

# Climate Change and Agriculture: Impacts, Mitigation, and Adaptation



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[http://www.usda.gov/oce/global\\_change/](http://www.usda.gov/oce/global_change/)

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# Overview



- Climate Change Effects
- Agricultural Mitigation
- Adaptation
- Strategic Research Priorities
- Decision Support



# Why is Climate Change Important to USDA?

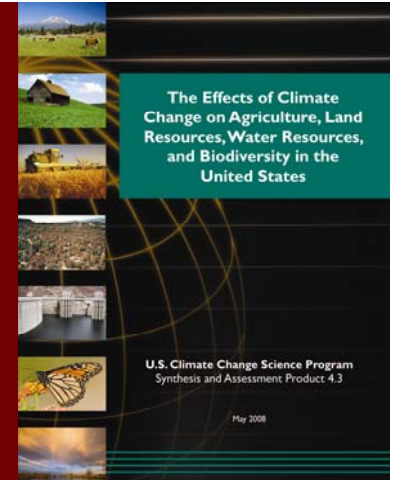


- Climate change affects agriculture, forestry, and land use.
- Agricultural and forest systems are important sources and sinks of GHGs.
- Forest and agricultural sinks offer potentially significant low-cost opportunities to address climate change.

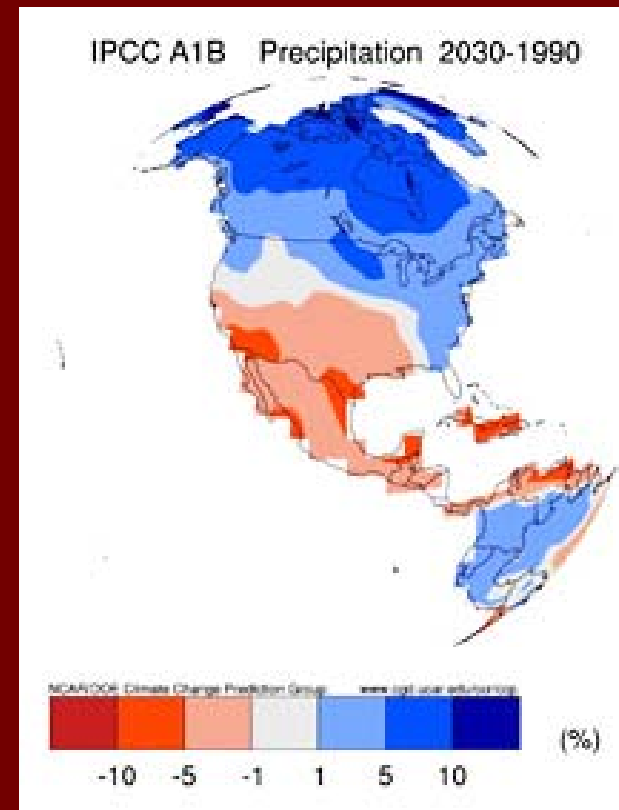
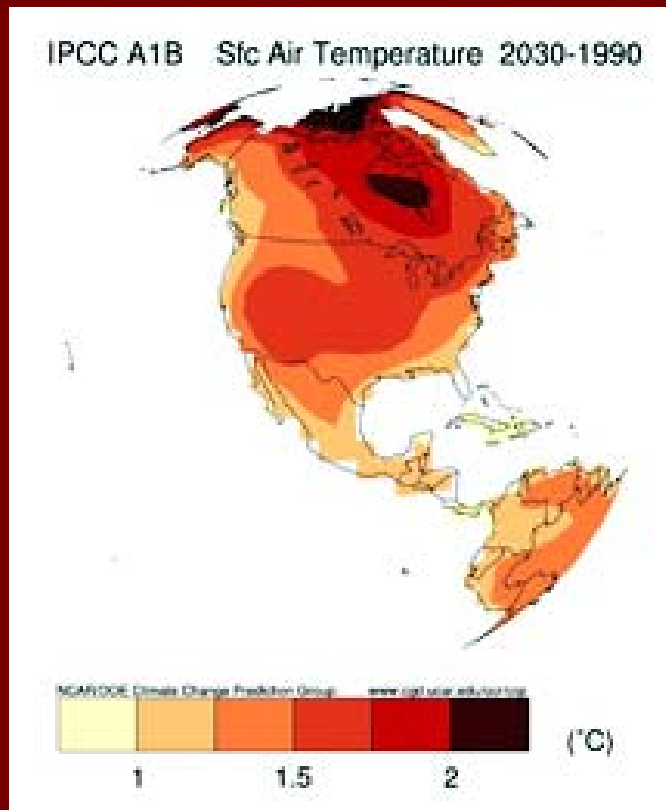


