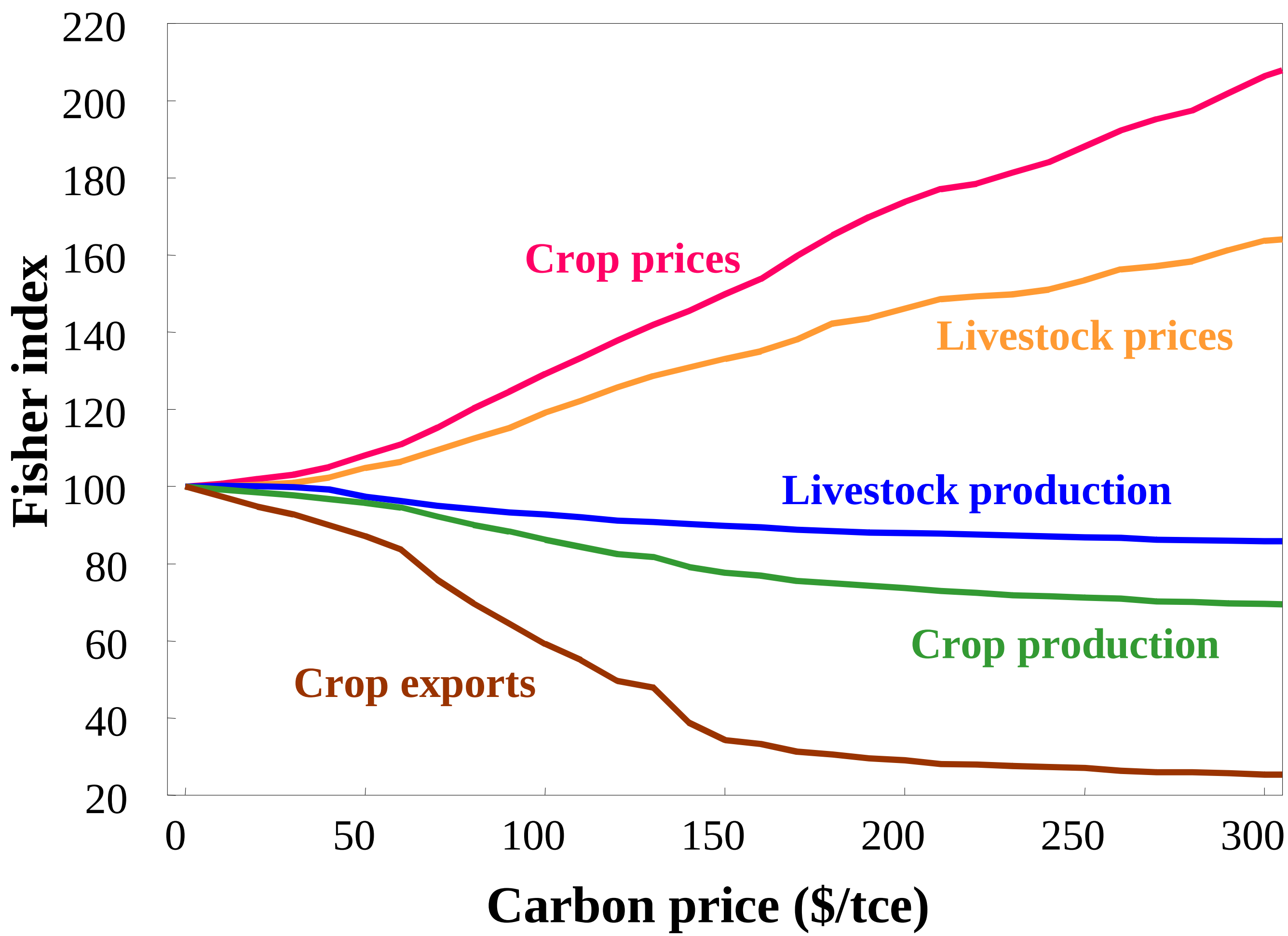
West and Post, Oakridge NL

Note saturation by year 20

Birdsey et al, USFS, FORCARB

Note saturation by year 80

GHG Mitigation and Ag-Markets

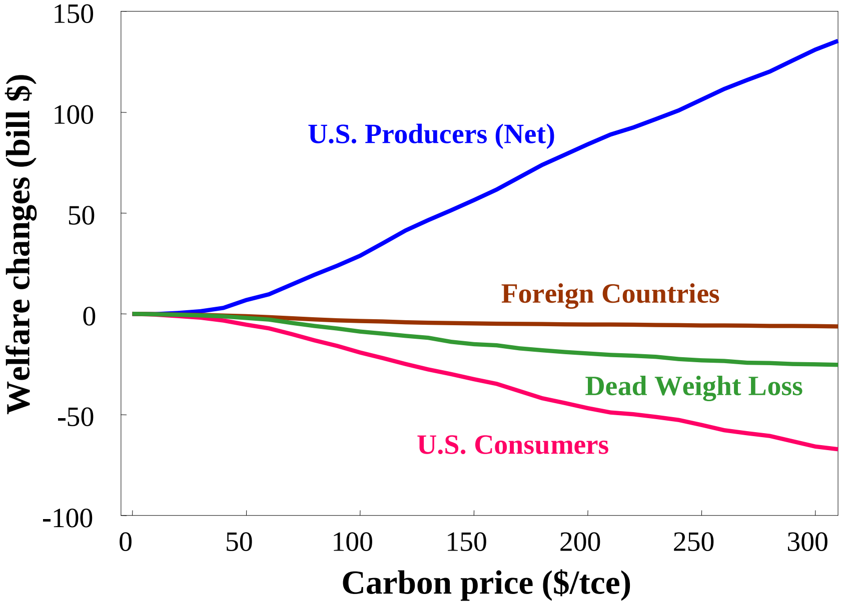


Tradeoff between carbon and traditional production – ag prices rise, forest products fall

