


Impact of climate change on agriculture and the food system: A U.S. perspective

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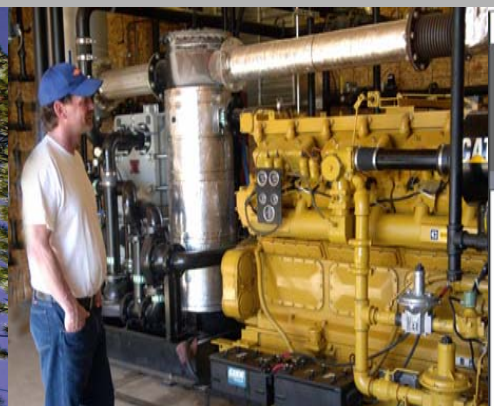
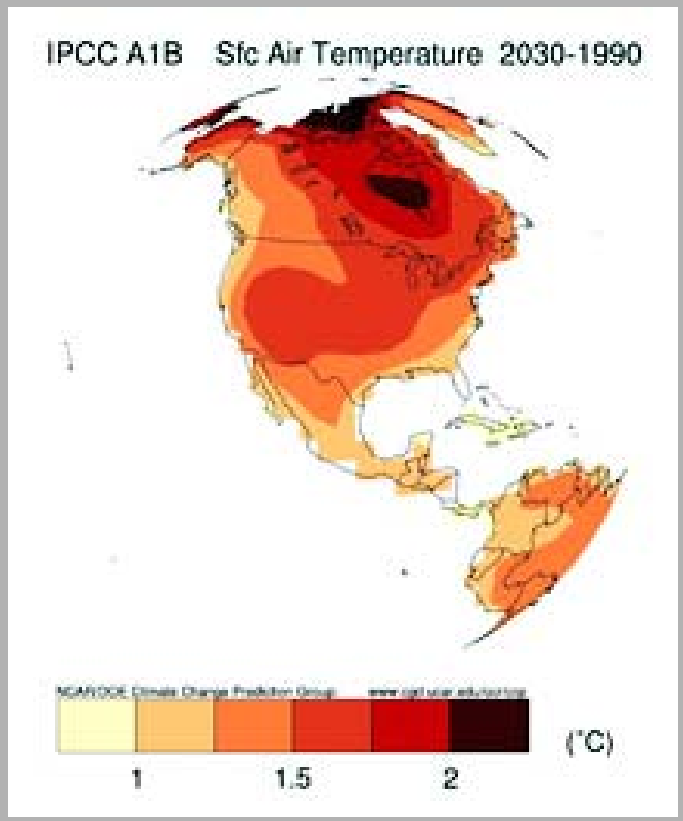
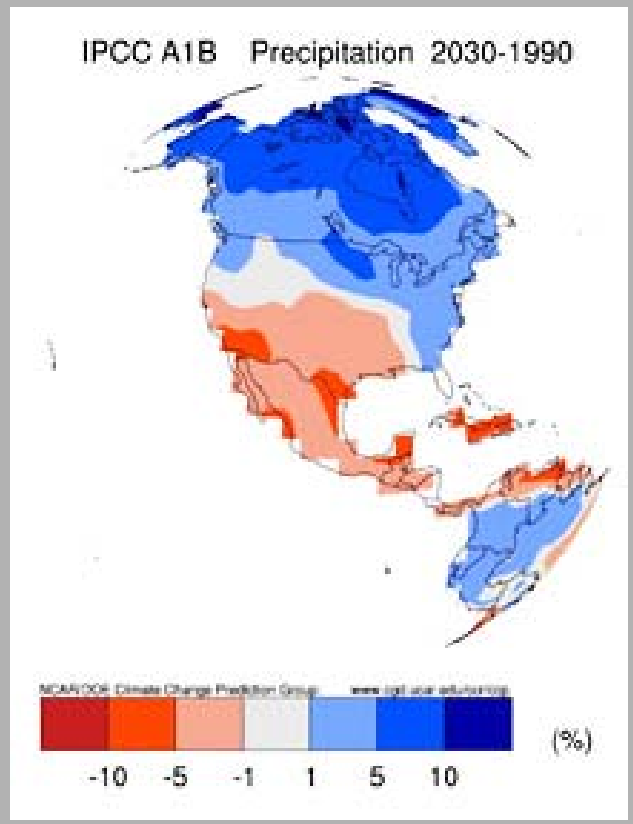



Overview of Presentation

- Current state of knowledge concerning the likely impacts of climate change on US agriculture and forestry resources.
- Why climate change is important to USDA.
- USDA climate change activities.