# USDA Climate Change Activities

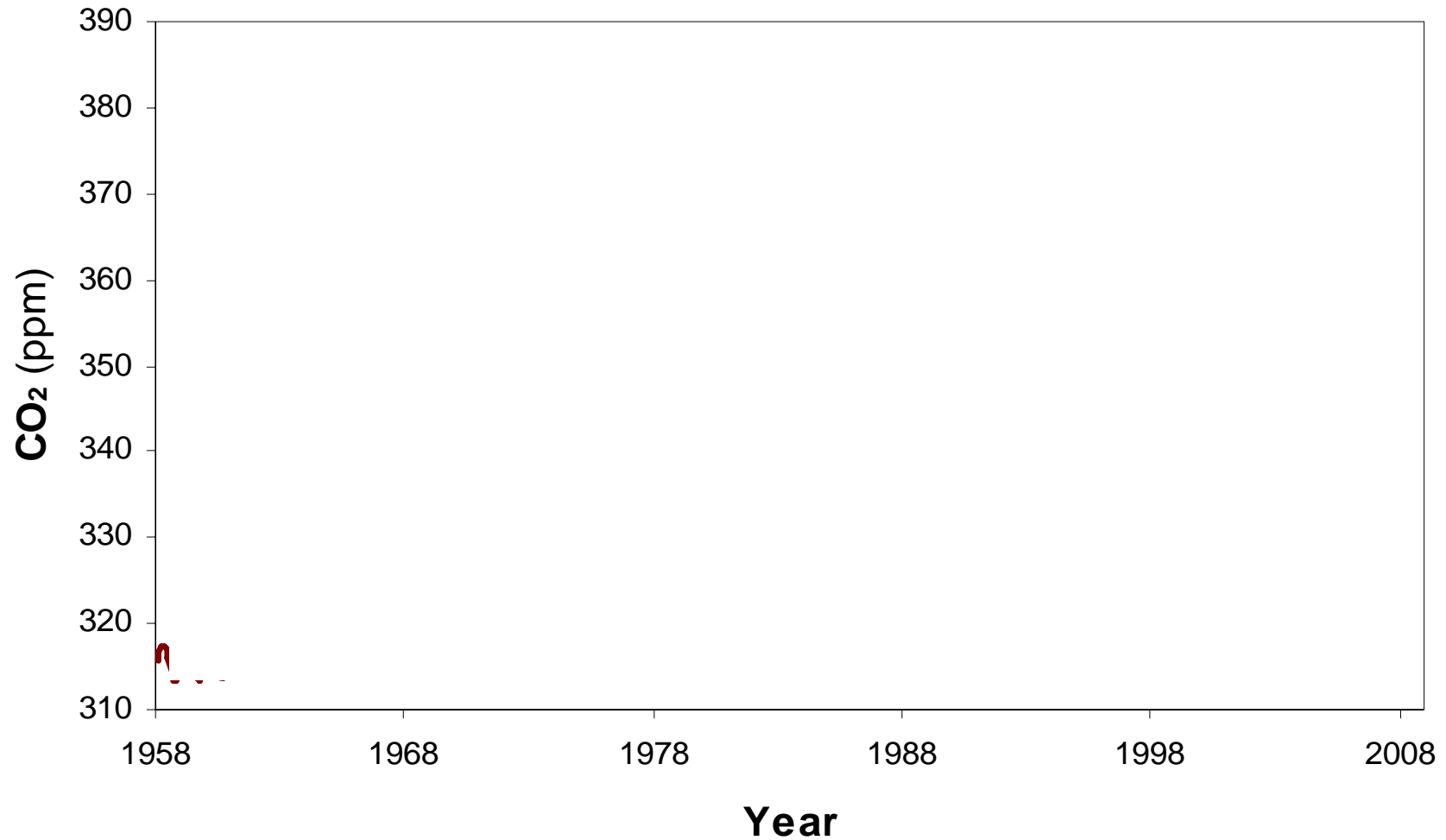
- SAP 4.3: Synthesis and assessment of the scientific literature on climate change effects on agriculture, biodiversity, land, and water resources.
- Technical Guidelines for Estimating GHG Emissions from Agriculture and Forestry Sources
- Encouraging GHG benefits in USDA's Conservation Programs
- Draft Strategic Plan for Climate Change Science



