On-Farm Carbon Sequestration?

Can a farmer make some money at it?

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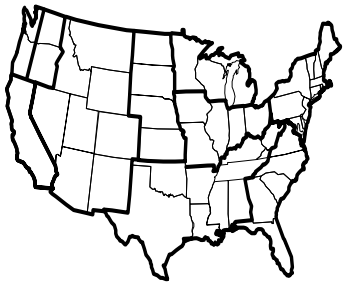
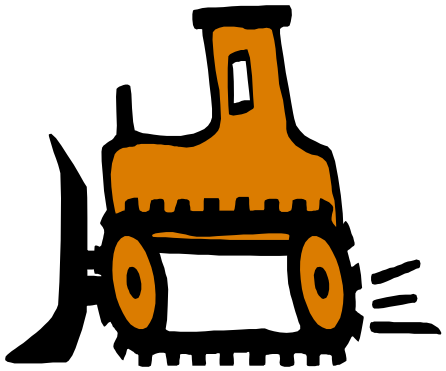
Let's Avoid Climate Change

Mitigation



Let's Let Climate Change Happen



Effects

Plan of talk

Why might an opportunity arise?

- Climate Change issue and prospects
- Greenhouse gas link
- Policy initiatives

Who might be a buyer?

What could agriculture do?

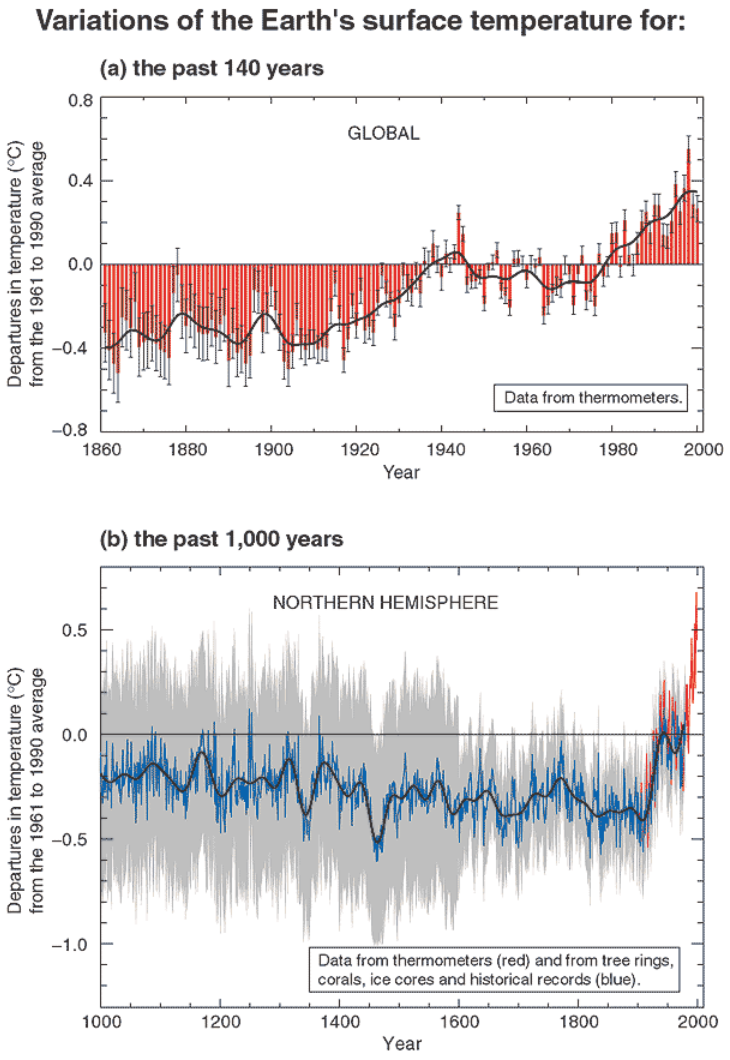
Is agriculture competitive?

What are prospects?

- Currently
- Future

What are risky aspects?

What is Climate Change About?



The global average surface temperature has increased over the 20th century by about 0.6°C.

- Global average surface temperature (average of near surface air temperature over land, and sea surface temperature) has increased since 1861. Over 20th century the increase has been 0.6 ± 0.2°

- Globally, it is likely that 1990s was warmest decade and 1998 the warmest year in the instrumental record, since 1861

- Analyses of proxy data for Northern Hemisphere indicate that increase in temperature in the 20th century is likely to have been the largest of any century during the past 1,000 years.

- On average, between 1950 and 1993, night-time daily minimum air temperatures over land increased by about 0.2°C per decade.

Source : Intergovernmental Panel on Climate Change. IPCC Third Assessment Report – Synthesis Report, http://www.ipcc.ch/.

