Global Climate Change and Indian Agriculture:

Impacts, adaptation and mitigation

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Climate Change and Indian Agriculture: Outline

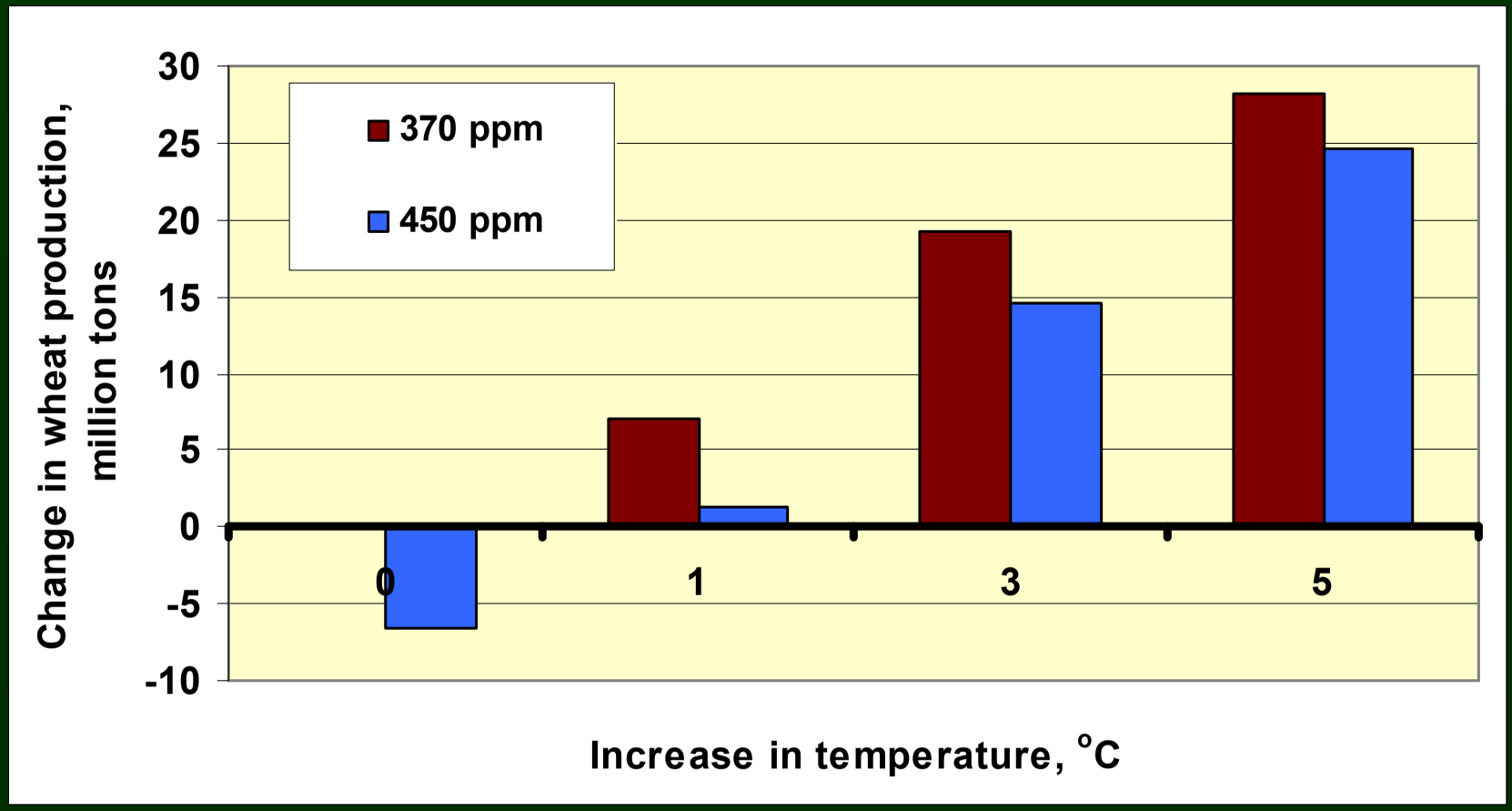
1. Projected impacts on agriculture
2. Adaptation options in agriculture
3. GHG emissions and mitigation
4. Conclusions and recommendations

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Projected impacts of climate change on Indian agriculture

- Productivity of most 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. This can be reduced to 1-2 million tons only if farmers change to timely planting.

