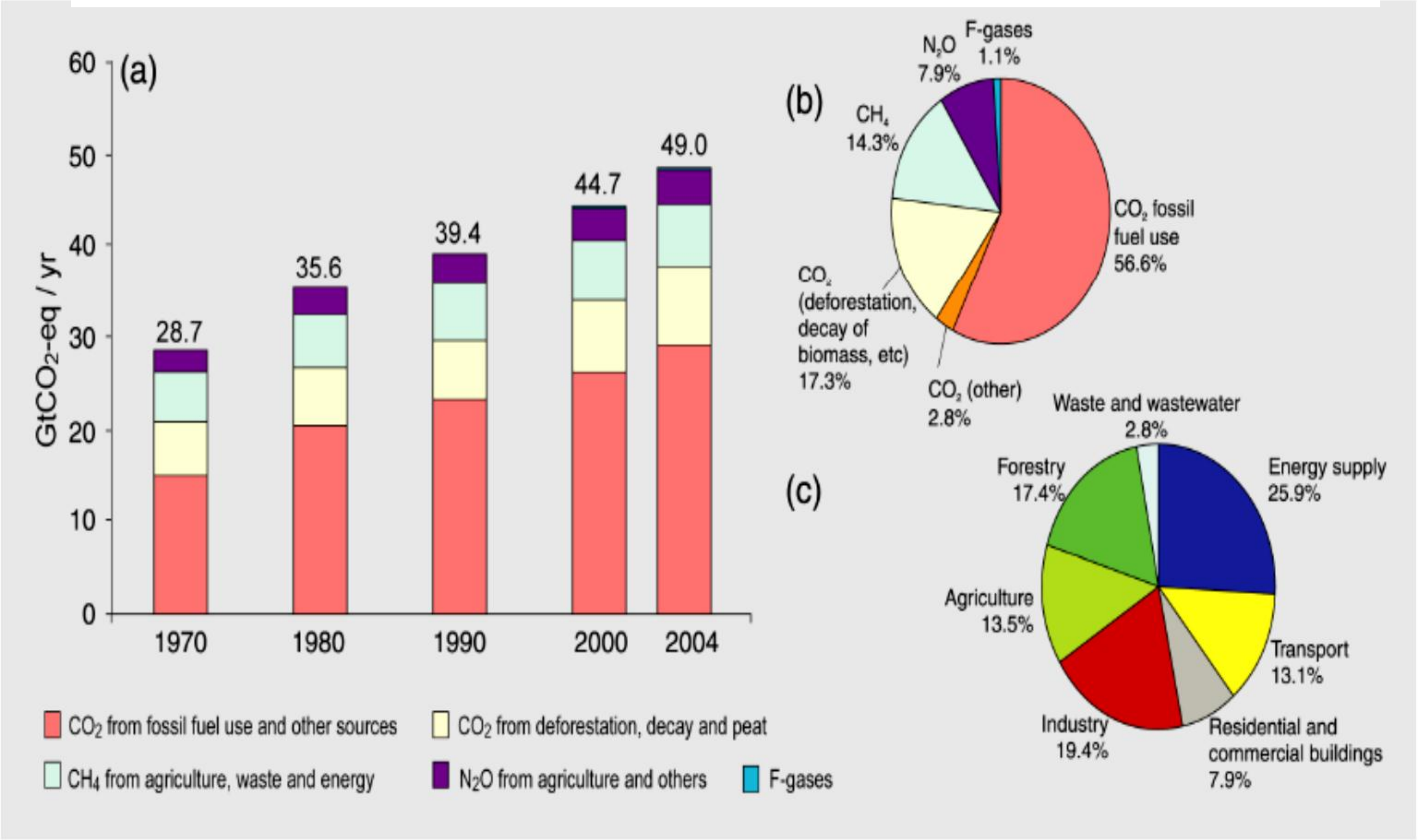
KANSAS EPSCoR
Partners in Science & Technology

Climate Change: Impacts,Adaptation, and Mitigation

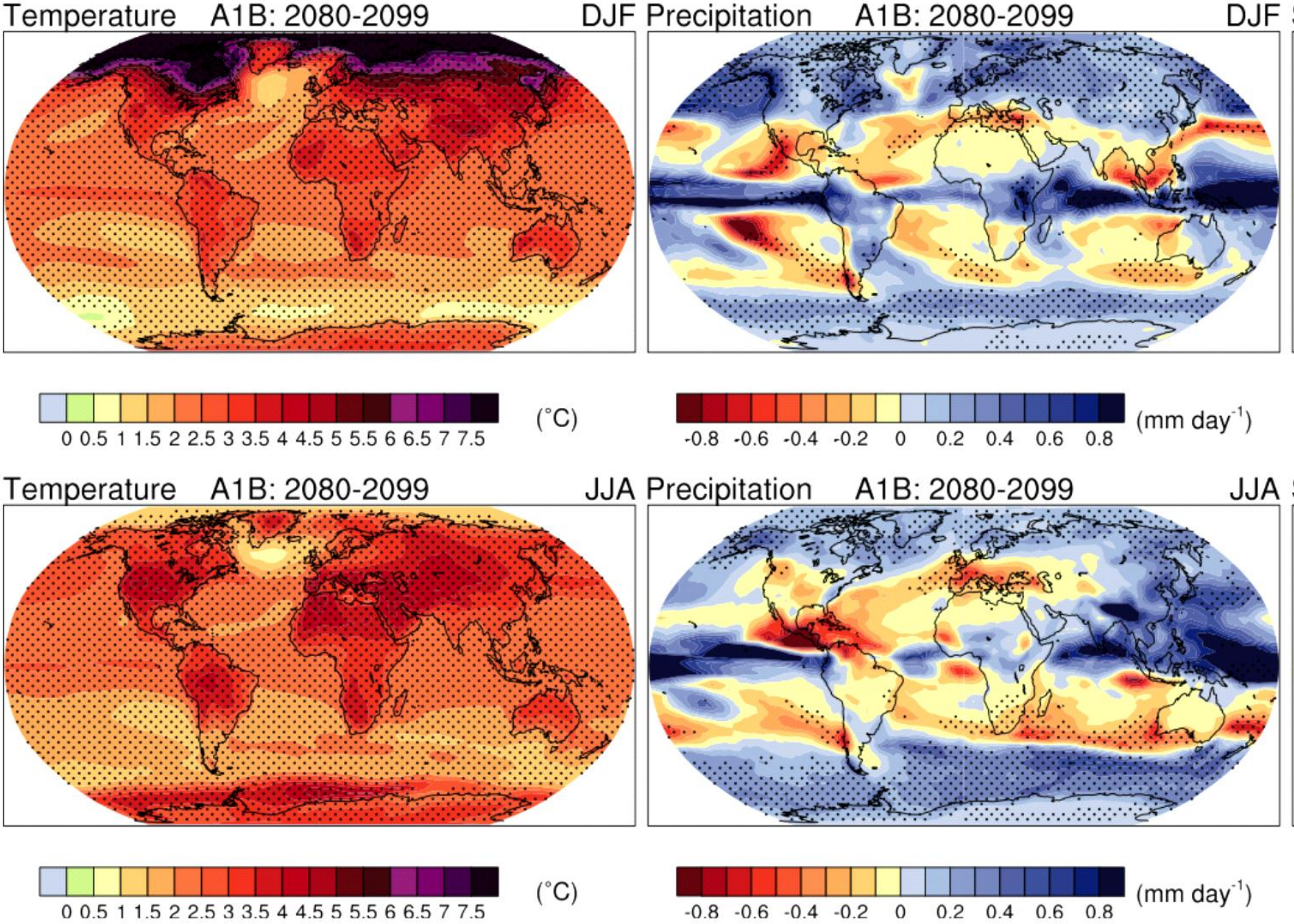
Charles W. Rice
University Distinguished Professor
Department of Agronomy
Kansas State University