# Projected Temperature and Precipitation Changes by 2030



# Atmospheric CO<sub>2</sub> Concentrations



# Climate Change in the U.S.

## Temperature

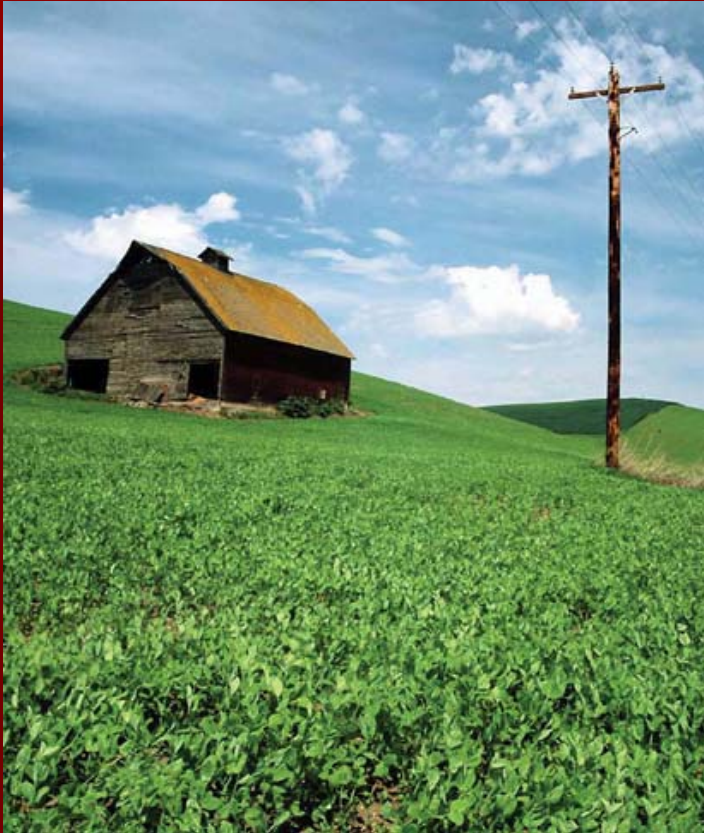
- Higher average temperature.
- Increased frequency of heat waves.
- Decreased frequency of unusually cold days and severe cold waves.
- Shorter winters.

## Precipitation and Drought

- Average increase in annual precipitation but with significant regional variability.
- Increase in heavy precipitation events.
- Increase in precipitation falling as rain rather than snow.
- Decrease in severity and duration of drought in some areas.
- Earlier, faster spring snowmelt.

**US Climate Change  
Science Program**  
[www.climatechange.gov](http://www.climatechange.gov)





Climate Change

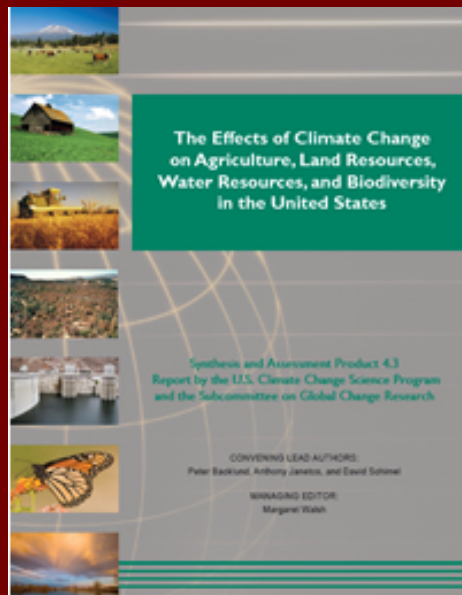
Effects

On Agriculture





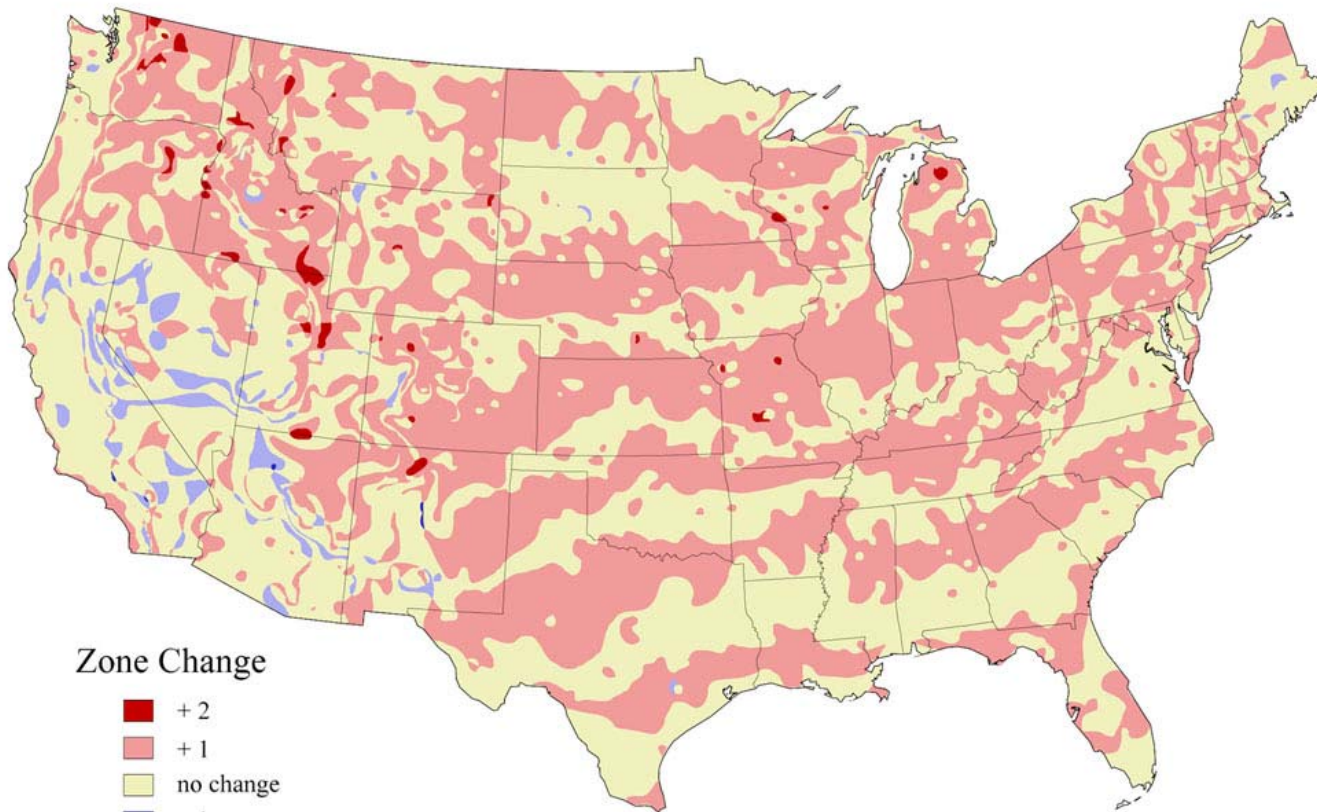
# Climate Change Implications for U.S. Crop Agriculture



