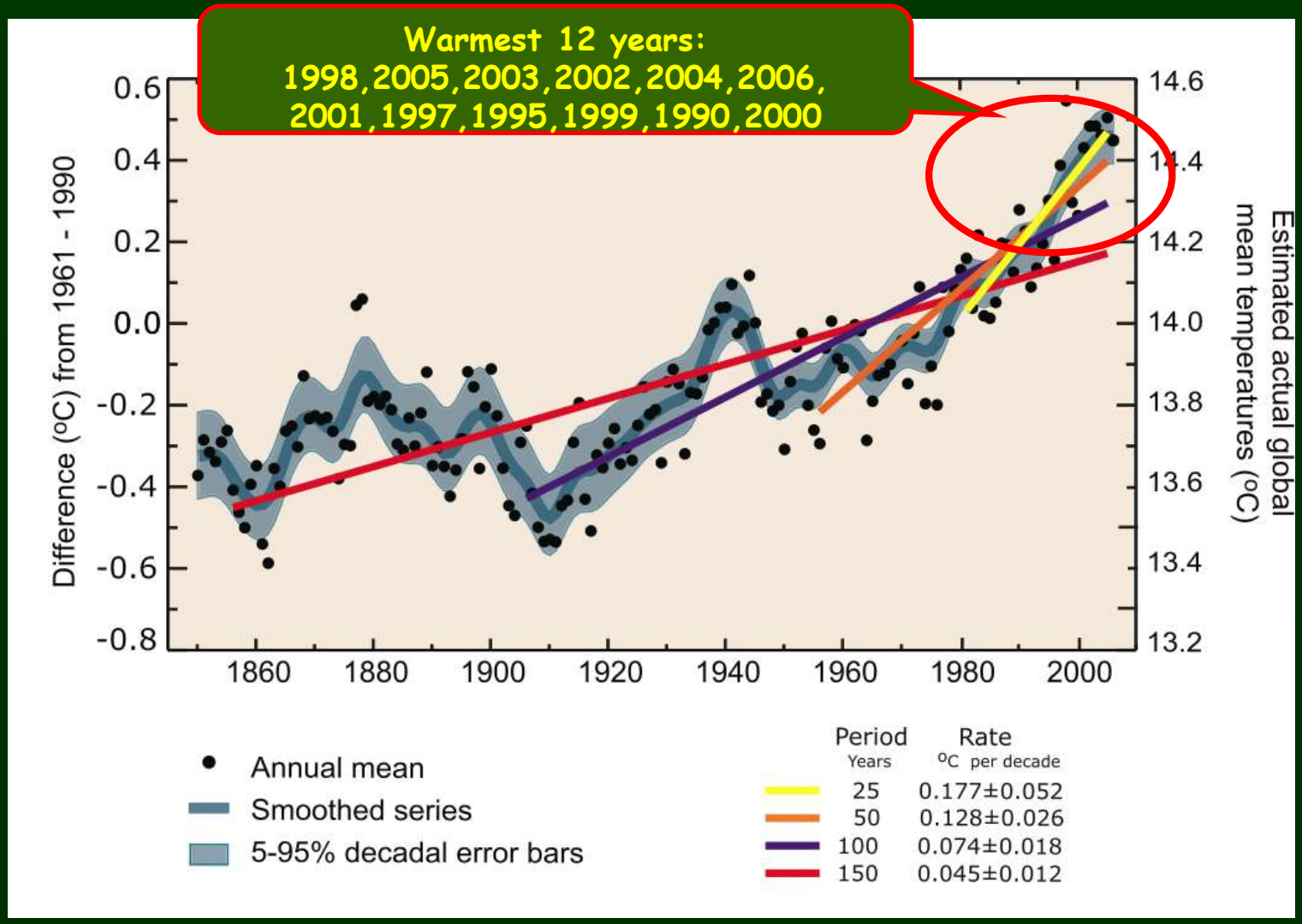
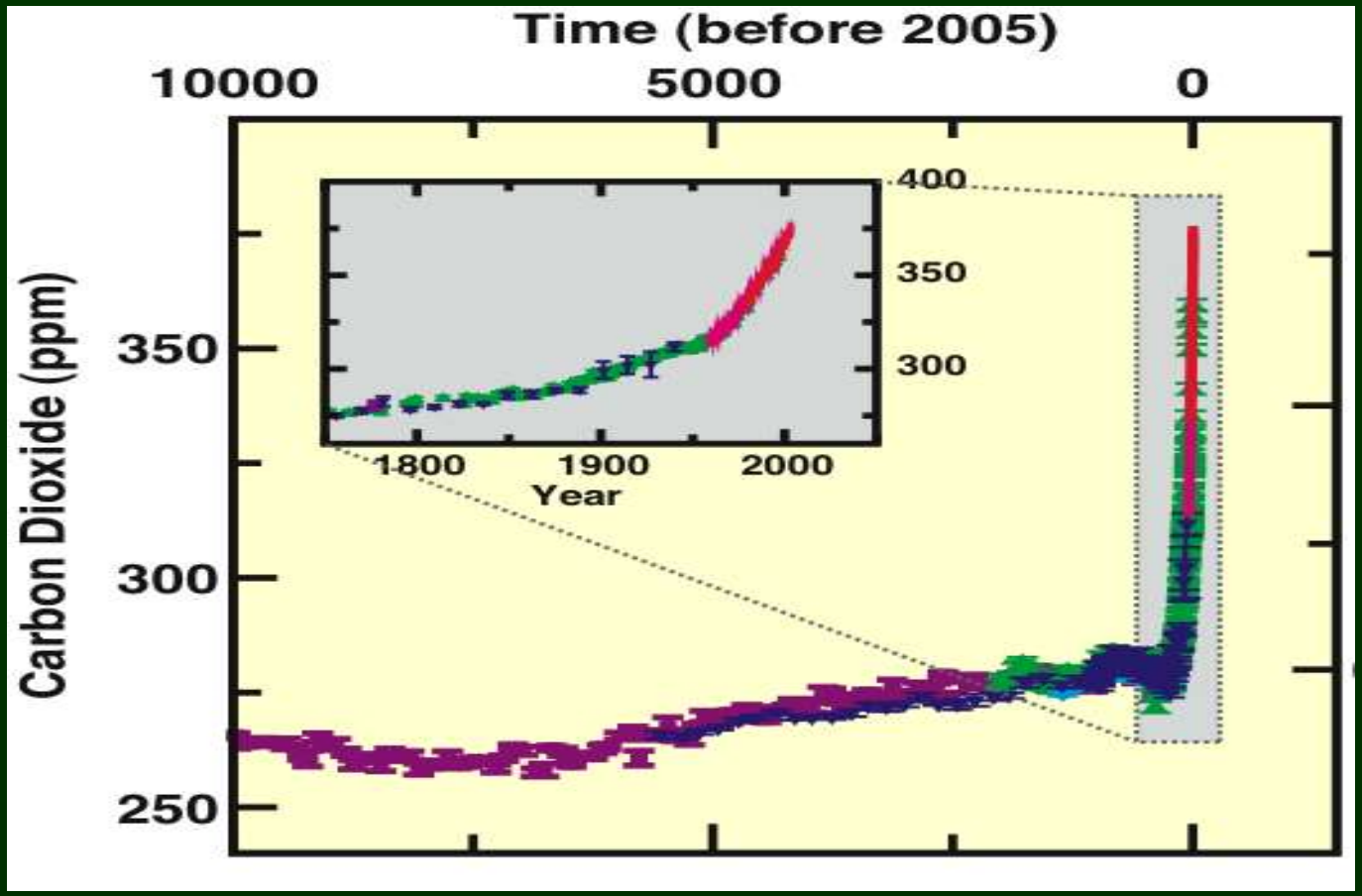
Global Climate Change: Implications for Indian Agriculture