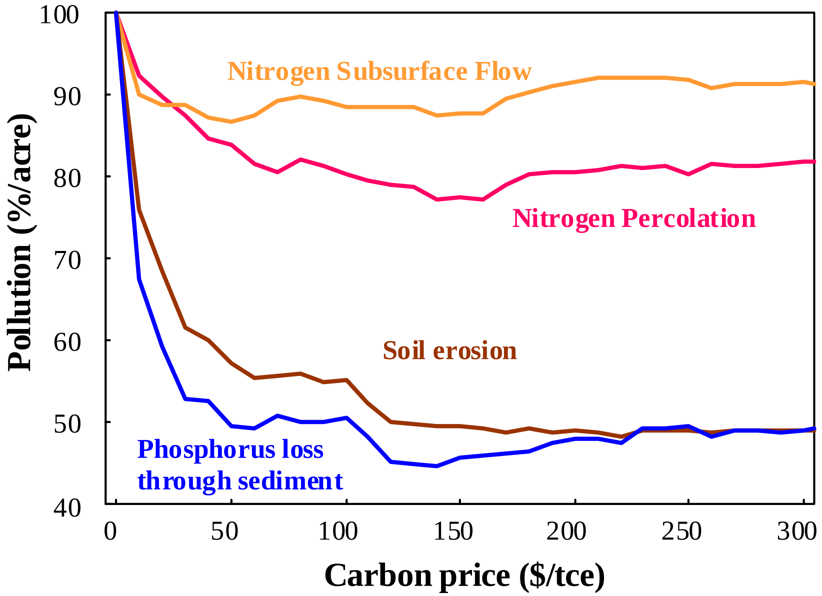
Source: Pattanayak, S.K., A.J. Sommer, B.C. Murray, T. Bondelid, B.A. McCarl, and D. Gillig, "Water Quality Co-Benefits of Greenhouse Gas Reduction Incentives in Agriculture and Forestry," Report to EPA, 2002.

Results: Co-Benefits, Economic & Envir.

