

# **Forest and Agriculture Sector Optimization Model-Green House Gases (FASOMGHG)— Analysis of Deforestation and Climate Change Mitigation Options**

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**Adam Daigneault, EPA**  
**Robert Beach, RTI**  
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**Kenneth Szulczyk, TAMU**

## **Sources of Support**

**USDA Forest Service**  
**USEPA**

# Outline of Talk

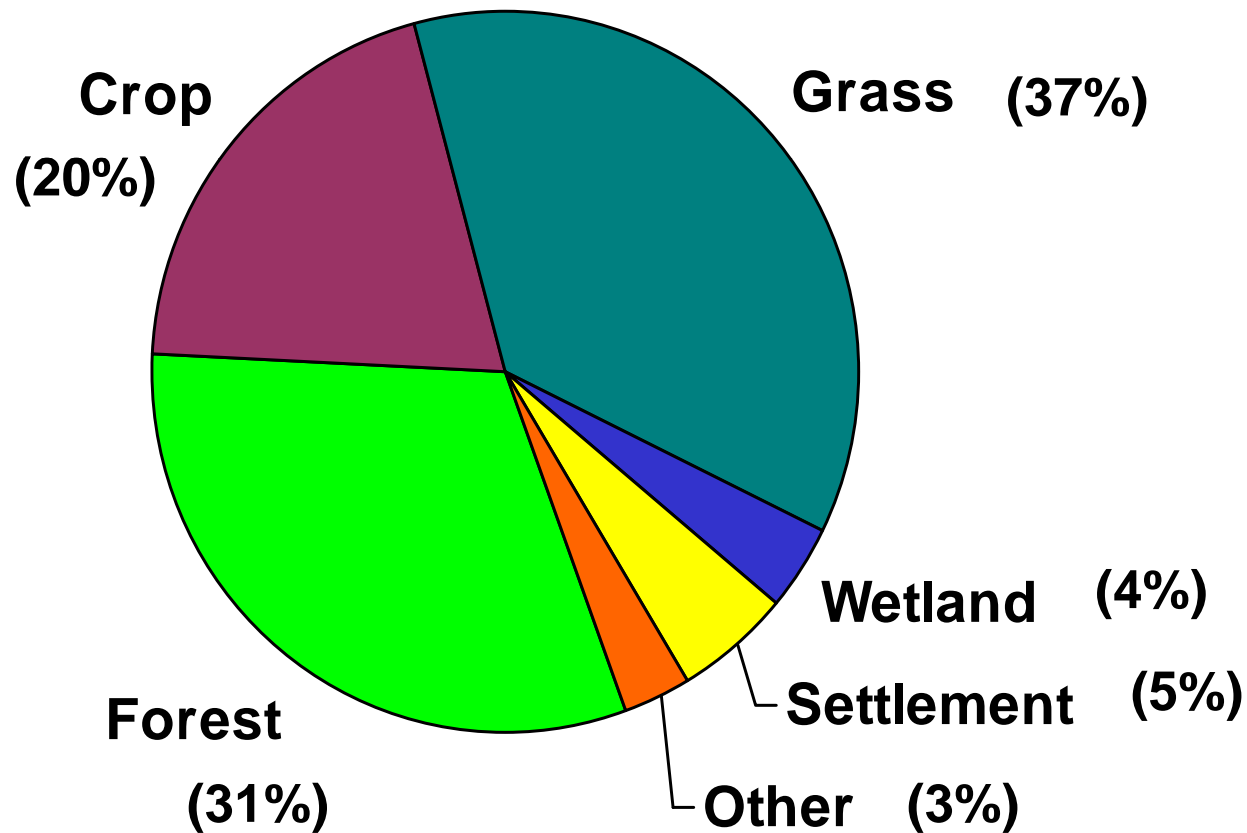
- **FASOM-GHG Modeling: Policy Context**
- **Base Case and Deforestation/Carbon Price/Land-Use Change Scenarios**
- **Preliminary Results**
- **Summary and Wrap-Up**

# Preventing GHG Emissions Through Avoided Land-Use Change

- April/May 2008: Society of American Foresters Task Force on Climate Change
- Globally, 1/3 of total carbon-related emissions between 1850 and 1998 due to forestland conversions
- Tools for Forest Retention, e.g., conservation easement
- Market-related effects for certain forest retention scenarios (this study)

# US land uses, 2006

Source: Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006, [www.epa.gov/climatechange/emissions/index.html#inv](http://www.epa.gov/climatechange/emissions/index.html#inv)



# Forest and Agricultural Sector Optimization Model (FASOM)-GHG

- Unique features:
  - Links forest and ag commodity markets,
  - Connects those markets to private land use decisions (for crops, pasture, forest)
- 5-year time step for optimization, typically 80-100 year time horizon
- CO<sub>2</sub>, methane and nitrous oxide emissions
- Underlying biophysical yields for ag, forest (including long-term forest growth process)
  - Can be adjusted to reflect forecast impacts of climate change

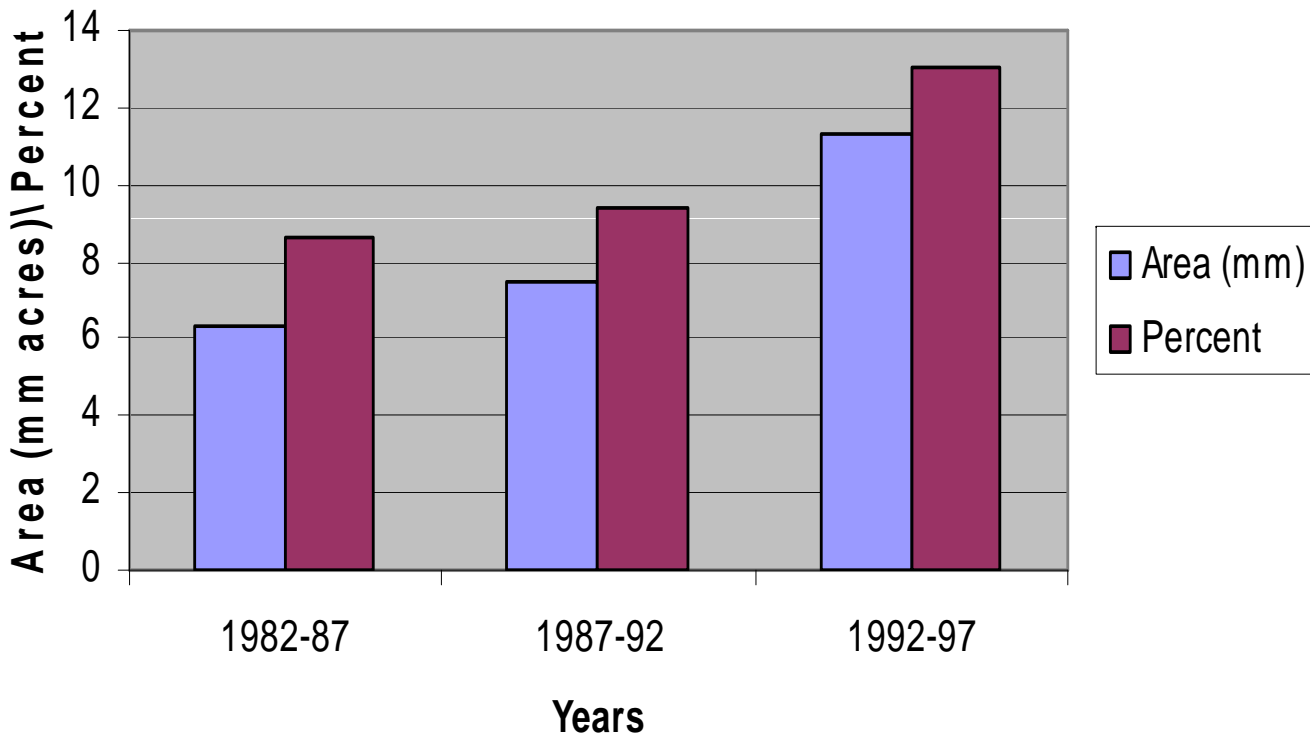
# FASOM-GHG research examples

- What may be the socio-economic impacts of climate change on the U.S. forest sector and recreation?
  - National climate change assessment: Irland, Adams, Alig, et al. (2001) *Bioscience*
- What may be the impacts of climate change on U.S. forest and ag. sectors and carbon budgets?
  - Alig et al. (2002) *Forest Ecology and Management*
- What is the economic potential for forestry and agriculture to supply GHG mitigation? (EPA, 2005)
- What is the magnitude of leakage from forest carbon sequestration projects/programs?
  - Alig et al. (1997) *Environmental and Resource Economics*
- How competitive would biomass-fueled energy be?
  - McCarl, Adams, Alig, et al. (2000) *Annals of Operations Research*