Global mean temperatures have increased by 0.74ºC during last 100 years.
The rate has become faster in recent years



Source: IPCC, 2007

Build-up of atmospheric carbon dioxide over time

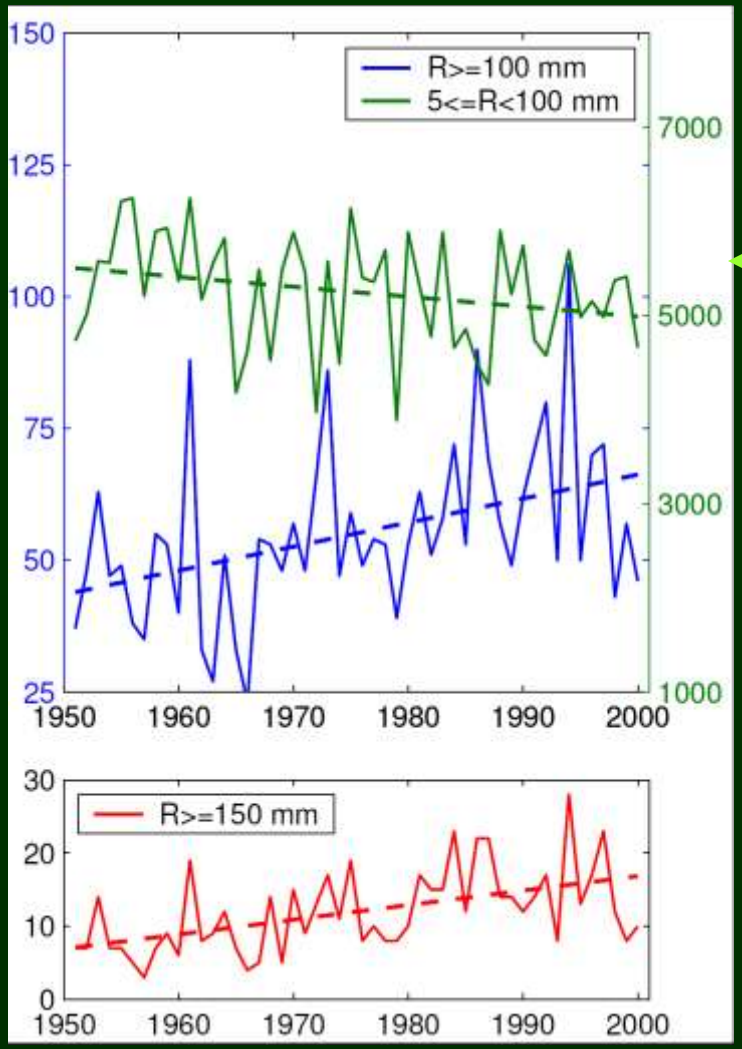


Source: IPCC, 2007

Other observations of change in global climate

- Globally, hot days, hot nights, and heat waves have become more frequent.
- Frequency of heavy precipitation events has increased over most land areas.
- Global average sea level rose at an average rate of 1.8 mm per year over 1961 to 2003.