Ag-Sector Welfare



Multi-environmental Impacts



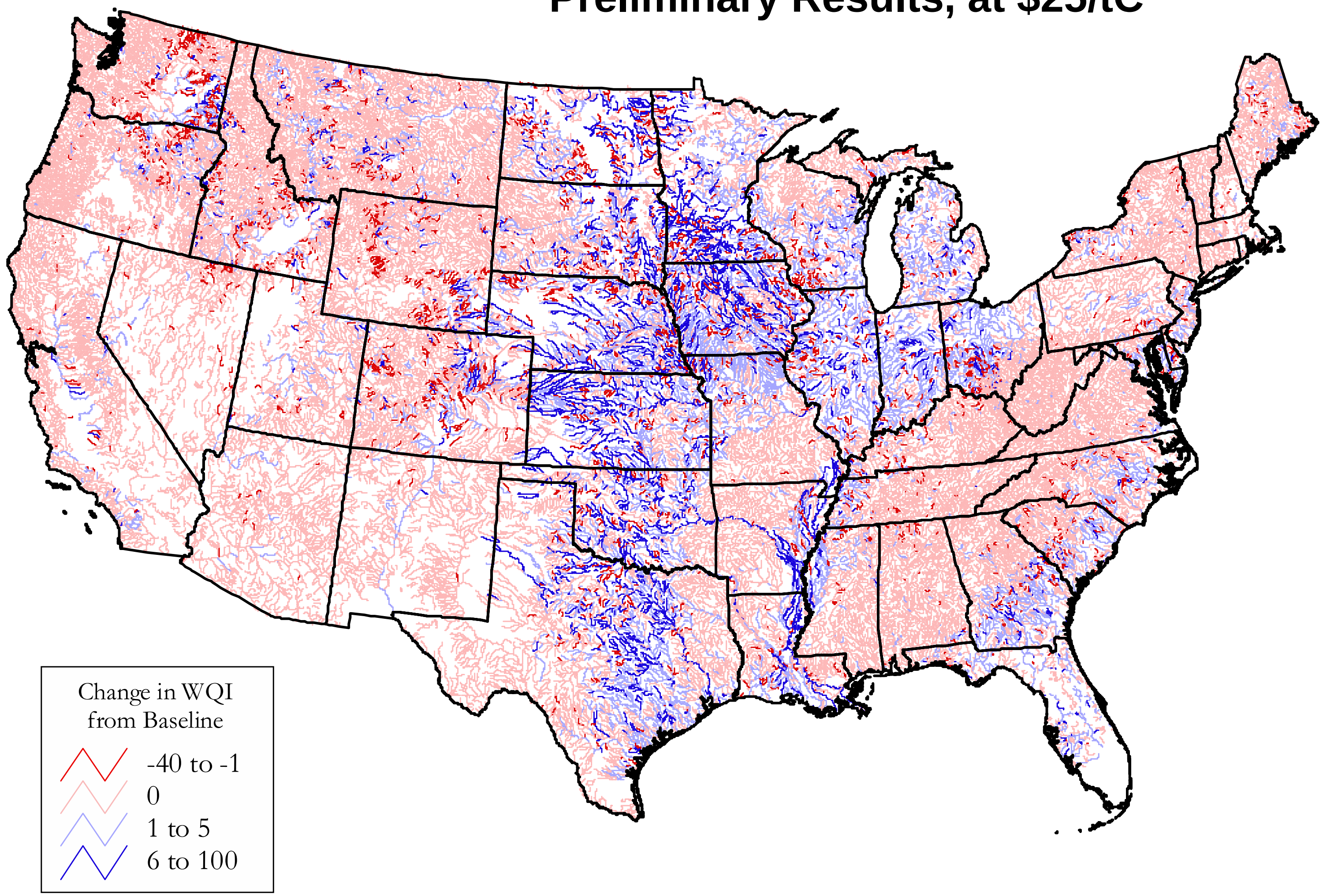
- Producers gain & Consumers lose
- Exports reduced
- Environmental gains
- High prices erode co-benefits due to intensification

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

Source: Pattanayak, S.K., A.J. Sommer, B.C. Murray, T. Bondelid, B.A. McCarl, and D. Gillig, "Water Quality Co-Benefits of Greenhouse Gas Reduction Incentives in Agriculture and Forestry," Report to EPA, 2002.

