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Countermeasures against Climate Change for Agricultural Sector

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SUMMARY

Climate change has been resulted from the disruption of energy balance for global climatic system caused by the increase of greenhouse gases and aerosol in atmosphere and changes in land covering and solar radiation. Countermeasures that the agricultural sector can consider in the face of risks and challenges of climate change, represented by global warming, are largely divide into the mitigation method that reduces the scale and rate of climate change by mitigating and absorbing the greenhouse gas emission and the adaptation method that admits the inevitability of global warming, understands the influences of changing climatic conditions, and reduces the detriments it could create.

INTRODUCTION

Climate change refers to the changes beyond the average atmospheric condition that are caused both by natural factors such as the orbit of earth's revolution, volcanic activities and crustal movements and by artificial factors like the increase in the concentration of greenhouse gases and aerosols. Climate change indicates the average increase in temperature globally mainly due to global warming which has turned into a trend leading to considerable changes in distant future throughout the globe. It is any type of remarkable change on long term basis in anticipated patterns of average weather conditions of a particular region or whole world when a significant period of time is considered. The enhancement in anthropogenic activities like rapid industrialization and urbanization; excessive grazing and deforestation; decline in land due to intensive and extensive agriculture; change in land use pattern and many others causes huge emission of harmful and poisonous green house gases like carbon di oxide, methane, nitrous oxide, chlorofluorocarbon etc. which accelerate the rate of climate change scenarios including increased temperature and atmospheric CO_2 concentrations, frequent adverse conditions like drought, flood etc. as well as change in precipitation pattern.

Mitigation Strategies for Climate Change

Mitigation is defined as any anthropogenic intervention to either reduce the sources of green house gases emissions through abatement or increase the carbon sinks via sequestration. Mitigation measures contribute to avoid, reduce and postpone various impacts of climate change by reducing greenhouse gas emissions. As climate change mitigation and adaptation are closely interrelated with each other, mitigation can be considered as belonging to adaptation measures on long term basis. Considering the given circumstances in a realistic manner, the means for greenhouse gas reduction are classified into economical means, regulatory means, voluntary agreement, research and development (R&D) and popularization, information provision, and promotion of public awareness.

Mitigation measures for the agricultural sector:

- Improvement of cultivation methods like proper irrigation scheduling and recommended dose of fertilizer application for arable sector to suppress major greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O)
- Improvement of animal excretion treatment technologies in livestock sector
- Carbon fixing for farmland soil
- Economic means refer to policies that utilize market mechanisms, such as charges, carbon tax or greenhouse gas tax, emission trading scheme, and subsidy.
- Greenhouse gas charge, a scheme to impose a charge equivalent to the input price for unit emission of greenhouse gas to specific greenhouse gas emitters, is an ideal economic means to achieve efficient resource distribution using financial encouragement.
- The taxes to reduce greenhouse gas emissions can be divided into carbon tax and greenhouse gas tax.
- Carbon tax is a system to impose taxes in proportion to the carbon content of fossil fuels used.
- Greenhouse gas taxes differ from carbon tax in that the former is based on the amount of gas emissions while the latter is dependent upon input or production quantity of fossil fuels, a vital source of GHG emissions.

- Though carbon tax is the same as a greenhouse gas tax, in that both can maintain the input amount of fossil fuels at efficient levels, the earlier one is more attainable because it can set the quantity of inputs such as fossil fuels as foundation for taxation.
- Direct regulation is a scheme in which the government regulates emission standards using various policies and measures under law to ensure that emitters can comply and meet the required greenhouse gas emission level.
- Some important regulatory measures may involve emission cap, chemical fertilizer spraying standard, manure and liquid fertilizer spraying standard and breeding density regulations.
- In addition, there are R&D and popularization for GHGs reduction and capture technologies, and information provision and public awareness enhancement for greenhouse gas monitoring.
- Two types of mitigation strategies are usually found in agricultural sector *viz.* carbon sequestration in soil and reduction of on farm emissions; besides, substitution of fossil fuels by cleaner sources like burning bio-energy, such as ethanol, biogas, and methane is another mitigation strategy.