Heavy precipitation events over Central India have increased during last 50 years



Light to moderate rainfall events (5-100 mm)

Heavy rainfall events (>10cm)

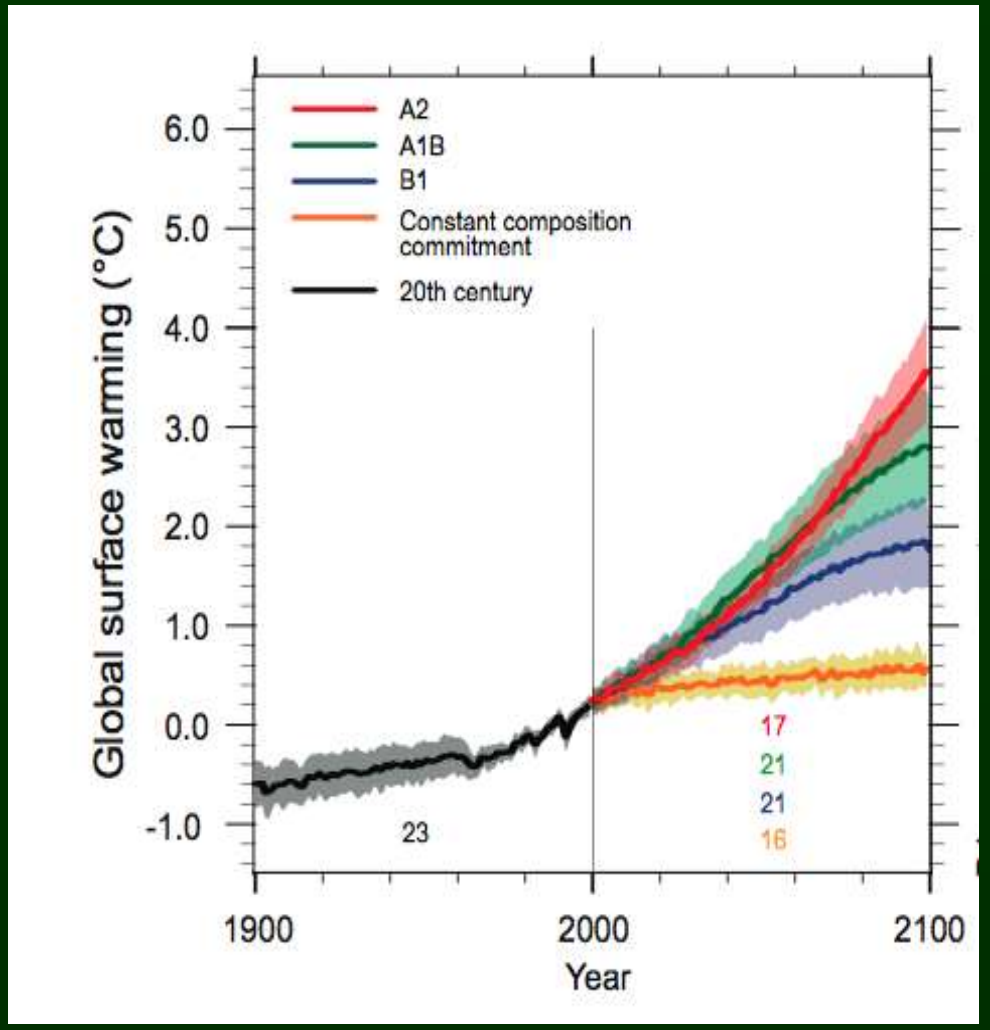
Very heavy rainfall events (>15cm)

Source: IITM, Goswami et al. 2006; data is the frequency in each of 143 grids in the region

Future Climate is Likely to be Warmer

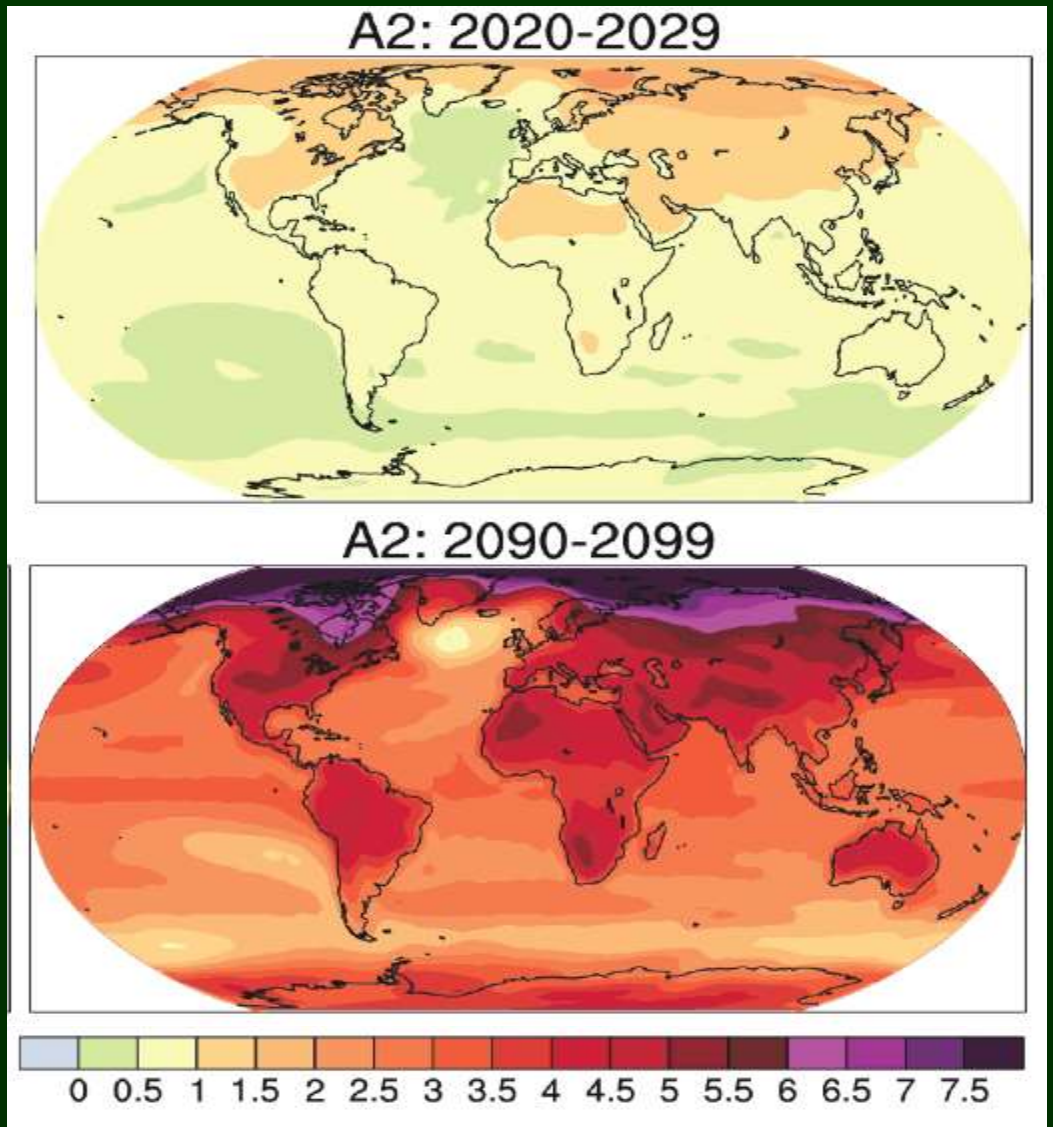
Although there is considerable uncertainty about future, all climate models indicate a rising trend in temperature. By 2100 a rise of 1.8 to 4°C is expected.