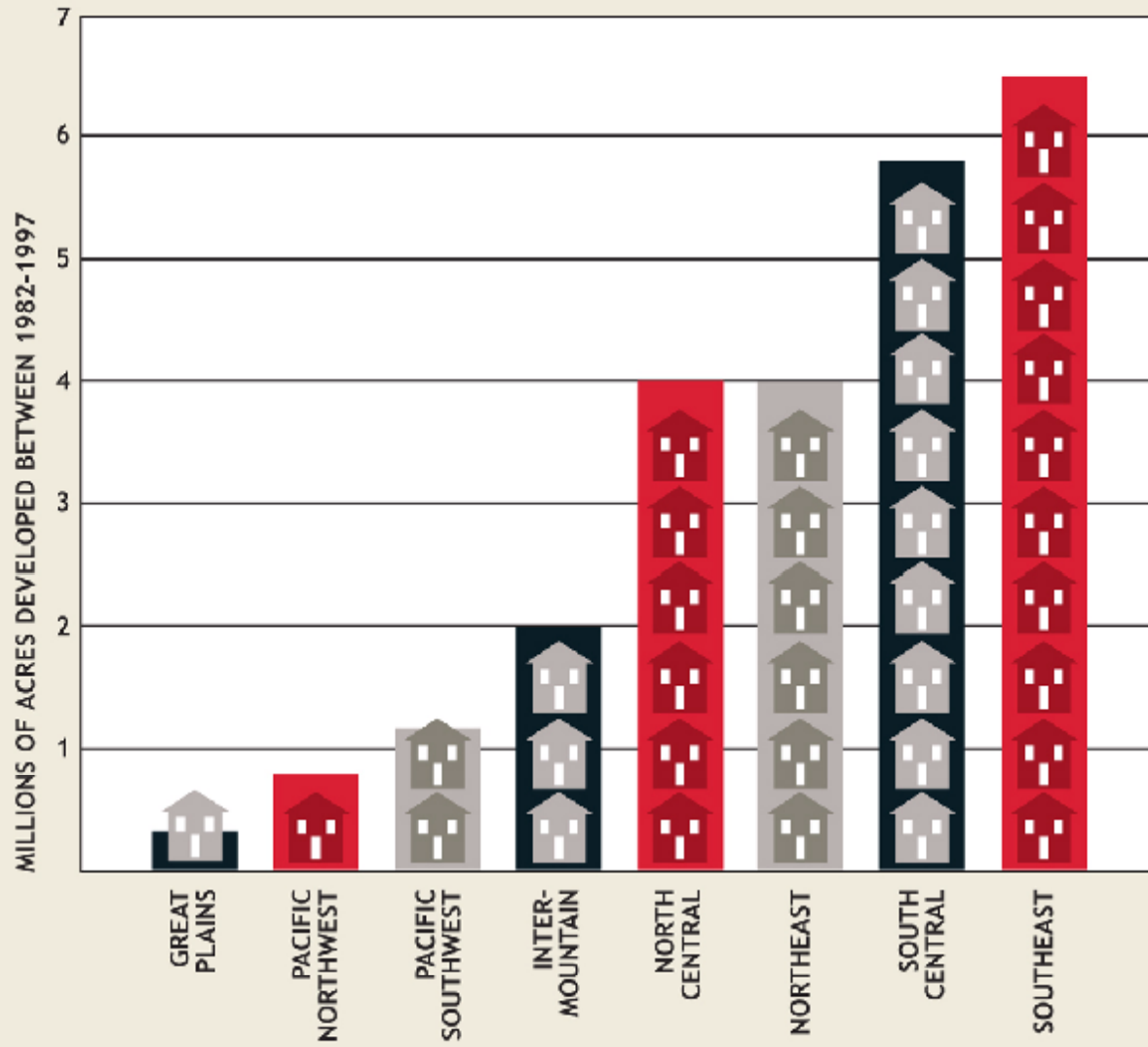
# Forestry/agriculture mitigation options

- Ag soil C-sequestration: crop tillage, crop mix, fertilization, grassland conversion
- Afforestation: from crop, pasture lands
- Forest management: harvest rotation, timber management intensity, forest set-asides
- Ag CH<sub>4</sub> and N<sub>2</sub>O: enteric fermentation; livestock herd size, management; manure management; rice acreage; crop tillage, crop mix, crop inputs
- Crop fossil fuel: crop tillage, crop mix, crop inputs, irrigation/dry land mix
- Biofuel offsets: produce crop or woody feedstocks

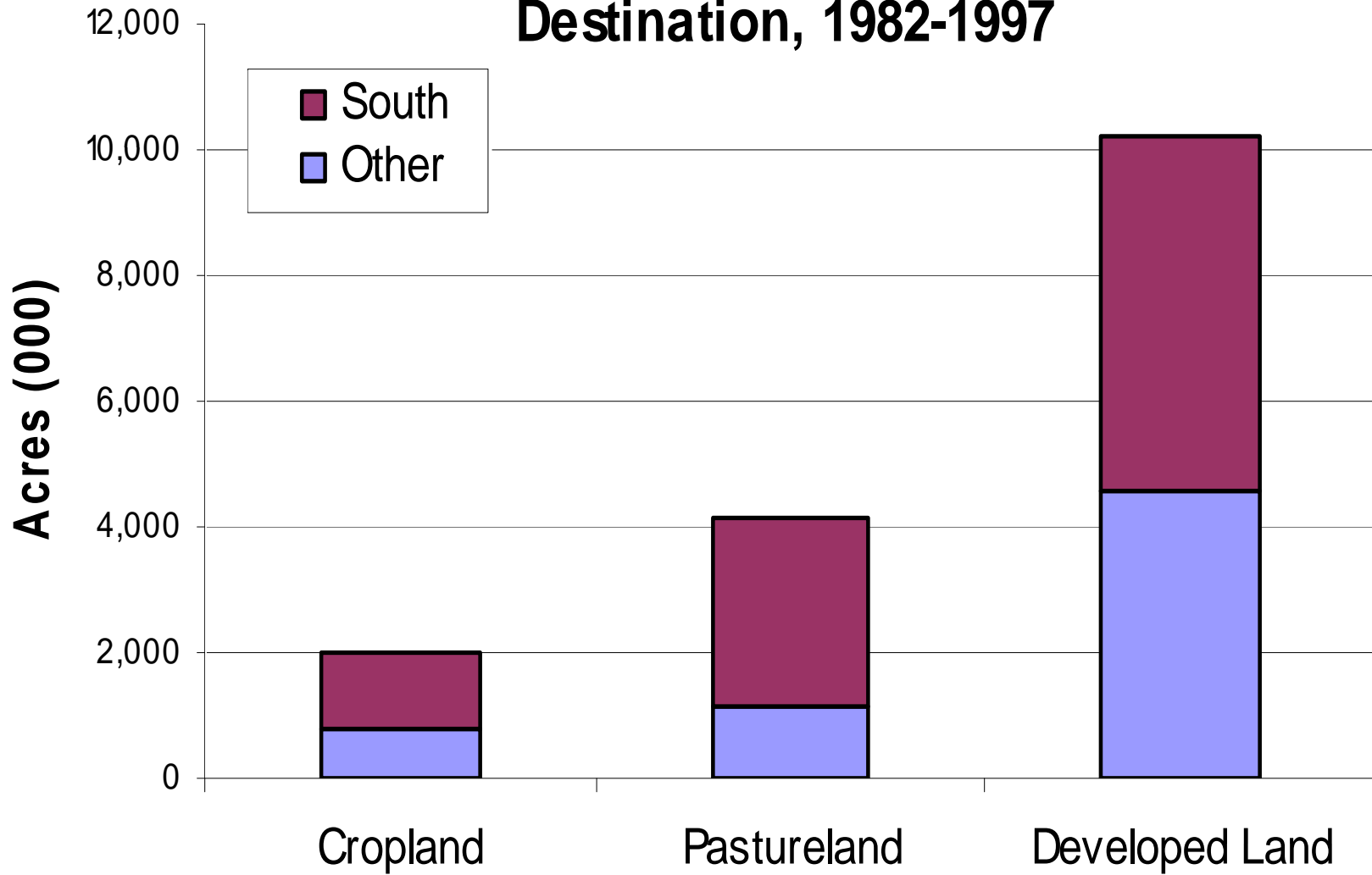
## Change in U.S. Developed Area



## REGIONAL TRENDS



# Forest Area Conversion by Region and Destination, 1982-1997



# Demand for Land

- \*World population to grow from six to nine billion, over next 50 years
- \*National population to grow by at least 120 million people over next 50 years, ~ 40%, with increased average personal incomes