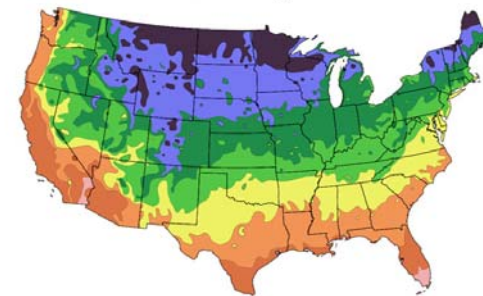
- The life cycle of grain and oilseed crops will progress more rapidly.
- Crops will increasingly begin to experience failure as temperature rises, climate variability increases, and precipitation lessens or becomes more variable.
- Horticultural crops are more sensitive to climate than grain and oilseed crops.
- Wider distribution as weeds move northward and are more resistant to herbicides.
- Disease pressure on crops and livestock will increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites.

# Difference Between 1990 and 2006 Hardiness Zones

Differences between 1990 USDA hardiness zones and 2006 arborday.org hardiness zones reflect warmer climate

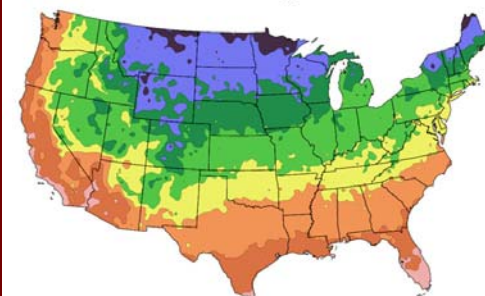


1990 Map



After USDA Plant Hardiness Zone Map, USDA Miscellaneous Publication No. 1475, Issued January 1990

2006 Map



National Arbor Day Foundation Plant Hardiness Zone Map published in 2006.

[http://www.arborday.org/media/map\\_change.cfm](http://www.arborday.org/media/map_change.cfm)

# Climate Change Implications for U.S. Animal Agriculture



- Higher temperatures reduce livestock production during the summer and reduce winter mortality.
- Forage production will extend into late fall and early spring, decreasing need for winter season forage reserves. Benefits will be influenced by regional variations in water availability.
- Climate change-induced shifts in plant species are underway in rangelands. Shifts in plant productivity and type will impact livestock operations.
- For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of changing climate; such protection is more available for non-ruminants (e.g., swine and poultry).



