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Agricultural conservation and climate change mitigation in India

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Abstract

Food security today is a major challenge globally due to looming threat of climate change on the potential of agriculture. The climate change, caused by greenhouse gas emissions in the atmosphere due to anthropogenic reasons, is going to impact entire life on earth. Climate change is going to impact agriculture in complex ways, affecting soil (changes in OM content, thermal regimes, hydrology and salinity etc.), water (melting/shrinking glaciers, flash floods, changing river flows, changing rainfall pattern, increased cloud-burst events etc.), crops (net decline in productivity of grains, pulses, oil-seed and other crops; decline in the impacts of cold waves and frost events on horticulture, vegetable and field crops; impacts on the nutritional quality of cereals, pulses, fruits, vegetables, tea, coffee, aromatic and medicinal plants etc.), livestock (heat stress is likely to impact forage quality, ingestion of fodder and feed, declines in physical activity, and ultimately decrease dairy milk yield and reproductive performance) and fisheries (likely impacts on fish breeding, migration and harvests etc.). Crop production is estimated to decline by 10-40% by 2100. In order to sustain agriculture in this scenario, the agriculture researchers must respond in terms of mitigation actions to slow down climate change, and adaptation to accommodate and adjust to unavoidable climate changes.

Keywords: Agricultural conservation, climate change, green house gasses etc.

Introduction

Agriculture is highly sensitive to climate change but at the same time is also major contributor to climate change. Therefore, climate change has emerged as a major challenge to Indian Agriculture. The most important reason of the climate change is the increased limits of green house gasses (GHG) in atmosphere due to burning of fossil fuels, increased use of refrigerments, enhanced agricultural related activities, transforming virgin soils into cultivated land and use of nitrogenous fertilizers are all contributing in release of GHG in atmosphere. Green house gasses have a great importance. Just like greenhouses that create the right temperature to grow vegetables, and other crops, gasses in our atmosphere trap the sun's heat-keeping the temperature and earth just right for us to live. These are known as green house gasses. Without these gasses, the temperature of the earth would be very chilly about 30°C lower than what it is today. Their increase on the other hand works in a reverse direction *i.e* make the earth warmer than before. The CO₂ in our atmosphere escapes into space protects us from too much heat and acts like an invisible blanket and keeps the temperature at a range at which we can live. One reason is that anthropogenic activities have disturbed this composition of atmosphere resulting in higher concentrations of CO₂ which accumulates along with other green house gasses like methane (NH₄) nitrous oxide (NO₂) chlorofluorocarbons etc in the atmosphere and lead to increase in the surface temperature of the earth. Climate change is also caused naturally by factors such as long term change in earth's orbit, change in sun's intensity, major volcanic eruptions and changes in ocean currents. Normally, there are natural "sinks" such as trees and means that remove CO₂ from atmosphere. However, worldwide humans are burning fossil fuels in such a large quantities that natural sinks can't remove it quickly, so the CO₂ builds up in the atmosphere warming the planet at an unprecedented rate.

Contribution of different countries to Global Warming

Extra gasses in the atmosphere caused by burning of fuels trap extra heat leading to a condition known as "Global Warming" which makes our climate to change. We are continuously adding a lot more gasses to the sky by burning coal, oil through our transport system (cars, trucks, trains, planes, etc) electricity generators (coal & diesel generators) deforestation (cutting

down trees that releases CO₂ stored in them), agriculture practices (paddy, cow rearing producing methane), fertilizers and industries (factories etc).

The atmospheric concentration of CO₂ is increasing at an alarming rate of 1.9 ppm/year. If the pace of this emission continues, it is expected that CO₂ concentration which is at present less than 400 ppm might reach to 800 ppm by the end of this century. US, China and Europe are the top three contributors of world GHG followed by Russia, Japan and India.

Due to these facts global average temperature has risen by 0.74°C in this century. Studies have revealed that if the conditions continue likewise, we are heading for 3.5- 7.4°C warming in this century. Current emissions have been recorded as higher than those predicted. Increase in earth's temperature means more melting of the ice in summer, more disease and pest infestations, heavier and erratic rainfall and snowfall coupled with drought, less water and more cyclones due to warm waters etc. The greatest threat to mankind and other living being is the global warming with potential to

disrupt the natural and social system throughout the world. Climate change is likely to effect the agriculture and food security across the globe. Therefore, community must prepare for the possibility of food shortage and make appropriate use of resources to protect their livelihood. India is more severely threatened in the context that population is increasing at a faster rate than the production and productivity of food grains. Another serious challenge confronting agriculture is the decrease in water resources due to increase in temperature. Besides climate change is likely to effect live stocks, soils, hydrologic balance, pests and disease and thereby the food and livelihood security of farming communities.