# U.S. Econometric Model of Land Use

- Ruben Lubowski's PhD work at Harvard
- Collaboration with Andrew Plantinga, Oregon State University
- Application in the 2010 Resources Planning Act Assessment: Projections of areas for major land uses, such as for developed land

# PROJECTIONS USING FASOM-GHG MODEL

- FASOM-GHG MODEL: 2008 Version
- Model runs by GREG LATTA and BRUCE MCCARL
- 80-year model runs, focus on first 50 years of projections in talk
- Funding assistance by EPA

# Exogenous amounts of Deforestation to Developed Use in the Base Case

- Average exogenous loss of forest area to developed uses is more than 7 million acres per decade over next 50 years
- Largest losses are in the South and NE

# Scenarios: FOREST TO DEVELOPMENT

- 2X BASE amount
- No loss of timberland to developed uses

# Carbon Price Scenarios

- \$25 and \$50 per tonne (CO<sub>2</sub> equivalent)
- Constant prices used in this analysis
- Reflected in FASOM-GHG objective function

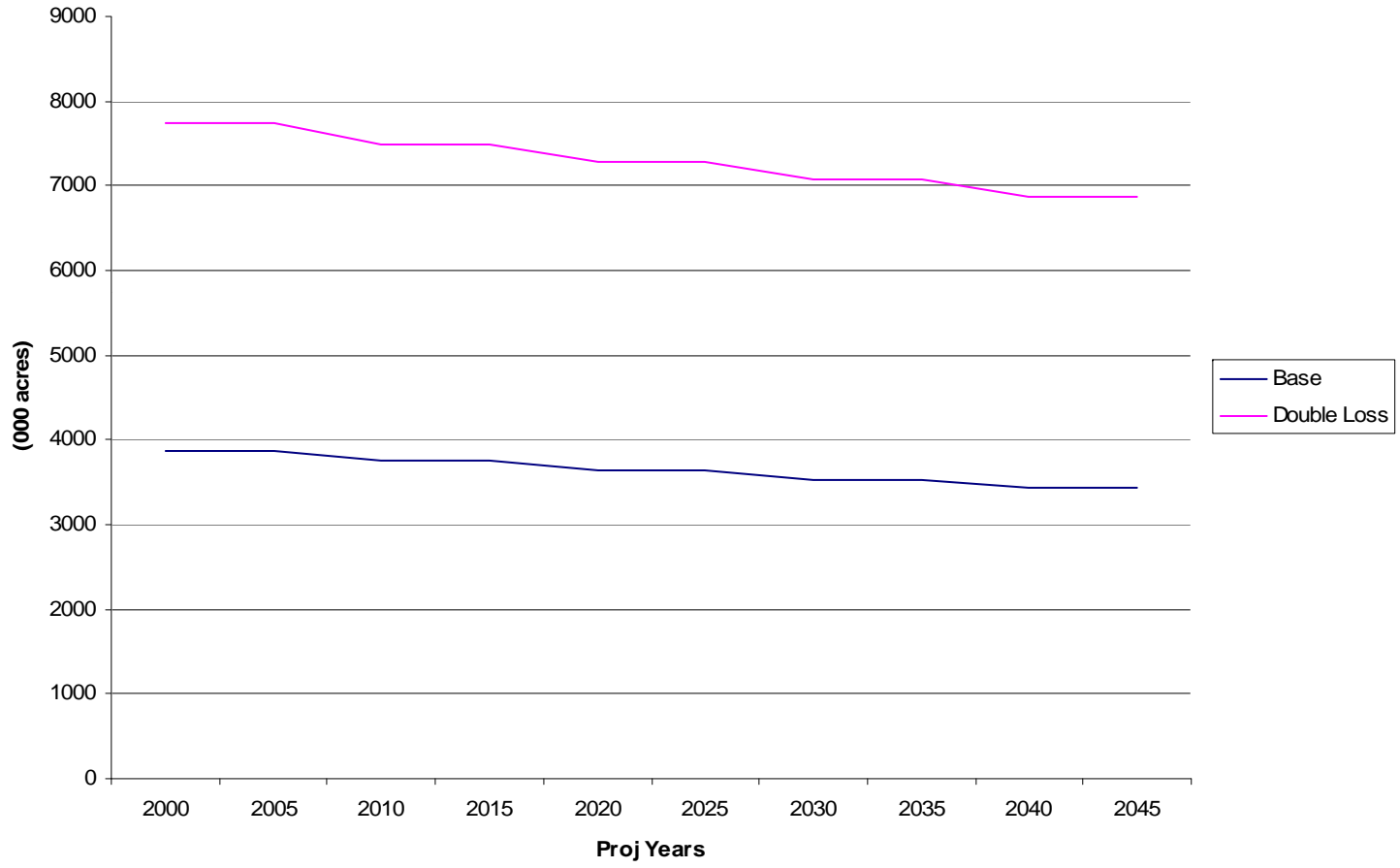
# Scenarios About Responses by Agricultural Sector

- Intersectoral land transfers (Fully endogenous)
- Intersectoral land transfers fixed at base run levels
- No transfers of land between forest and ag. sectors, such that timberland area is fixed except for transfers of timberland to developed uses

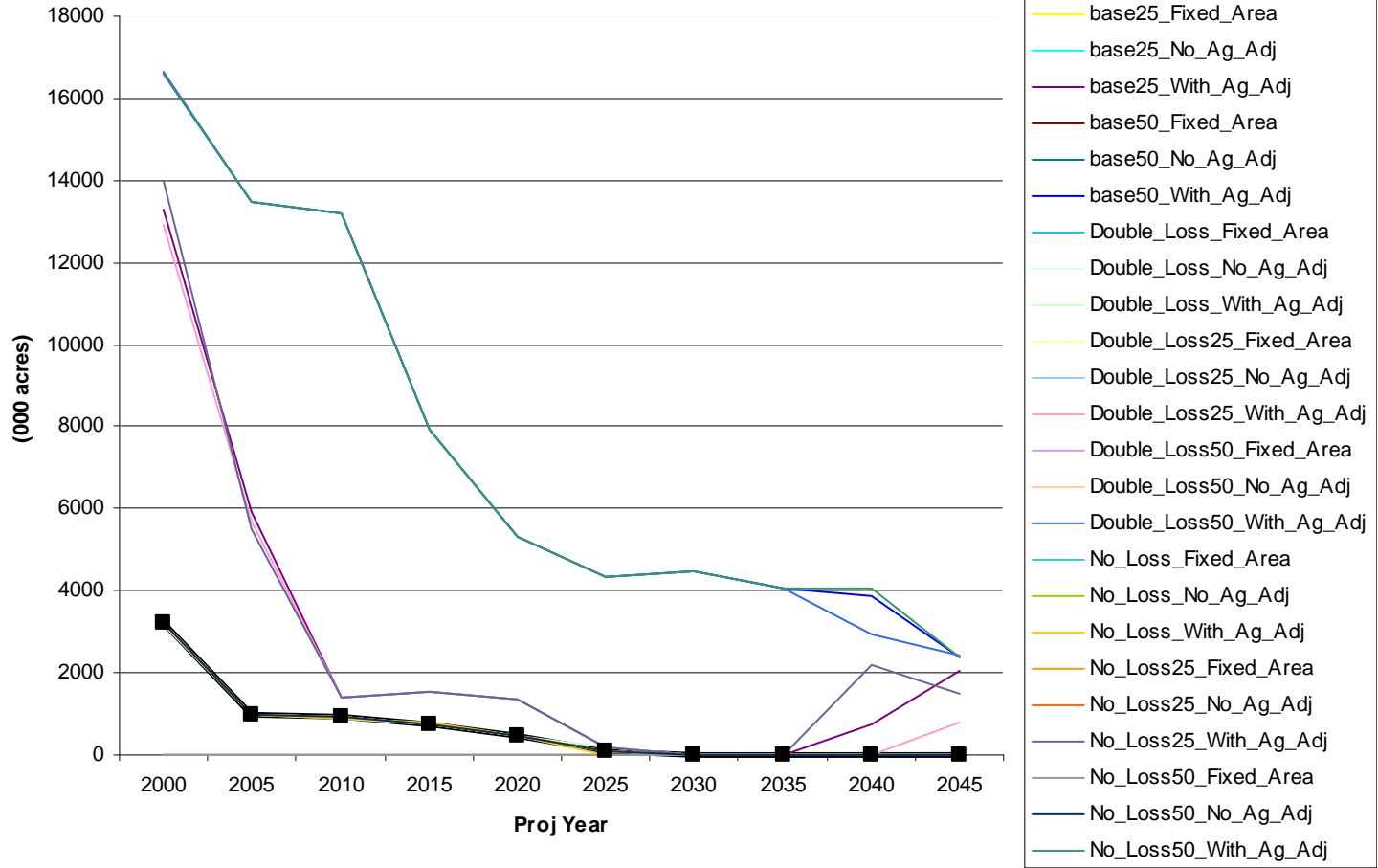
# COMBINATIONS

1. Timberland loss to development (Base, No Loss, Double Loss)
2. Carbon Price (0, \$25, \$50)
3. Intersectoral land transfers (Fully endogenous; Fixed at base run levels  
“limited ag adjustment;“ no transfers of "No land between forest and ag sectors"