Co-Benefits: Water Quality Changes

Preliminary Results, at $25/tC

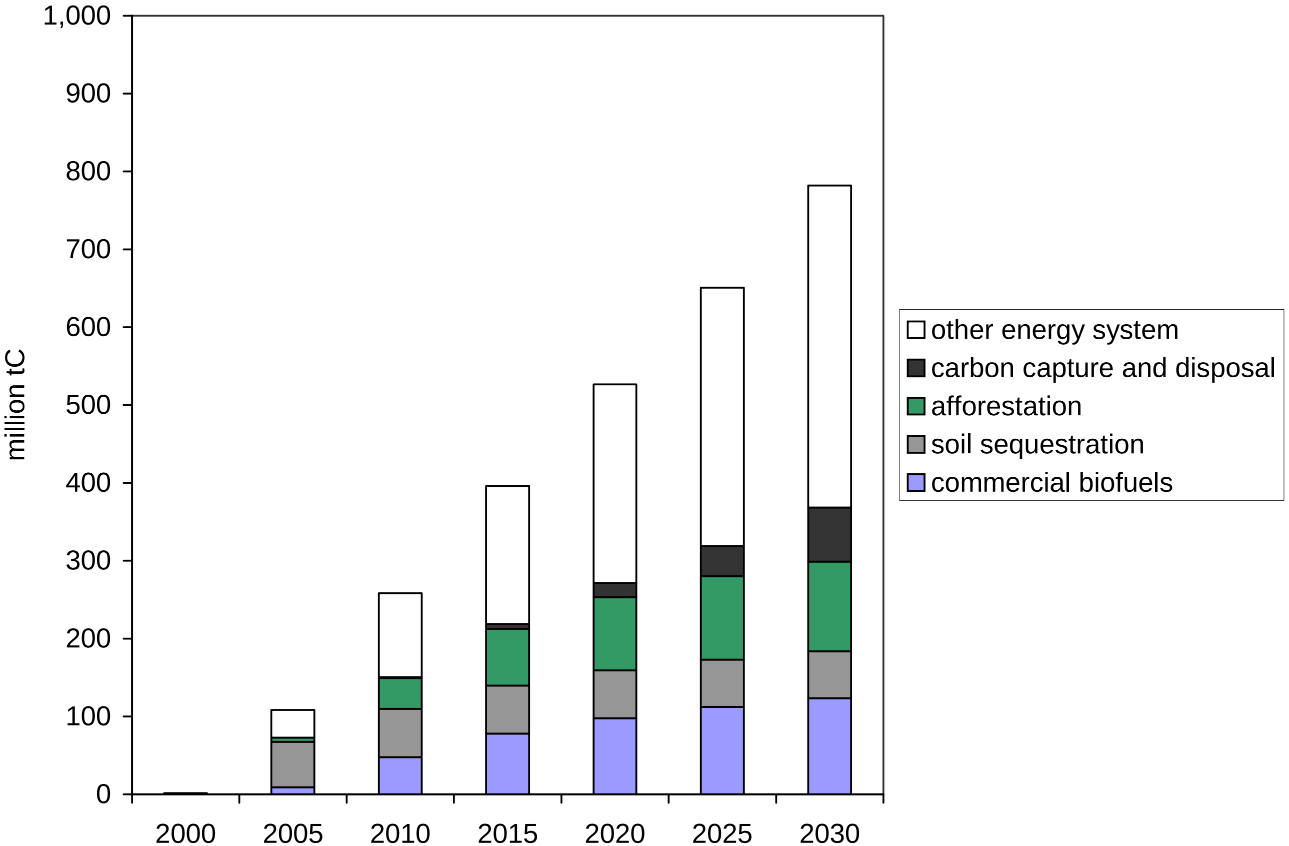


Source: Pattanayak, S.K., A.J. Sommer, B.C. Murray, T. Bondelid, B.A. McCarl, and D. Gillig, "Water Quality Co-Benefits of Greenhouse Gas Reduction Incentives in Agriculture and Forestry," Report to EPA, 2002.

Total Economy Competitive Potential

SGM CGE Model

Composition of U.S. Emissions Reductions (remain at year 2000 emissions)



From Sands, R.D., B.A. McCarl, and D. Gillig, "Assessment of Terrestrial Carbon Sequestration Options within a United States Market for Greenhouse Gas Emissions Reductions," Presented at the Second Conference on Carbon Sequestration , Alexandria, VA, May 7, 2003.

Conclusions

- Biofuels could play an important part in a GHGE mitigating world if price was above $50 per ton of carbon.
- At low prices opportunity cost of resources exceeds value of feedstocks generated.
- Only the ability to collect benefits from carbon savings makes the biofuels competitive.
- Competitive because biofuels continually offset fossil fuel emissions in comparison to changing tillage which saturates
- Biofuels may also yield other ancillary benefits.
- Big question: Will society choose to reward their carbon recycling characteristics?
- This will entail society deciding to attach a substantial price to the right to emit GHGs into the atmosphere.