Low-Carbon Strategies for India in Agriculture and Forestry

Anwarul Hoda, ICRIER

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Scope of Presentation

- Impact of climate change
- Adaptation strategies
- Possibilities for mitigation
- Harmonising action for mitigation with development

Climatic Changes Affecting Agriculture and Forestry in India – I

- **Higher temperature**
  - Between 1901-2007 temp rose 0.56^0C per 100 years
  - Acceleration in warming in last three decades: 0.2^0C per decade
  - Projection for 2030: mean annual air surface temperature will rise by 1.7 to 2.0^0C
- **Increased precipitation**
  - No discernible trend toward increase in 1871-2009
  - Deficient years predominated in 1871-1920 and in 1961-2009, excess rainfall in 1961-2009
  - Projection of 3-7 % overall increase in summer monsoon rainfall and decrease in winter
  - Number of rainy days will increase but rainfall intensity will increase.

Climatic Changes Affecting Agriculture and Forestry in India – II

- **Variability in climate**
  - Incidence of droughts increased from six in the first half to 12 in the second half of 20th century
  - Increase in magnitude of flooding too, from 19 mha in mid 20th century to 40 mha in 2003
  - Significant increase in Extreme Precipitation Rainfall Events after 1980
  - No increase in frequency of cyclonic activity over time
  - Projection for decrease in frequency but increase in intensity of cyclonic disturbances
- **Rise in sea level**
  - Mean sea level rise over the long term observed in India is about 1.3 mm/year
  - East coast is more vulnerable because of greater frequency of storms and low lying topography of the shores
  - However, all coastal aquifers are vulnerable to saline intrusions.

Impact of Rise in Temperature on Agricultural Productivity

Field experiments in combination with simulation models show decline in crop productivity

- 1^0C increase would reduce wheat production by one million MT without adaptation and CO2 fertilisation
- 5^0C increase would reduce wheat production by 27.5 million MT while CO_2 fertilisation would reduce losses by 4-5 million MT
- 1-4^0C increase would reduce grain yield in rice by 0-49 per cent, potato by 5-40 per cent, green gram by 5-40 per cent and soybean by 11-36 per cent

Magnitude of crop yield reduction in India estimated by experts

- By 4.5 to nine per cent in medium term by 2039
- By 29 per cent in 2080 after taking carbon fertilisation into account

Impact on milk production

- Initial estimates suggest reduction of milk production by 1.5-2.0 million MT by 2020 and 15 million MT by 2050

Impact of Climate Change on Indian Forest

- India forests are already under intense pressure from over-extraction, insect outbreaks, over grazing by livestock and forest fires.
- Scientific modelling suggests large scale changes by mid 21st century due to increase in CO2 and changes in temperature and rainfall
- Biome types would change and during transitional period forests would be vulnerable to adverse climatic condition and biotic stress and may suffer from diebacks
- Increased incidence of fire and pest and disease will exacerbate the situation.
- Vulnerability will be high for forests in the northwest, northern western ghats and central parts of the country, wherever open forests predominate, and which will also be hotter and have less rains.

Adaptation Strategies

- Strategies already adopted in the past
  - Agronomic adaptation/crop management involving altering dates of planting, spacing etc.
  - Use of alternate crops or cultivars more adapted to change in environment
  - Crop diversification and intercropping
  - Genetic adaptation for drought tolerance
  - Development of resource conserving technologies, e.g. zero tillage
  - Improved risk management through crop insurance against natural disasters

- Strategies already adopted on water resource management
  - Construction of major, medium and minor irrigation projects
  - Rural electrification for promoting groundwater development
  - Watershed development including artificial recharge of aquifers
  - Use of micro irrigation methods, e.g. drip and sprinkler

Recent Adaptation Strategies

National Mission on Sustainable Agriculture

- Rain fed area development by promoting integrated farming systems
- On farm water management – investment subsidies for promoting drip and sprinkler systems
- Promotion of soil health management by setting up new soil testing laboratories
- Strengthening irrigation programmes
- Ongoing major and medium irrigation projects and command area development
- Watershed development
- Restoration of irrigation facilities from existing water bodies

National Mission for a Green India

- Expanded programme for afforestation and reforestation in 10 mha
- Above programme will contribute to adaptation to climate change of vulnerable species and ecosystems
- Increased supplies of wood, fodder, NTFPs etc. will help forest dependent communities to adapt

Emissions from Indian Agriculture

Agriculture accounts for about 30 percent of India's net emissions

Direct Emissions from Agriculture ($MtCO_2e$)	
Livestock	212.10
Rice Cultivation	69.87
Soil Management	43.40
Burning of Crop Residues	6.61
Manure Management	2.44
Total	*334.41*
Other Emissions Attributable to Agriculture ($MtCO_2e$)	
Use of Electricity	130.63
Use of Other Energy	33.66
Energy Use in Fertiliser Production	20.57
Grand Total	519.27