Projected Temperature and Precipitation Changes (IPCC)





U.S. Temperature and Precipitation Changes by 2030.

Climate changes observed over the last 50 years in the United States

US Climate Change Science Program
www.climatescience.gov

Synthesis and Assessment Products: Summary Findings

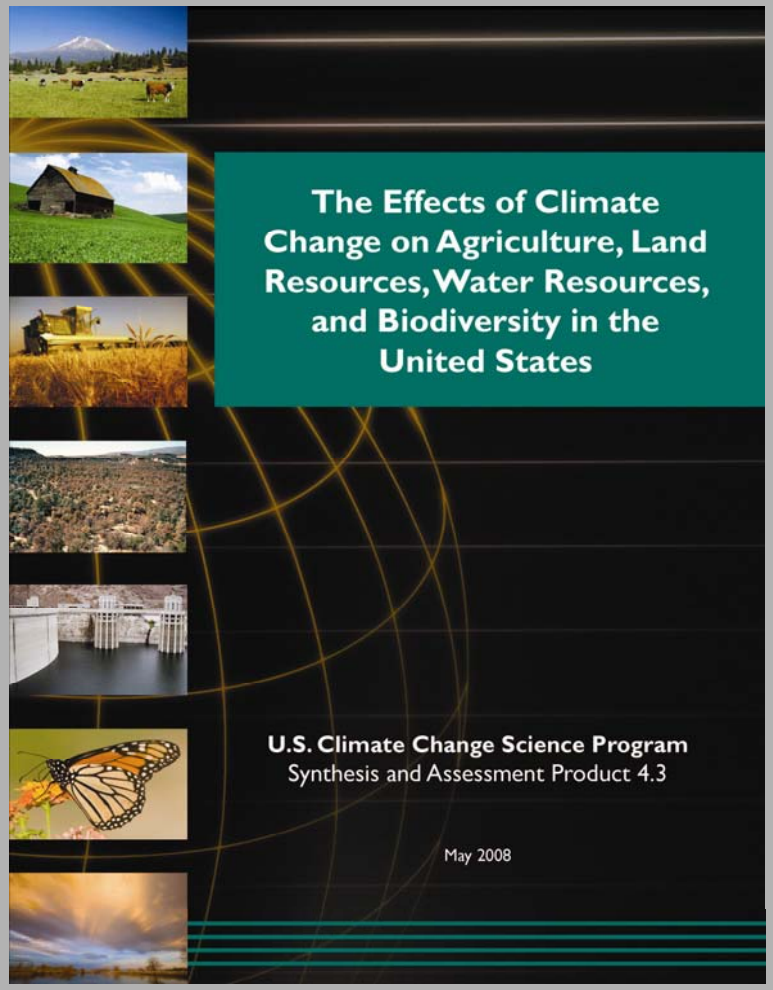
Temperature

- **Increase in US average temperatures**
- Increased frequency of heat waves.
- Decreased frequencies of unusually cold days and severe cold waves

Precipitation and drought:

- Overall increase in annual precipitation but with significant regional variability.
- Increase in heavy precipitation events
- Increase share of annual precipitation falling as rain (rather than snow).
- Tendency toward decrease in severity and duration of droughts

Synthesis and Assessment Report 4.3

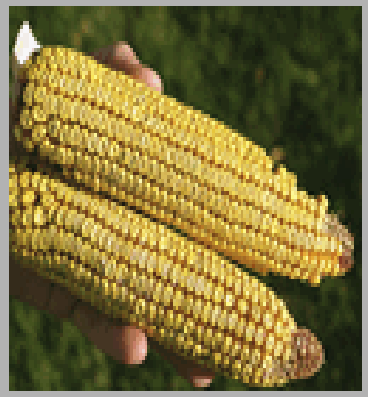


Assesses the current state of our scientific knowledge regarding the likely effects of climate change on:

- Agriculture
- Land Resources
- Water Resources
- Biodiversity

Available at: http://www.usda.gov/oce/global_change/index.htm

SAP 4.3: Climate Change Implications for U.S. Crop Agriculture

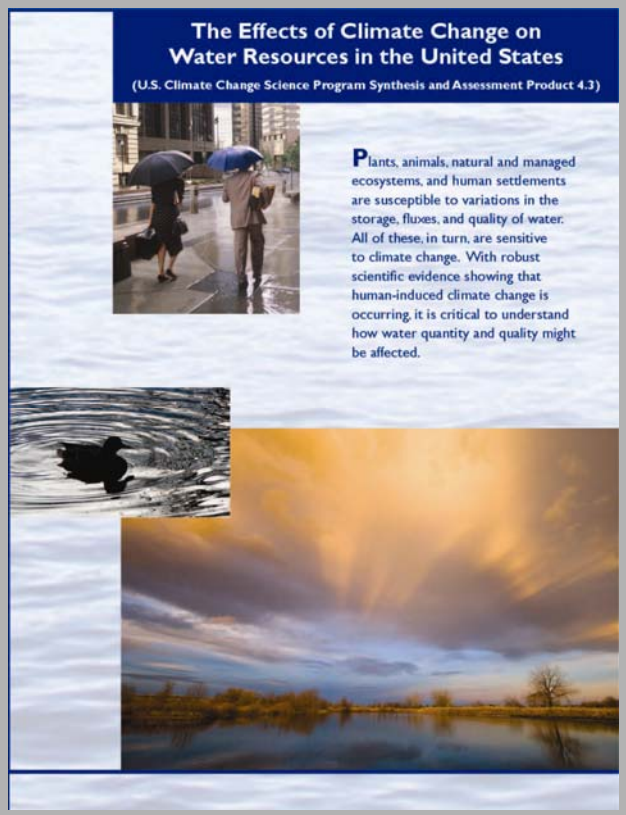


- With increased CO2 and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly.
- As temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.
- The marketable yield of many horticultural crops is very likely to be more sensitive to climate change than grain and oilseed crops.
- Climate change is likely to lead to a northern migration of weeds (particularly C3 weeds).
- Disease pressure on crops and livestock will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites.

SAP 4.3: Climate Change Implications for U.S. Animal Agriculture

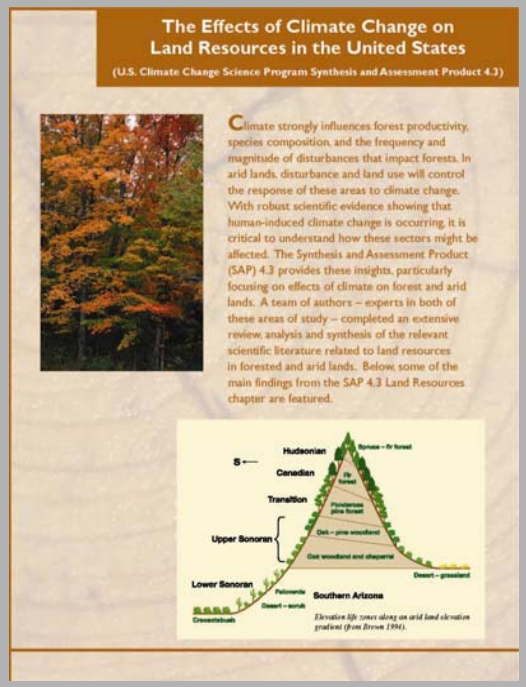
- Projected increases in temperature and a lengthening of the growing season will likely extend forage production into late fall and early spring, thereby decreasing need for winter season forage reserves.
- Forage benefits will very likely be affected by regional variations in water availability.
- Climate change-induced shifts in plant species are already under way in rangelands. Establishment of perennial herbaceous species is reducing soil water availability early in the growing season. Shifts in plant productivity and type will likely also have significant impact on livestock operations.
- Higher temperatures will very likely reduce livestock production during the summer season.
- 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).