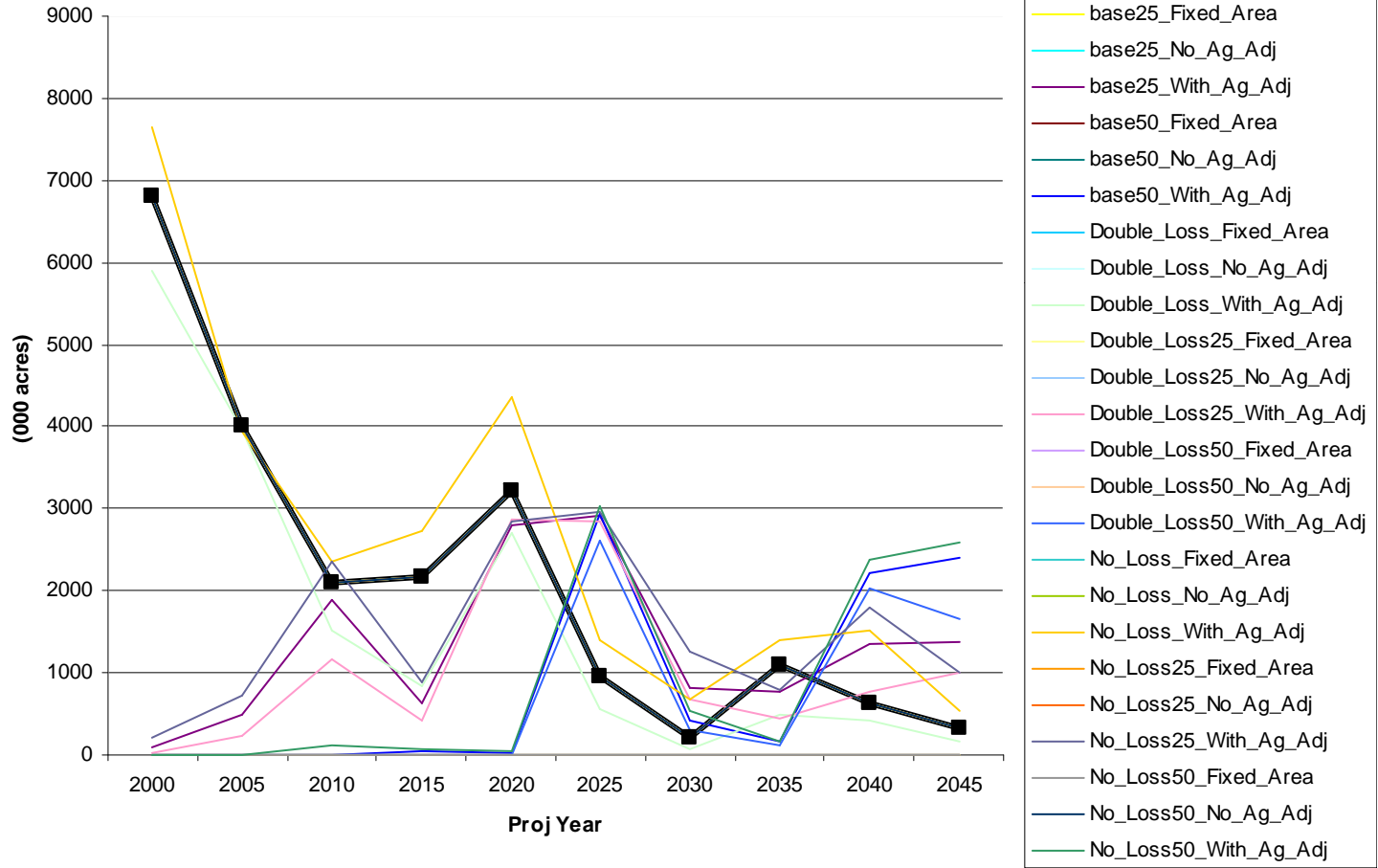
### Deforestation Scenarios



### Afforestation Area

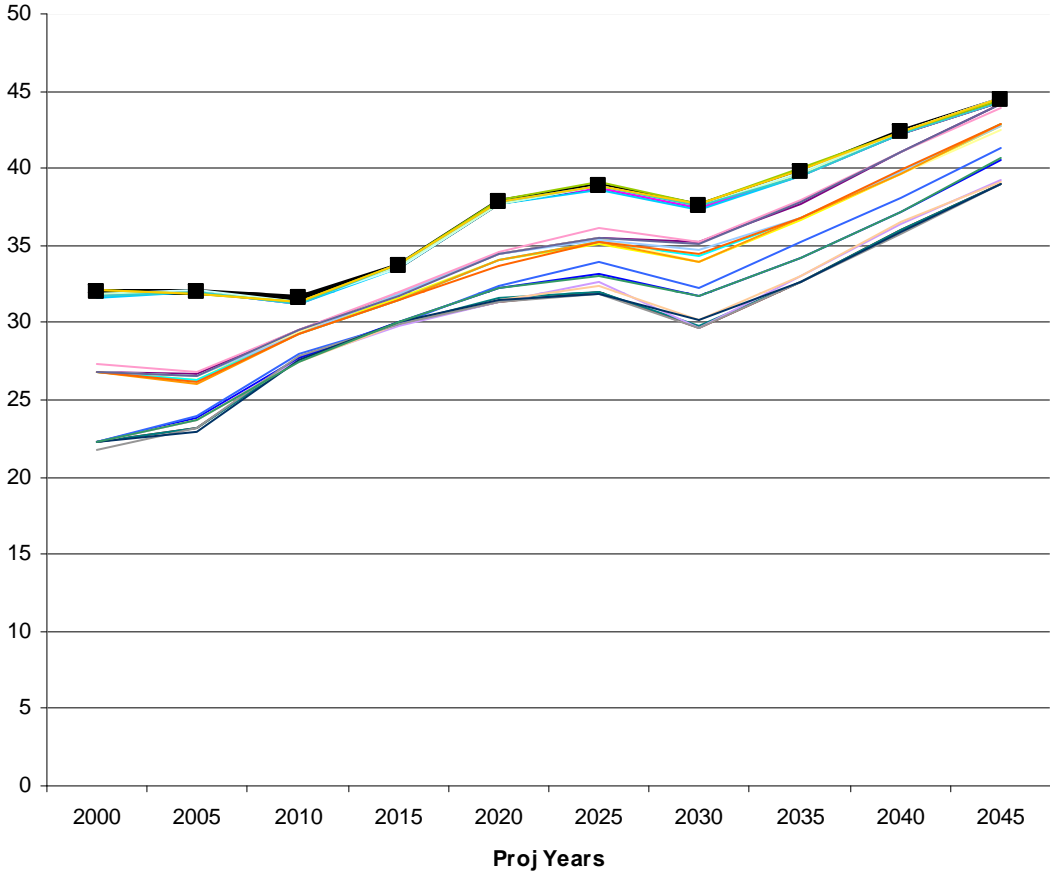


Deforestation to Ag