Global Contribution of different sectors to carbon dioxide emissions

Sources of Green House Gas emissions are energy supply (25.9%), industries (19.4%), land use change and forestry (17.4%), agriculture (13.5%), transport (13.1%), residential and commercial buildings (7.9%), waste and waste water (2.8%)

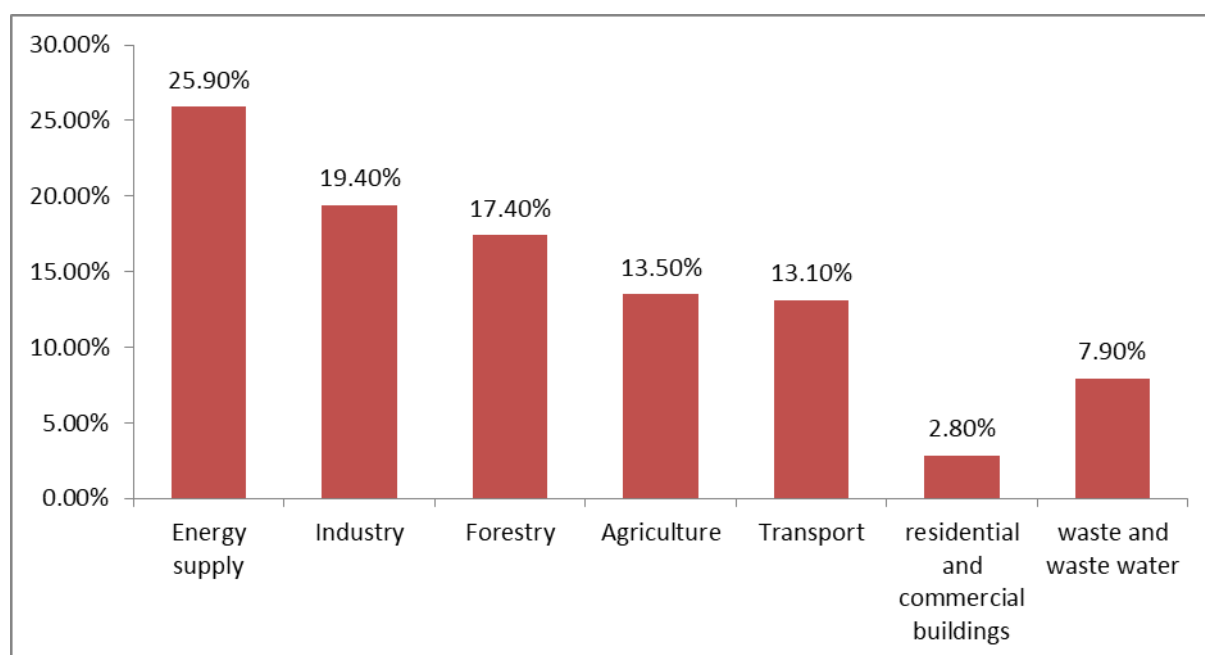


Fig 1: Contribution of different sectors to CO₂ emissions and climate change. IPCC, 2007

Estimates of future levels of CO₂ in atmosphere

S. No.	Year	CO ₂ (ppm)
1	2000	369
2	2010-2015	388-398
3	2050-2060	463-623
4	2100	478-1099

Effects of climate change on agriculture

Climate change will show its effect on agriculture by way of:-

- Disrupted hydrological balance (change in precipitation pattern, intensity and frequency of extreme weather conditions such as floods, droughts, heat waves, glacier retreat, increased sea level).
- Reduction in crop yield.
- Shrinking of snow cover affecting availability of water for irrigation.
- Shortage of water affecting changes in cropping pattern.
- Erratic snowfall accumulation and melting patterns
- More droughts like conditions, more floods, cyclones and hailstorms.

- Greater precipitation in *Kharif*.
- Temperature rise in *rabi*.
- Decline in soil fertility due to increased soil run off.
- Loss of biodiversity
- Spread of some more diseases, pests and weeds.
- Rise in sea level by 0.18 to 0.59 m.
- Irregularities on onset of monsoon.
- Abrupt and untimely rainfall and snowfall
- Heavy rains and wind storms.