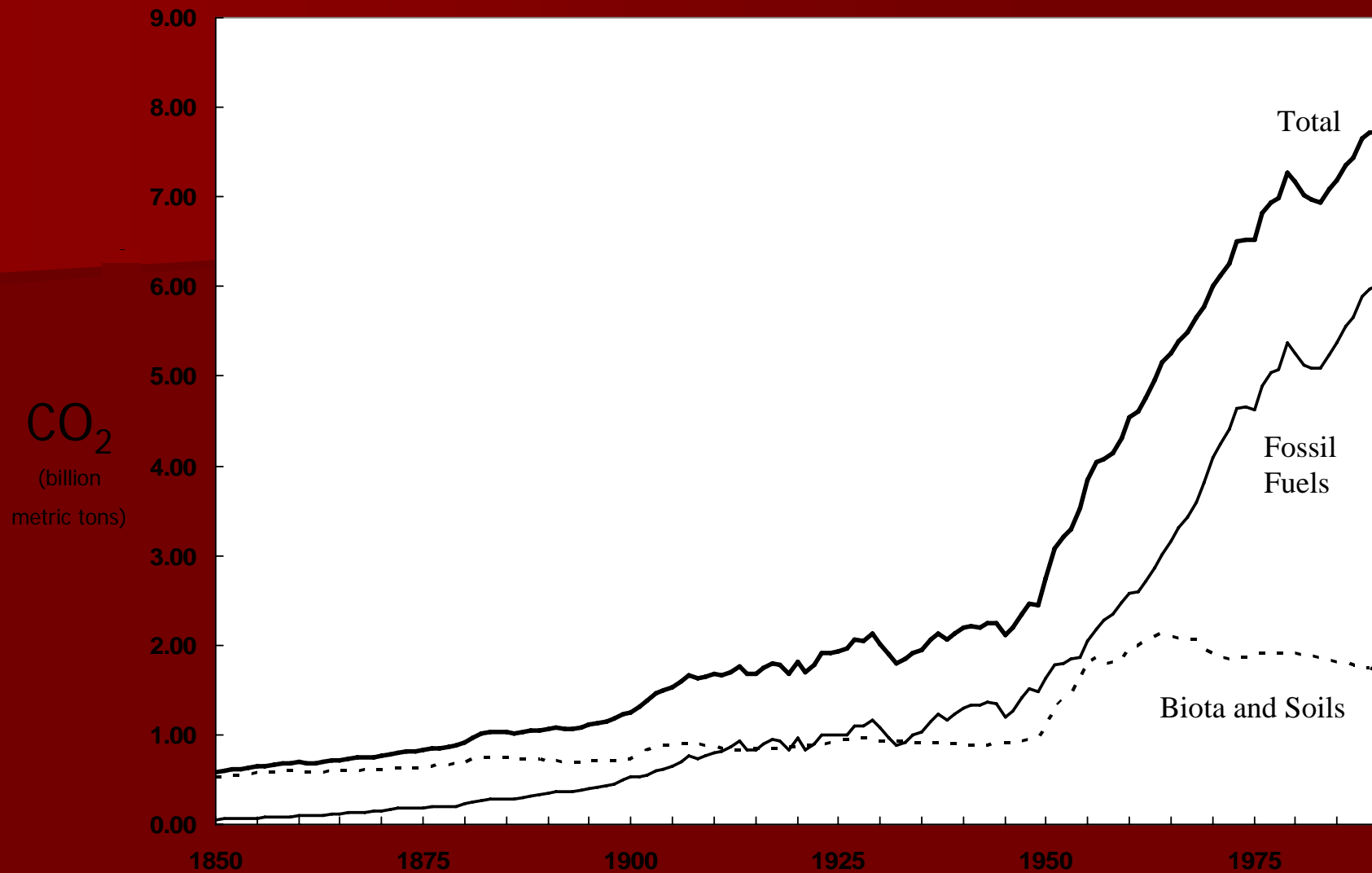
# Research Priorities: Effects

- ID & quantify climate effects on productivity, food security, ecosystem services, water, soil, invasives, pathogens, weeds, insects, disturbance regimes, and management options.
- Develop indicators for identifying and monitoring climate change effects.
- Improve models.
- Interactions between socioeconomic and production, processing, storage, delivery, rural communities, agricultural workforce, and other human dimensions.