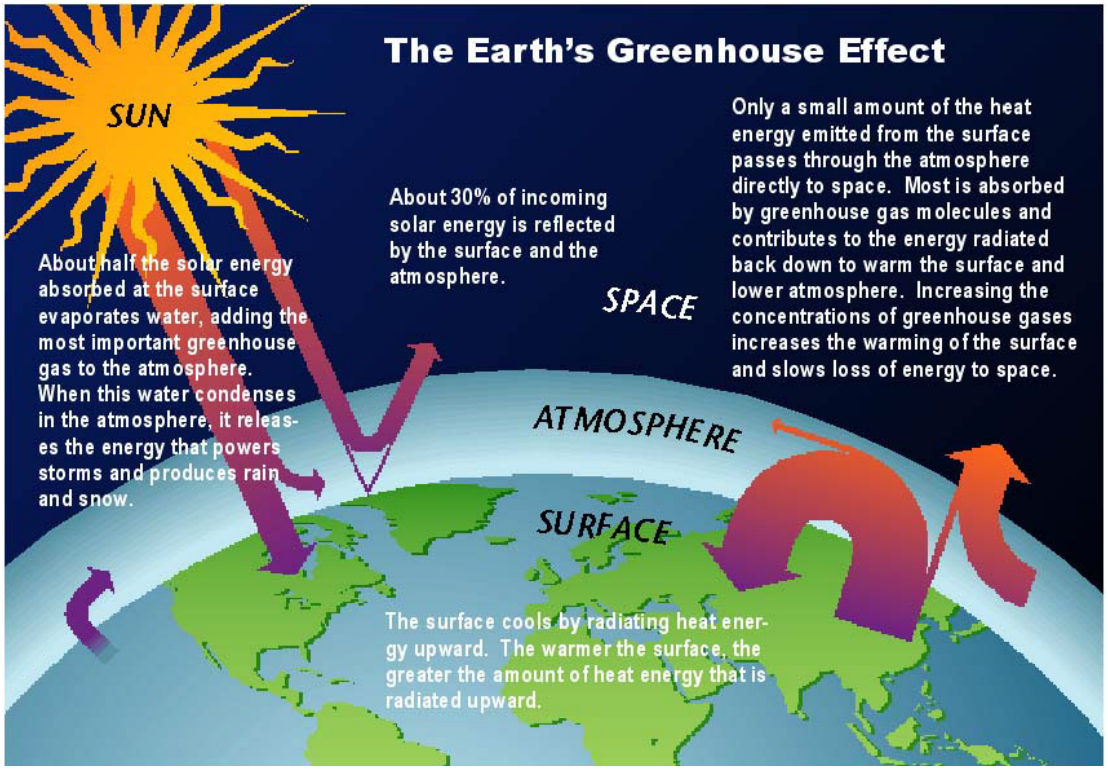
Climate Change is altering the planet

Available observational evidence indicates that regional changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems in many parts of the world.

Observed changes include

Shrinkage of glaciers and sea ice
Snow cover has decreased
Thawing of permafrost,
Later freezing and earlier break-up of ice on lakes/rivers
Lengthening of mid- to high-latitude growing seasons
Poleward and altitudinal shifts of plant and animal ranges,
Declines of some plant and animal populations,
Earlier flowering of trees, emergence of insects, and egg-laying in birds
Global average sea level has risen and ocean heat content has increased

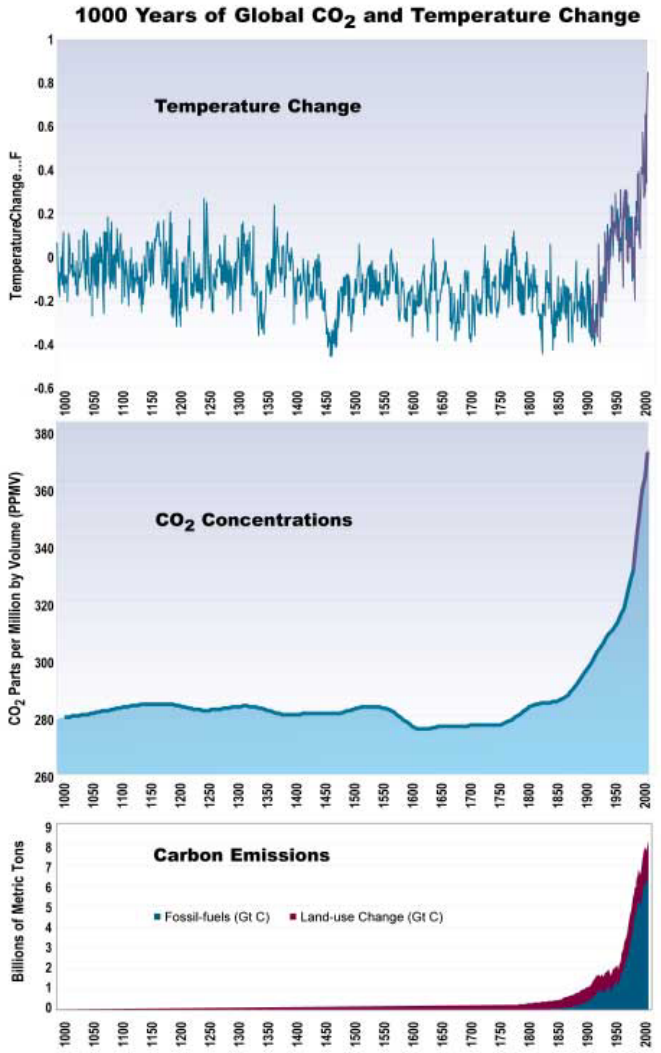
This Climate Change has a physical cause