Mitigation Opportunities: Reducing Methane Emissions from Livestock

- Methane emission from livestock is the result of digestive process
- High breeding overhead: 57 % of herd is non-milk producing against world average of 41 %
- Poor health and fertility of animals: first calving at 3.1 years against global average of 2.4 years
- Death rates of calves and other animals: 31.1 an 8.1 % against global average of 17.8 and 6.1 %
- Male animals used less as draught animals because of mechanisation, but slaughter (of cattle) banned
- Improvement in animal feed can reduce emission and also lead to better lactation
- Improvement in health can reduce first calving age and lower mortality
- Semen sexing in artificial insemination can reduce number of male calves

Mitigation Opportunities: Reducing Methane Emissions from Rice Cultivation

- Methane emission in rice mainly due to irrigation by continuous flooding
- Emission can be reduce by water management practices such as additional drainage
- But problem is caused because drainage may lead to emission of nitrous oxide
- Agro-ecological practice known as System of Rice Intensification (SRI) has shown promise
- In SRI soil is maintained in moist condition instead of continuous flooding
- Benefits include an increase in yield by 20 -100 %, reduction in seeds by 90 % , water saving by 50 % and reduction of methane emission by 61.1 %
- SRI can be adopted in irrigated rice only which accounts for 58 % of the rice area

Mitigation Opportunities: Reducing Nitrous Oxide Emissions from Soil Management

- Use of fertiliser is the most important source of emission from soils
- Government has a long standing subsidy policy for fertilisers
- The policies have led to overuse of fertilisers and skewed use of nitrogenous fertilisers
- Government has been promoting use of fertilisers on the basis of soil analysis and the soil testing laboratories have been recently strengthened
- There is a case for the government to rationalise the subsidy regime to discourage skewed use
- In addition government could consider replacing the current system by one that involves direct cash transfers

Mitigation Opportunities: Expanding & Improving Surface Irrigation

The main reasons for farmers shifting to groundwater irrigation

- A large number of ongoing major and medium projects have not been completed
- Command areas have not been fully developed in completed projects
- Many existing projects have become non-functional because of disrepair
- Highly concessional or even free supply of electricity to farmers

While the complete control that farmers have in groundwater irrigation in drawing out water at the time and quantities that they require is a factor, it is possible to induce farmers to rely less on groundwater if the government takes action to redress the situation arising from the above factors.

Mitigation Opportunities: Improving Energy-Use Efficiency for Irrigation Pumps

- 19.03 million irrigation pump electrified as on 31 January 2014
  - Level of efficiency of these pumps can be improved from current level of 25-35 % to 50-52%
  - Energy saving potential of replacing these pumps with star rated ones is 30-40 %
- Another 9 million diesel pumps are being used largely for pumping surface water
  - Solar irrigation pumps have emerged as a feasible alternative, owing to declining cost of solar panels
  - Solar pumps are convenient to use from the point of view of operation and maintenance

Mitigation Opportunities: Promoting Micro Irrigation

- Drip and sprinkler irrigation systems have considerable potential for saving water in agriculture
- National Task Force had assessed in 2004 that drip irrigation can cover 27 mha and sprinkler 42.5 mha
- Drip can be used in oilseeds, cotton, vegetables, fruits, spices and sugarcane and sprinkler in cereals and pulses
- Research has shown that in vegetables drip can reduce water use by 12-84% and increase yield by 45-81 %; in sugarcane the corresponding figures are 65 and 33 and in cotton, 53 and 27 %
- For a range of crops sprinkler has similarly been shown to reduce water use by 30-40 % and increase yield by 20-30 %

Mitigation Opportunities: Reducing Emissions from Crop Residue Burning

- In the states of the north west burning of crop residue from paddy crop is prevalent
- This practice deprives the soil of nutrients, causes pollution and respiratory ailments in the population in adjoining areas
- Harvester combines used for common rice crops leave a stubble of 8 to 10 inches high plants
- Since the farmer is in a hurry to plant wheat they find it convenient to burn the crop
- Recent years have seen the development of technology which provides a viable alternative
- The 'Happy Seeder' is a tractor mounted machine that cuts and lifts the residue of the rice plants, sows wheat into the soil and spreads the straw over the sown area as mulch
- Farmers are slow to adopt the technology and need to be encouraged through extension and some investment subsidies

Mitigation Opportunities: Forestry Development for Carbon Sequestration

- Green India Mission: Eco-restoration & afforestation in 10 mha

Action Proposed	Area (mha)	Incremental Annual Mitigation Potential after Implementation ($MtCO_2e$)
Improving canopy density of moderately dense forest	1.5	6.7
Eco-restoration of open forests	3	27
Restoration of scrubland	1.2	5.2
Restoration of wetlands	0.2	1.6
Agro-forestry etc.	3.2	8.3
Others (shifting cultivation etc.)	0.9	6.0
Total	10.0	55