Carbon sequestration

- Carbon sequestration can enhance and preserve carbon sinks and include any practices that may store carbon through 'best management practices' *viz*. zero tillage, or slow down the quantity of stored C emitted into the atmosphere by the means of burning of fossil fuels, deforestation as well as tillage.
- The carbon is ultimately deposited in soil leading to an enhancement in soil organic carbon content or SOC.
- Reduction in bare fallow, restoration of degraded lands, improvement of pasture and grazing lands, proper irrigation methods, crop and forage rotation, and also no tillage are the best management options that can increase soil organic carbon content.
- On the other hand, the management of grazing lands increases the coverage of high productivity grasses and overall grazing intensity finally resulting into an increment in SOC content.

Bio-energy

- The production of liquid fuels from devoted energy crops like grains and oilseeds has been re-evaluated considering the interests over ecological sustainability.
- The use of bio-fuels can reduce C emissions potentially that is heavily relying upon the nature of production process by which they are being manufactured and cultivated.
- Bio-energy production has a technical potentiality of almost 200 Mt CO_2-eq/ year by the year 2030.
- It is calculated that 5-30% of total C emissions could be diminished if bio-energy is supplied 10-25% of cumulative global energy by the year 2030.

On farm mitigation

- Improved practices such as livestock and manure management, fertilizer handling and proper methods of rice cultivation can play a vital role in reducing on farm emissions.
- Enhancement of the digestive efficiency of livestock along with better feeding habits and dietary additives depending upon the feed quality, livestock breed and age, as well as the condition if the animal is freely grazing or stall fed helps to reduce methane emissions via enteric fermentation.
- Developing countries generally provide feed of lower quality to livestock, which can raise the emission rate per animal.
- The technical potentiality of mitigation of livestock emissions by the end of the year 2030 is forecasted at 300 Mt CO_2-eq/ year.
- In manure management,
- Rapid cooling and utilization of solid covers for storage tanks and lagoons, separation of solids from slurry, capture of emitted methane, composting of manure and alteration of feeding habits are some of the relevant technologies of manure management that can decline the emissions to an extent.
- The technical potentiality of improved manure management by the end of the year 2030 is estimated at 75 Mt CO_2-eq/ year.

- Moreover, improvement in the efficiency of fertilizer application or switching to organic production may reduce the amount of nutrient loads and nitrous oxide emissions.
- The technical potentiality of overall cropland management by the end of the year 2030 is estimated up to 150 Mt CO_2-eq/ year.
- Improved water management in highly methane emitting irrigated rice systems through mid season drainage or alternate wetting and drying methods can remarkably reduce emissions in Asian countries mainly; nevertheless, the impacts may be moderately compensated by enhanced N_2O emissions.
- The technical potentiality of improved rice management by the end of the year 2030 is estimated at 300 Mt CO_2-eq/ year.
- According to the aggregated estimates of global potential of both on-farm and C sequestration technologies carried out by the IPCC, a maximum global mitigation potentiality of 4.5-6 Pg or 4500-6000 Mt CO_2 equivalents per year by the end of 2030 can be achieved; among which approximately 90% of the total potential is obtained from C sequestration, whereas 9% and 2% come from methane mitigation and N_2O emission reductions, respectively.

Adaptation Strategies for Climate Change

Adaptation to climate change is not optional but rather a compulsory countermeasure against climate change. According to IPCC, adaptation is defined as an adjustment in natural and human systems in response to actual or anticipated climatic stimuli and their impacts. UNFCCC defines adaptation as 'regulating process of ecological and socioeconomic systems to reduce possible damages from actual and expected climate change, that is, actions taken to help communities and ecosystems cope with changing climate conditions'. As adaptation contributes to reducing the negative risks of climate change and provides opportunities to use the climate for positive effects, it plays an important role in mitigating the impacts of climate change. Adaptation includes both actions taken to directly mitigate the damages from the climate and enhance the future adaptive capacity and actions to contribute to indirectly mitigating the damages from climate change. According to IPCC (2001), adaptive capacity or adaptive capability refers to the potential of a specific system to regulate itself, reduce potential damages, or use opportunities in response to climate change, or to cope with the consequences of climate change.

