Agricultural Adaptation for Mitigating Impact of Climate Change

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According IPCC Working Group II, Climate is average weather conditions (temperature, rainfall, wind) usually over a 30 years period. Climate Change (CC) is a change in the climate that persists for decades or longer, arising from either natural causes or human activity.

Life Cycle of GHGs

The GHG absorbs infrared radiation in the atmosphere. Their lifecycle vary, such as carbon dioxide (CO_2) – 100 years; methane (CH_4) – 12 years; nitrous oxide (N_2O) - 114 years; Hydrofluorocarbons (HFCs) – 45 years; Perfluorocarbons (PFCs) – 45 years and sulphur hexafluoride (SF6) – 45 years.

Warming Potential of GHGs

The warming potential of GHGs also vary and relative to CO_2 (1), methane (CH_4) = 25; nitrous oxide (N_2O) = 298; hydrofluorocarbons (HFCs) = 124-14,800

Atmospheric Concentration—GHGs

In 1750-pre industrialization the atmospheric concentration of GHGs was 280 ppm, increased to 315 ppm 1955; and today it is 430 ppm, which has passed the safe level of 350 ppm, it is projected to be 550 in 2035.

Adaptation and Mitigation

Adaptation (dealing with water and plants) is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Whereas the *Mitigation* (dealing with emission of gases) is an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce GHGs sources and emissions and enhancing greenhouse gas sinks.

Impact of GHGs emission

Major impacts of GHGs emissions are, the increased carbon dioxide, prolonged drought and increased aridity. increased day and night temperatures, altered rainfall amounts, frequency and intensity, increased evapotranspiration and plant water demand, ice melting and sea level rise, depletion of renewable water resources and increased water scarcity, extending growing seasons in many crop regions and decline in agriculture productivity, and ecosystem degradation.

A Sustainable Mode of Climate Change

Production of crops and livestock is able to adapt to climate change conditions because it is designed to minimize soil and ecosystem degradation, and the overall integration of production within a stable and healthy ecosystem.

An Explosive Mode of Climate Change

An explosive mode could be in the form of environmental damage, natural vegetation eradication, denudation of land, loss of biodiversity, decomposition and depletion of organic matter, leaching of nutrients, water and wind erosion, soil structure deterioration, gradual loss of productivity and increase of salt-affected lands.

Multi-pronged Approach Needed to Address Adaptation to Climate Change

Global Warming and Agriculture

Global Warming and Climate Change are subjects of wider considerations than restricting them to only AGRICULTURE. It is a paradox that Agriculture on one hand, besides providing food and fiber, both contributes to as well as mitigate climate change.

Climate Change and Agriculture

Geographically, there will be winners and losers, eg Europe and northern temperate area in Canada and Russia are likely to be gainers due to longer growing seasons. Semiarid and subtropical areas will be greatest losers due to increased heat and drought stress. Severest impact is expected in Near East, North and sub-Saharan Africa rural households engaged in subsistence agriculture and smallholder farmers in developing countries are most vulnerable.

A large proportion of the mitigation potential of agriculture (excluding bioenergy) arises from soil carbon sequestration and through increasing soil carbon sinks and by reducing GHG emissions.

Carbon sequestration can be achieved through capturing carbon in plant residues and slowing the carbon cycle. No tilling can lead to retain carbon in crop residues to an extent of 0.1-0.7 Mg C ha^{-1} yr^{-1}.

Under Business As Usual (BAS) scenario, global agricultural productivity could decline between 10-25% by 2080. Decline in yield in rain-fed agriculture can be as much as 50% for some countries. Agriculture is 7% of GHG problem, however, it represents 20% of the solution.

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Climate Change and Smallholder Farmers

CC will impact the smallholder farmers in various ways, such as but not limited to, increased likelihood of crop failure., increase in disease and mortality of livestock, and forced sale at disadvantageous prices, increased livelihood insecurity results in assets sale, indebtedness and dependency on food aid, downward spiral of human development indicators, such as health and education, rural to urban migration likely to increase as many rural livelihood become less viable.

Agriculture Adaptation Through Reforestation

Clearing of forests for other uses increases GHG emission, therefore, avoid conversion to another land use, such conversion induces 33% anthropogenic CO_2 emission. During the last 50 years, 30-50% mangroves forests are reduced through deforestation. Mangroves store more than 5 times carbon than other forests on per unit area basis. Introduction of forests can significantly sequester carbon and improve the environment.

Livestock Welfare

Livestock sector contributes 18% of total anthropogenic GHGs through enteric fermentation, manures and respiration (CH_4 emission). Livestock welfare, such as improved digestion and grazing systems can reduce GHG emission. Changing eating habits from meat to vegetarian can reduce CH_4 emission.

Agriculture Adaptation to Climate Change

Farmer Education is Must for Successful Agricultural Adaptation to Climate Change

In countries where there are limited arable land and water for irrigated agriculture, agricultural adaptation must come from water saving and rationale use of soil resources, otherwise agriculture practices can cost the environment significantly. Under such environmental conditions, it is essential to introduce innovative technologies suitable to vulnerable areas including but not limited to varieties resistant to heat shock, salinity and drought, diversifying rotations, reduce fallow and increase crop intensity, optimizing water uses-smart irrigation practices, using alternate water sources such as drainage and treated wastewater, enhancing fertilizer use efficiency and use of biofertilizers, and adoption of conservation agriculture.

Arab World contribute 4.2% to global GHGs but highly vulnerable to Climate Change, requiring adequate resources and strong research base to address CC issues.

Water and not Land is Limiting Factor in Agriculture Production and Adaptation to Climate Change

Some Innovative Technologies

There is urgent need to developing viable options to maximize yield under warmer and water deficit conditions through breeding and agronomic research, developing cultivars with lower water use efficiency in early season, stomata closure midday etc). Introduce Biological Nitrogen Fixation (BNF) character in non leguminous crops to reduce use of chemical fertilizers, enhance sunlight efficiency for photosynthesis, improve enteric fermentation (Livestock) for less CH_4 emission, improve rice varieties (less CH_4 emission) or explore ways of drying and wetting conditions in rice cultivation to reduce carbon reduction that lead to CH4 emission, and use technologies such as conservation and precision agriculture practices.

Ecological Creditors and Debtors

Today, more than 80 percent of the world's population lives in countries that use more resources than what is renewably available within their own borders. These countries rely for their needs on resource surpluses concentrated in ecological creditor countries, which use less biocapacity than they have. Such situations lead to high food import or investment in such countries. Food import enhances trade with other countries, however, it has financial obligations – capital flow, no control on food quality – production, risks during wars – food insecurity, risks when food import demand increases, increase virtual water (1000 litre/kg wheat; 15,000 litre/kg edible meat).

Food insecurity will be exacerbated in coming years by strong population growth, low agricultural productivity and climate change impact. Climate change management issues raised be translated into decisions and for policy by the stakeholders to address CC issues, increase local production & ensure food security.

Farmers Education and Awareness

Regardless of developing innovative technologies in agriculture as means of adaptation to climate change, if these technologies are not reaching to end users the farmers, and farmers are not educated in using such technologies there will be minimum overall impact. It is therefore essential to continue educating the farmers in such technologies, such as soil and water management, nutrient management, crop management and pest management.

Innovative technologies are to be provided to farming communities. Prior to adoption *pros and cons* of such technologies must be fully understood and examined.

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Mangroves Store More Than 5 times C Than Other Forests. Forests can Sequester C and Improve the Environment

Rising Temperature, Rainfall Decline, Sea Level Rise, Aridity, Drought and Water Scarcity are the Main Issues of CC