Kansas State
UNIVERSITY

Figure SPM.3. (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO_2-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation). {Figure 2.1}



IPCC Fourth Assessment Report, Working Group III, 2007



IPCC Fourth Assessment Report, Working Group III, 2007

Projected Changes for the Climate of the Midwest

- Temperature
  - Fewer extreme high temperatures in summer in short term but more in long term
  - Higher nighttime temperatures both summer and winter
  - Increased temperature variability
- Precipitation
  - More (~10%) precipitation annually
  - Change in "seasonality": Most of the increase will come in the first half of the year (wetter springs, drier summers)
  - More variability of summer precipitation
    - More intense rain events and hence more runoff

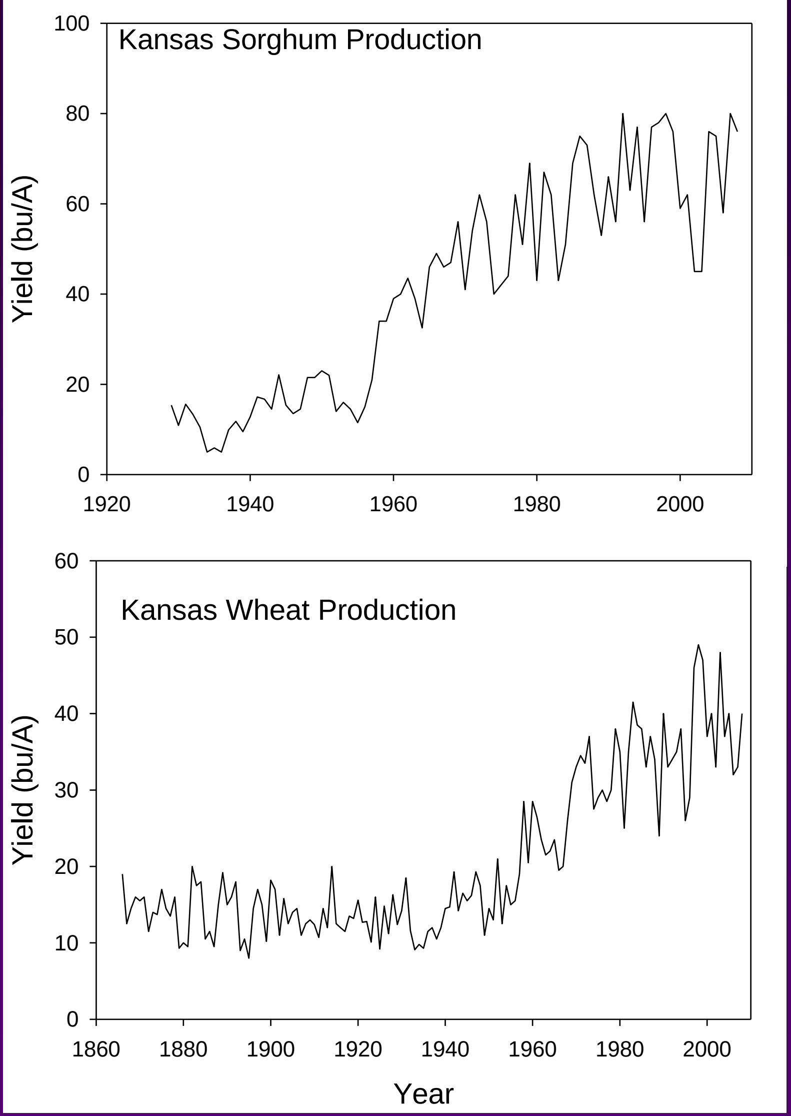
*Estimated from IPCC reports

Climate Impacts

Crop	Yield Change
Maize	-4.0%
Soybean-Midwest	+2.5%
Soybean-South	-3.5%
Wheat	-6.7%
Rice	-12.0%
Sorghum	-9.4%
Cotton	-5.7%
Peanut	-5.4%
Bean	-8.6%