SAP 4.3: Climate Change Implications for U.S. Water Resources



- For US generally, more precipitation.
- Drier conditions in the western states – (due to decreases in precipitation and mountain snowpack, and, earlier snowmelt). Some indications suggest droughts in the West and Southwest will increase in duration and severity.
- Stream temperatures are likely to increase as the climate warms (some such increases have already been detected). Stream temperature changes will be most evident in low-flow periods. begun to
- Changes in water quality likely due to higher temperatures and changes in precipitation.

SAP 4.3: Climate Change Implications for U.S. Land Resources



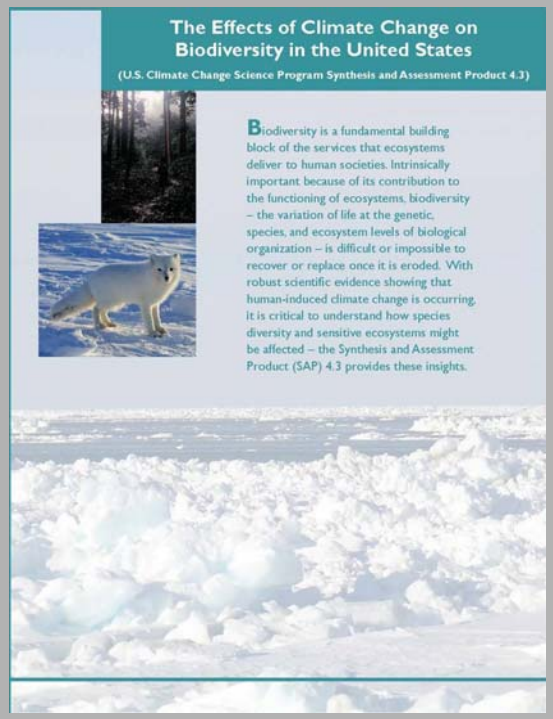
- Climate Change has very likely increased the size and number of forest fires, insect outbreaks, and tree mortality in the West. Fire frequencies will also likely increase in arid ecosystems.

- Nitrogen deposition and warmer temperatures have probably increased forest growth where adequate water is available

- In arid lands, higher temperatures, increased drought, and more intense storms will very likely decrease vegetation cover, increase erosion, and promote invasions of exotic grass species.

- River and riparian ecosystems in arid lands will likely be negatively impacted by decreased stream flow, increased water removal, and greater competition from non-native species.

SAP 4.3: Climate Change Implications for U.S. Biological Diversity



- Climate change is already affecting U.S. biodiversity and ecosystems including changes in growing seasons, phenology, primary production, and species distribution and diversity.

- Rapidly warm arctic regions are experiencing reduced snow and ice covers that provide denning and hunting habitat for polar bears.

- Coral in many tropical regions are experiencing substantial mortality from increasing water temperatures and storm intensity (and other factors).

- In 866 peer-reviewed papers assessing ecological impacts of climate change, 60 percent of 1,598 species studied exhibited shifts in distribution and/or phenology over periods of 20 – 140 years.

SAP 4.3: Monitoring Climate Change

- **Agriculture: Systems for monitoring long-term responses of agricultural lands are numerous but integration is limited.**

- **Water Resources: Monitoring systems are not set up to detect effects of climate change.**

- **Land Resources: Current monitoring systems are inadequate to separate climate change effects from other effects.**

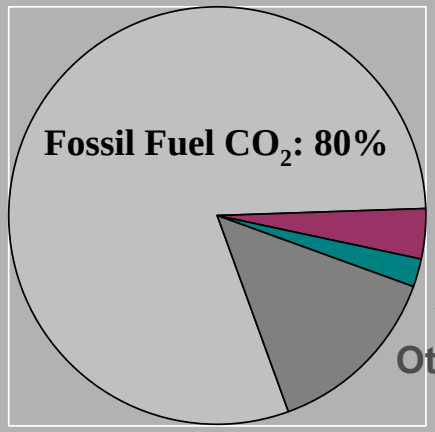
- **Biological Diversity: Current monitoring systems are generally not set up to detect effects of climate change on biological diversity. Also unclear if existing systems can be maintained long enough to detect such effects.**

Why is climate change important to USDA?