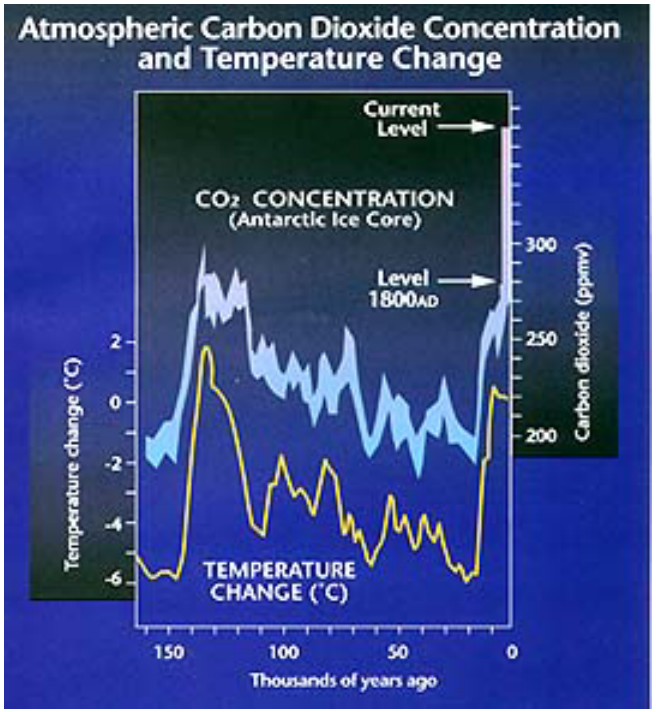
Some gases, like carbon dioxide (CO), trap heat in the atmosphere by absorbing longwave radiation while letting the Sun's energy pass through. The transparent roof and walls of a greenhouse allow in the sunlight while keeping in the heat. Since these gases act similarly in the atmosphere, we call them **greenhouse gases**.

Source : U.S. National Assessment/ http://www.usgcrp.gov/usgcrp/Library/nationalassessment/images/Greenhouse-s.jpg.

Climate Change has in part a human cause



Source : U.S. National Assessment.



Source http://ssca.usask.ca/2002conference/Bennett.htm

Gas concentrations and sources

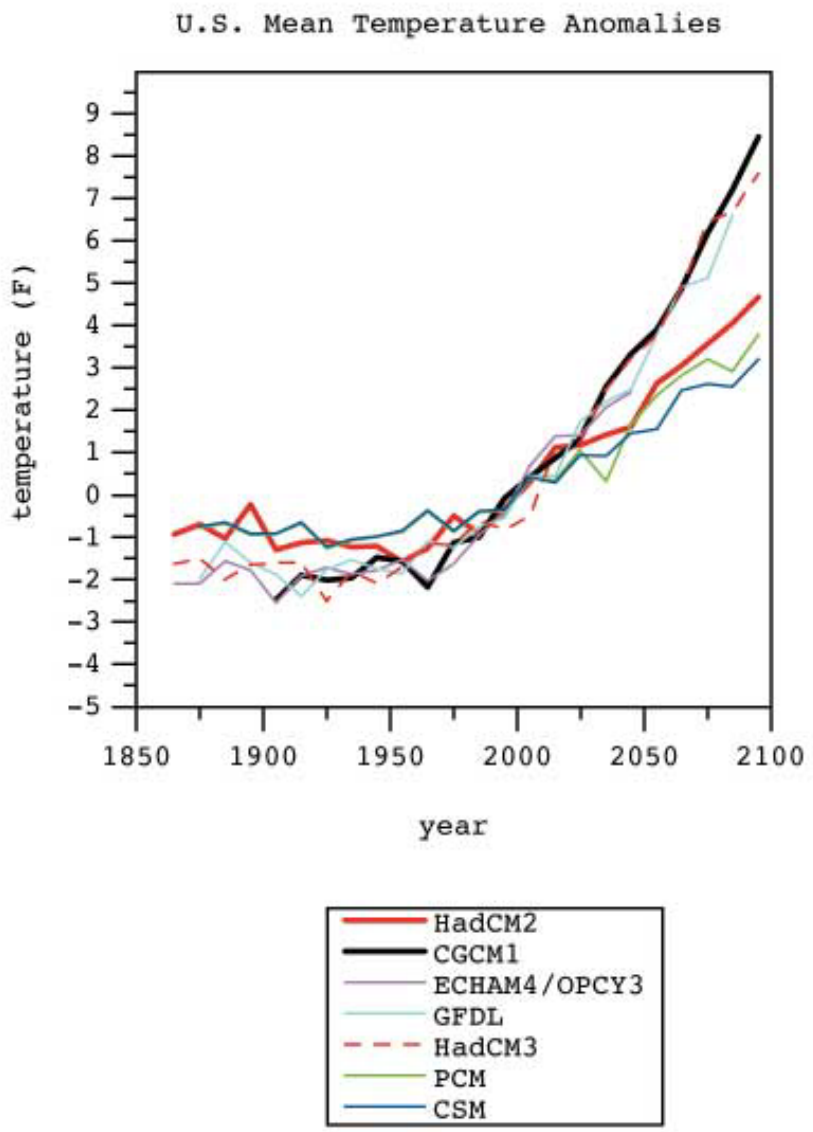
Carbon dioxide (CO_2) has increased by 31% since 1750. Present concentration has not been exceeded during past 420,000 years and likely not during the past 20 million years. Current rate of increase is unprecedented during at least past 20,000 years. Three-quarters of anthropogenic emissions during the past 20 years due to fossil fuel burning. The rest is largely from land-use change, especially deforestation.