Hatfield et al., 2008

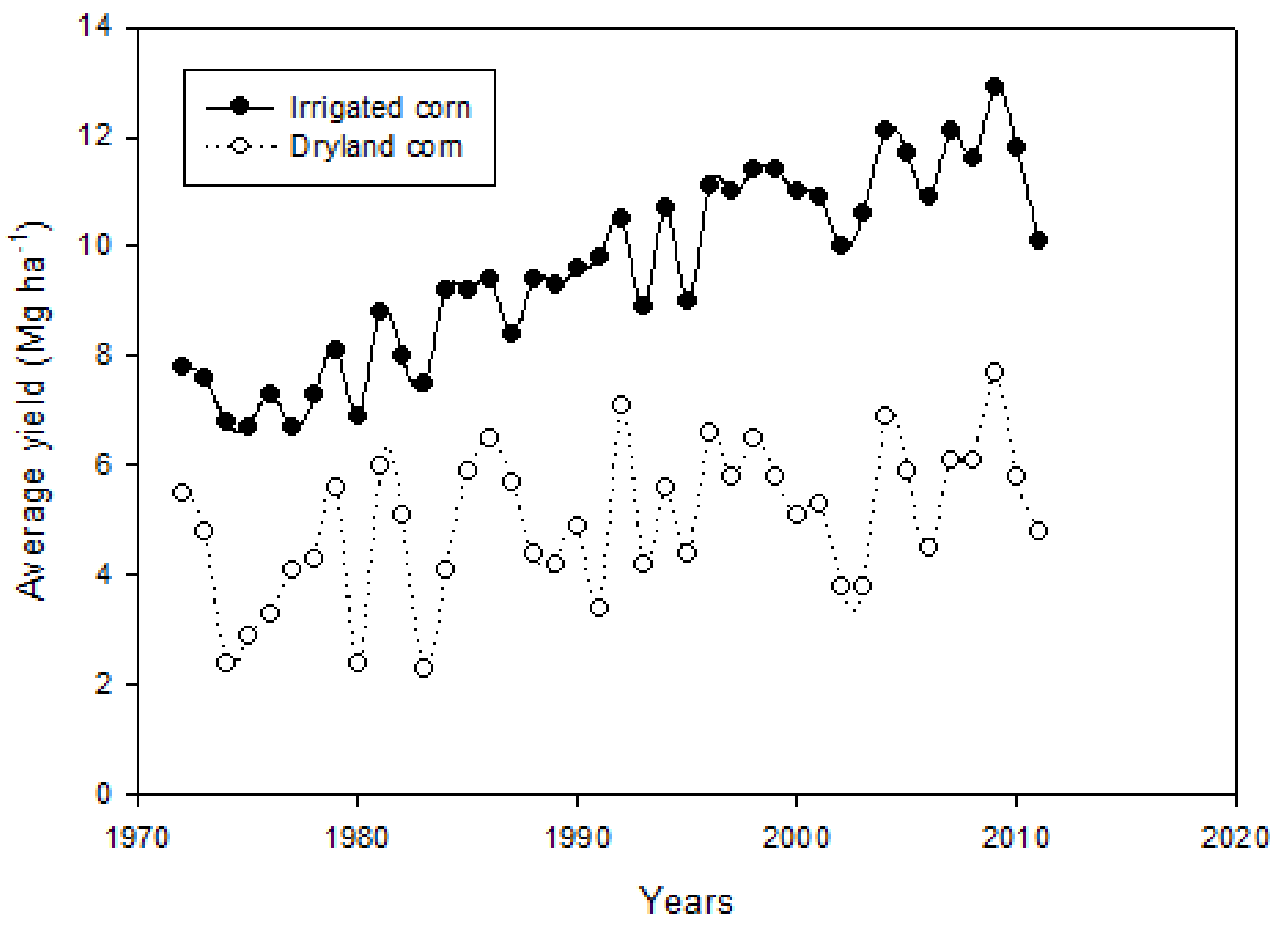
Variation in Crop Yields



Sorghum

Wheat

Irrigated Corn in Kansas

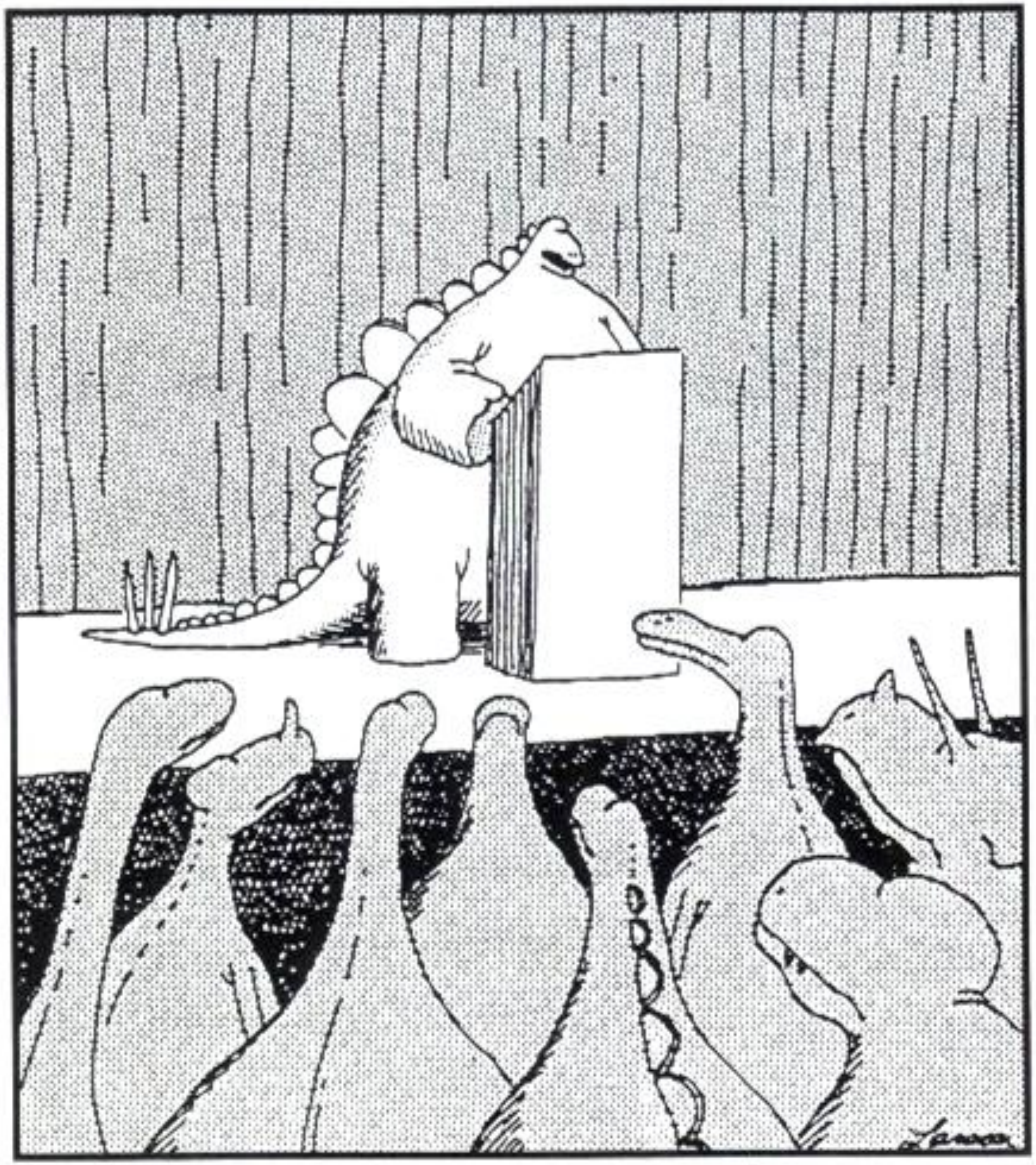


Assefa, Roozeboom and Rice

Adaptation

1. Develop crop varieties
2. Develop new irrigation technologies
3. Develop more diverse cropping systems
4. Improve the synchronization of planting and harvesting operations
5. Develop soil and crop management strategies.
6. Increase soil C sequestration.
7. Develop new technologies to increase N-use efficiencies.
8. Develop soil erosion prevention and protection.
9. Value agricultural commodities.
10. Apply concepts of precision/target conservation.