Higher values cannot be ruled out



Source: IPCC, 2007

Projected warming in 21st century is expected to be greatest over land and at most high northern latitudes



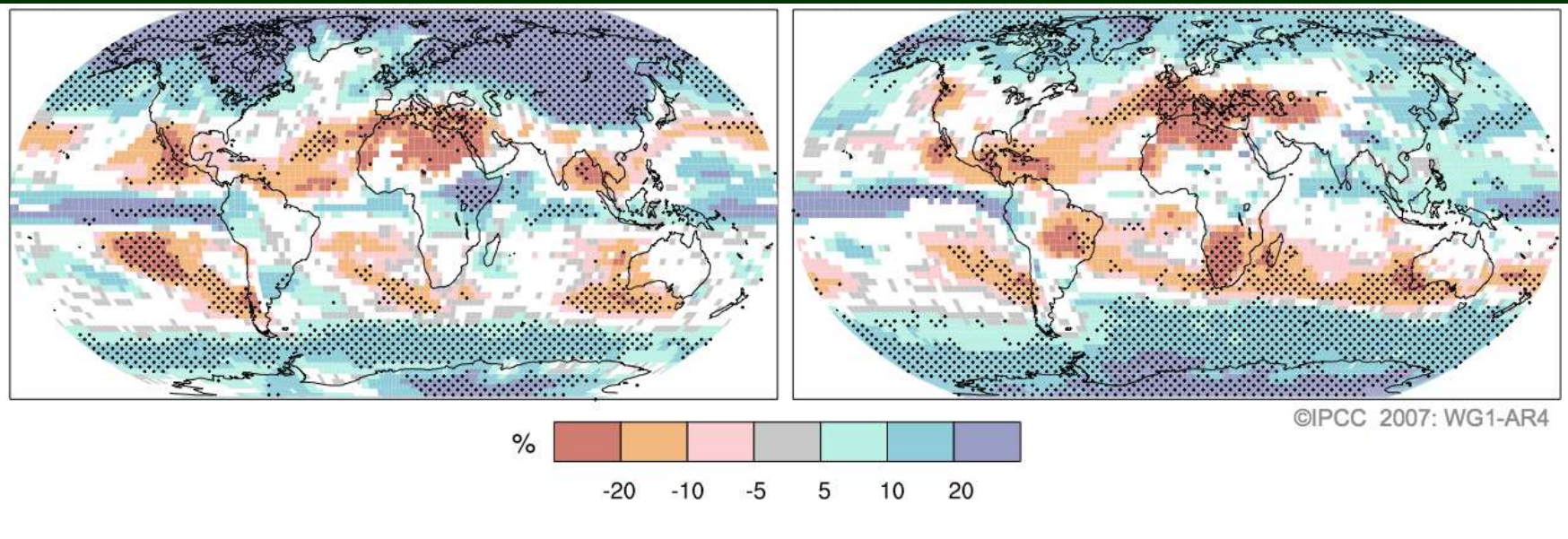
In India, greater warming is expected in the Indo-Gangetic plains

Source: IPCC, 2007

Some areas are projected to become wetter, others drier with an overall increase projected

Annual mean precipitation change: 2071 to 2100 Relative to 1990

Winters (Dec-Feb) **Monsoon (Jun-Aug)**



White areas have disagreement among models

Source: IPCC, 2007

Climate Change Scenarios for South Asia

Period	Temperature, C		Precipitation, %	
	DJF (rabi)	JJA (kharif)	DJF (rabi)	JJA (kharif)
2010-2039	1.17	0.54	-3	5
2040-2069	3.16	1.71	0	13
2070-2099	5.44	3.14	-16	26