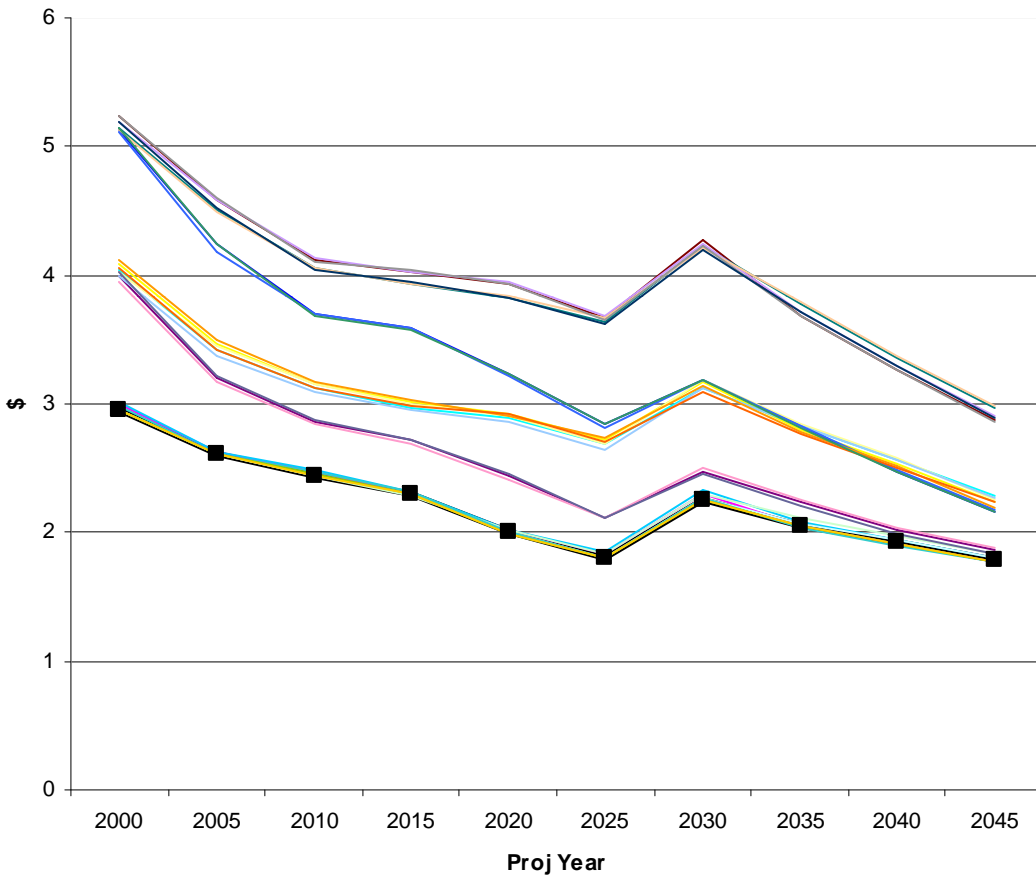


### Softwood lumber production



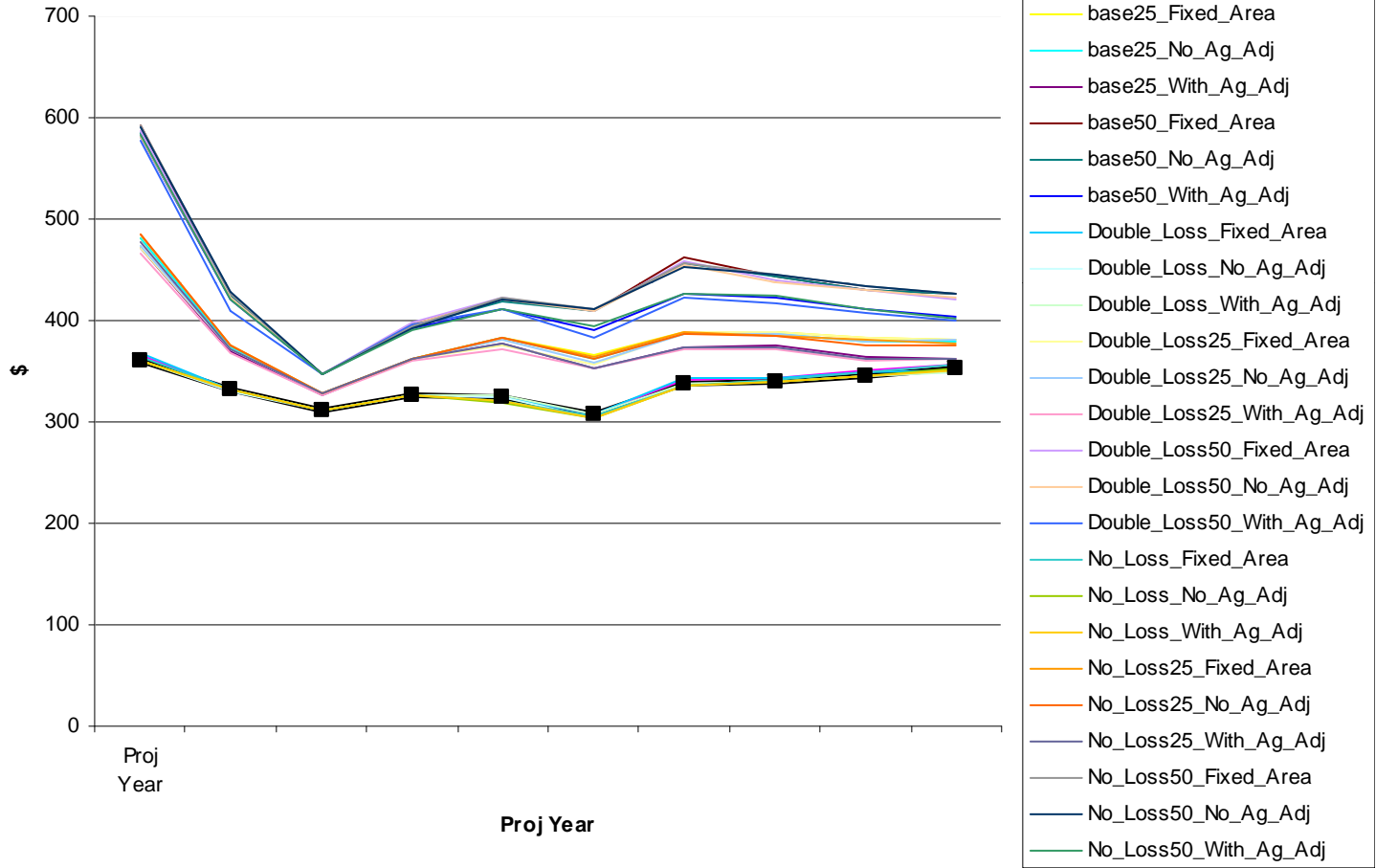
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Softwood Log Prices SC Region