Methane (CH_4) has increased by 151% since 1750. Present concentration has not been exceeded during the past 420,000 years. More than half of CH_4 emissions are anthropogenic (e.g., use of fossil fuels, cattle, rice, agriculture and landfills).

Nitrous oxide (N_2O) has increased by 17% since 1750. Present has not been exceeded during more than the past thousand years. About a third of current N_2O emissions are anthropogenic (e.g., agricultural soils, fertilization, cattle feed lots and chemical industry).

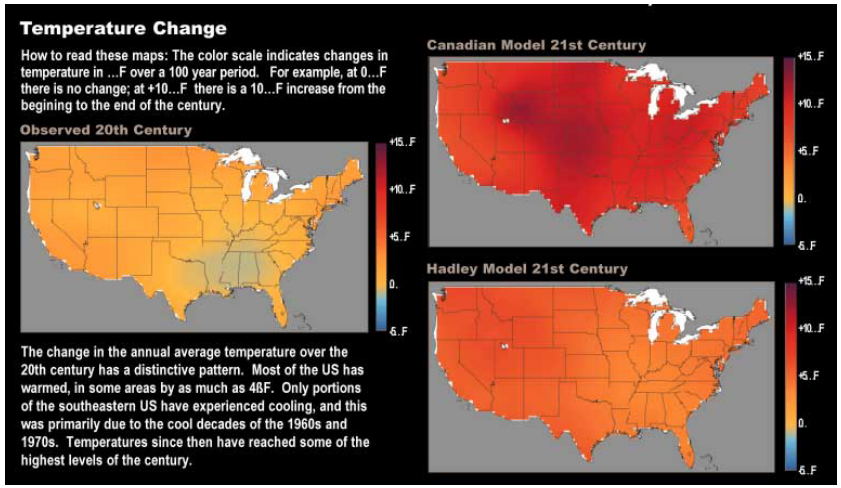
Climate Change is projected to go on

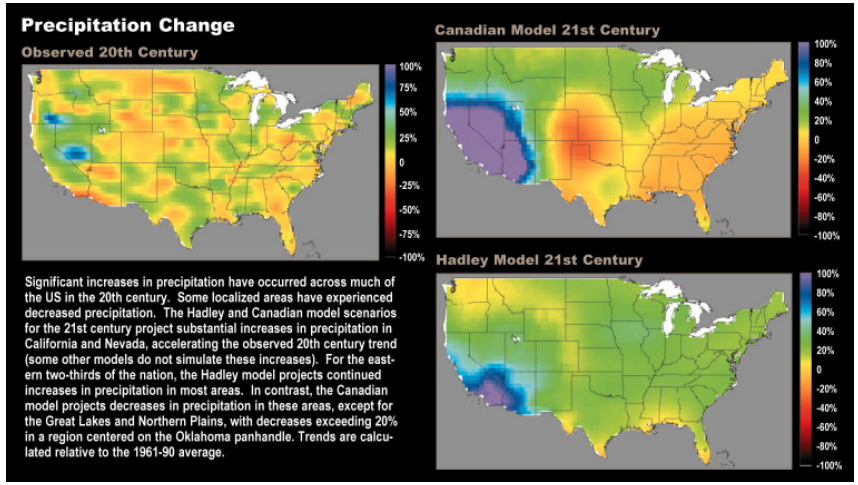
Virtually all climate models predict increasing emissions will cause a temperature increase