Type of adaptation to climate change includes those reducing the sensitivity of systems significantly affected by climate change like:

- Enhancement of storage capacity of reservoirs
- Cultivation of heat resistant crops
- Preparation against floods, droughts and other weather extremities

Type of adaptation to climate change includes those changing the exposure of a system to the impacts of climate change such as:

- Utilization of the investment in provision against risks and
- Early Warning System

Type of adaptation also includes those increasing the resilience of social/ecological system like:

- Resource preservation

Formally defined, adaptation to climate change is an adjustment made to a human, ecological or physical system in response to a perceived susceptibility or vulnerability.

- Alteration in tillage methods or livestock breeds is a short term measure.
- Long term measures, such as improved water management or building of irrigation systems can help in adapting to a changing climate.
- Help the cultivators to cope with the current climatic hazards to some degree through provision of value added weather services to them, shifting planting dates, choosing appropriate cultivars with different growth durations, changing crop rotations etc.

- An early warning system must be advocated to monitor shifts in pest and disease outburst; besides, the pest management strategy should be dependent upon IPM or integrated pest management by taking care of multiple pests in a specific climatic scenario.
- Participatory and formal plant breeding programmes for developing crop varieties resilient to higher temperature, drought and salinity as well as short duration cultivars maturing before the peak heat phase sets in; selection of crop genotypes having a greater per day yield potential to compensate yield losses resulting from heat induced reduction in growing periods are other significant adaptive strategies.
- On the other hand, certain preventive measures to adapt to drought involve construction of on-farm reservoirs on medium land condition; growing of pulses and oilseeds instead of rice in uplands; ridge and furrow systems; intercrops alternative to pure crops particularly in upland situation; land grading and levelling; stabilization of field bunds by stone and grasses, graded line bunds, contour trenching for runoff collection, conservation furrows, mulching and application of farm yard manure and many other options.
- Technologies helpful for efficacious utilization of water include application of shallow irrigation frequently, micro irrigation such as drip and sprinkler methods for high value crops, irrigation at critical stages etc.
- Provision of optimum fertilizer dose; split application of nitrogenous and potassic fertilizers; deeper placement mainly in reduced zone; use of *neem*, *karanja* and other nitrification inhibitors; liming of acid soils; use of micronutrients like zinc and boron; use of sulphur in oilseed crops; integrated nutrient management etc. should be adopted to use fertilizer efficiently.
- Seasonal weather forecasting, provision of greater coverage of weather linked agricultural insurance and intensification of food production through improvement in the technology and input delivery system are advisable as supportive measures.
- Adoption of resource conservation technologies *viz.* minimum or zero/no tillage, laser land levelling, direct seeding of rice, crop diversification etc. can reduce the global warming potential.
- National grid grain storages at household or community level or at the district level must be established to guarantee local food security and stabilize prices.
- Incentives to the farmers for resource preservation and maintaining its efficacy through provision of credit for transition to adaptation strategies should be provided.
- Technical, institutional and financial support to establish community banks of food, forage and seeds along with greater amount of fund allocations for strengthening research must be furnished.

CONCLUSION

Once climate change starts, components of the climatic system such as atmosphere, hydrosphere, cryosphere, biosphere, lithosphere, etc. are initially affected and attempt to adapt themselves to that stimulus voluntarily. Notwithstanding, if the climate change impact is considerable, the system cannot afford the effect merely via voluntary adaptation; therefore, planned adaptation should be accepted. If climate change still has an impact on climate even when the planned adaptation is in effect, it is said that there is a remaining impact. As it is difficult for the systems to adapt to climate change, efforts have focused on reducing the scale of climate change through mitigation measures such as greenhouse gas reduction.

REFERENCES

IPCC. (2001). Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.