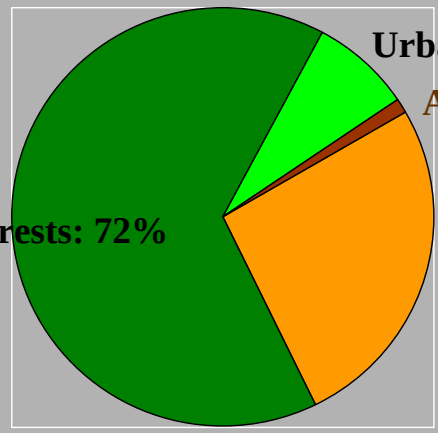
- Agriculture is a source of GHG emissions
- Agriculture and forestry are potential sources of emissions reductions and carbon sequestration
- Potential role of agriculture and forestry in a future GHG mitigation framework

Agriculture accounts for 7 % of U.S. GHG emissions and is a major source of N_2O and CH_4 emissions

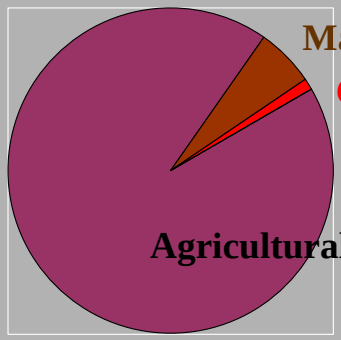
Total Gross U.S. Emissions: 7,260 $MMTCO_2E$



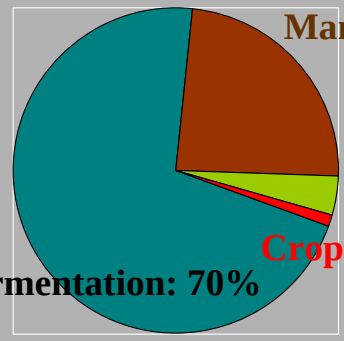
Terrestrial Carbon Sequestration: 828.5 $MMTCO_2E$



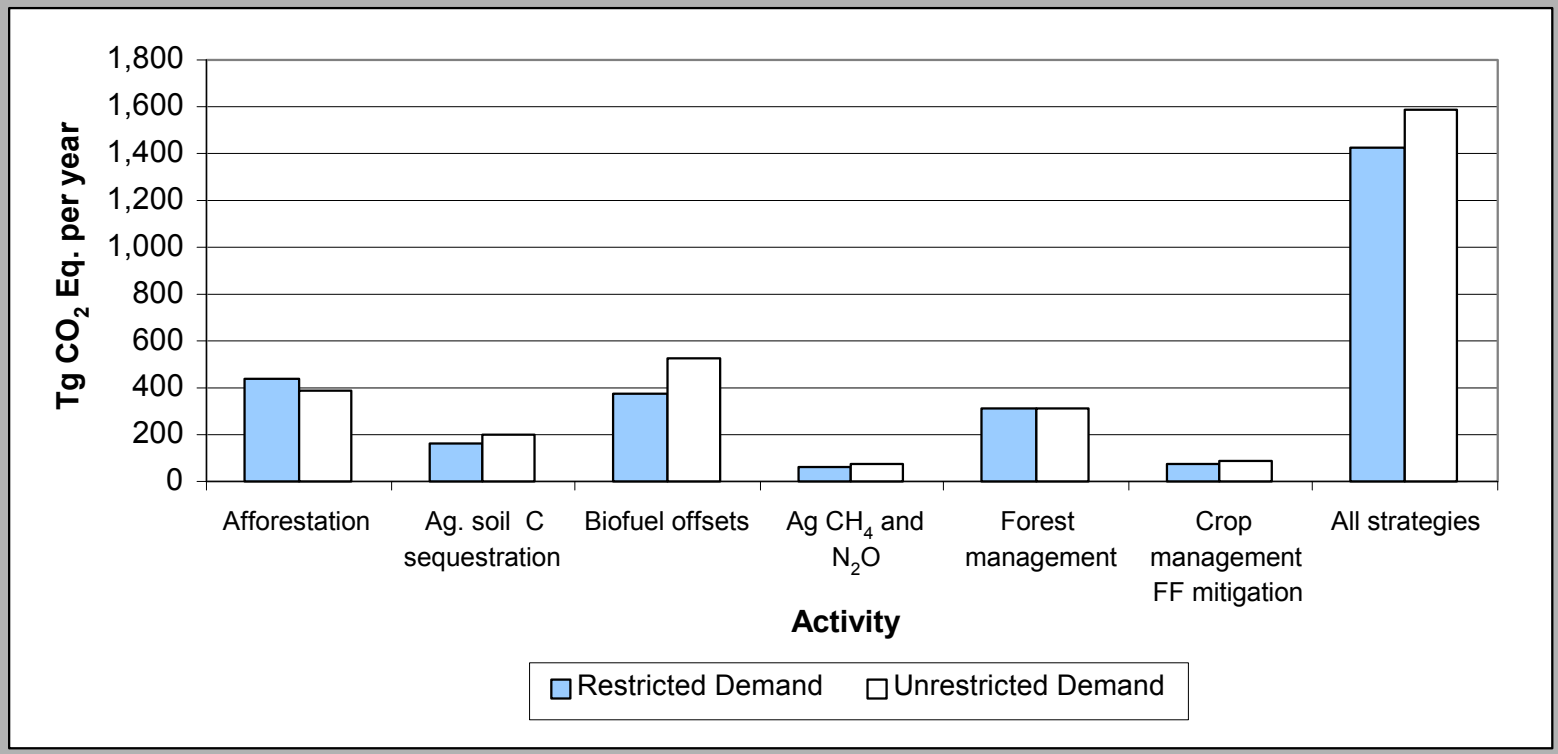
Agricultural N_2O Emissions: 375.1 $MMTCO_2E$