Agricultural  
Mitigation  
of Climate Change

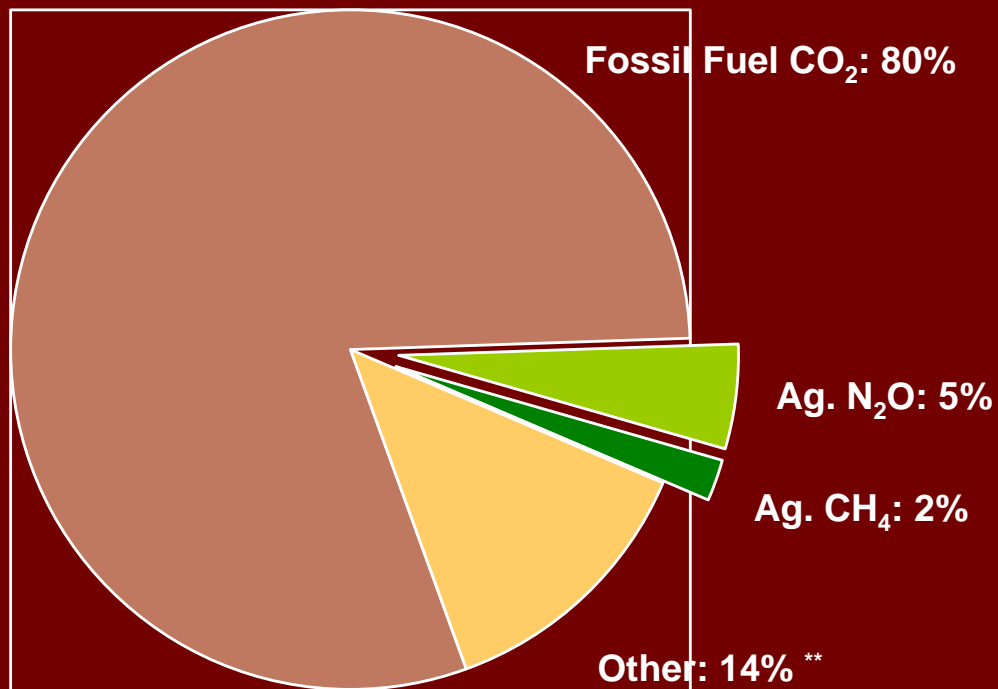


**Globally, land use change and soils are significant contributors to the build up of atmospheric CO<sub>2</sub>**

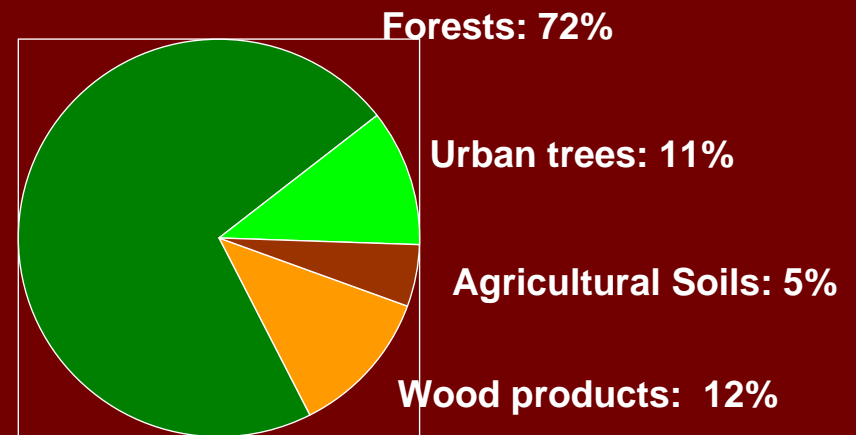
# Agriculture accounts for 7% of U.S. GHG emissions

## Carbon sequestration offsets 11% of U.S. emissions

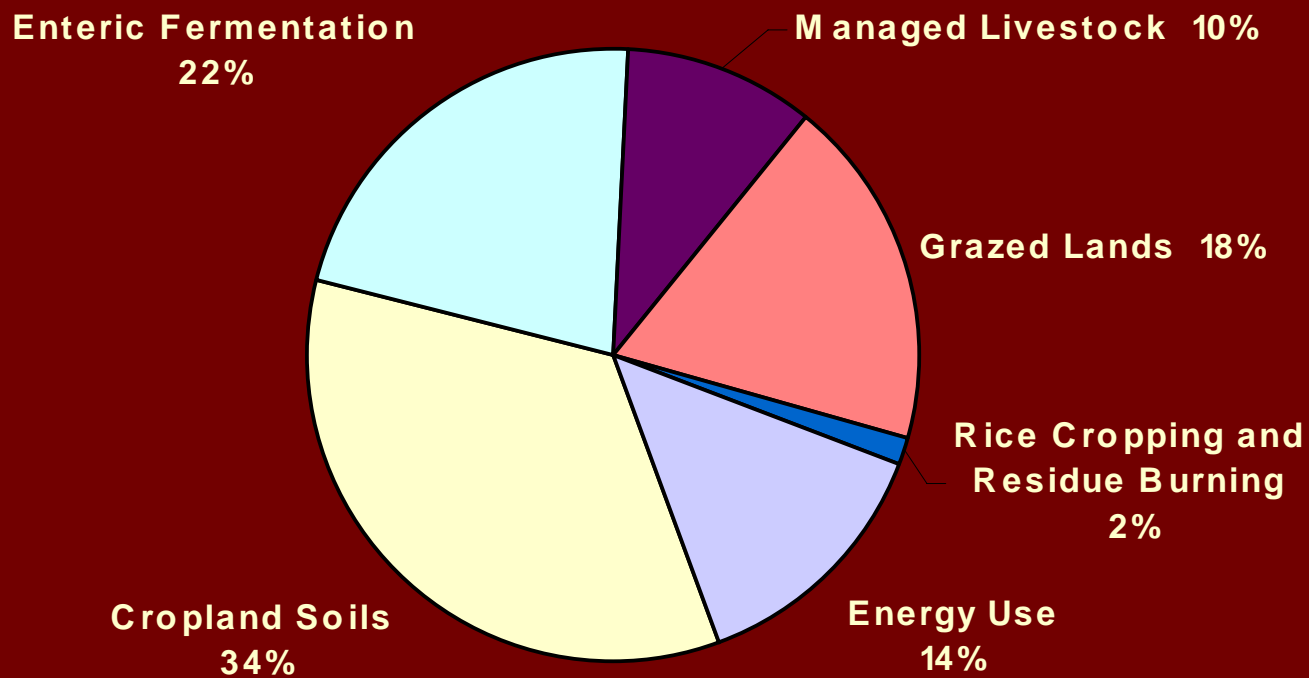
**Total U.S. GHG Emissions:  
7,260 MMT CO<sub>2</sub>e**