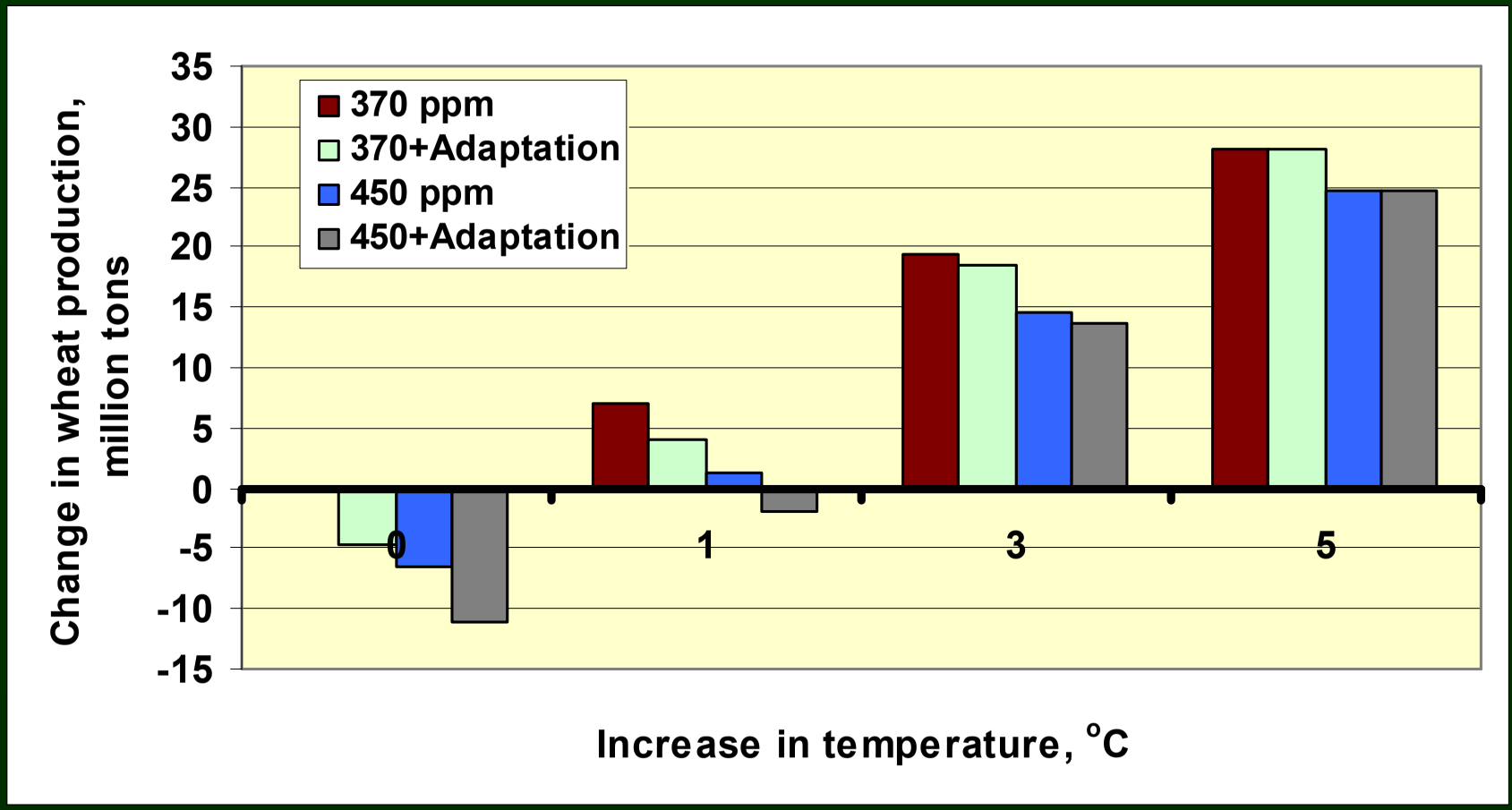
Loss in wheat production due to climate change



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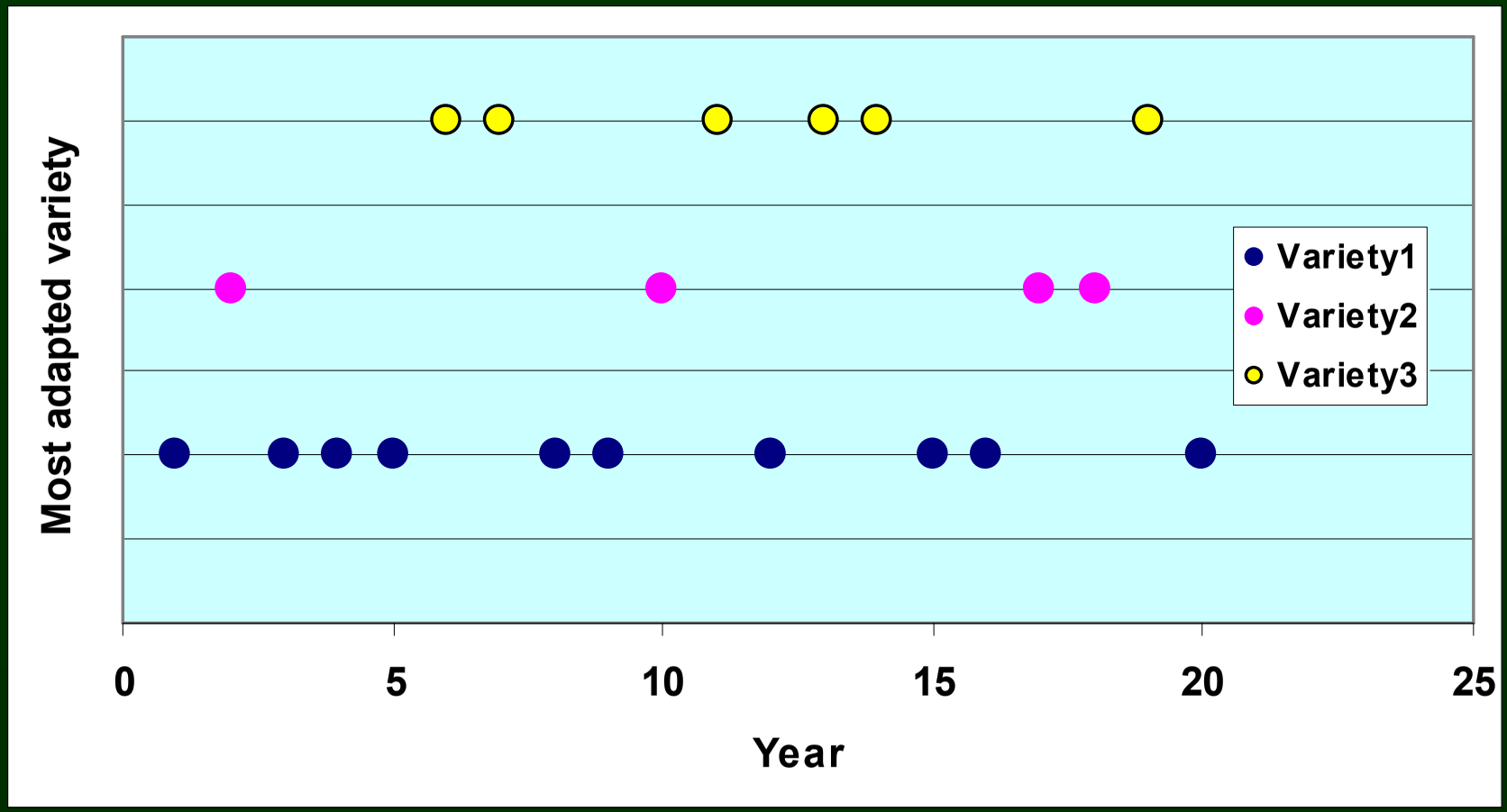
Loss reduction in wheat if farmers adapt*



