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Food Security in a Changing Climate

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(1) Agriculture sector is more vulnerable to climate change than other sectors of the economy as climate change is expected to cause higher variability in rainfall pattern, general reduction in precipitation in the arid and semi-arid regions and increase in the frequency of extreme events such as drought, floods, heat and frost. Agriculture production systems, therefore, have to cope with more variability in river water flows and temperature regimes, making food security susceptible to these variation. The less privileged people/farmers who are often located in the marginal production areas such as rainfed, coastal, and mountenace, are likely to be affected more by climate variability whether drought or floods, heat or frost. These changes in climate enhance the risk of crop failures and livestock morality thereby causing financial and economic losses and the risk of food insecurity.

(2) Adapting agriculture production systems to climate change is therefore urgent as many of the water and temperature related impacts are already being felt. In the short term, adaptation can reduce the economic impact of these changes with the existing technologies, while we search for new technologies in the medium to long term. Agricultural research could play a central role in helping farmers, farmer communities and policy-makers develop strategies to adapt to or mitigate the adverse effects of climate change.

(3) *Improving the reliability of seasonal forecasts* is a key to reducing farmers' exposure to risk. For example the seasonal forecast for rainfall helps manage the irrigation system better under dry, normal, and wet climate for the cropping season in question; likewise the forecast about frost and heat would help in adjusting the cropping calendar or even the cropping pattern.

(4) *Reducing carbon emissions and other greenhouse gases* that contribute to climate change is another important area of research, where economists and scientists need to work together to look at ways to compensate farmers for planting trees and reforestation of degraded forests or deforested areas.

(5) *Developing new crop varieties* for better water-use efficiency, tolerance to drought and flooding, and resistance to pests and disease that may become more prevalent in a changed climate. An important aspect of research is the collection of plant material for international gene banks to increase biodiversity.

(6) *Changing farming practices from extensive to intensive production system,* to promote sustainable agriculture development. For example, reducing livestock numbers per hectare was shown to increase yields and profits for smallholders in China, while at the same time reducing soil erosion and methane production.

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(7) *Recycling of waste organic material and crop residues* in the soil rather than burning them to clear the fields would help in building up soil carbon which is rapidly depleting due to unsustainable farming practices.

(8) Each of these climate-change projects should be driven by the need to improve smallholder productivity while at the same time addressing climate change and environmental issues. If new practices and products are more cost-effective and improve agricultural profitability and sustainability, there is a good chance they will be adopted by farmers. And the benefits to the environment, in terms of reduced greenhouse gas emissions and land degradation would automatically accrue.

(9) The medium to long term measures and research priorities for adaptation strategies would include but not limited to the following:

- Determining potential water productivity increases in crop agriculture under different technological options such as high efficiency irrigation systems, furrow irrigation, precision land lavelling, bed planting, zero tillage etc.
- Defining method for improved correlation and linkages between remote sensing information and ground-based data for crops and water resources.
- Downscaling climate projections for use in hydrologic modeling and irrigation water management schemes.
- Reducing carbon emissions and other greenhouse gases particularly CH_4 and NO_2 through improved crop and livestock management.
- Assessment of carbon sequestration and opportunities for using soil as carbon sink in the arid and semi-arid region of South Asia and for carbon trading under CDM.
- Determination of carrying capacity of rangelands and adjusting grazing animal's population density to this capacity.
- Systematic recording of changes in frequency and intensity of extreme events (temperature, rainfall, floods and droughts) on long-term basis for purposes of long term monitoring and modeling studies.
- Redefining the land use pattern and agro-ecological zones based on latest data on climate pattern.
- Response of major crop varieties and animal breeds to climate change based on future long term studies at specific sites in each of the major agro-climatic zones (GIS based sample studies).
- Monitoring the behavior of glaciers-melt, indus delta region, and the indus river system.
- Exploring the technical, economic and environmental feasibility of using Indus. basin as storage-aquifer for access water during the monsoon season (e.g. similar to that of underground storage of natural gas).
- Improved water governance both at system and field level and strengthening of related institutions.