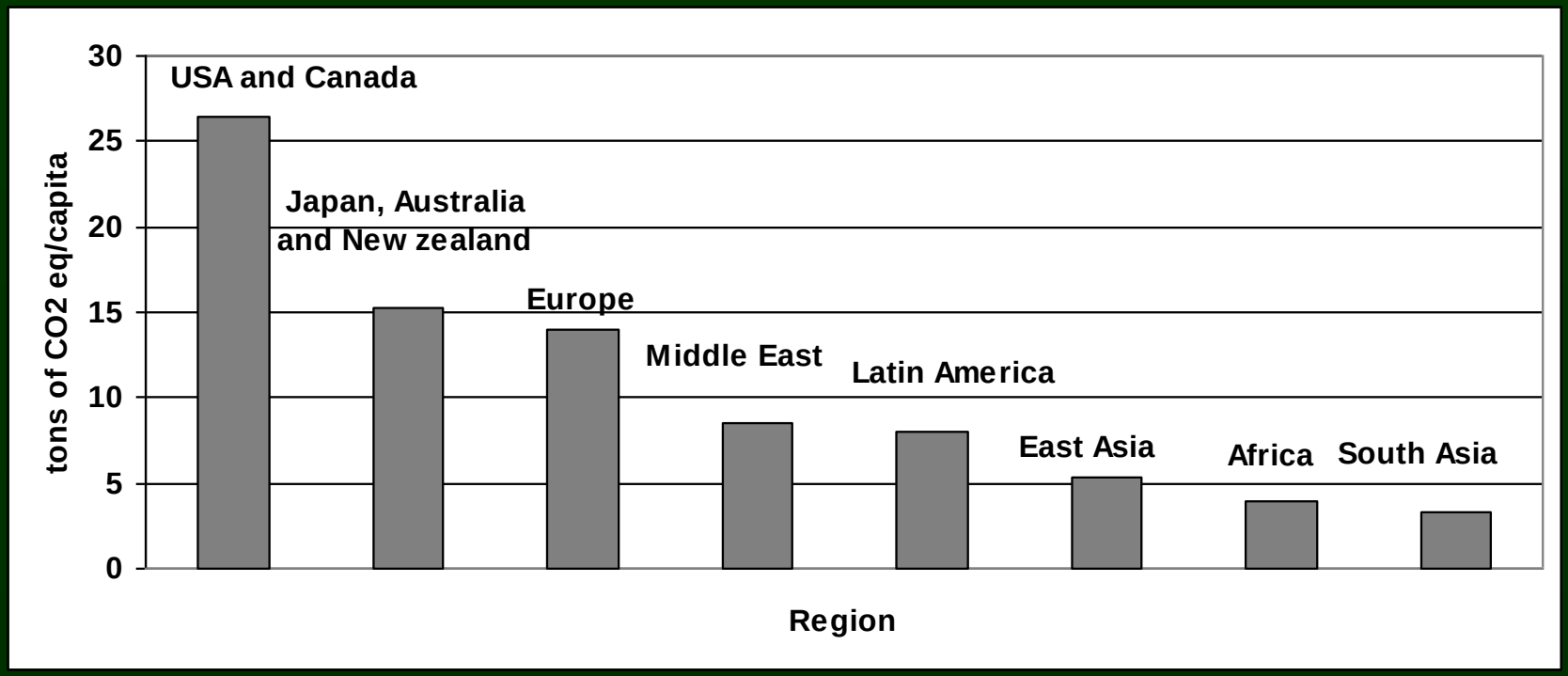
CO2 levels: 393 ppm by 2020; 543 ppm by 2050 and 789 ppm by 2080

Source: IPCC, 2007

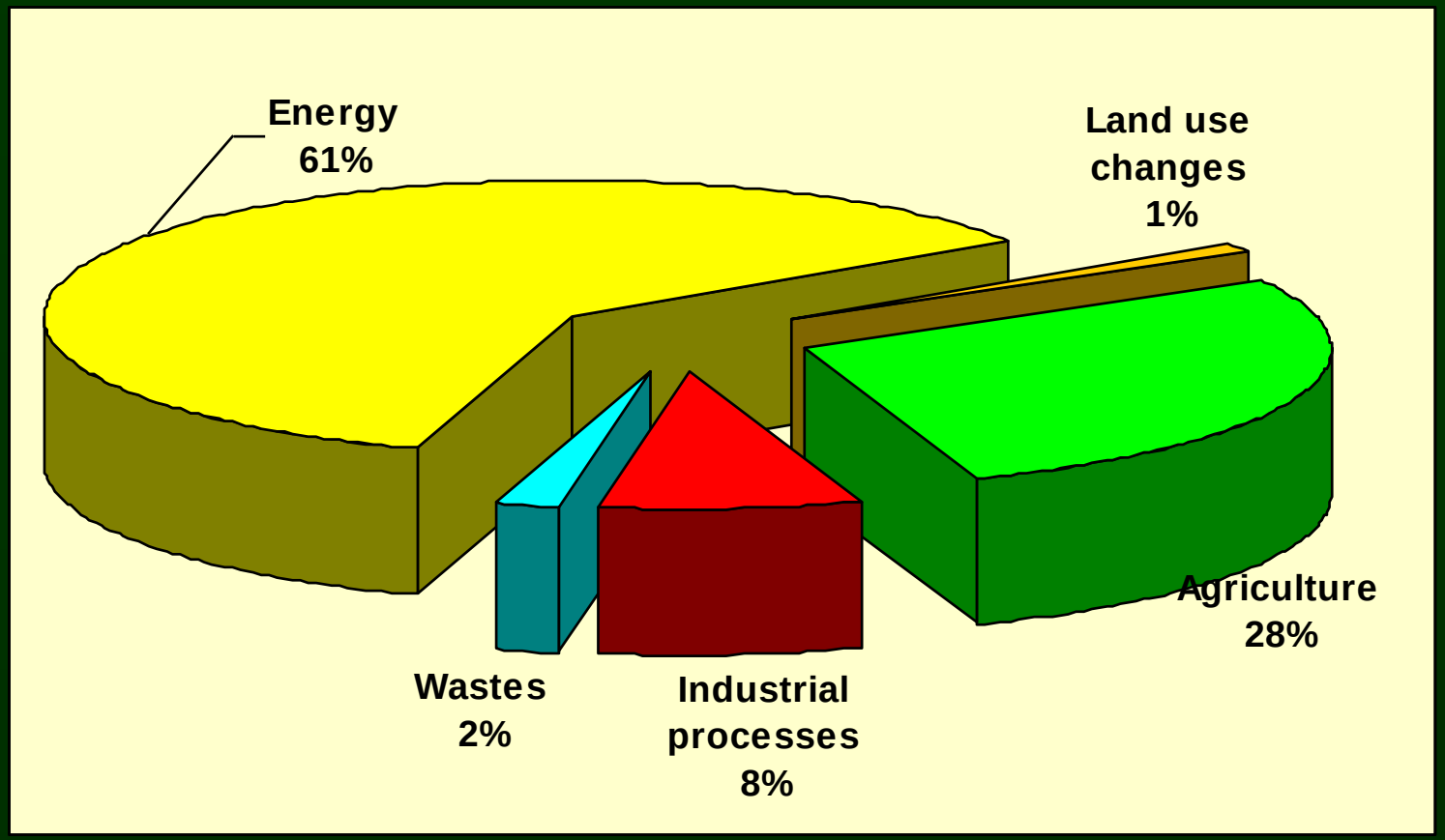
Other changes in global climate in future