Change in variety and 50% reduction in late sowing area

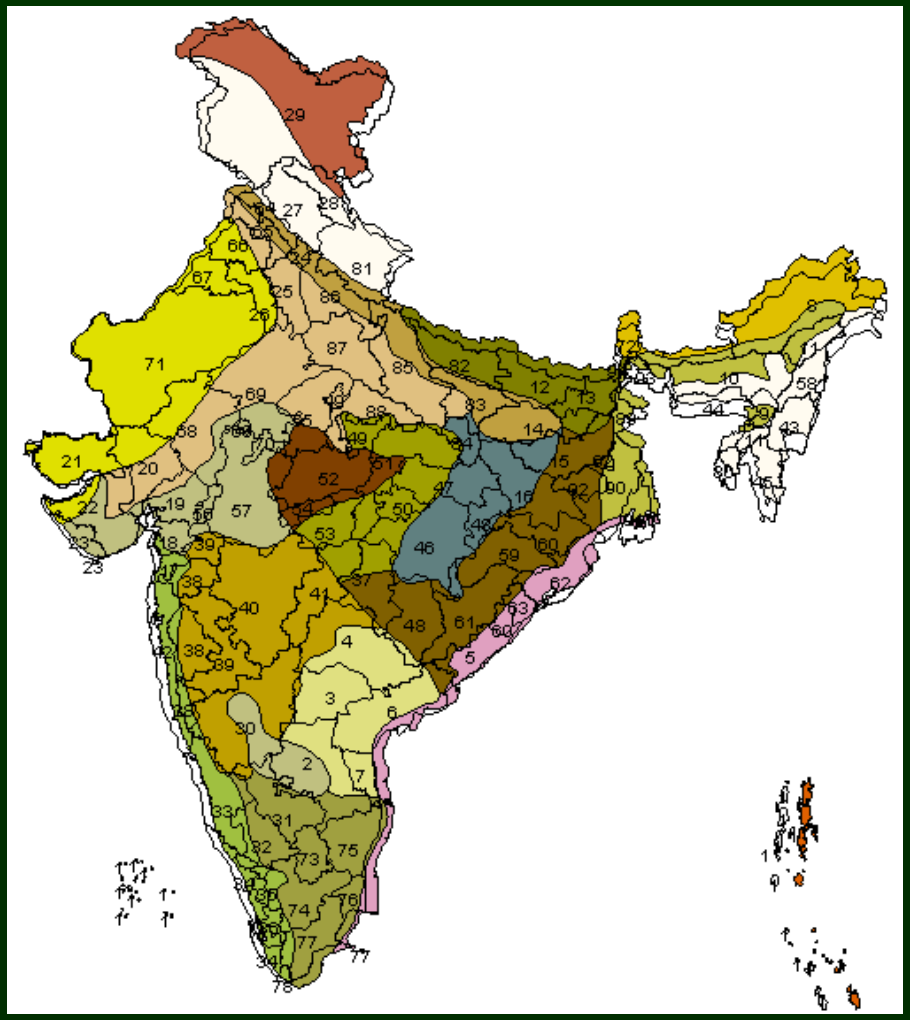
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Increasing climatic variability may make adaptation decisions more difficult



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Results based on simulated impacts in different agro-ecological regions defined by Planning Commission



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Opportunities for increasing wheat production