Delgado et al, 2011; J. Soil Water Consn, Vol 66 - Best paper award



"The picture's pretty bleak, gentlemen. …
The world's climates are changing, the mammals
are taking over, and we all have a brain
about the size of a walnut."

The Far Side®

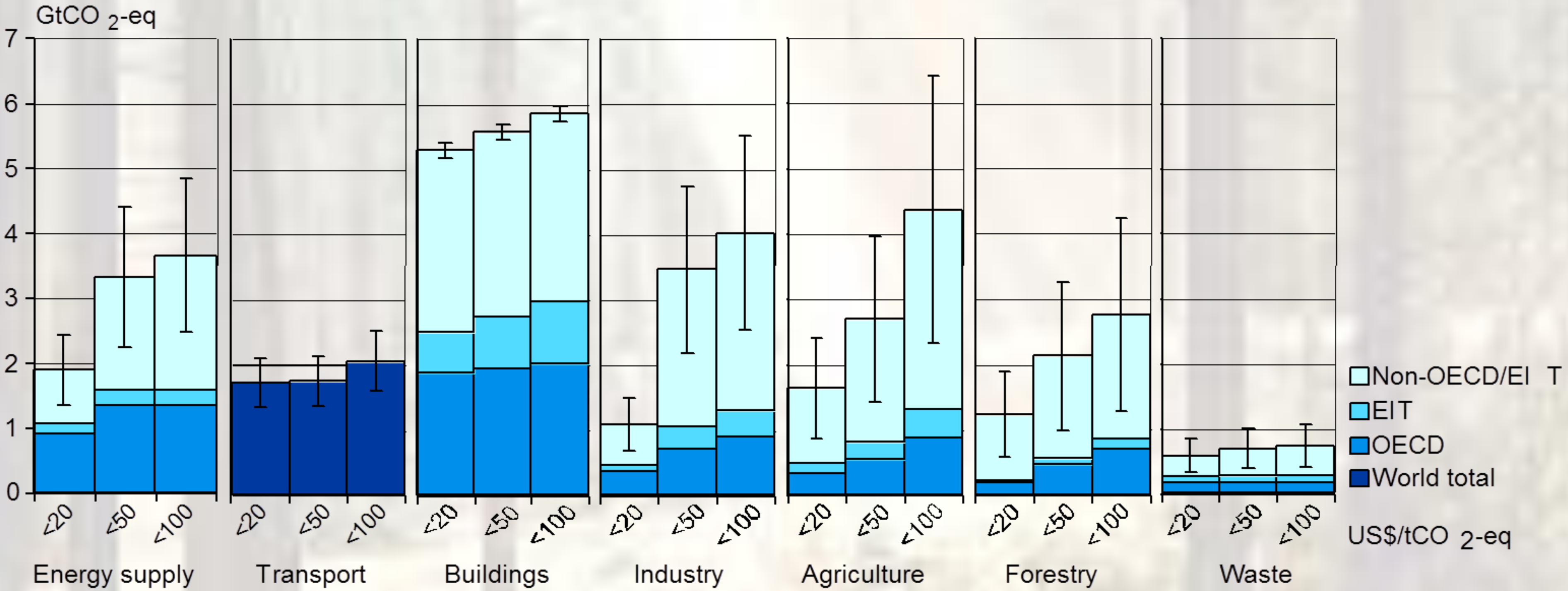
LAST IMPRESSIONS

—— 2002 ——

March

Saturday 23

Global economic mitigation potential for different sectors at different carbon prices