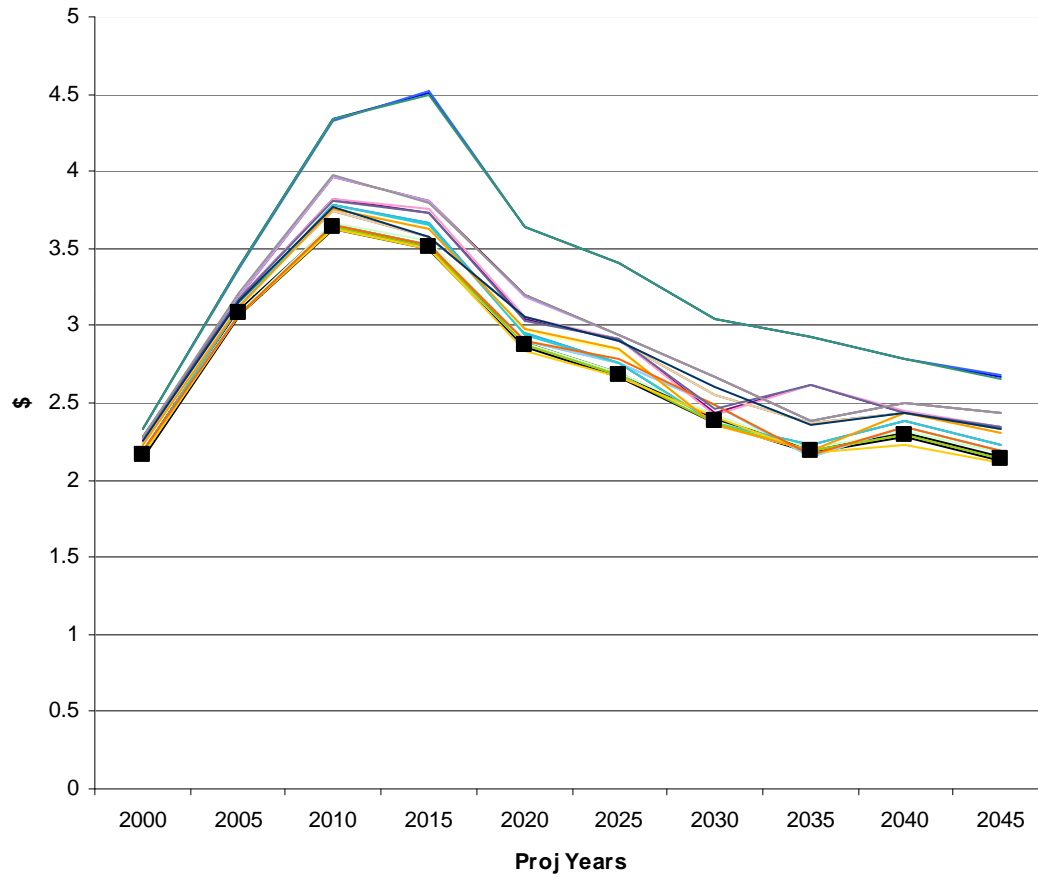


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### Softwood Lumber Prices

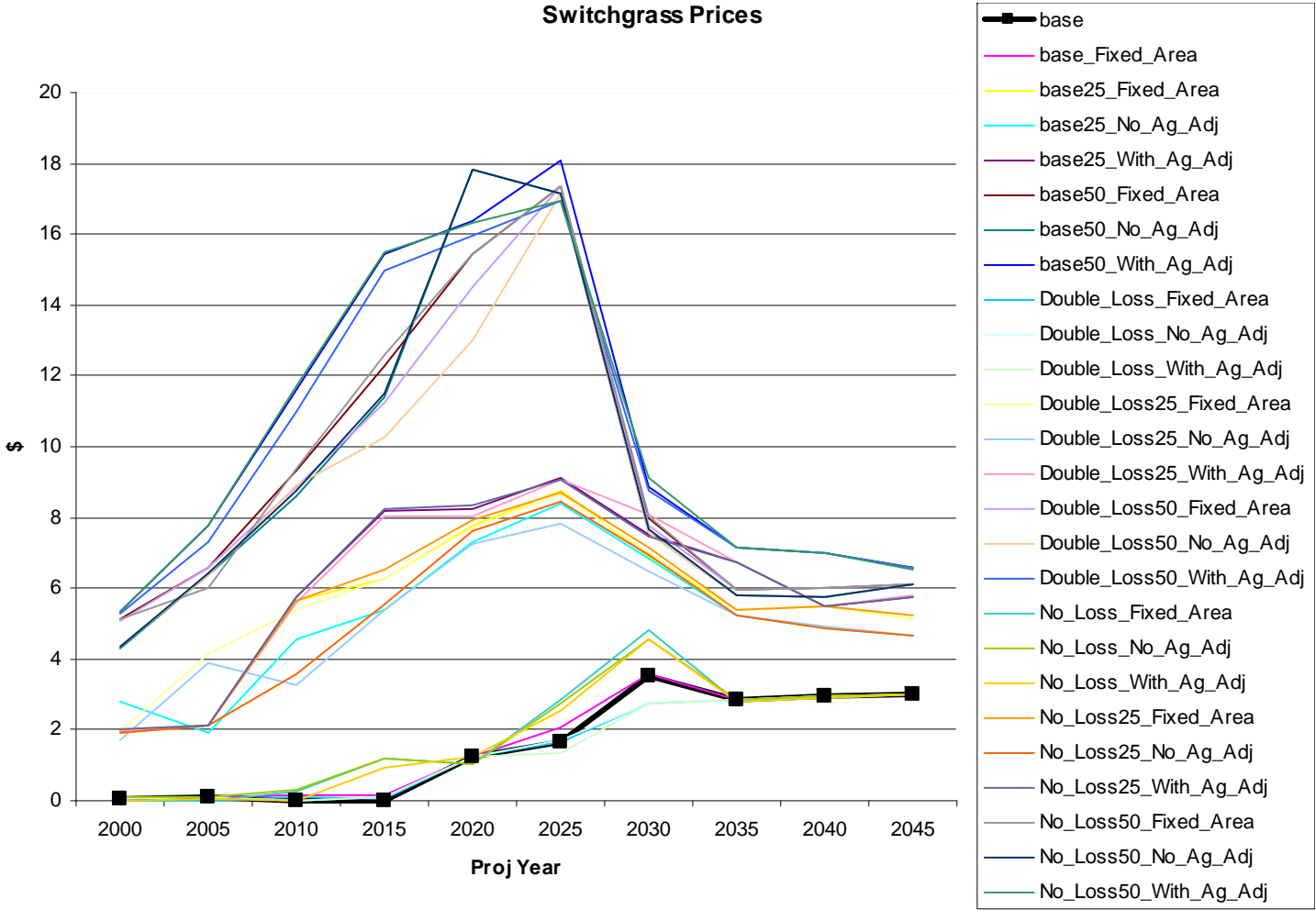


### Corn Prices

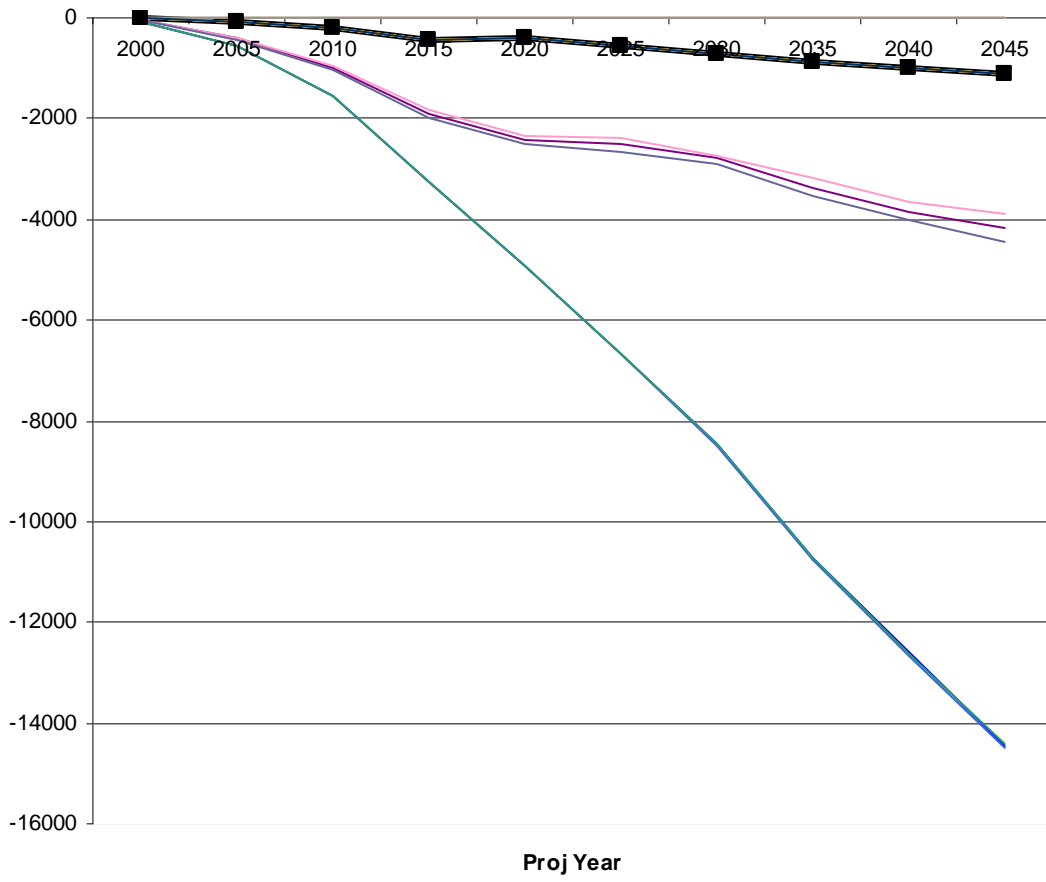


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Switchgrass Prices