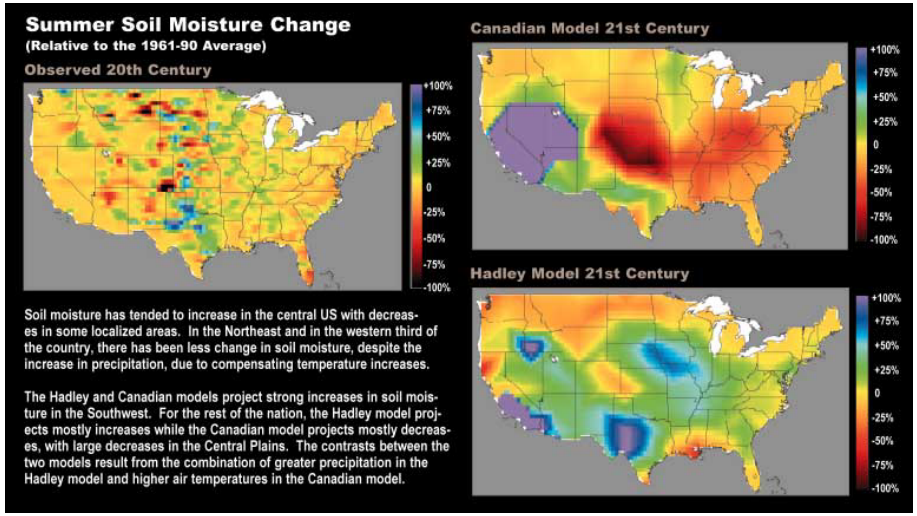


Source : U.S. National Assessment

Climate Change is projected to go on







Source : U.S. National Assessment

Society has become concerned and is acting

Globally UNFCCC : *UN Framework Convention on Climate Change*

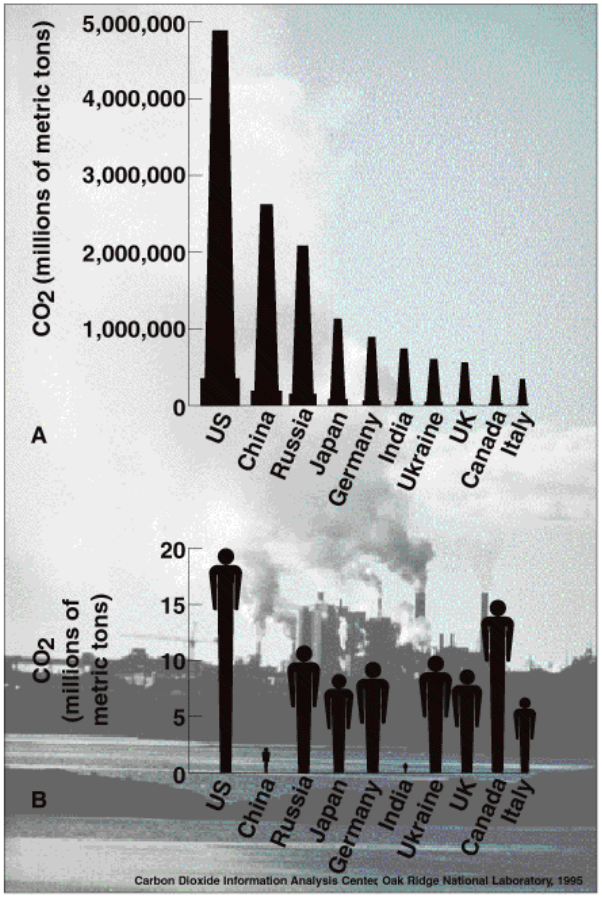
- Adopted in 1992 and ratified by 176 governments
- Designed "... to achieve ... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with climate system".
- Under it's auspices, the KYOTO Protocol was adopted.
- To comply US emissions would have had to decline by about 30% from projected 2010 levels. US said no thank you in summer 2002

US Policy

- US administration is committed to cutting greenhouse gas intensity -- how much we emit per unit of economic activity -- by 18 percent over the next 10 years. About 1/6th the effect of Kyoto Protocol http://www.whitehouse.gov/news/releases/2002/02/20020214-5.html
- Many states acting unilaterally

Where do emissions come from?