IPCC, 2007

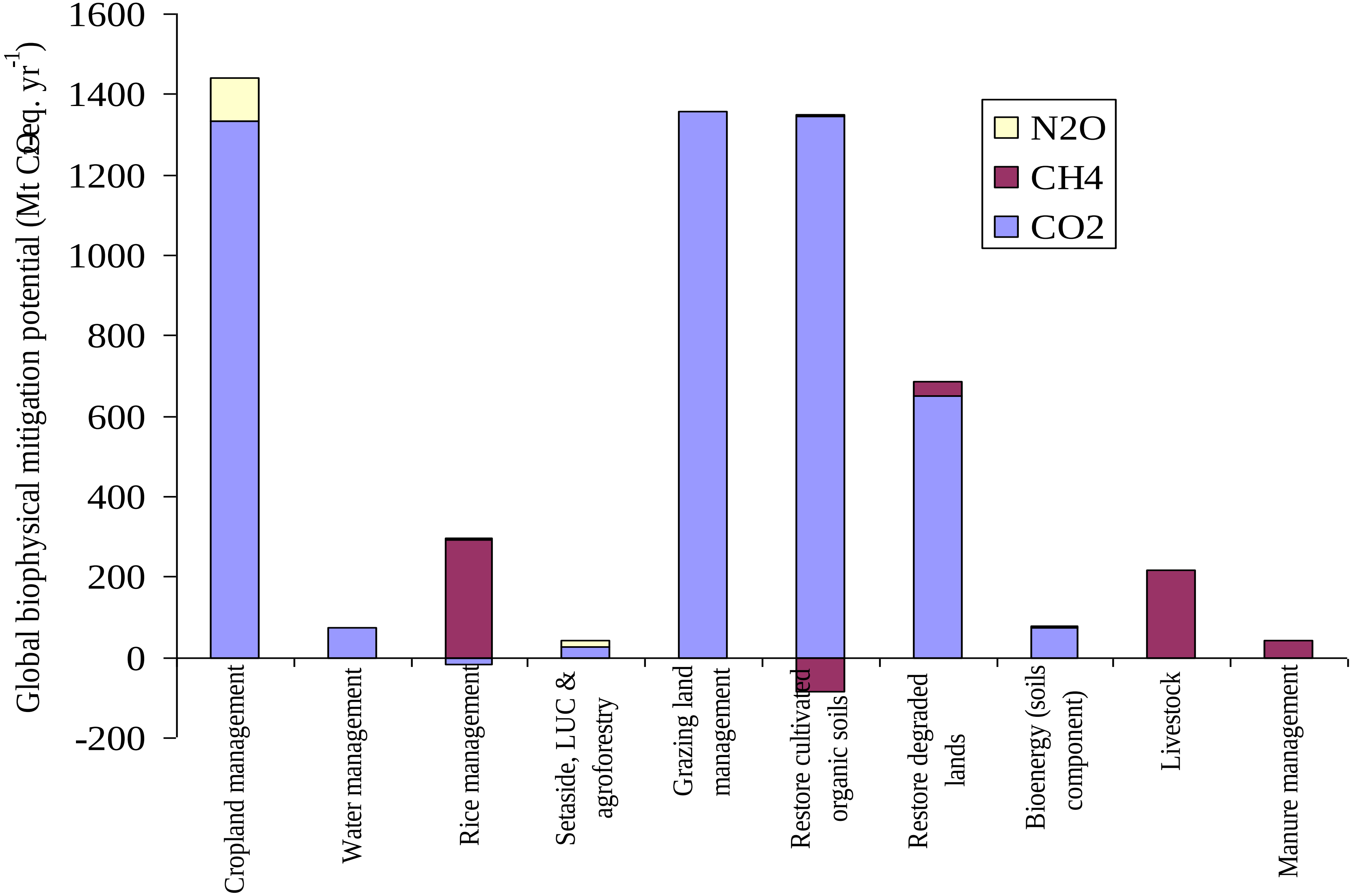
Agriculture

- A large proportion of the mitigation potential of agriculture (excluding bioenergy) arises from soil C sequestration, which has strong synergies with sustainable agriculture and generally reduces vulnerability to climate change.

- Agricultural practices collectively can make a significant contribution at low cost
  - By increasing soil carbon sinks,
  - By reducing GHG emissions,
  - By contributing biomass feedstocks for energy use

IPCC Fourth Assessment Report, Working Group III, 2007

Global mitigation potential in agriculture



Smith et al. (2008)

Many opportunities for GHG mitigation!

Cropland

- Reduced tillage
- Rotations
  - Reduced bare fallow
  - Increased intensity
- Cover crops
- Fertility management
  - Nitrogen use efficiency
- Water management
  - Irrigation management

Biophysical GHG Mitigation Potential

	Soil C
	---- t CO_2e/ha/yr ------
No-till*	**1.09** **(-0.26–2.60)**
Winter cover crops*	**0.83** **(0.37–3.24)**
Diversify Annual Crop Rotations*	**0.58** **(-2.50–3.01)**

Olander et al., 2011

Carbon sequestration rate (C rate) expressed in equivalent mass (Mg C/ha/y) to a 30 cm depth for Manhattan, KS USA Conversion from tilled to no-till

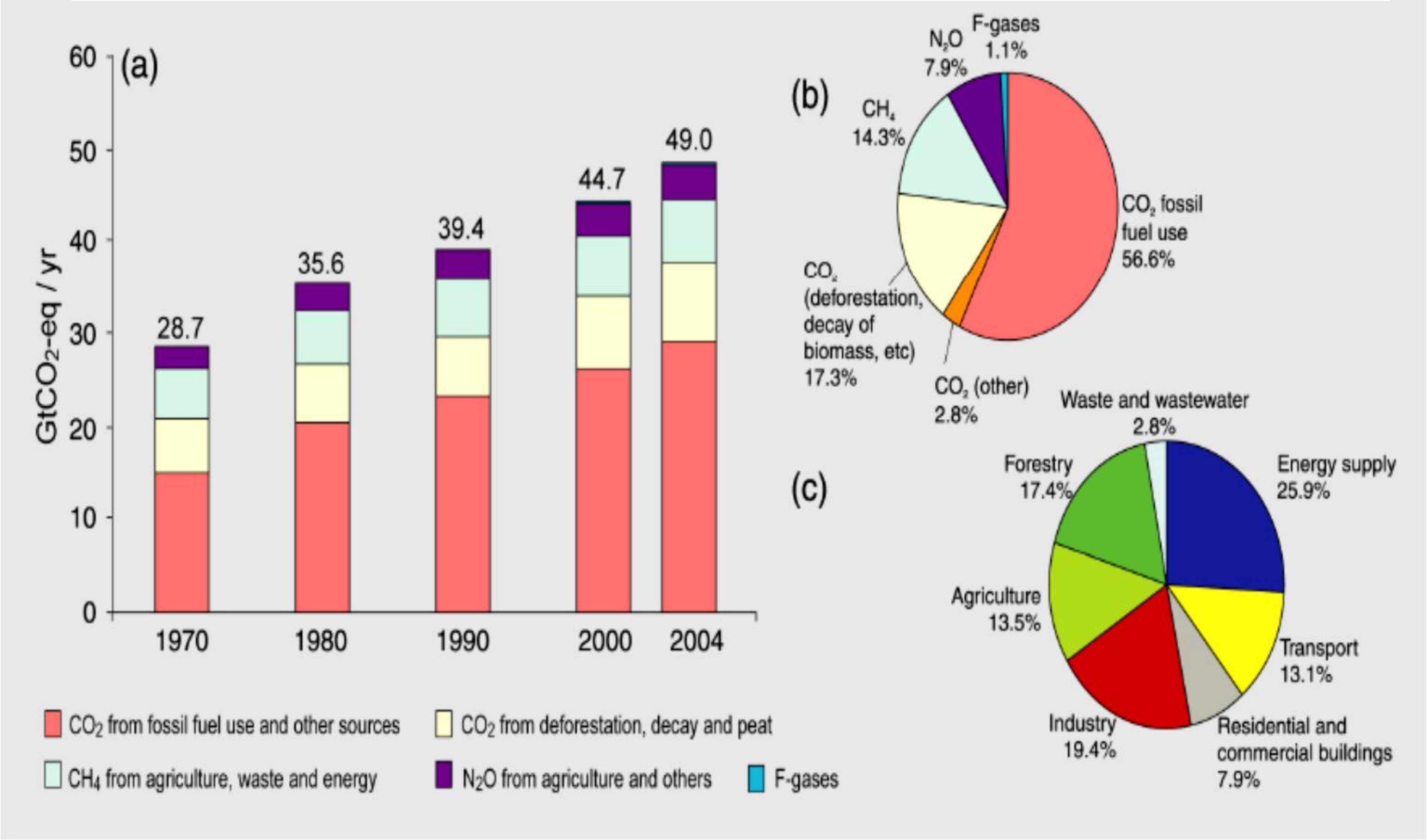
Rotation	
Continuous Soybean	0.066
Continuous Sorghum	0.292
Continuous Wheat	0.487
Soybean - Wheat	0.510
Soybean - Sorghum	0.311