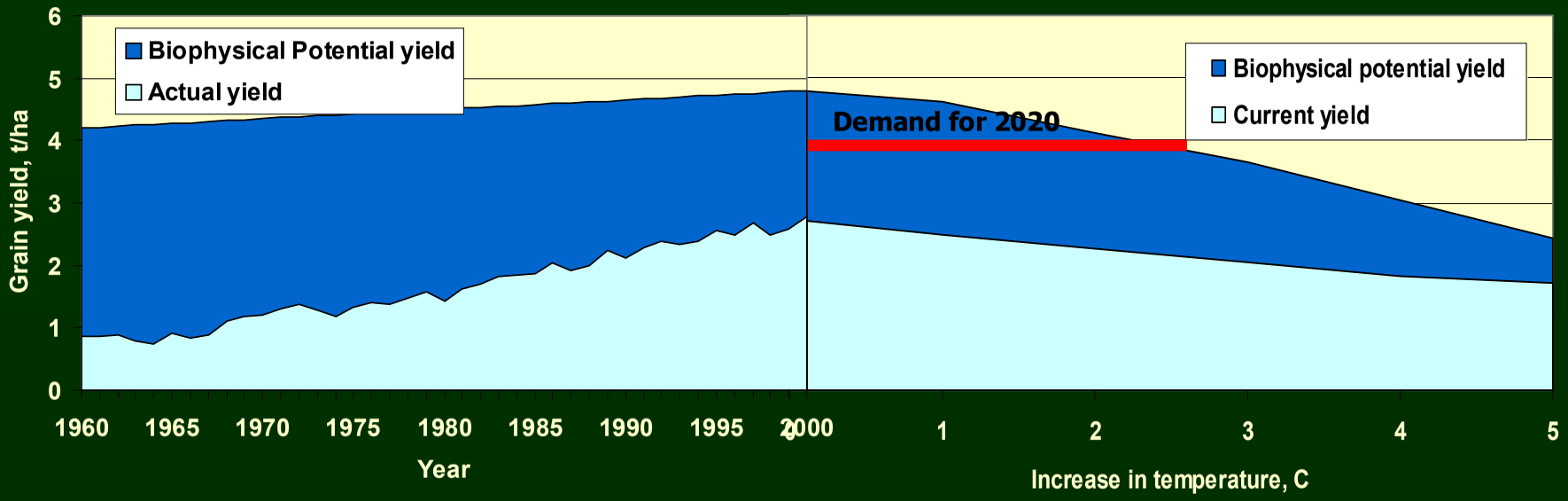
- Current wheat yield = 2.8 t/ha
- Demand by 2020* = 3.9 t/ha
- Biological potential yield = > 8.0 t/ha
- Biophysical potential yield = 5.0 t/ha

*Kumar 2000

Source: IARI/ ICAR network

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Impact of climate change on future opportunities for increasing wheat production



Any decrease in irrigation in IGP would further reduce yields

Source: IARI/ ICAR network

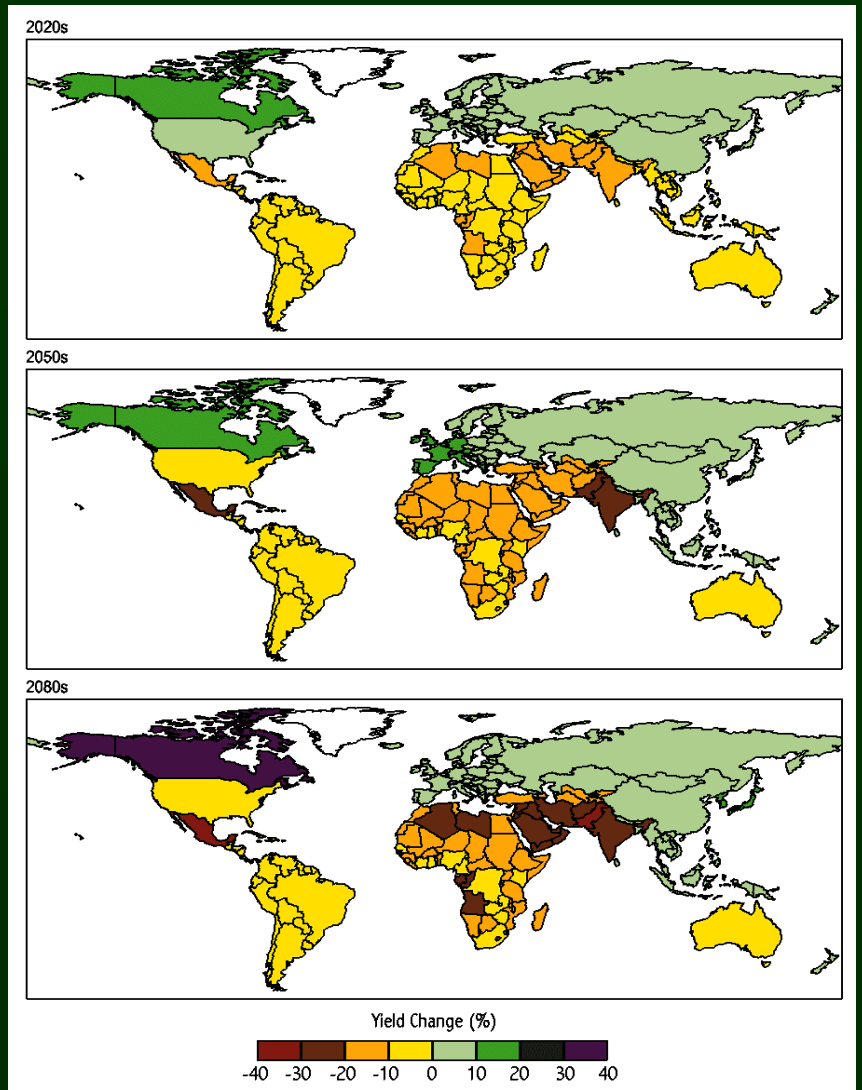
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Projected impacts of climate change on Indian agriculture

- Increased droughts and floods are likely to increase production variability
- Reduced frequency of frost damage in Punjab (beneficial)
- 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

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Crop Yields are Projected to Decrease Throughout the Tropics and Sub-tropics, but Increase at High Latitudes