Thompson and Turk: Earth Science and the Environment, 2/e
Figure 18.16



Saunders College Publishing

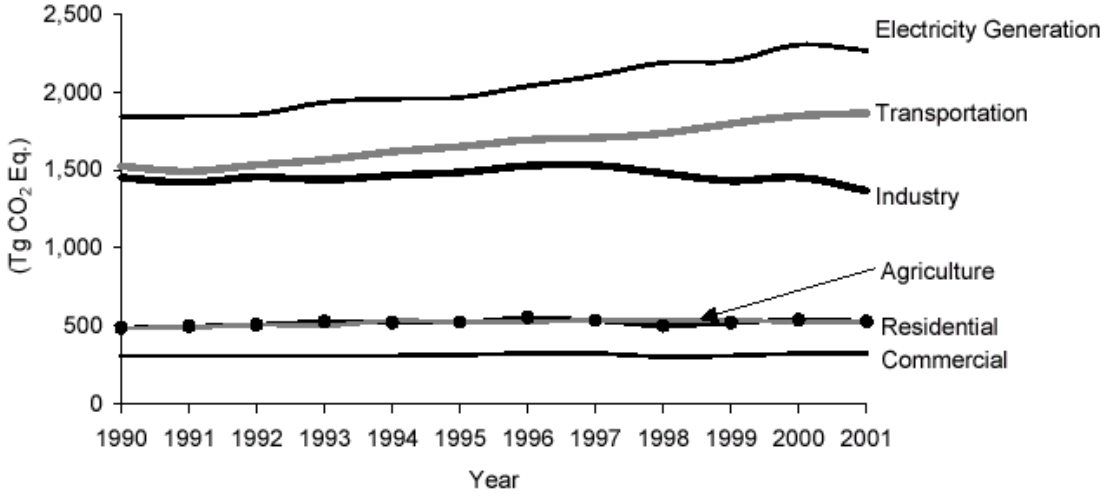
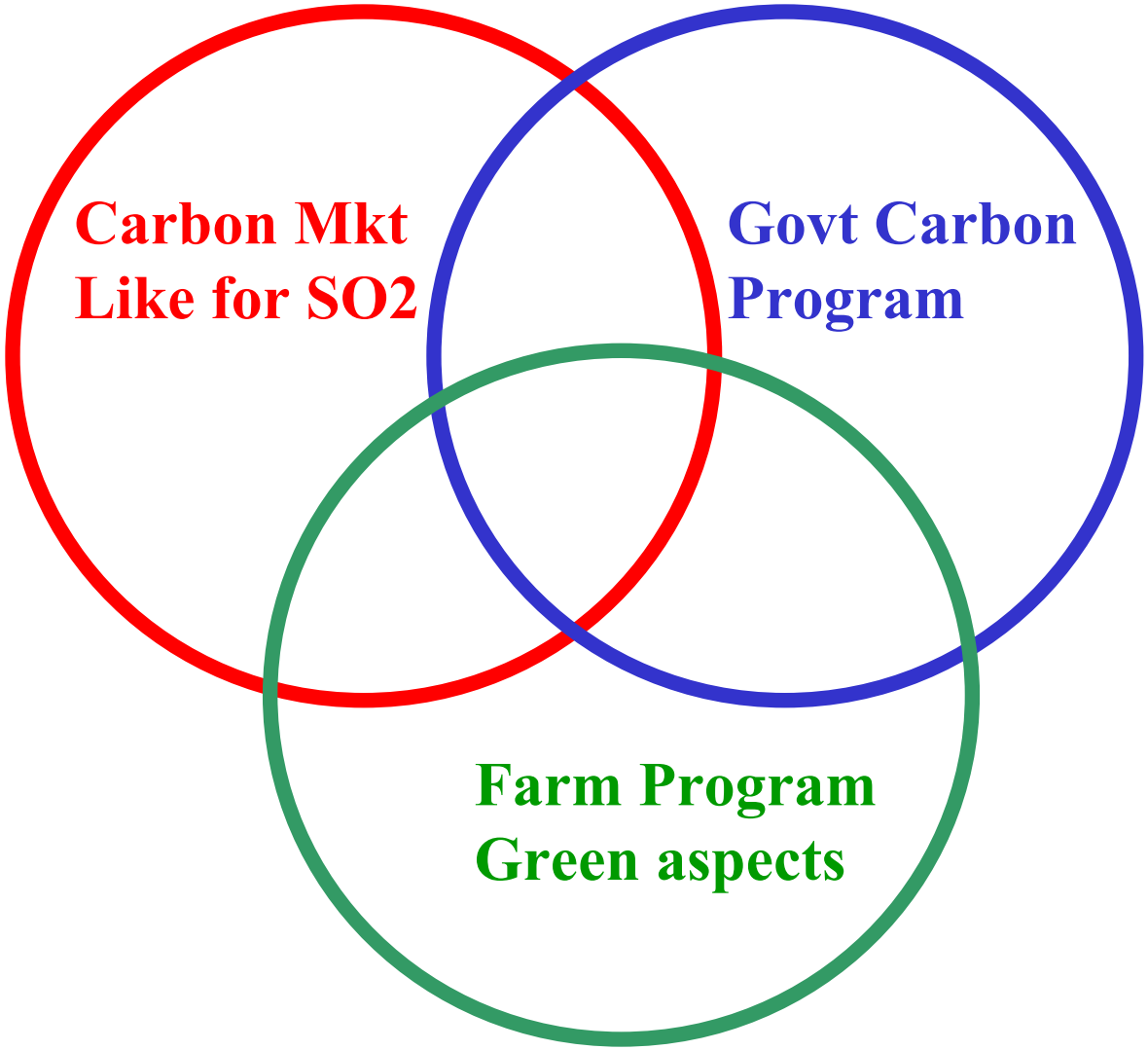


Figure 1-6: Emissions Allocated to Economic Sectors

Source EPA Inventory of U.S. GHG Emissions Inventory 2003 (Draft)

Reductions could influence way we live

How would CO2 emissions be reduced?
Policy alternatives



How would emissions be reduced?