Fabrizzi, 2006

No-Tillage Cropping Systems
Conservation Agriculture

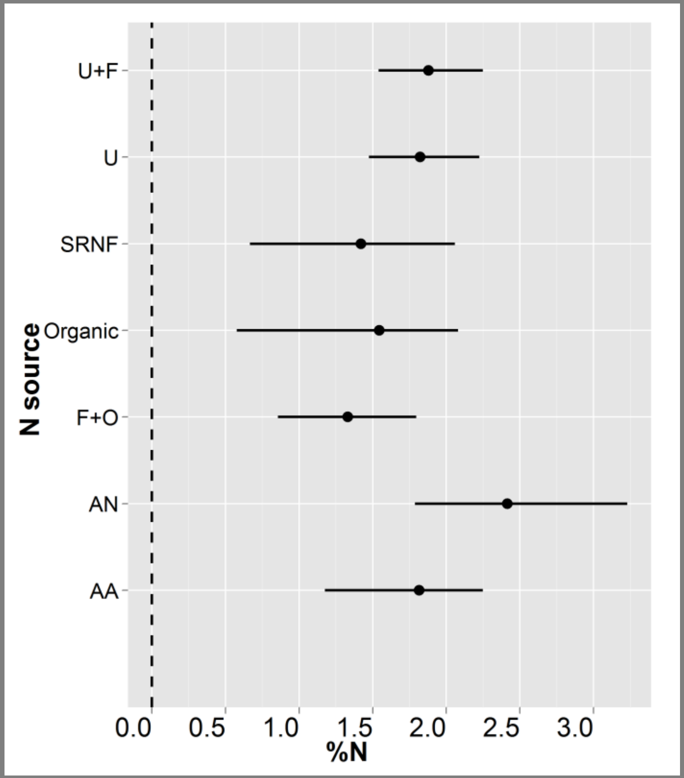
- Restores soil carbon
- Conserves moisture
- Saves fuel
- Saves labor
- Lowers machinery costs
- Reduces erosion
- Improved soil fertility
- Controls weed
- Planting on the best date
- Improves wildlife habitat

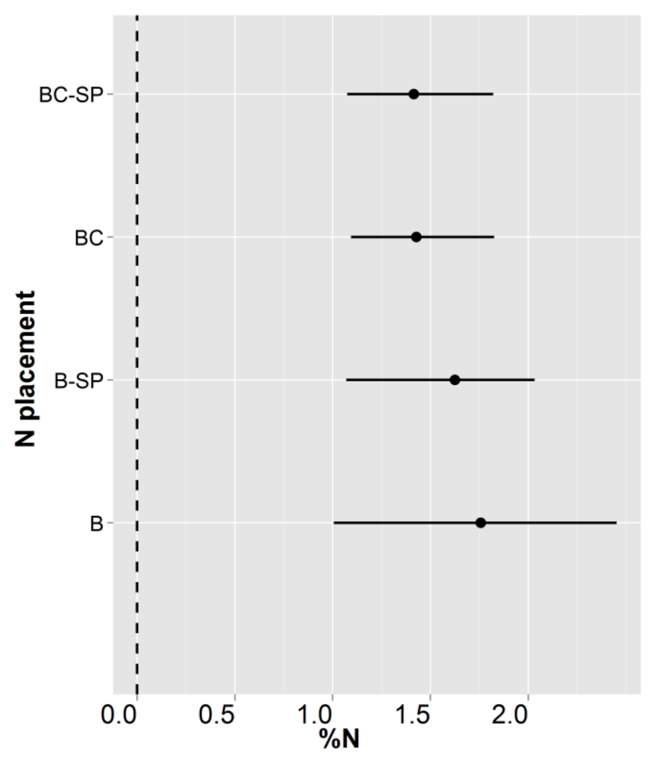
Figure SPM.3. (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004. (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO_2-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation). {Figure 2.1}