- Tropical cyclones to become more intense, with heavier precipitation.
- Snow cover is projected to contract.
- Hot extremes, heat waves, and heavy precipitation events will become more frequent.
- The projected sea level rise to be 0.18 - 0.59 meters.

Most of the greenhouse gas emissions are from the industrialized countries



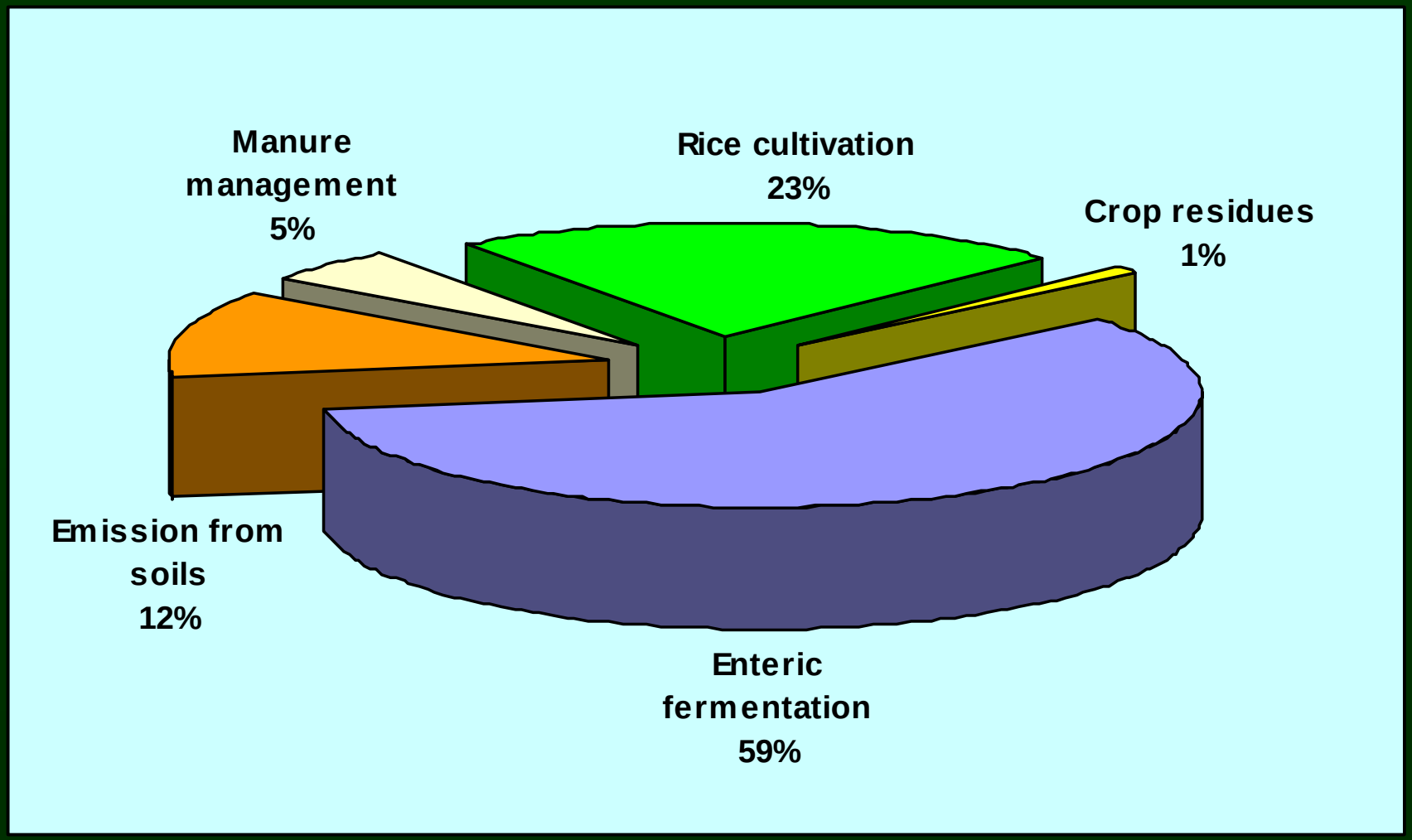
What is the contribution of different sectors in India to climate change?
(Sources of greenhouse gas emissions in India)