Projected impacts of climate change on Indian agriculture

- Generally productivity will be decreased by 10-40% by 2100.
- Gradual decrease in Rabi crops. Every 1°C increase in temperature will reduce wheat production by 4-5 million tons.
- Reduced frequency of frost damage.
- Increased droughts and floods.
- Increased hailstorms and cyclones.

- Increased sea and river water temperatures to affect fish breeding, migration of coral reefs etc.
- Considerable effect on microbes, pathogens and insects
- Increasing water, shelter and energy requirements.
- Increasing temperature would require increased fertilizers for the same production targets which will result in higher GHG emissions.
- New areas may become available for fisheries
- Rise in demand of improved land and water management practices.
- Effect on quality of agricultural produce.
- Emergence of new diseases, pests and weeds.

Adaptations to climate change

Some degree of future climate change will occur regardless of how stringent future mitigation policies will be. Adopting to or coping with climate change will therefore become necessary for certain socio-economic and environmental systems. Adaption options in agriculture can involve a range of actions such as-

- Development of new varieties- drought, heat and pest resistant
- Developing new farm management practices.
- Change in land use pattern
- Efficient water shed management practices
- Investment in flood protection
- Planting different crops including underutilized crops
- Installing early warning systems in different districts of the country.
- Making available business investment, know how and newer technologies to respond to challenges of adapting to climate change

Mitigates the effects of climate change

The vulnerability of climate change to agriculture is of paramount importance and research as well as extension efforts should simultaneously focus on adaptations and mitigation in order to cushion the effects of climate change. Major steps which are required to be taken to mitigate the effects of climate change are;-

- Retraining of extension staff to acquire new knowledge and skills in climate risk management.
- Setting up of emergency management unit to attend to victims of climate risks.
- Demonstration methods in teaching farmers the measures to mitigate climate change.
- Organize seminars, workshops and field days to sensitize farmers and public on climate risk management
- Involve more persons in waste management and recycling
- Need to give stress on more biomass production
- Need to give more stress on organic culture and less stress on the use of synthetic fertilizers and pesticides.
- Promoting the production of local crops
- Use of ICT's to create awareness on climate change issues.
- Addressing the water challenges.
- Public- private partnership
- Promotion of innovations to mitigate climate change
- Giving out global warming messages to communities
- Launching of climate friendly research and extension projects
- Restoration of degraded soils by afforestation

- Resource conservation strategies.
- Enriching soil organic matter
- Use of biofuels
- Making available alternate land use system
- New technologies to minimize post harvest losses.
- Develop climate change literature for wider dissemination.
- Incorporating climate change in course curricula.
- Adoption of zero or minimum tillage
- Use of weather forecast system
- Use of farmer field schools to promote faster learning of farmers to understand to mitigates the effects of climate change.

Reduce Green House Gas concentrations

Carbon sequestration is long term storage of carbon in oceans, soils, vegetations etc. Soil plays an important role in maintaining a balanced global carbon cycle. Soil has been seen to store most of the earths carbon pool in land i.e 3 times more than what is stored in living plants and animals. Increasing storage of carbon in soils can reduce atmospheric carbon dioxide. This can be done by returning greater biomass from crops to soil, by reducing the soil erosion, taking place by available soil disturbances during tillage and by opporprate manuring of soils. Agricultural practices that can help improving carbon sinks in soils are:-

- To reduce the concentrations of green house gasses by taking CO₂ from the atmosphere and sequestering it in biomass and soils
- Improving N-use efficiency as the primary means of decreasing N₂O emissions
- Decreasing methane emissions by capturing or preventing emissions from animal manure storage and by increasing live stocks production efficiency
- Conservation tillage
- Intensive use of cover crops
- Change in land use pattern
- Alternate land use
- Use of balanced fertilizers and organic fertilizers
- Adopting balanced manuring practices.
- Crop diversification
- Crop rotation especially with those with high residue
- Wider use of inter cropping

Conclusion

In the coming years agricultural will be encountered by unpredictable climate change due to accumulation of higher concentration of Green House Gasses in atmosphere resulting in higher temperature, increase in ultra violet radiations, shift in rainfall patterns, shortage of water etc that would effect agriculture globally on the other hand expanding world population demands more food, better quality food, more energy and water. The mountain areas including Jammu & Kashmir are more vulnerable to such climatic changes. Therefore, there is need of develop extension strategies to grow more foods develop varieties tolerant to higher temperature, drought, develop efficient water harvesting structure, same biodiversity and take appropriate steps to mitigate the effects of climate change.

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