**U.S. Carbon Sequestration:  
828.5 MMT CO<sub>2</sub>e**

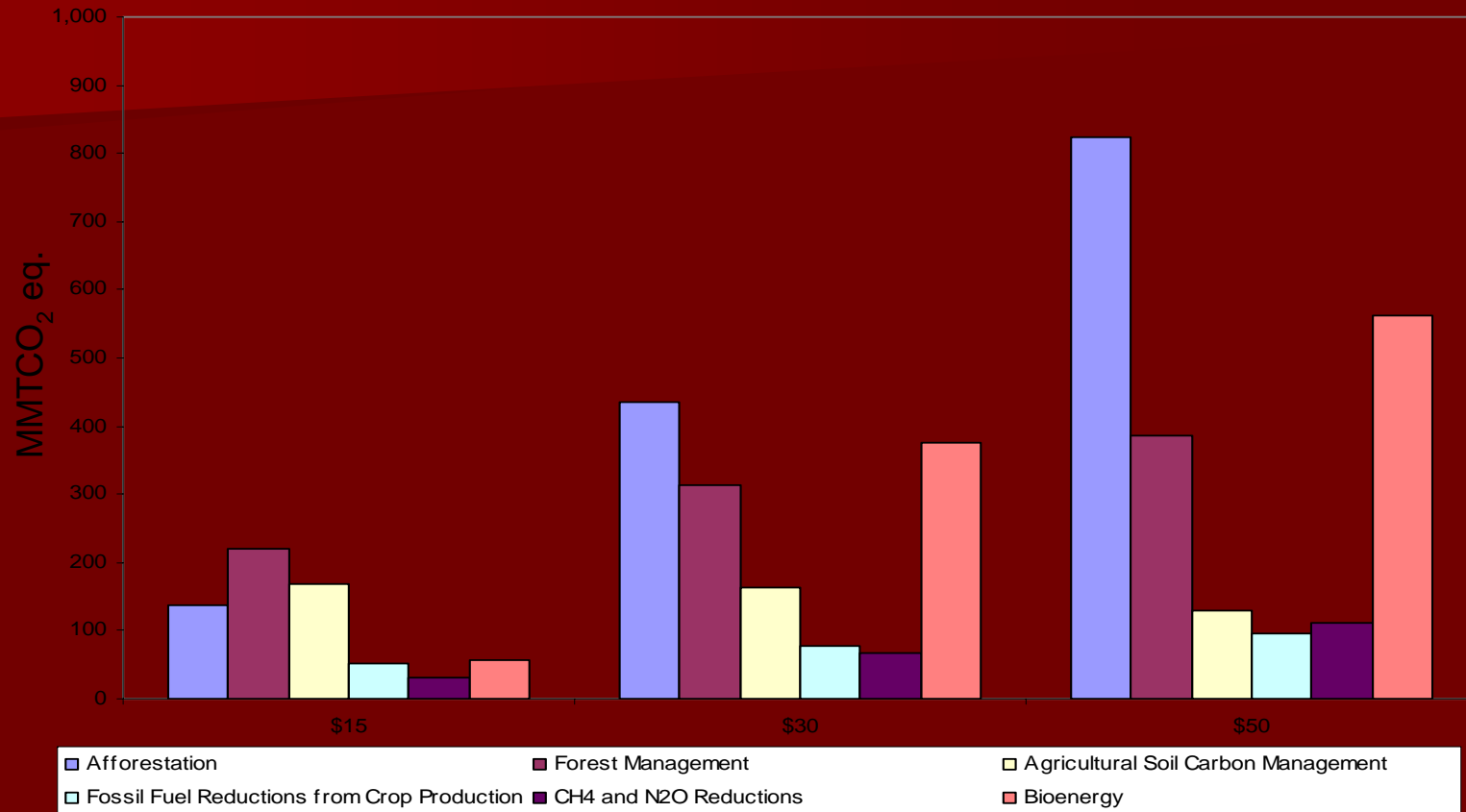


- Half of agricultural emissions are from livestock and grazing.
- One- third are from cropland nitrogen.
- The remainder is from energy use and small sources.





# Opportunities for GHG Reductions in the Agriculture and Forest Sectors



At \$15/ton CO<sub>2</sub>, agriculture and forestry could offset 10%  
At \$30/ton CO<sub>2</sub>, agriculture and forestry could offset 25%

# Mitigation Framework Options

- Voluntary Actions and Markets
  - This has been the approach favored to date
- Cap-and-Trade
  - Set over-all limit on emissions (could apply to sectors, regions, country)
  - Issue permits equal to that emissions level and require all emitters to have a permit for all covered emissions
  - Distribute emissions permits via an allocation rule or auction
  - Allow entities to trade permits - those needing additional permits buy/ those with excess permits sell
- Government Incentive Payments
  - Government sets an emissions reduction target and offers entities carbon payments to meet it – higher targets require higher payments
  - Conceptually similar to USDA's conservation programs
- Regulatory Approaches
  - Require entities to meet emissions reductions targets
  - Example: mandating fuel efficiency standards
  - Generally the most difficult to accomplish politically
- Carbon Tax
- Hybrid frameworks