Agricultural CH_4 Emissions: 161.2 $MMTCO_2E$



Forest and agriculture could offset 10-25% of total U.S. GHG emissions



- **At $15/ton CO2, agriculture and forestry actions could eliminate 10% of US GHG emissions**
- **At $30/ton CO2, agriculture and forestry actions could eliminate 25% of US GHG emissions**

(Source: EPA, 2005)

Bills to Regulate GHG Emissions Introduced in the 110th Congress

Bill	Approach	A & F Offsets
S.280	C&T	Yes
S.485	C&T	Up to President
S.309	C&T	Option exists
S.1177	C&T	Yes
S.1168	C&T	Yes
S.1201	C&T	Yes
S.1554	Trading	Some - by 2022
S.1766	Trading	Not explicit
S.2191	C&T	Yes
HR.620	C&T	Yes
HR.1590	C&T	Option exists
HR.2069	C tax	Yes
HR.3416	C tax	Qualified projects

USDA Climate Change Activities

- Decision and Technical Support Activities
  - Technical Guidelines for Estimating GHG Emissions from Agriculture and Forestry Sources
  - US Agriculture and Forestry GHG Inventory

- Encourage GHG benefits in USDA's Conservation Programs

- Support for Renewable Energy Systems and Energy Efficiency

- Support Basic Research

Decision and Technical Support Activities: TG for Estimating GHG Emissions and Removals from Agriculture and Forestry

Inventory methods for all agricultural GHG sources – including:

- Enteric fermentation
- Manure management
- Nitrogen fertilizer applications
- field residue burning
- rice production
- lime applications

Methods for estimating increases in carbon sequestration

- Default carbon yield tables by region, species, management intensity, productivity class
- Models
  - COMET-VR Model
  - Cole Model
  - Forest Vegetation Simulator
- Measurement and sampling protocols

USDA TG: Emissions Estimation Examples

1. Reducing N_20 emissions: Organic and synthetic commercial fertilizer

   Eq CO_2 = **9.23 - 9.35 mt** per mt nitrogen applied

2. Reducing CH4 emissions: Manure management (Anaerobic waste digester)

Ex: Wisconsin Dairy with 1,000 cows, 500 heifers, and 500 calves

Emissions before digester installation:

System	Methane	Nitrous Oxide
Anaerobic Lagoon	**6,684 mt CO_2**	**71 mt CO_2**
Liquid/Slurry/Deep pit	**2,211 mt CO_2**	**71 mt CO_2**
Paddock/Range/Drylot	**79 mt CO_2**	**977 mt CO_2**
Emissions after installation:	0 mt CO_2	0 mt CO_2