Example of Sulfur Dioxide Acid Rain Program

– allowance trading system

- EPA sets individual firm emission limits
- Regulated firms decide the most cost-effective way
  - employing energy conservation measures
  - switching to a lower sulfur fuel
  - employing pollution control technologies, etc.
  - Trade with someone else
- Firms that reduce their emissions below their regulated allowances may trade their allowances, sell them on the open market or through EPA auctions, or bank them to cover emissions in future years.

Source: EPA's Acid Rain Program: Overview at http://www.epa.gov/airmarkets/arp/overview.html

Role of Agriculture & Forestry in GHG Mitigation

- Four agricultural and forestry roles w.r.t. GHG emission reductions
  - Emission reducers
  - A carbon or GHG sequestering sink
  - Offsetting net GHG emissions
  - Operating in a mitigating world

- Society is searching for low cost emission reduction options.
- The first place they will look is in the energy sector where 80% of the emissions come from.
- They will only come to the ag and forest sector if it is cheaper or otherwise attractive.

Ag Mitigation Strategies

Strategy	Basic Nature	CO2	CH4	N2O
Crop Mix Alteration	Emis, Seq	X		X
Crop Fertilization Alteration	Emis, Seq	X		X
Crop Input Alteration	Emission , Seq	X		X
Crop Tillage Alteration	Emission , Seq	X		X
Grassland Conversion	Sequestration	X		
Irrigated /Dry land Mix	Emission	X		X
Rice Acreage	Emission	X	X	X
Biofuel Production	Offset	X	X	X
Afforestation	Sequestration	X		
Existing timberland	Sequestration	X		
Deforestation	Emission	X		
Enteric fermentation	Emission		X	
Livestock Herd Size	Emission		X	X
Livestock System Change	Emission		X	X
Manure Management	Emission		X	X

Emission sources and possible reductions

Ag's share of anthropogenic emissions have been estimated to be 50% of methane(CH_4), 70% of nitrous oxide N_2O, and 20% of CO_2.

- **Livestock numbers and management**
  - Enteric fermentation
  - Manure
- **Rice cultivation**
- **Fertilizer application**
  - Manufacture of nitrogen
  - Nitrification and denitrification
  - Roughly 2 tons C equivalent for each ton N
- **Legume cultivation**
- **Changes in land use**
  - Deforestation,
  - New lands to cultivation
- **Crop residues**
- **Fuel use** plowing, drying, harvesting, transport