- Improving canopy density in available 32.07 mha moderately dense forests and 28.78 mha open forests

Way Forward I

- Agriculture has received little attention in India's low-carbon development strategy
  - India's official position (COP18): Agriculture is a sensitive issue in developing countries and pursuing agricultural mitigation would compromise agricultural development and jeopardise food and rural livelihood security
  - Agriculture has virtually been excluded from low-carbon strategy
  - There is no serious consideration of livestock emission, which is the largest chunk
- However, there does not have to be any trade-off
  - Facts suggest a strong convergence across development, adaptation and mitigation in Indian agriculture
  - Resource use efficiency is the key that would also lead to productivity gains
- On the contrary, India is not hesitant to pursue forestry development for carbon sequestration
  - Evident from Green India Mission
  - But, need to take aggressive and sustained measures

Way Forward II

- Feed quality improvement and health and reproduction management in livestock will lead to increased lactation, reduction in herd size with reduction in the number of male animals that have less use in India, reduction in breeding overhead and a generally healthier herd. All these will increase the farmer's income besides reducing emission. Since the small land holders are more dependent on livestock it would be inclusive development. Potential reduction in emission is 27.3 Mt CO_2 eq in 5-10 years and 54.6 Mt CO_2 eq eventually

- Adoption of SRI in rice cultivation relies on keeping the roots moist against the traditional method of irrigation by continuous flooding. It would reduce water use, increase yield , reduce seed use and at the same time reduce emission . Reduction in water use would help adaptation and at the same time bring about reduction in use of energy and thus contribute further to mitigation. Economy in inputs and increase in yield would increase farmer income. Potential reduction in emission is 5.56 Mt CO_2 eq in 5-10 years and 22.23 Mt CO_2 eq eventually

Way Forward III

- Replacement of 19.03 million of electric irrigation pumps with star rated ones would reduce emission by 39.2 Mt CO_2 eq within 5-10 years.
- With the rapid decline in the price of solar panels it is possible to envisage replacement of nine million diesel pumps with solar pumps. It would result in saving of the cost of diesel and lead to an increase in the farmer's income besides eliminating emission of 7.5 Mt CO_2 eq in 5-10 years.
- Drip and sprinkler can reduce water use and at the same time enhance productivity. On the basis of targets of 5 mha in the next 5-10 years and 20 mha eventually and a water saving of 30 per cent the mitigation potential works out to 3.27 and 13.10 Mt CO_2 eq respectively
- With the improvement in surface irrigation facilities as a result of completion of 337 ongoing major and medium projects, command year development in completed projects, repairs of existing water bodies providing irrigation it is possible to foresee 5 mha of agricultural land shifting from ground water to surface irrigation

Way Forward IV

Other action in agriculture

- Overuse of fertilisers and skewed use of nitrogenous fertilisers can be addressed by shifting to a system of subsidies through direct cash transfers to farmers conditional on their getting soil analysis done for their land. It has not been possible to quantify the mitigation benefit of this intervention.
- Improvement in energy efficiency of fertiliser factories is already foreseen in the National Mission for Enhanced Energy Efficiency. The mitigation effect is assessed at 1.34 Mt CO_2 eq
- Use of tractor mounted 'happy seeder' machine for sowing of wheat seeds while simultaneously cutting the stubble of paddy plants left behind by harvester combines and also spreading the straw as mulch can obviate recourse to burning of crop residue. Such action will improve productivity by enriching the soil through the use of mulch and at the same reduce pollution causing health problems and also reduce emission. Mitigation potential is 5.3 Mt CO_2 eq in 5-10 years and 6.61 Mt CO_2 eq eventually

Way Forward V

Additional mitigation potential in forestry

- Improvement of canopy density of 30.57 mha of moderately dense forests would result in incremental annual mitigation potential of 136.3 Mt CO2 eq after implementation
- Improvement of canopy density of 25.78 mha of open forests would result in incremental annual mitigation potential of 232 Mt CO2 eq after implementation
- Afforestation over an area of 17 mha in the forest fringe villages in the next 10 years would result in an incremental annual mitigation potential of 12.5 Mt CO2 eq assuming that 50 per cent of the biomass would be removed by the forest communities
- Distribution of improved cook stoves and services for use of alternative fuel such as LPG among about 120 million rural households using firewood will have an annual mitigation potential of 43.92 Mt CO2 eq
- Eco restoration and afforestation interventions suggested above would not only increase the GDP but contribute to inclusive development by strengthening the livelihood of 275 households in forest dependent communities through additional supply of fodder, timber ,NTFPs etc. Supply of efficient cook stoves and alternative fuel services would also improve the living conditions and health of women in these households.

Thank You