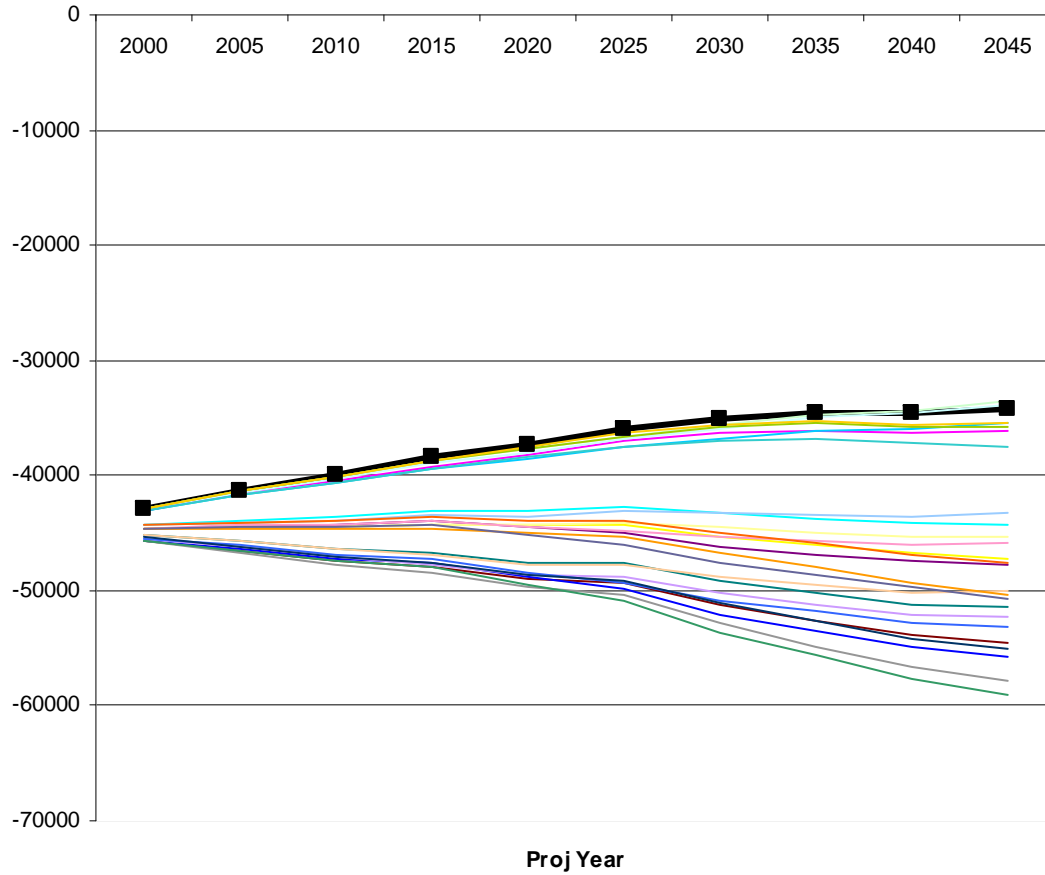


### Afforestation carbon



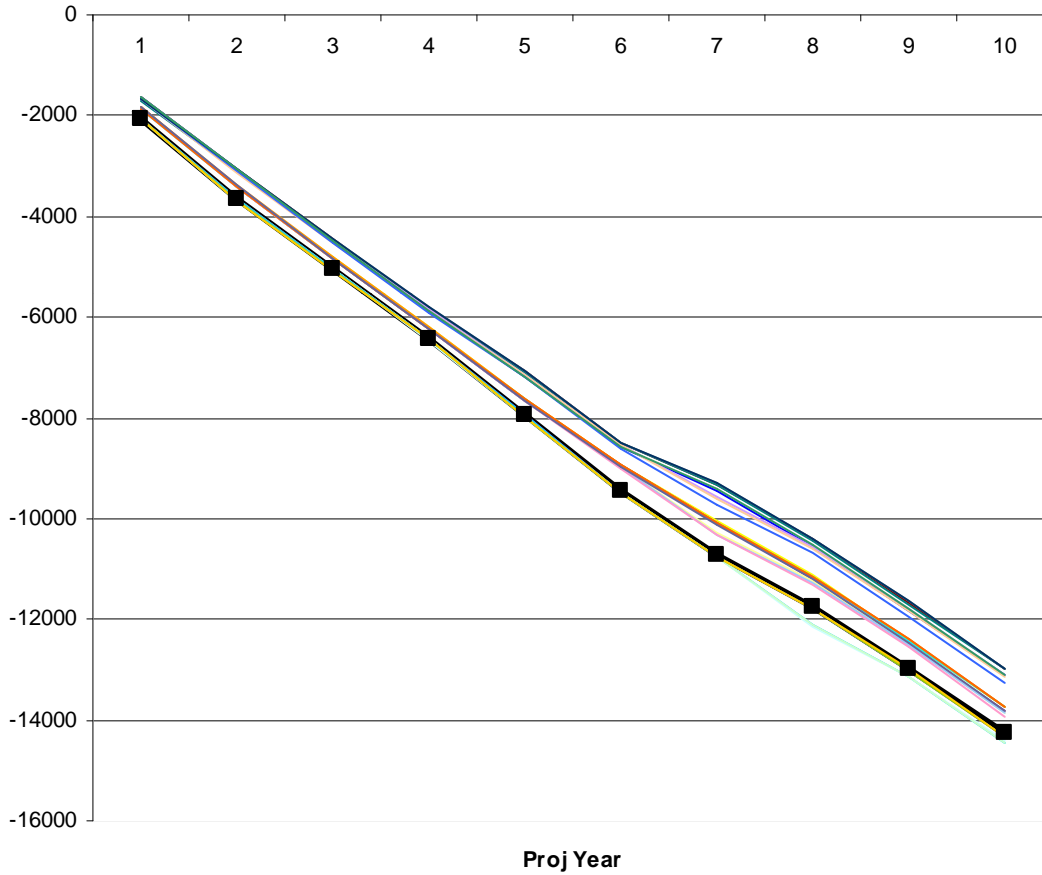
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### Forest Management Carbon



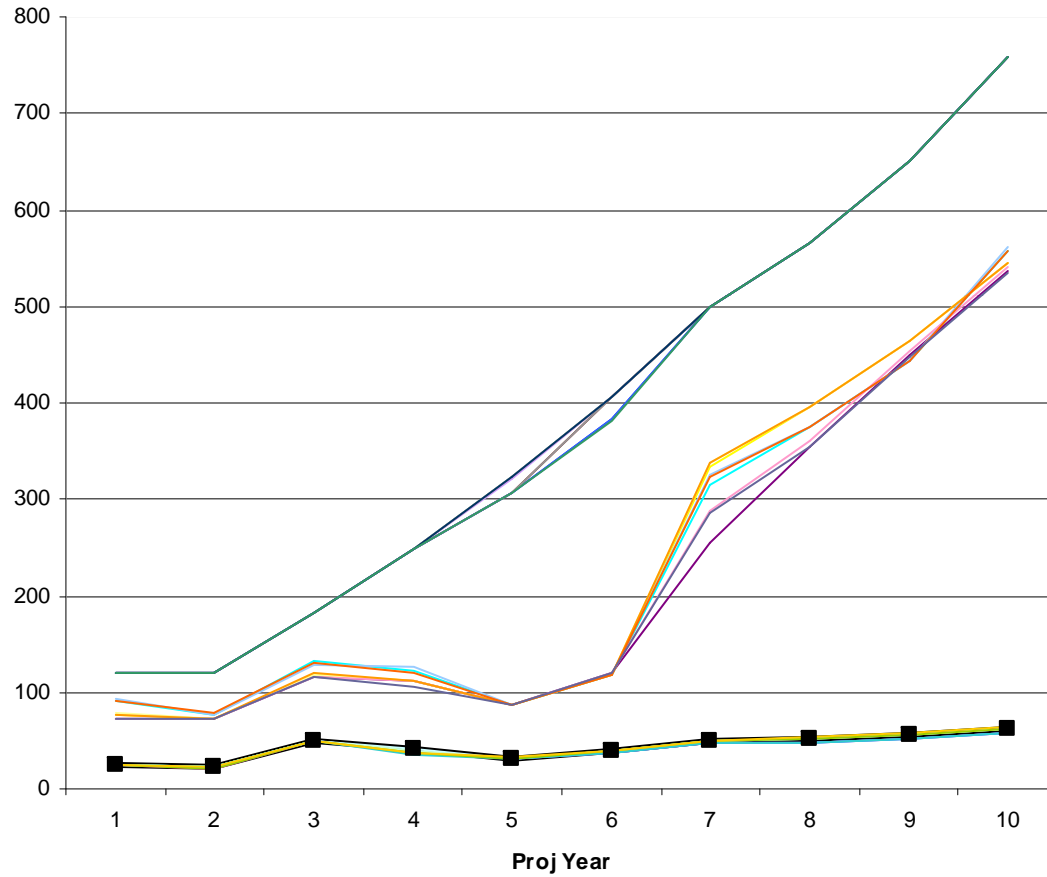
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- No\_Loss50\_With\_Ag\_Adj