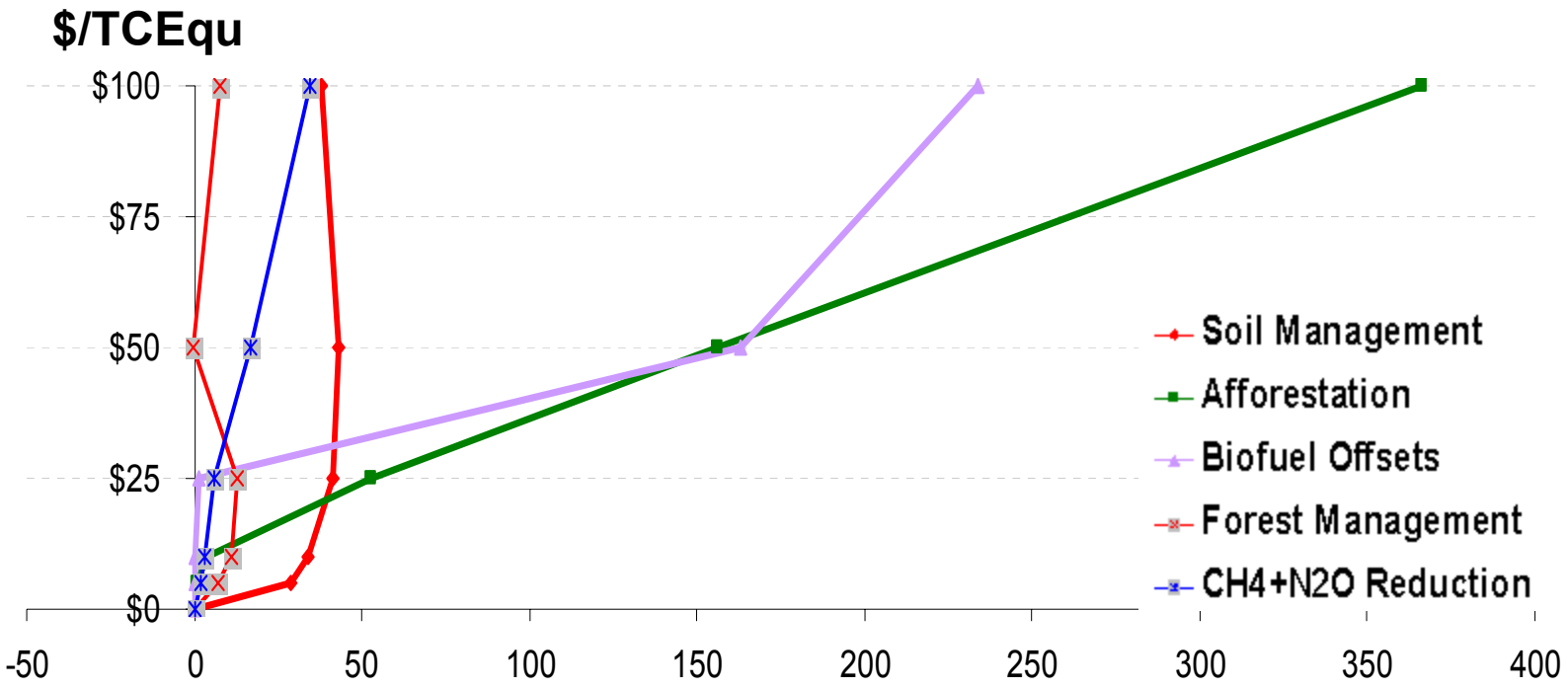
Sink / Sequestration options

- **Soil Sequestration**
  - **Carbon changes with changes in land use, tillage system, residue management.**
    - **Less intense tillage**
    - **Perennials**
    - **Grass conversions**
    - **Increasing carbon input to soil (fertilizer, irrigation, more yield) – be careful with other gasses**
- **Forest Sequestration**
  - **Conversion of agricultural lands to tree plantations**
  - **Management of existing forests**
    - **Growth promotion**
    - **Longer rotations**

Offset possibilities

- **Biomass for power plants or homes**
  - Using agricultural products as feedstock
  - Burning agricultural biomass to offset fossil fuel
  - Not now competitive - A million BTUs from Biomass will cost $1.45-$2.16 as opposed to a $0.80 cost of using coal
- **Liquid fuel production – Ethanol**
  - Converting corn or other cellulose laden products into ethanol substitution for petroleum.
  - Ethanol production costs are between $1.2 and $1.35 (Jerko) as opposed to a $0.60 per gallon of gasoline from fossil fuel production (U.S. DOE, 1998b).
  - Not a good carbon prospect due to energy use ratio
- **Building products substitution**
  - Using wood in construction

Research Insights – What will be competitive



Emission Reduction in MMTCEqu

- **Different strategies dominate at different price levels and price estimate under Kyoto was $50 or above**
- **Low C price => Soil management**
- **High C price => Biofuel offsets and afforestation**

Current Prospects

International

- Kyoto coming into being slowly
- Low market price
- US is excluded

Domestic

- No Emissions limit
- Voluntary Programs

Current Prospects

Firms with assets at risk

- a 30% cutback is frightening to a power plant

Hogs and GEMCO

The Chicago Climate Exchange (CCX)

- Wants an Ag soil group
  - Min contract size 10,000 tonnes from a group of farms
  - ½ ton CO_2 per acre so 20,000 acres
  - min commitment 4 years of min till – no history
  - Farms must have at least 250 acres
  - Will be inspected
- Price ~$5 per acre but market is thin

Can't make money today except in a niche

Future Prospects

Need an emissions cap or a government program

The Chicago Climate Exchange (CCX)

AGCERT and Hogs

US into Kyoto later? Takes 20 Kyoto's to stabilize at 550 ppm
compared to today 360 ppm

Saturation an issue (soils 20 years)

Double edged sword and property rights an issue.
Once you sell what happens if you change land use
Emission Permits to fertilize, feed, change tillage?

May make money tomorrow but costs will also come

Specific Concerns for Farmers

- Contract terms: duration, carbon or practice, exit provisions, provisions to sell land during the contract period, risk in regards to implementation and maintenance of projects, who bears risk (buyer or seller), monitoring and verification
- Property rights: If you sell carbon will you face other emission limits?
- Rate of Payment: timing of carbon price or future carbon price
- Additional costs: cost of equipment, more herbicide? Weed resistance

Resources

Intergovernmental Panel on Climate Change. IPCC Third Assessment Report - Climate Change 2001: Impacts, Adaptation and Vulnerability, http://www.ipcc.ch/.

Intergovernmental Panel on Climate Change. IPCC Third Assessment Report - Climate Change 2001: Mitigation , http://www.ipcc.ch/.

Intergovernmental Panel on Climate Change. IPCC Third Assessment Report - The Scientific Basis, http://www.ipcc.ch/.

Intergovernmental Panel on Climate Change. IPCC Third Assessment Report – Synthesis Report, http://www.ipcc.ch/.

National Assessment Synthesis Team, US Global Change Research Program , Climate Change Impacts on the United States:*The Potential Consequences of Climate Variability and Change O*verview: 2000
http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overview.htm

National Assessment Synthesis Team, US Global Change Research Program , Climate Change Impacts on the United States:*The Potential Consequences of Climate Variability and Change* Foundation: 2000
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McCarl Papers, http://ageco.tamu.edu/faculty/mccarl/papers/htm