Fossil fuel used in agriculture considered in energy sector

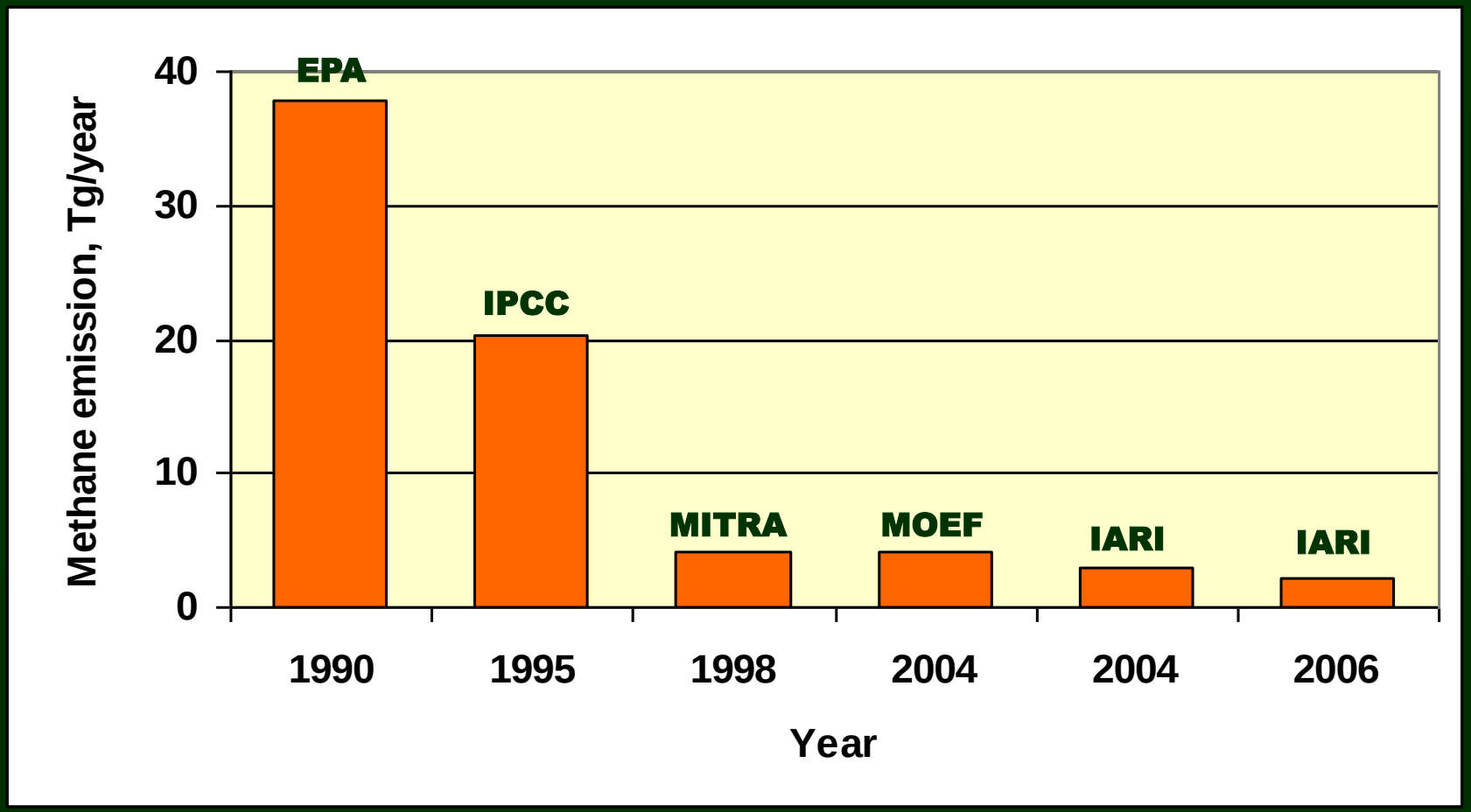
Source: India's Initial National Communication on Climate Change, 2004

What sectors of agriculture in India contribute to climate change?



Source: India's Initial National Communication on Climate Change, 2004

Methane emissions from rice is much smaller than estimated by western agencies



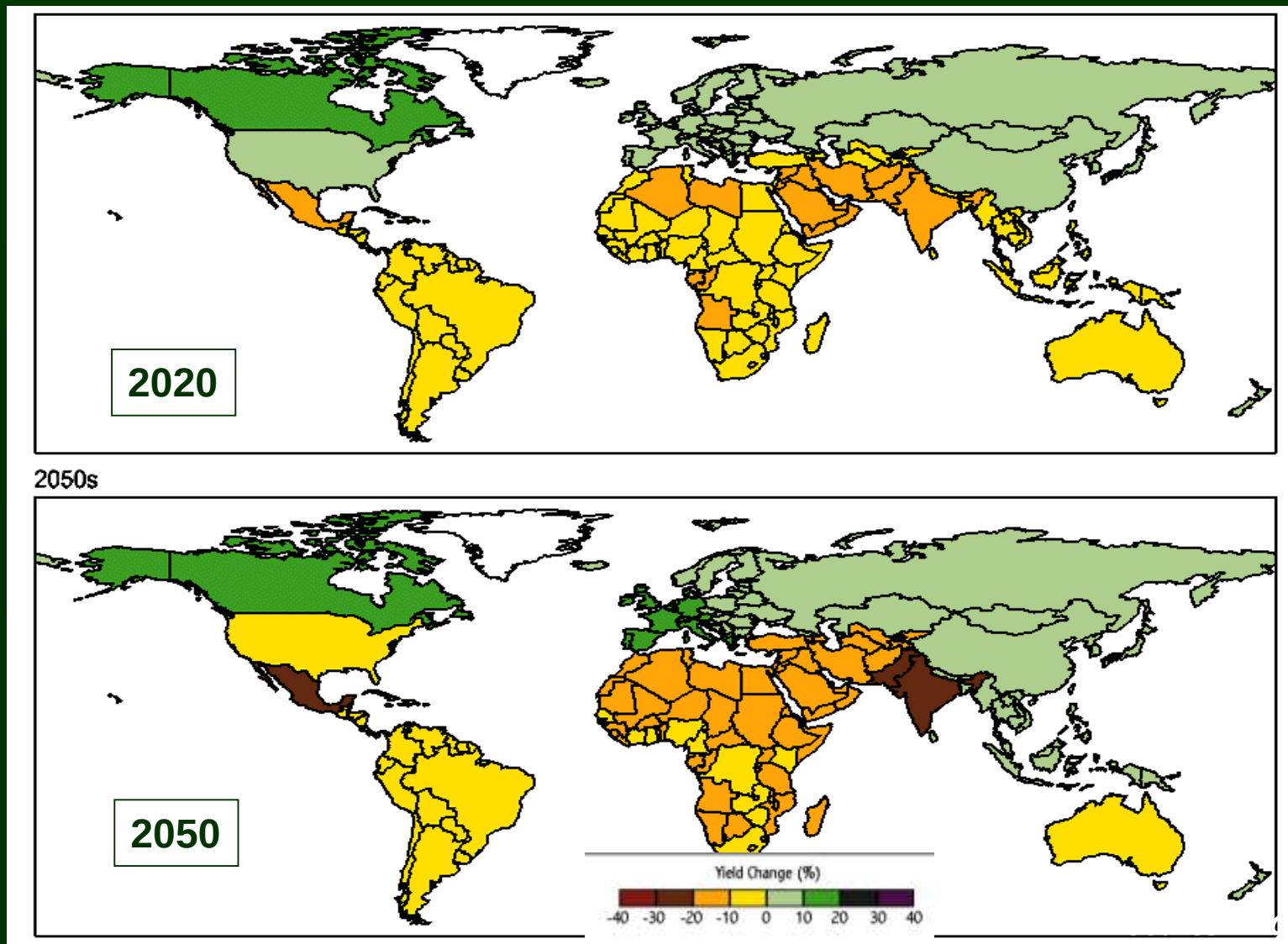
Projected impacts of climate change on Indian agriculture