Source: IPCC, 2007

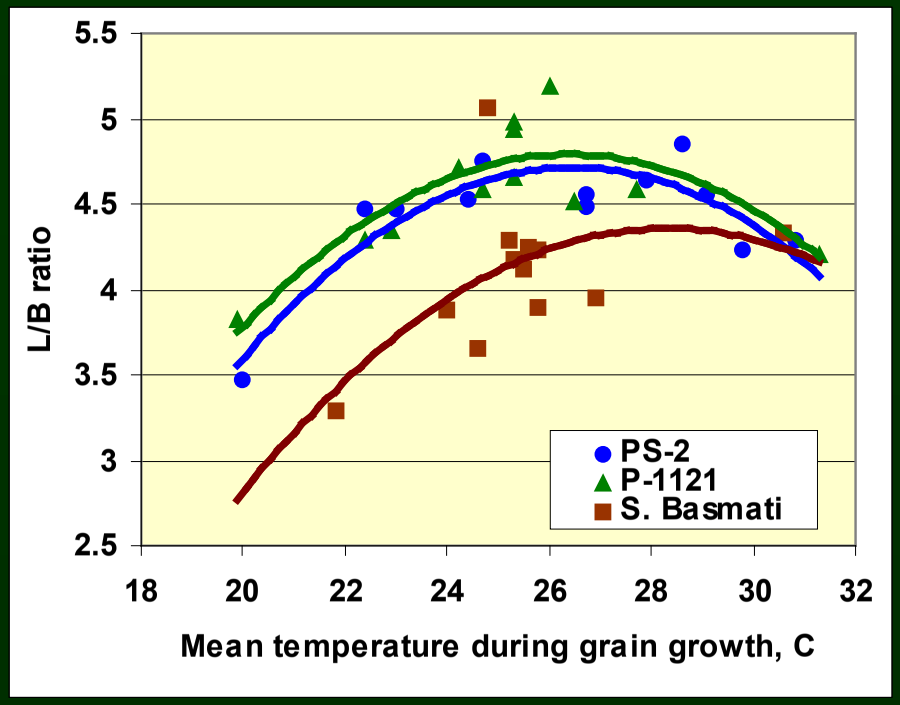
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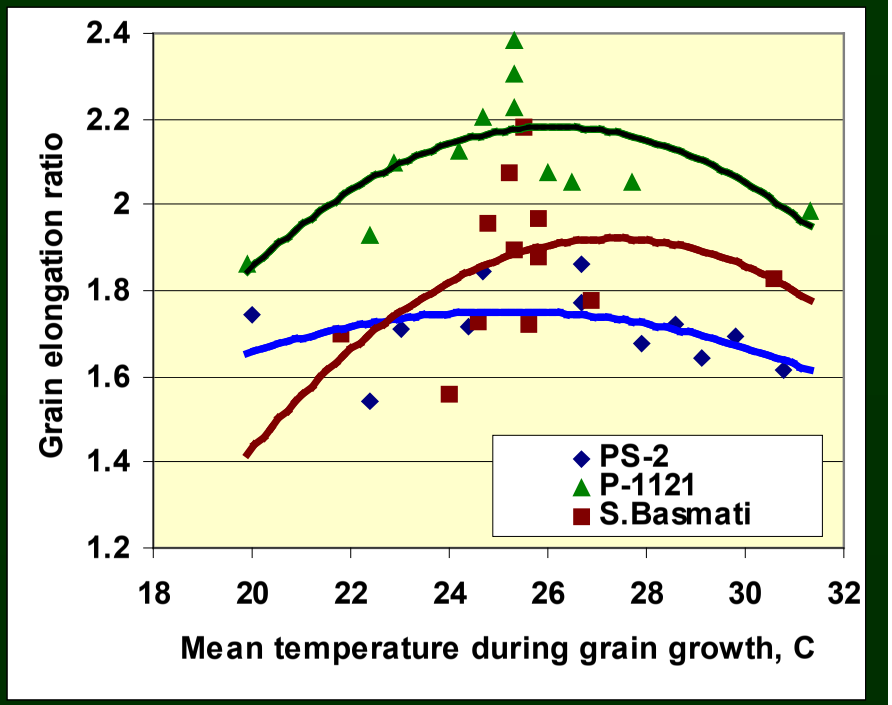
Projected impacts of climate change on Indian agriculture

- 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.
- New 'flooded' areas may become available for fisheries (beneficial)
- Increased water, shelter, and energy requirement for livestock

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Effect of temperature on basmati rice quality





