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IMPLICATIONS OF GLOBAL CLIMATE CHANGE FOR INDIAN AGRICULTURE

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ABSTRACT

Recent IPCC report and several other studies indicate a probability of 10-40% loss in crop production in India and other countries of South Asia with increases in temperature by 2080-2100 and decrease in irrigation water. India could lose 4-5 million tons wheat production with every rise of 1^{o}C temperature throughout the growing period even after considering carbon fertilization (but no adaptation benefits). The losses would be even higher in case irrigation would decrease in future. Losses for other crops are still uncertain but they are expected to be smaller, especially for monsoon season crops. These modeling-based estimates are in line with the recent field observations.

Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves are known to negatively impact agricultural production, and farmers' livelihood. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers. Increased production variability could be perhaps the most significant impact of global impact change on India. All agricultural commodities even today are sensitive to such variability.

Early signs of decrease in yields due to changing weather have started becoming visible. Analysis of the historical trends in yields of crops in the Indo-Gangetic plains using regional statistics, long-term fertility experiments, other conventional field experiments and crop simulation models has shown that rice yields during last three decades are showing a declining trend and this may be partly related to the gradual change in weather conditions during last two decades. Apple yields are showing a declining trend in lower hills of Himachal Pradesh due to non-fulfilment of chilling requirement essential for proper flowering and fruiting.

Producing enough food for meeting the increasing demand against the background of reducing resources in a changing climate scenario, while also minimizing further environmental degradation, is a challenging task. This would require increased adaptation and mitigation research, capacity building, changes in policies, regional cooperation, and support of global adaptation and mitigation funds and other resources. Simple adaptations such as change in planting dates and crop varieties could help in reducing impacts of climate change to some extent. Losses in wheat production can be reduced from 4-5 million tons to 1-2 million tons if a large percentage of farmers could change to timely planting. This may, however, not be easy to implement due to constraints associated with wheat planting time in rice-based cropping systems. Additional strategies for increasing our adaptive capacity include bridging yield gaps to augment production, development of adverse climate tolerant genotypes and land use systems, assisting farmers in coping with current climatic risks through providing weather linked value-added advisory services to farmers and crop/weather insurance, and improved land and water use management and policies.

KEYWORDS

India, climate change, adaptation, crop yields, simulation

Implications of Global Climate Change for Indian Agriculture

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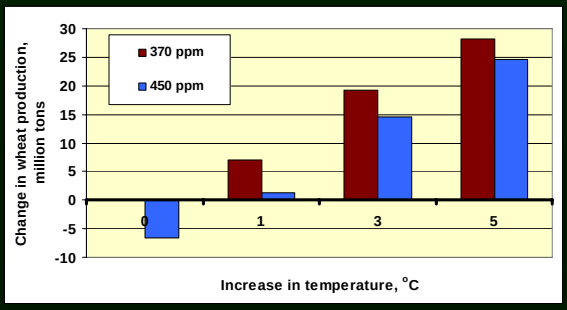
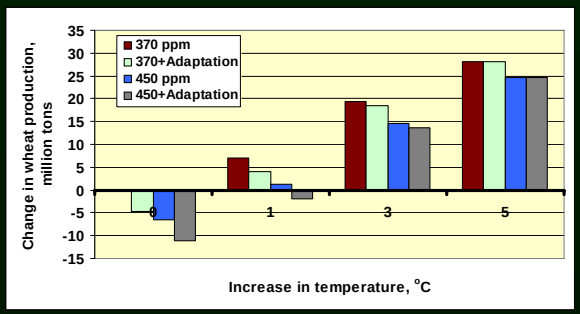
Projected impacts of climate change on Indian agriculture

- 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°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