Next Step: Make the USDA TG Easy to Use

Example: COMET-VR: A Web-Based Tool for estimating:

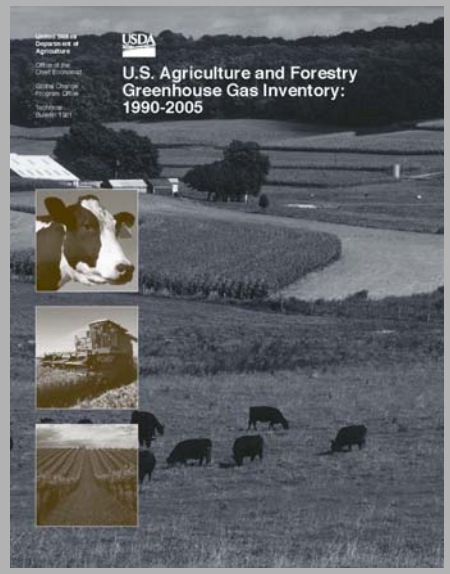
- Changes in carbon stored in agricultural soils
- Changes in GHG emissions from field operations (coming soon)

Worth knowing:
Based on Century model
Easily updated
Test drive COMET-VR at:
http://cometvr.colostate.edu

Decision and Technical Support Activities: US Agriculture and Forestry GHG Inventory

Describes agriculture and forestry GHG emissions and sinks by:

- Year (1990 – 2005)
- Gas (CO2, CH4, N2O)
- Source and sink
- State
- Commodity.



Report structure:

Chapter 2: Livestock and Grazed Land Emissions
Chapter 3: Cropland Agriculture
Chapter 4: Carbon Stocks and Stock Changes in U.S. Forests
Chapter 5: Energy Use in Agriculture

Encouraging GHG benefits into USDA Conservation Programs

Environmental Quality Incentives Program (EQIP)

- NRCS provided guidance to make GHG a priority resource concern

Conservation Reserve Program (CRP)

- USDA is targeting 500,000 acres for afforestation with bottomland hardwoods
- The Benefits index (EBI) used to rank lands offered for enrollment was modified to allow bids with high carbon sequestration to be awarded 10 additional points.
- In 2002, USDA codified landowner's right to sell carbon benefits associated CRP lands.

Encouraging GHG benefits into USDA Conservation Programs

Nutrient Management and Precision Agriculture

- Tiered payments under EQIP and CSP will reward producers who improve nutrient management

Anaerobic Digesters

- New practice Standards for digesters announced by NRCS
- Eligible for cost-share assistance in EQIP

Estimated GHG Benefits of CRP Lands (TG CO2):

Practice / Activity	2000	2002	2004	2006
Carbon Sequestration				
Cropland to grass				
Area (million acres)	29.5	31.7	31.0	32.8
CO2 sequestered	28.1	30.3	29.4	31.3
Cropland to trees				
Area (million acres)	2.6	2.9	3.3	3.7
CO2 sequestered	13.0	13.4	15.8	17.2
Cropland to grass Wetlands				
Area (million acres)	0.4	0.4	0.4	0.5
CO2 sequestered	1.6	1.8	2.0	2.1
Total Sequestration on CRP lands	***42.7***	***45.5***	***47.2***	***50.6***

Estimated GHG Benefits of CRP Lands (in TG CO2):

Practice / Activity	2000	2002	2004	2006
Reduced Emissions				
ॐ N_2O Emissions	4.63	5.01	5.11	5.30
ॐ CO2 from fossil fuel use	3.23	3.47	3.54	3.68
Total Emission Reductions	*7.86*	*8.48*	*8.65*	*8.98*
Total GHG Benefits of CRP	***50.6***	***54.0***	***55.9***	***59.6***

USDA's 9006 Renewable Energy and Energy Efficiency Improvement Program: FY03 – 06

- USDA invested $122 million in renewable energy systems and energy efficiency projects,
- Leveraged about $1 billion in outside funding

- Helped finance
  - 91 anaerobic digesters,
  - 168 wind projects,
  - 40 solar projects
  - 15 geothermal projects
  - > 400 energy efficiency improvements

Potential GHG Benefits of Selected 9006 Energy Projects (FY 2003 – 2006; in mt CO_2)