Source: IARI/ICAR network

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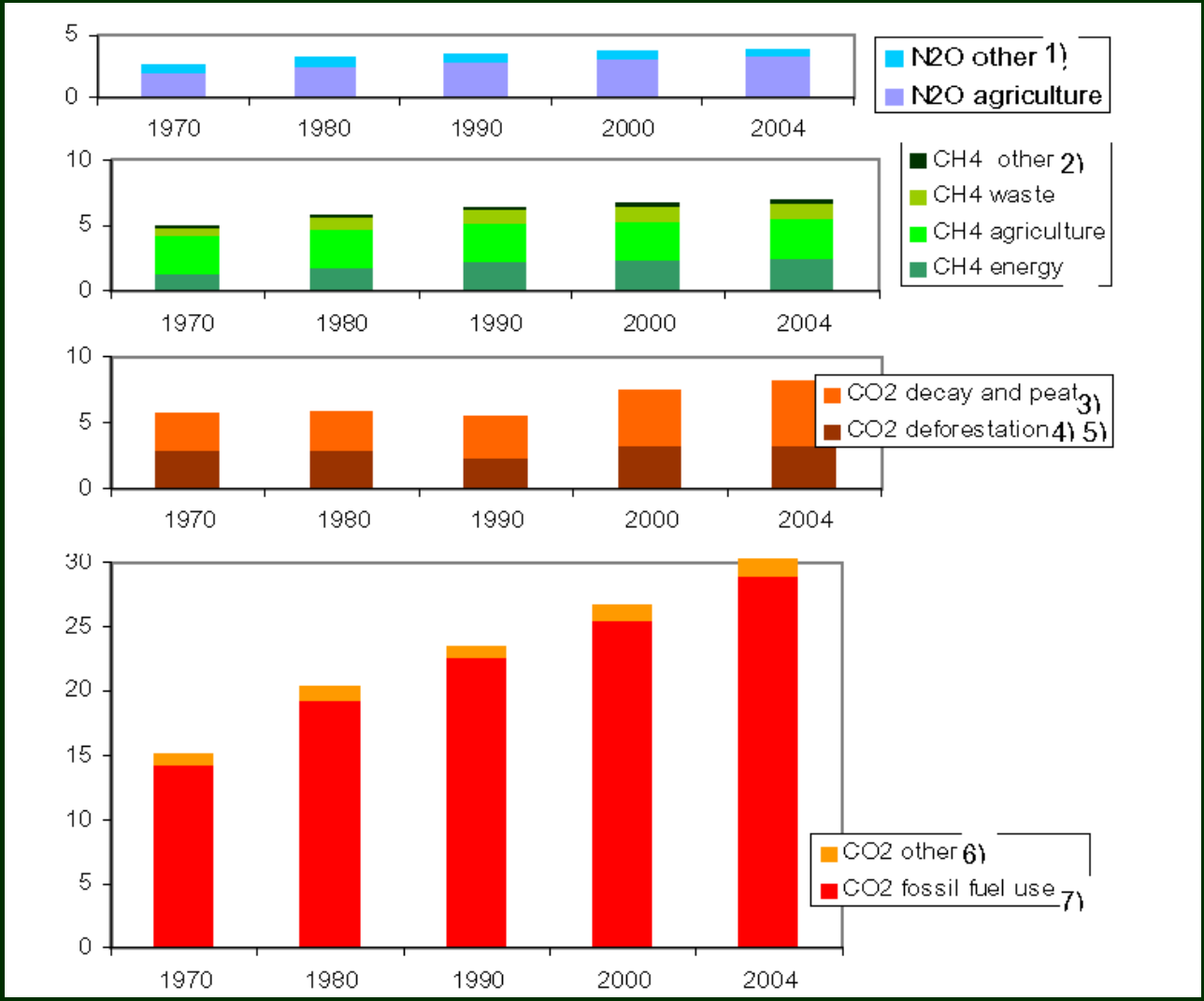
How to adapt agriculture to climate change?

- 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
- Relocation to more productive areas
- 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

Emission of GHGs from agriculture and their mitigation

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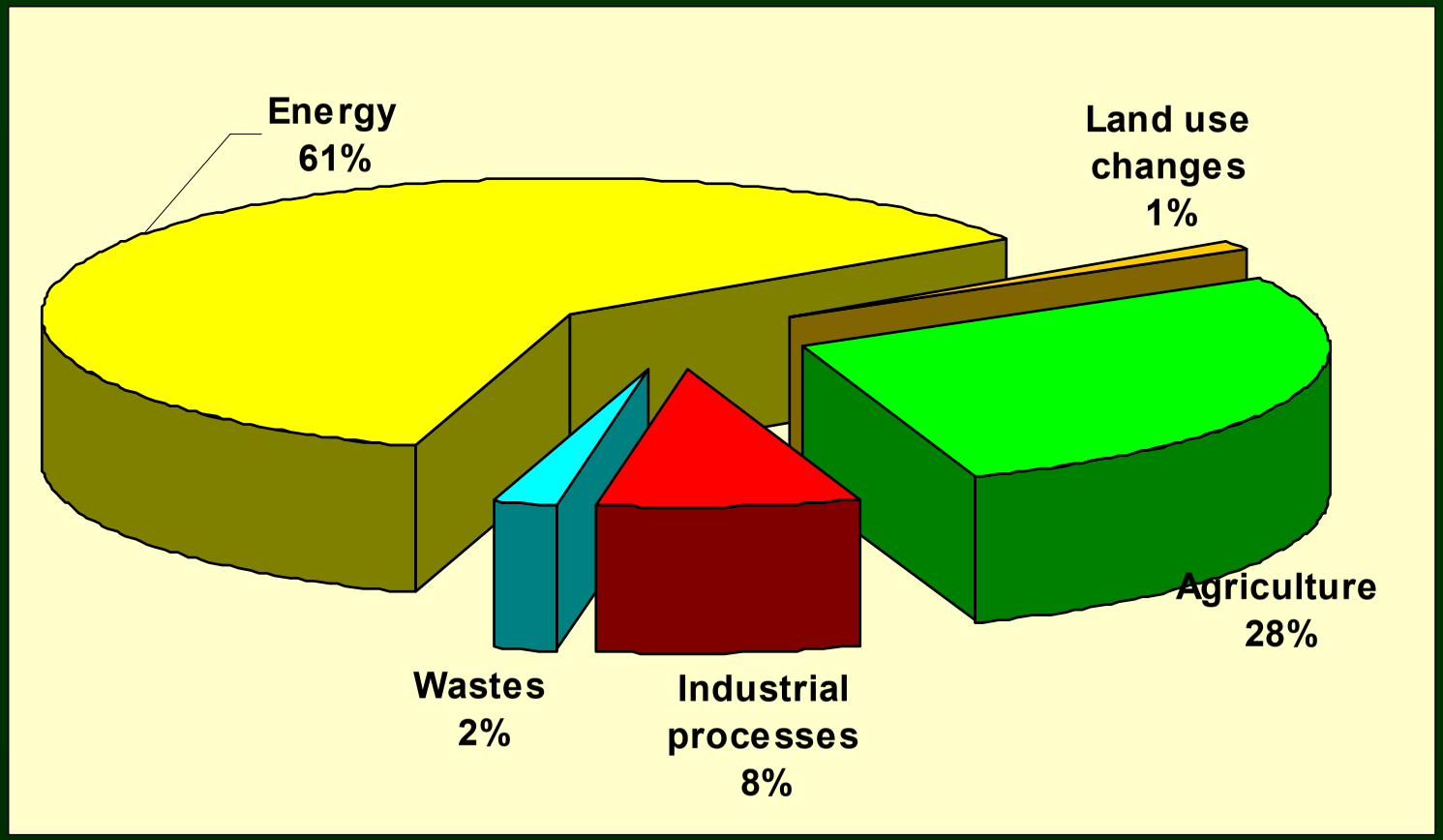
Global warming potential of GHGs, 1970-2004