Loss reduction in wheat if farmers adapt*

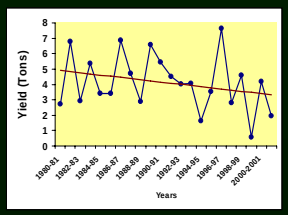


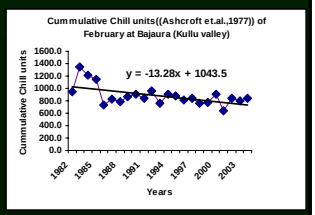
Change in variety and 50 % reduction in late sowing area

Projected impacts of climate change on Indian agriculture

- Increased climatic extremes- 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

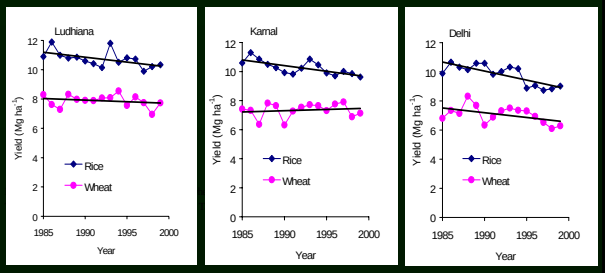
Declining apple yields in Himachal due to inadequate chilling





Source: HPKVV/ICAR network

Relation of Recent Weather Trends with Yields of Paddy and Wheat

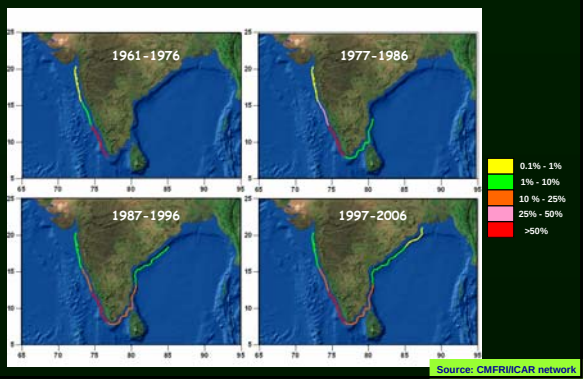


Impact of climate change on fisheries

- Increasing sea and river water temperatures are likely to affect fish breeding, migration, and harvests.
- Coral reefs start declining from 2030 in Indian ocean. Rise in sea surface temperature (2-2.5ºC) in May 1998 led to bleaching in 85% coral reefs.

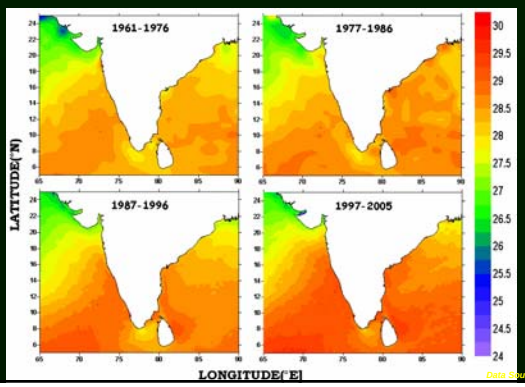
Extension of northern boundary of oil sardine due to rise in sea surface temperature

The colored lines indicate percentage of All India oil sardine production



Source: CMFRI/ICAR network

Sea surface temperature patterns along the Indian coast



Data Source : NOAA/NASA

Impact of climate change on livestock

- Increased water, shelter, and energy requirement for livestock
- Animal distress due to heat-effects on reproduction
- Loss of 1.5 million tons of milk by 2020 in business as usual scenario

Source: NDRI

Projected beneficial impacts of climate change on Indian agriculture

- Reduced frequency of frost damage: less damage to potato, peas, mustard
- Possibly higher yields of coconut in west coast (?)
- Some improvement in chickpea, mustard, and rabi maize, sorghum and millets (?)
- New 'flooded' areas may become available for fisheries in coastal regions
- Other potential benefits, if any, need to be characterized

Adaptation and mitigation framework: Need to consider emerging scenario

- Greater demand for (quality) food; yields need to increase by 30-50% by 2030
- Increasing urbanization and globalization
- Increasing competition from other sectors for land, energy, water and capital