### Forest Products Carbon



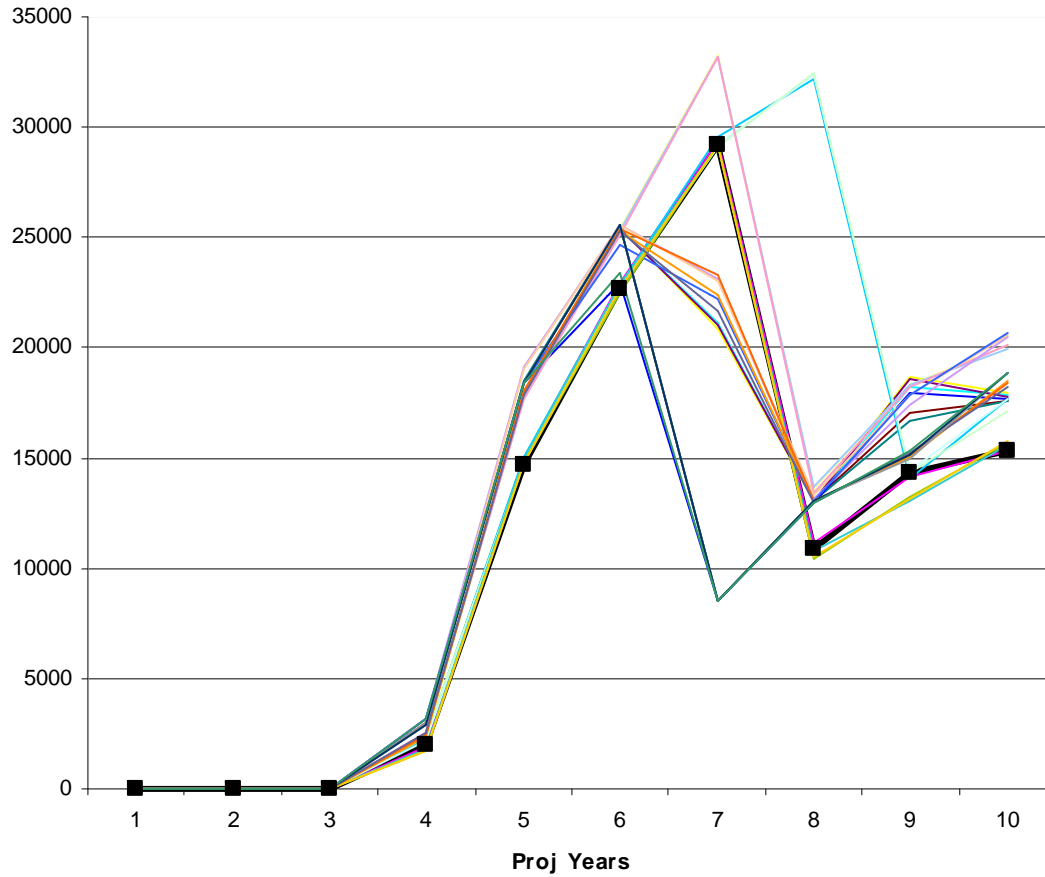
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### Bioelectricity



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- base50\_No\_Ag\_Adj
- base50\_With\_Ag\_Adj
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Hardwood mill residues to ethanol



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- base25\_With\_Ag\_Adj
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- base50\_No\_Ag\_Adj
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# Welfare Impacts

- Highest objective function values with carbon prices are for \$50 carbon and no loss to development and opportunity to transfer land with agriculture
- Ag welfare is highest when no land is transferred to forestry and carbon price is \$50

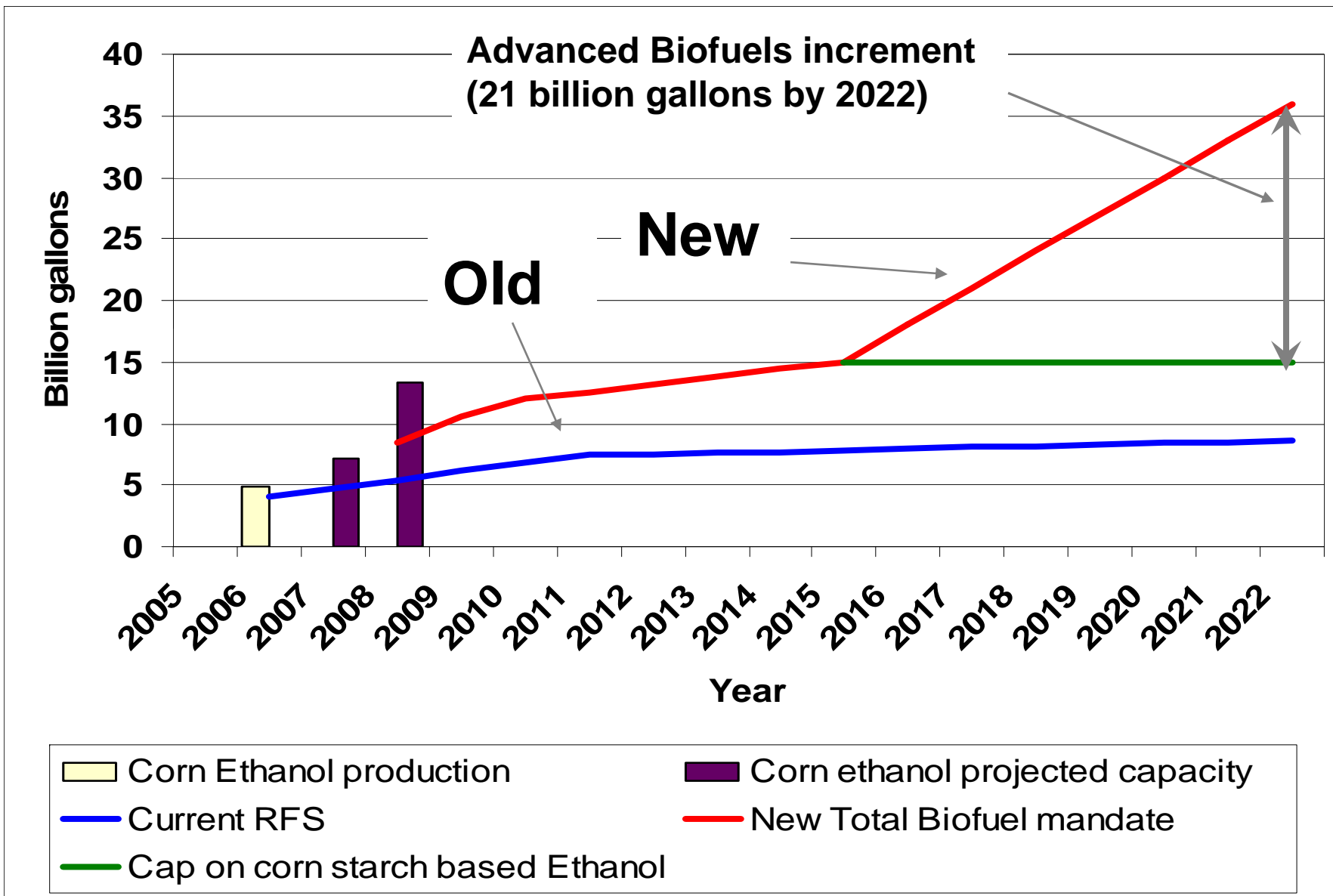
# Summary

- Carbon Price Has Relatively Large Influence on FOR-AG interactions for Prices Examined--\$25 and \$50
- With large land base, U.S. deforestation can be largely accommodated in terms of aggregate effects
- Land transfers between forestry and agriculture are important in climate change mitigation options involving forestry, including when carbon prices are in effect

# Summary (con't)

- Timing of ag crop peak prices influenced by Renewable Fuels Standard, with corn price peaking around 2015-2020, and more reliance on switchgrass in subsequent decades and switchgrass prices peaking about 10 years later
- Amount of afforestation is frontloaded in projections, as is deforestation to ag
- Amount of bioelectricity from cellulosic sources is notably higher with \$50 carbon price

# Old and new Renewable Fuels Standards





**If bioenergy places demands on land areas used for fiber production, then wood fiber competition is inevitable.**

**Also, expansion in biomass energy could result in higher wood prices and more SRWC's.**