Source: IPCC 2007

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

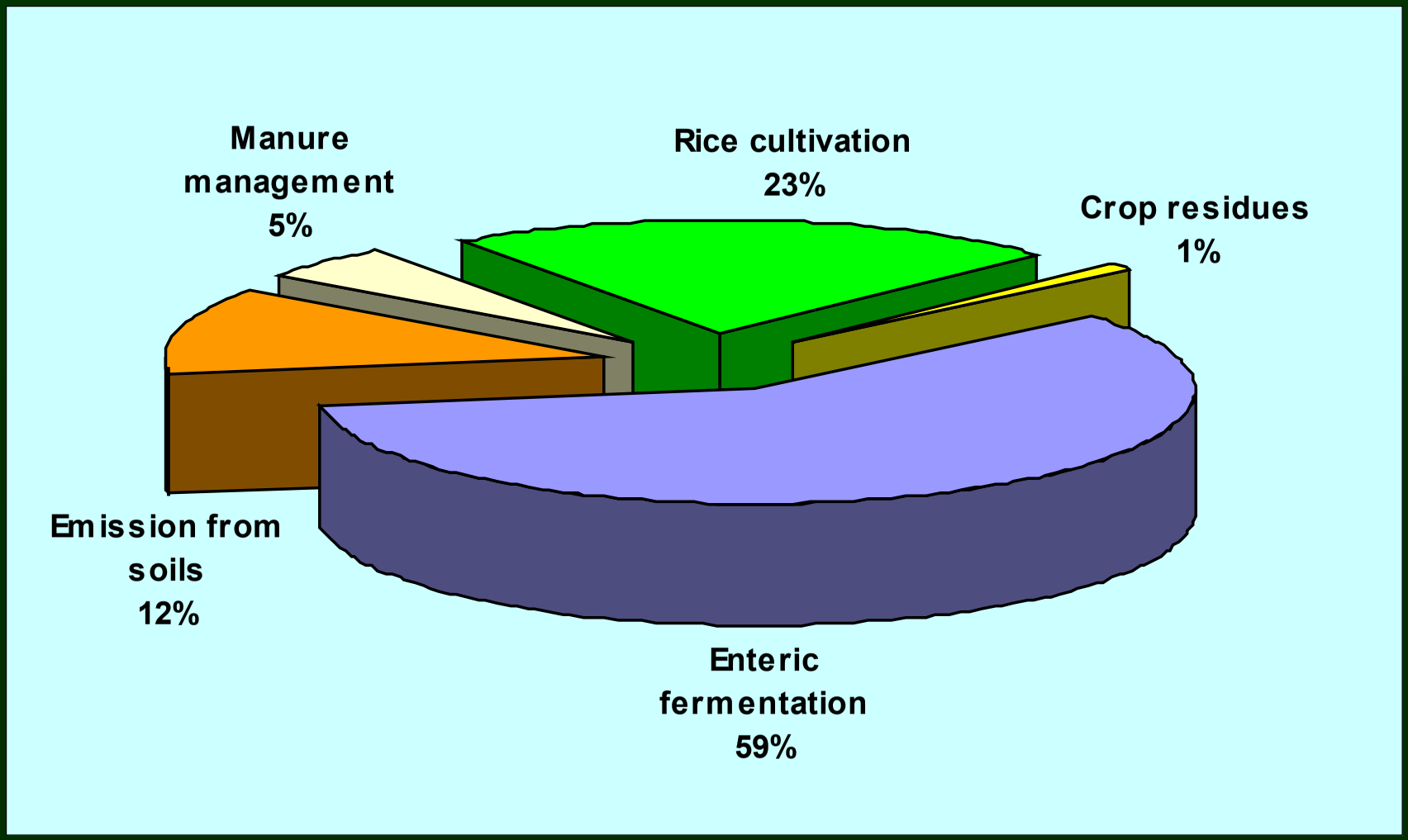


Fossil fuel used in agriculture considered in energy sector

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

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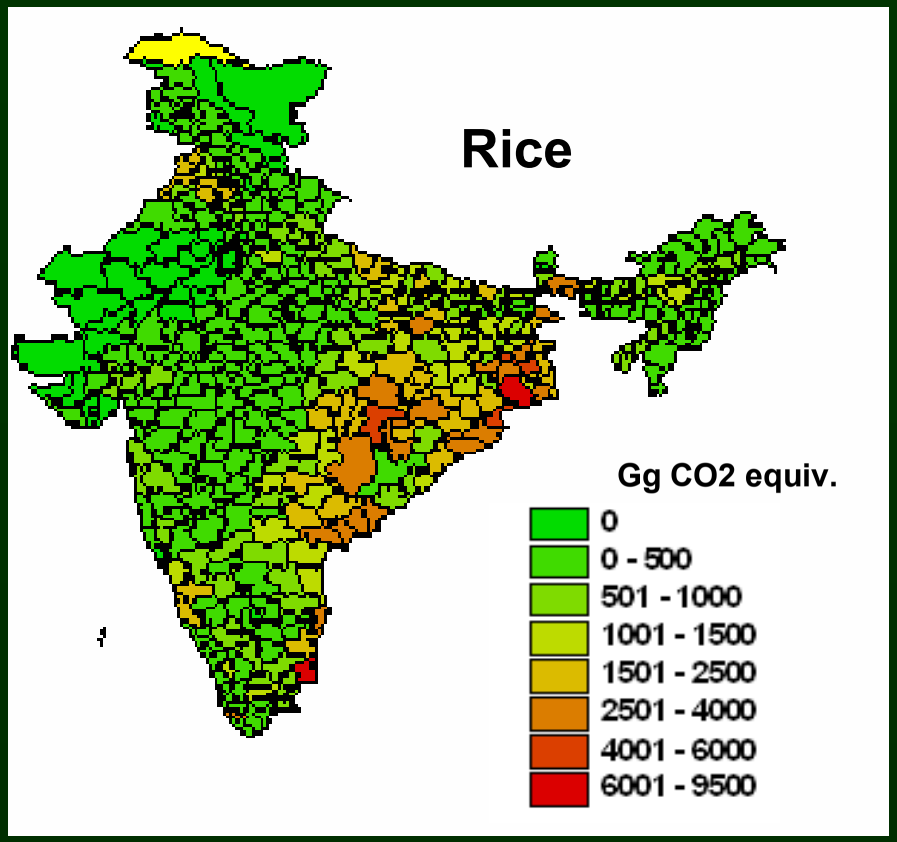
What sectors of agriculture in India contribute to climate change?

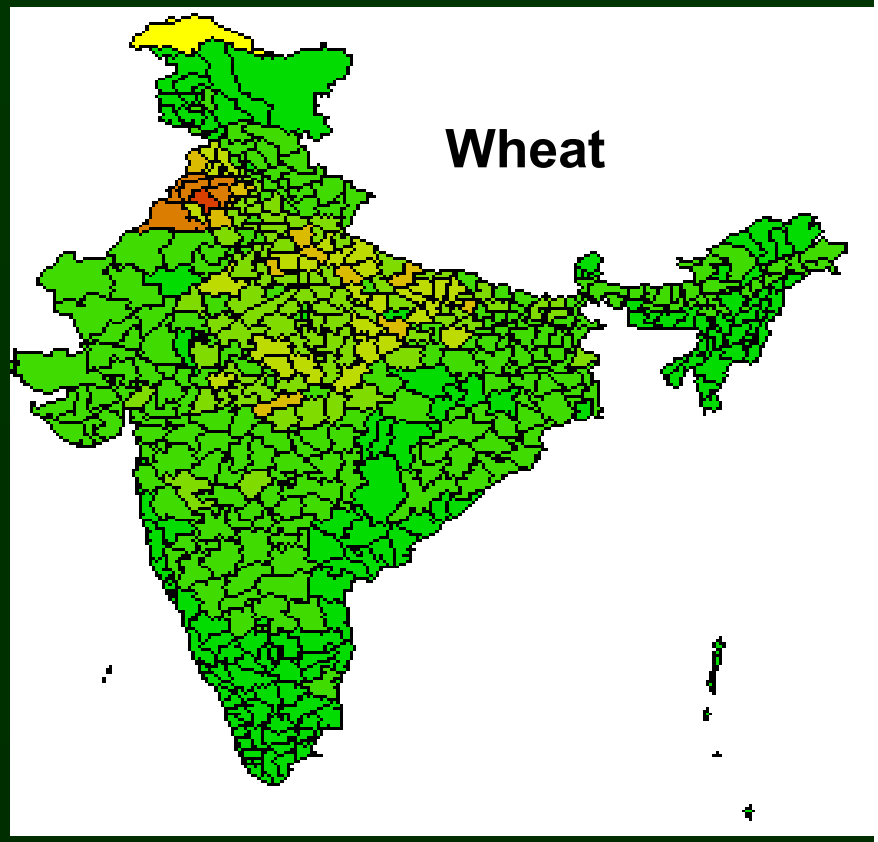


Source: India's Initial National Communication on Climate Change, 2004

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Global warming potential (Gg) of rice and wheat





Source: IARI/ICAR network

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Global warming potential of GHG emissions (Gg) from rice

Methane estimates (Tg)

EPA (1990)	IPCC (1995)	Mitra (1998)	NATCOM (2004)	IARI (2004)	IARI (2006)
37.8	20.2	4.19	4.07	2.9	2.18

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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
- Change land use: increasing area under biofuels, agro-forestry - but trade-off with food production.

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Conclusions

- Climate change is a reality and may constrain attainment of future food production targets
- 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

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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.

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National Network: Impacts, Adaptation and Vulnerability of Indian Agriculture to Climatic Change

Thrust Areas

- **Impact Assessment on demand and supply of food:** crops, plantations, agro-forestry, soils, water, pests, fish, and livestock, equity, vulnerable ecosystems
- **Adaptation strategies:** drought/heat tolerant genotypes, improved farm management practices, change in land use, watershed management, agri-insurance
- **Mitigation options:** agro-forestry systems, resource conservation technologies, soil organic matter