Key elements of the adaptation and mitigation framework

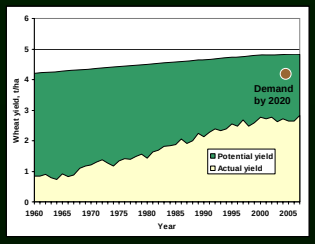
1. Assist farmers in coping with current climatic risks
2. Intensify food production systems
3. Improve land and water management
4. Enable policies and regional cooperation
5. Sequester carbon in soils
6. Strengthen research for enhancing adaptive capacity and mitigation potential

Adaptation framework: Assist farmers to cope with current climatic risks

- **Risk characterization:** better climate information
- **Risk management tools:** DSS and other tools
- **Risk management research:** applications of climatic info/forecasts
- **Risk management policy:** access of poor to weather info, financial support, insurance
- **Risk management communication:** to farmers, planners, and industry

Adaptation framework: Intensify food production systems

Yield gaps in wheat in India

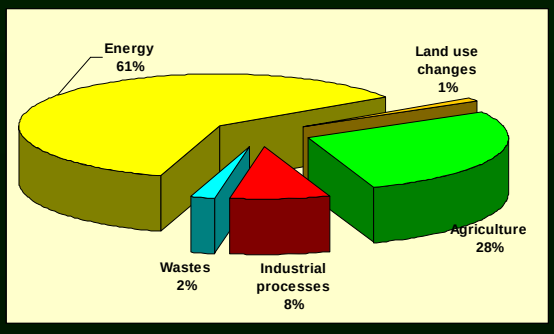


- Bridge yield gaps in crops and regions
  - Quality seed
  - Integrated nutrient management
  - Integrated pest management
  - Demonstrations of new technologies
  - Farmers training

Adaptation framework: Strengthen research on adaptation

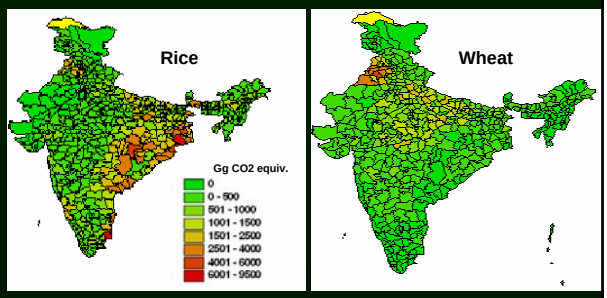
- Assess regional impacts on crops, livestock, fisheries, pests, and microbes
- Evolve 'adverse climate tolerant' genotypes and land use systems
- Evaluating the biophysical and economic potential of various adaptation strategies
- Study dynamics of pest movements and virulence
- Re-examine water and fertilizer management for adaptation and mitigation
- Compile a compendium of indigenous, traditional knowledge and explore its suitability for climate change adaptation

Contribution of different sectors in India to climate change



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

Global warming potential (Gg) of rice and wheat



Source: IARI/ICAR network

Sequestering soil carbon and mitigating GHGs

- Addition of organic manures, minimal tillage, residue management, agro-forestry, water and nutrient management, and restoration of degraded soils
- Midseason drainage or alternate drying in irrigated paddies
- Appropriate crop management practices, which lead to increase nitrogen use efficiency
- Improved efficiency of energy use by increasing fuel efficiency in agricultural machinery, use of wind / solar power, and laser levelers
- Improved management of livestock diet

These strategies have costs and other implications

Conclusions

- Climate change may constrain attainment of future food production targets
- Several options for adaptation and mitigation are available. These need research, policy, and financial support
- Costs of adaptation and mitigation are not clear but likely to be high; costs of inaction could be even higher
- Priority for actions that maximize synergies between adaptation, mitigation, food production and sustainable development. Need to consider payment to farmers for environmental services they provide.
- Regional cooperation through SAARC