# State and Private Sector Initiatives

## ■ States

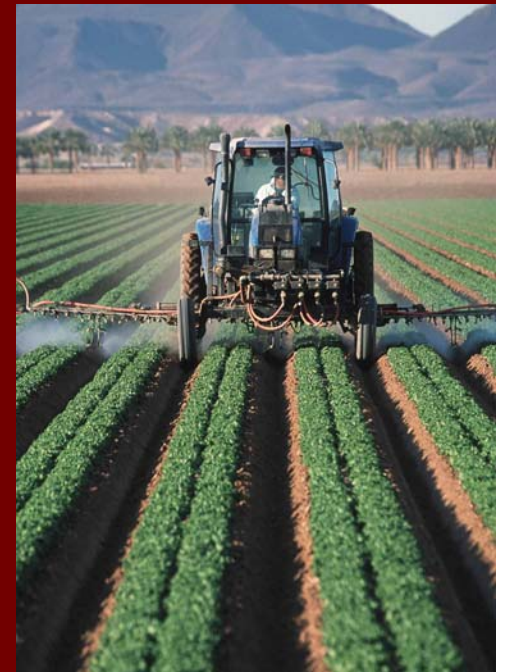
- California, Western Climate Initiative,
- Western States
- Northeastern States -- Regional Greenhouse Gas Initiative (RGGI)
- Midwestern Regional Greenhouse Gas Reduction Accord

## ■ Private Sector Registries

- Chicago Climate Exchange
- Numerous Voluntary Activities/Transactions

## ■ Actions by Companies and Retailers

- Demand for “carbon neutral” goods



# Agriculture and Forest GHG Offsets

## Benefits:

- Lowers overall costs to everyone
- Can build new markets for environmental performance in agriculture
- Could supplement farm income
- Will not distort trade



## Concerns:

- Would the action have happened anyway? (Additionality)
- Will other firms/entities fill gaps if the action results in a drop in production? (Leakage)
- What are we measuring benefits against? (Baselines/benchmarks)
- Will the carbon that is sequestered and stored be kept out of the atmosphere? (Permanence)
- Can we truly assess the benefits? (Measurement uncertainties)

# Research Priorities: Mitigation

- Develop & encourage management options that increase forest carbon sequestration.
- Technologies and strategies for managing agricultural, forestry, and grassland GHG emissions.
- Environmental effectiveness, economic efficiency, and tradeoffs of incorporating GHG management technologies.
- Assess the effectiveness of GHG emission and sequestration management.

# Agricultural Adaptation to Climate Change



# Adaptive Practices

<h2>Crops</h2>	<ul style="list-style-type: none"><li>Adjust planting/harvest timing</li><li>Double cropping</li><li>Nutrient management</li><li>Precision agriculture</li><li>Herbicide and pesticide applications</li><li>Change varieties or cultivars</li><li>Genetic adaptation</li><li>Reevaluate irrigation needs</li></ul>
<h2>Pasture &amp; Range</h2>	<ul style="list-style-type: none"><li>Stocking rates</li><li>Weed management</li><li>Fire management</li><li>Interseed legumes</li><li>Extend grazing season</li><li>Drought-resistant forage species</li><li>Alter supplemental feeding practices</li></ul>
<h2>Livestock</h2>	<ul style="list-style-type: none"><li>Reduce overwinter forage</li><li>Change breeds, species</li><li>Change timing of breeding, calving, weaning</li><li>Stocking rates</li><li>Shelter</li><li>Climate control</li></ul>



Also, consumer adaptation: seasonal availability, overall availability, cost.

# Adaptation Context



- Many techniques are already used by producers to manage variable climate conditions.
- But, the range of variability will be outside previous experience.
- Options: Adapt in anticipation of or reaction to climate change.
- Adaptation is often technically viable. It is not necessarily free or inexpensive.



# Research Priorities: Adaptation



- Strategies to cope with drought, heat stress, excessive moisture, longer growing seasons, plant community changes, and changes in disease and pest prevalence.
- Increase resilience to better withstand climate change's direct and indirect effects.
- Economic costs and benefits of producer and market responses.
- Develop metrics for evaluating adaptive strategies.
- Improve life-cycle analysis and management strategy assessments.





# Decision Support

- Educate USDA customers, stakeholders, and collaborators about climate change's effects and adaptation strategies.
- Integrate climate change into decision making of natural and managed systems.
- Distribute USDA climate change data, info, and technology.
- Assist resource managers with enhancing carbon sequestration.
- Develop tools to aid policymakers, program managers, producers, and land managers.
- Facilitate interagency communication and planning to provide timely information, develop/retool programs to address climate change.
- Develop risk management systems to help balance production, conservation, and climate change priorities.
- Produce synthesis and assessment products that identify responses to GHG stabilization at various levels.

# Enabling Activities

- Assessments
- Observations and Monitoring
- Analysis and Modeling
- Communication, Outreach, and Education



Thank You