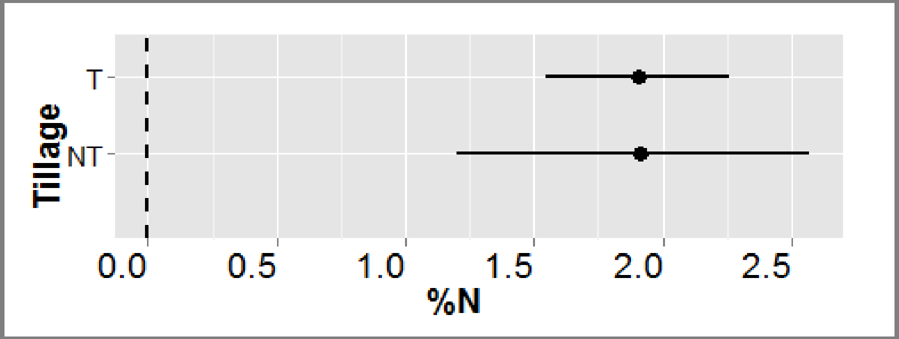


IPCC Fourth Assessment Report, Working Group III, 2007

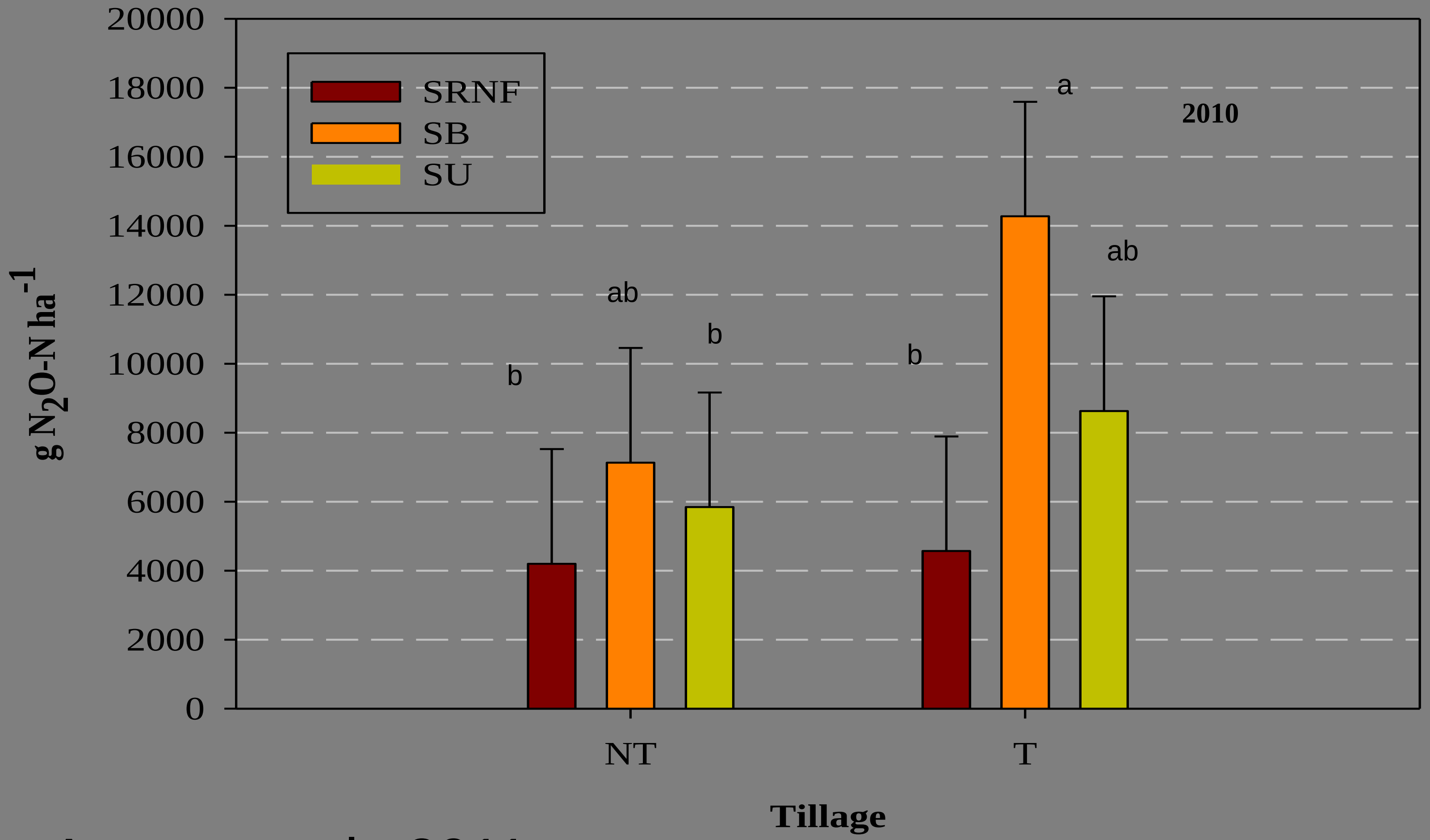
Results: N source, placement and rate







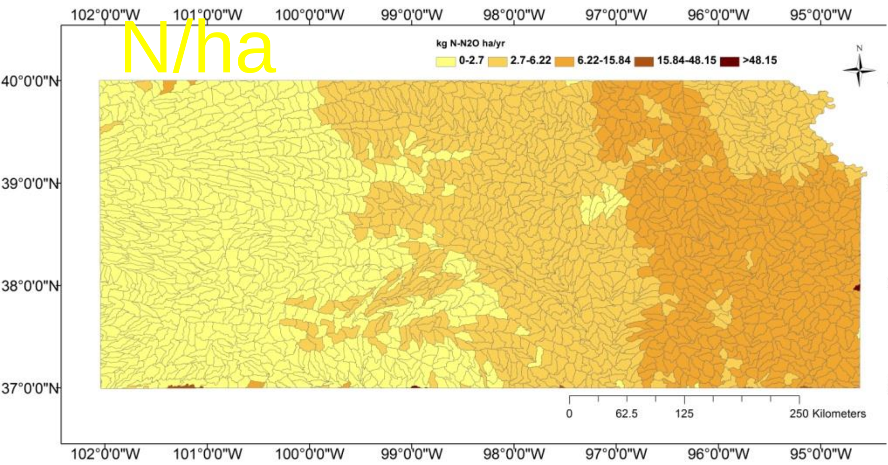
Long-Term Exp: Cumulative N_2O-N emissions

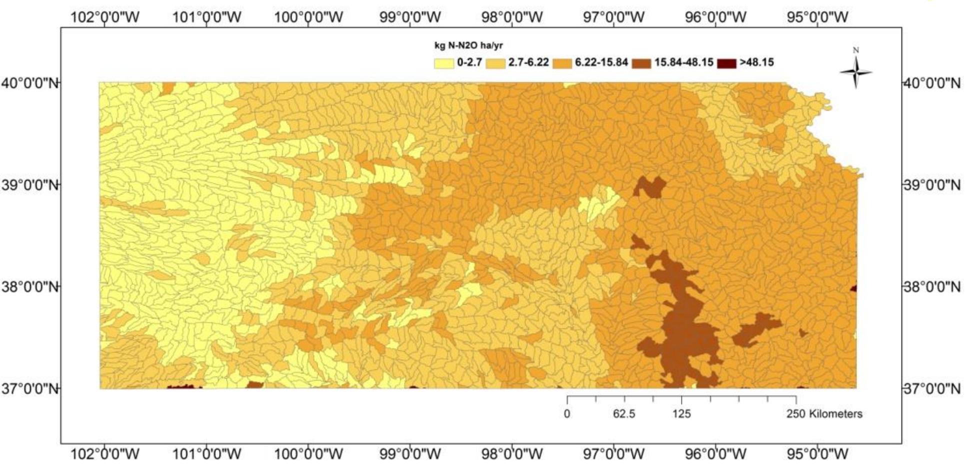


Arango et al., 2011

Results: Regional N_2O simulations

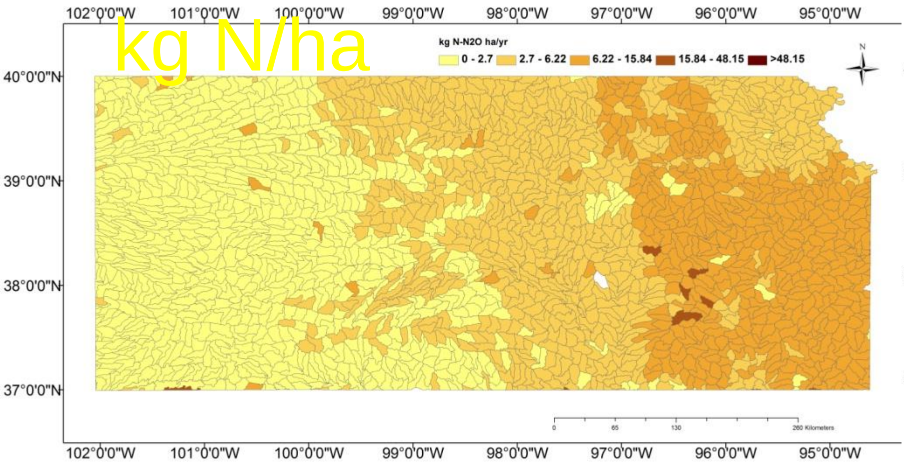
Scenario: T-F Non-Irrigated continuous corn 147 kg N/ha