- Productivity of cereals would decrease (due to increase in temperature and decrease in water availability (especially in Indo-Gangetic plains).
- Global reports indicate a loss of 10-40% in crop production by 2100.
- Greater loss expected in rabi. Every 1^{o}C increase in temperature reduces wheat production by 4-5 million tons. Loss only 1-2 million tons if farmers could plant in time.

Projected impacts of climate change on Indian agriculture

- Increased droughts and floods are likely to increase production variability
- Considerable effect on microbes, pathogens, and insects
- Imbalance in food trade due to positive impacts on Europe and N.America, and negative impacts on us

Crop yields are projected to decrease in the tropics/sub-tropics, but increase at high latitudes



C, 2007

Projected impacts of climate change on Indian agriculture

- Increasing temperature would increase fertilizer requirement for the same production targets; and result in higher emissions
- Increasing sea and river water temperatures are likely to affect fish breeding, migration, and harvests. Coral reefs start declining from 2030.
- Increased water, shelter, and energy requirement for livestock; implications for milk production

Projected beneficial impacts of climate change on Indian agriculture

- Reduced frequency of frost damage: less damage to potato, peas, mustard
- New ‘flooded’ areas may become available for fisheries in coastal regions
- Other potential benefits, if any, need to be characterized

How to adapt agriculture to climate change?

- Investments in adaptation research capacity: varieties, land use systems, resource conservation technologies, pest surveillance
- Changes in policies e.g. incentives for resource conservation (C,W,E) and use efficiency, pricing of resources, credit for transition to adaptation technologies
- Investments in infrastructure for water management
- Greater insurance coverage for the farm
- Improved communication of climate changes and options to adapt to them
- Creating alternate livelihood options and reducing dependence on agriculture

How can we reduce emission of Greenhouse gases from agriculture?

- Improve management of water and fertilizers in rice paddies; use nitrification inhibitors, fertilizer placement/schedules
- Improve management of livestock population and its diet
- Increase soil carbon: minimal tillage, residue management
- Improve energy use efficiency in agriculture: better designs of machinery, and by conservation practices

Conclusions

- Climate change is a reality
- Indian agriculture is likely to suffer losses due to heat, erratic weather, and decreased irrigation availability
- Adaptation strategies can help minimize negative impacts
- These need research and policy support
- Costs of adaptation and mitigation are unknown but likely to be high; costs of inaction could be even higher
- Start with ‘no-regrets’ adaptation options

New initiatives of ICAR

- A Network - 'Impacts, Adaptation and Vulnerability of Indian Agriculture to Climatic Change' launched in 2004
- Network expanded in 11th plan with 25 centers
- Multi-Disciplinary Expert Group established for planning and monitoring
- Climate change identified as a priority area for National Agricultural Innovations Project (NAIP) funding
- A National Conference on this theme was organized in October 2007 to prioritize thrust areas.

Recommendations of ICAR Conference

1. **Enhance research capacity and international collaboration:**
   - Quantitative impact assessment on different sectors
   - Development of climate responsive crops and land use systems
   - Seasonal weather forecasts
   - Regionally differentiated contingency plans for increased risk management
   - Reexamine water and fertilizer management with added dimension of reducing GHG emissions
   - Determine optimal size of livestock population considering milk requirement, diet, greenhouse gas emissions, and social issues
   - Development of decision support systems for policy guidance

Recommendations of ICAR Conference

2. ***Strengthen institutions:***

- ***Establish an Agricultural Intelligence System f*or impact of weather and inputs on production of important commodities at national as well as international level.**
- **Weather watch groups**
- **Increase pest surveillance**
- **Explore feasibility of establishing feed, fodder, and seed banks**
- **Increase farm insurance coverage using weather derivatives**
- **Enhance climate literacy**

Recommendations of ICAR Conference

3. Improve land/resource use policy

- Enhance investment in irrigation infrastructure, and efficient water use technologies
- Adopt scientific pricing policies for water, land, energy, and other resources
- Consider financial incentives for improved land management, e.g. resource conservation/ enhancement (water, carbon, energy)
- Consider incentives to industry and farmers for reducing emissions such as for neem coated urea
- Explore international partnerships for joint food security

Recommendations of ICAR Conference

4. Capacity building

- Establish automatic weather stations in KVKs for agromet observations.
- Develop specialized, state of art, climate control facilities (CO_2, temperature, water).
- Enhance national capacity on decision support systems.
- Intensify efforts for increasing climate literacy among all stakeholders of agriculture, including students, researchers, policy planners, science administrators, industry as well as farmers.