	FY03	FY04	FY05	FY06
Energy Efficiency Projects	38,656	16,273	10,527	55,600
Renewable Energy Systems				
Anaerobic Digest.				
Reduced CH_4	113,496	170,244	56,748	42,561
Reduced CO_2	62,779	115,089	39,601	30,162
Wind – large	455,265	127,135	249,459	94,383
Other	2,708	20,250	11,184	4,212
Biomass: Solid Fuel	95,771	42,054	162,222	59,219
Total mt CO_2	**768,675**	**491,045**	**529,741**	**286,137**

USDA Global Change Research Expenditures for Fiscal Year 2008

US Global Change Research Program

Program Title	$ Million	Agency Shares
Global Carbon Cycle	12.8	FS 63 %, ARS 29 %, CSREES 7 %
Water Cycle	5.6	ARS 63 %, FS 39 %
Understanding Atmospheric Composition and Chemistry	19.6	ARS 100 %
Understanding Ecosystem Changes	15.7	ARS 70 %, FS 27%,
Other	2.5	CSREES 100%
USGCRP Total	56.2	

USDA Global Change Research Expenditures for Fiscal Year 2008

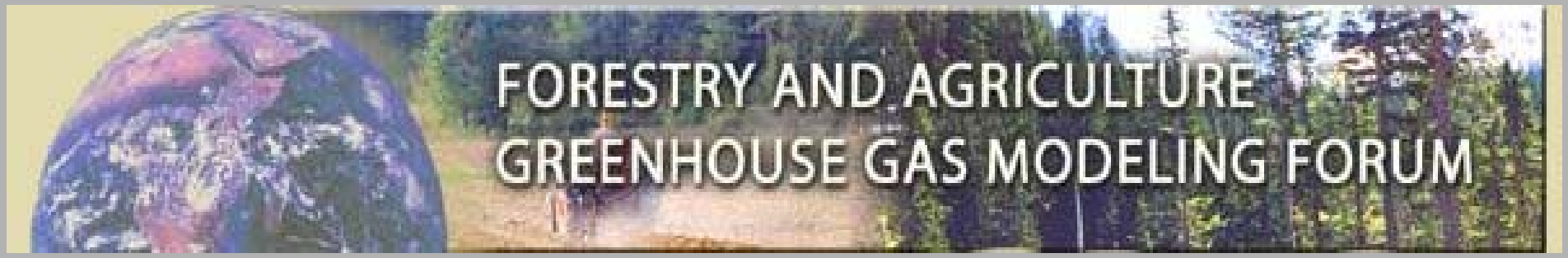
Climate Change Research Initiative:

Carbon Cycle Research	4.1
Carbon Management Research	1.9
Regional & Sector impacts	1.0
Carbon Inventory and Analysis	1.1
USDA CCRI Total	8.1

GCRP + CCRI = $ 64.4 million
Adjusted GCRP + CCRI = $ 43.2 million

Source: http://www.climatescience.gov/

Supporting Research: Upcoming Event



- Partners: USDA, EPA, Nicholas Institute, Agriculture and Agri-Food Canada, RTI International, and the Farm Foundation

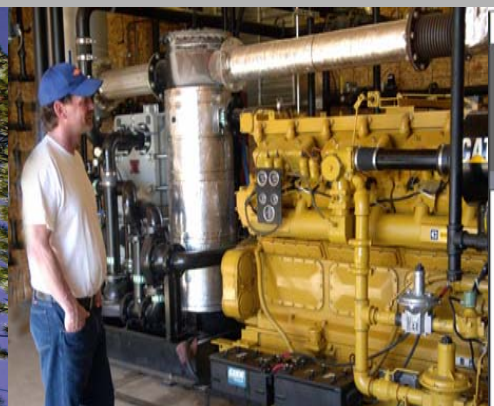
- Goals:
  1. Review the state of economic and biophysical models used to assess climate change issues of interest to agriculture and forestry.
  2. Identify those issues that are likely to be most relevant to climate change policy over the next 2 years

- Tentatively Scheduled: May-June 2009 in Shepherdstown, WV

- Keep posted at: http://foragforum.rti.org/index.cfm




Thank You

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Introduction
About 1605 (b)