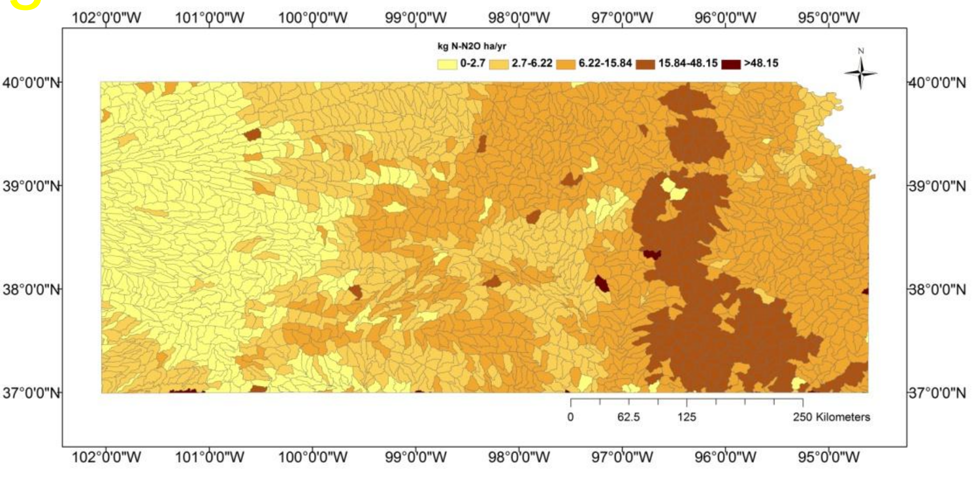




Current Future

Scenario: NT-F Non-Irrigated continuous corn 147 kg N/ha



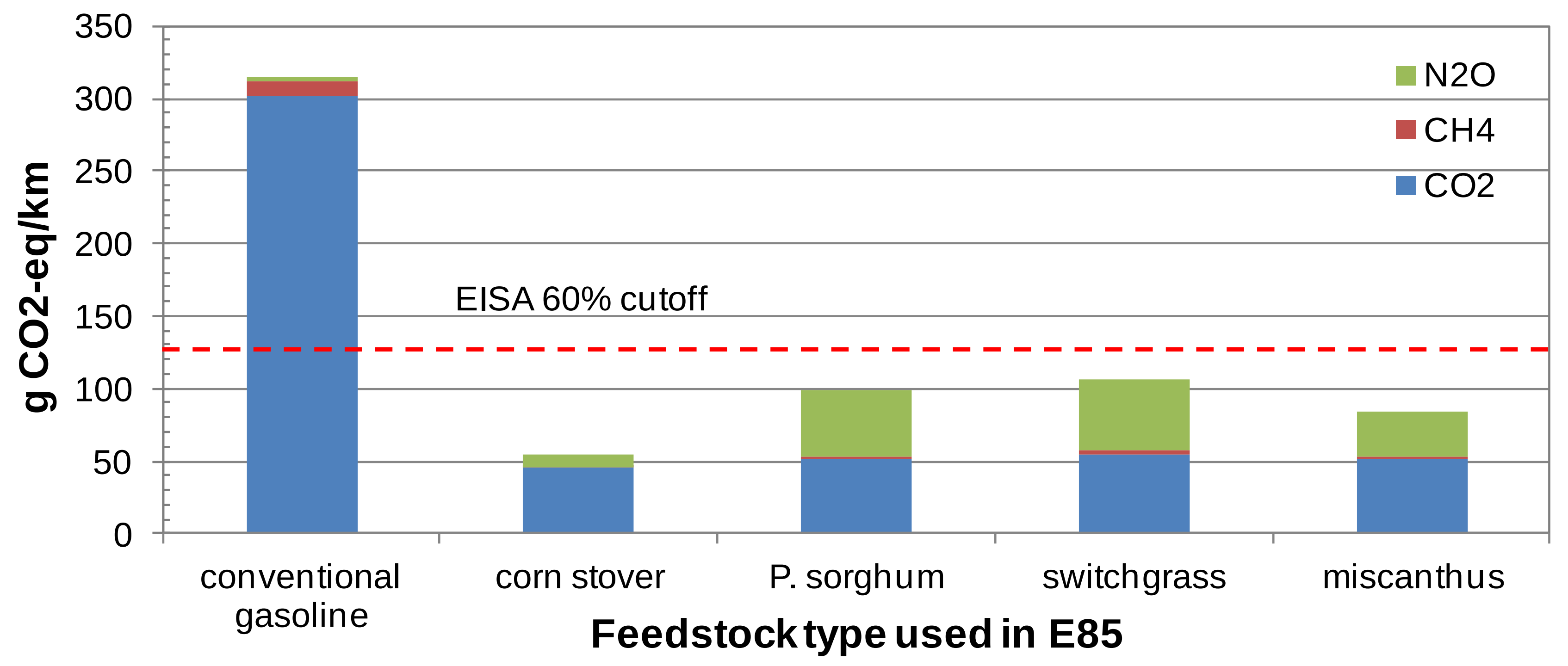


N_2O Mitigation Potentials

Practice	% Reduction
Soil Emissions	
Soil N Tests	10
Fertilizer Timing	10
Cover Crops	5
N Fertilizer Placement	5
Nitrification & Urease Inhibitors	5
Indirect Fluxes	
Crop N use efficiency	20
Riparian Zone Management	5
Ammonia Management	5
Wastewater Treatment	5

Robertson

Results



- All bioethanol blends had W2W GHG emissions substantially below those of conventional gasoline

Providing Education in Face of Climate Change, Food and Energy Scarcity

Charles W. Rice, Kansas State University
Telmo Amado, Universidade Federal de Santa Maria

Scott Staggenborg, Kansas State University
Jac Varco, Joseph Massey, Mississippi State University
Eduardo Couto, Universidade Federal de Mato Grosso
and Luis Avila, Universidade Federal de Pelotias

CAPES

Ministério BRASIL

FIPSE

US-Brazil
Higher Education
Consortia Program

Kansas State
UNIVERSITY

MISSISSIPPI STATE
UNIVERSITY

Universidade Federal de Santa Maria
SEDES SAPIENTIAE
1960

UNIVERSIDADE FEDERAL
DE MATO GROSSO

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

Croplands
Research Database

- The Global Research Alliance brings countries together to find ways to grow more food without growing greenhouse gas emissions.

- The Alliance’s Croplands Group is focused on reducing greenhouse gas intensity and improving overall production efficiency of cropland systems.
- The Group will work together to find ways to limit the losses of valuable carbon and nitrogen from crops and soils to the atmosphere, and transferring that knowledge and technologies to croplands farmers, land managers and policy makers around the world.

Conclusions

- Agriculture contributes to climate change
- Agriculture is and will be affected by climate change and variability
- Agriculture has a significant role to play in climate mitigation
- Agricultural mitigation should be part of a portfolio of mitigation measures to reduce emissions / increase sinks whilst new, low carbon energy technologies are developed.

Chuck Rice
Phone: 785-532-7217
Cell: 785-587-7215
cwrice@ksu.edu

- Websites

  www.soilcarboncenter.k-state.edu/

K-State Research and Extension