Climate Change and Food Security in South Asia

Edited by: Bipul Chatterjee • Manbar Khadka

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Acknowledgement

This study on Climate Change and Food Security in South Asia will impart a greater understanding about this subject among the policy-makers, researchers, civil society organisations and media. It is based on a sample size of 1,200 farmers, drawn from only three agro-climatic zones in four countries, viz. Afghanistan, Bangladesh, India and Pakistan.

We express our gratitude to Oxfam Novib, The Netherlands for their support in implementing this project. Our partners have done a commendable job in addressing this complex subject and implementing it in difficult terrains. Thanks are due to Afghan Development Association, Afghanistan; Practical Action, Bangladesh, Centre for Community Economics & Development Consultants Society, India; and Sustainable Development Policy Institute, Pakistan.

We acknowledge the contribution of Siddhartha Mitra, Madhuri Vasnani, Mukesh Tyagi and Suranjan Roy in publishing this report.

Words alone cannot convey our gratitude to those who have contributed in every big and small way to this report.

Abbreviations

ADB	Asian Development Bank
CUTS	Consumer Unity & Trust Society
EU	European Union
FAO	Food and Agriculture Organisation
GBM	Ganges, Brahmaputra and Meghna
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHGs	Green House Gases
GHI	Global Hunger Index
HPN	Humanitarian Practice Network
HYV	High Yielding Varieties
IPCC	Intergovernmental Panel on Climate Change
MDG	Millennium Development Goal
NGO	Non-governmental Organisation
PDS	Public Distribution System

R&D	Research and Development
SAARC	South Asia Association for Regional Cooperation
SAFTA	South Asia Free Trade Agreement
SAR	South Asian Region
TERI	The Energy and Resources Institute
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
WB	World Bank
WFC	World Food Council
WFP	World Food Programme

Foreword

The phenomenon of climate change and its impact on developmental concerns such as agricultural development and food security has emerged as a global developmental issue for the past several decades. Whatever be the disputes about weather patterns changes in weather have intensified and new trends have emerged due to global warming. Climate change has devastating effect upon food security around the world, as many methodologically sound studies have argued. In order to minimise its effect upon food security, particularly in a poor region like South Asia more and more in-depth, field-based research is required. I am happy that CUTS, an internationally reputed organisation doing policy research and advocacy, has taken up this subject.

This publication mainly sheds light on the awareness and perception that small and marginal farmers of selected South Asian countries have on climate change and its impact on agricultural production in general and food security in particular. It highlights their concerns associated with the phenomenon of climate change and explores their thinking and actions on possible adaptation and mitigation strategies. It suggests major policy recommendations to minimise the effects of climate change on food security in South Asia.

While factual data on climate change and its impact on food security are available for countries such as Bangladesh, India,

and Pakistan, not much information is available for Afghanistan. This study covers them and, as such, adds value to existing research on this subject.

Success stories emanating from one country can be replicated in other neighbouring countries given that these countries have similar geographical topography. For example, farmers across India use crop insurance as a climate change adaptation strategy. This strategy has worked well in some parts of India in securing poor farmers' livelihoods during climatic crises. This strategy can be practiced by farmers in other South Asian countries as well. Since South Asian countries have similar geographical topology, not only climate change adaptation and mitigation strategies, but also agricultural technology can be shared. This way the region can effectively and efficiently address climate change and food security issues in a collective manner.

With a significant number of people living in abject poverty, food insecurity is widely prevalent in South Asia. However, the region is well endowed with fertile soil to not only produce sufficient food to feed its population but also to increase its productivity and production to serve other food importing countries. Unfortunately, issues like poor governance among others have derailed the gains that some countries have made in increasing agricultural productivity and production. By analysing the impact of climate change on food security, this publication has underlined the importance of good governance in poverty reduction.

The report has several interesting policy implications for addressing food security issues amid climate change in South Asia. More efforts (including adaptation and mitigation efforts in regard to climate change and its impact on agriculture) are

needed to boost agricultural production in these countries. There is a greater need for shifting from traditional rain-fed agriculture to irrigation-based farming across the region. And there is a greater urgency for developing rural infrastructure to enhance the market accessibility of poor rural farmers. At the regional level, the study recommends the promotion of intra-regional trade in food items and that of the SAARC food bank which remains ineffective.

Climate resilience agriculture is the need of the hour to protect humanity from food deprivation. With support from international agencies such as the Asian Development Bank and International Food Policy Research Institute, the region can practice climate resilience agriculture. With the development of climate resilient seeds, both agricultural production and productivity can be increased. With the right selection of crop genotypes and livestock breed, rural livelihoods can be made more secured.

Thus, this study has touched upon several important aspects of climate change and its impact on food security in the region. It has not only assessed the awareness and perception of small and marginal farmers about climate change and food security but has also provided sound policy recommendations for addressing plethora of issues emanating from changing climatic conditions.

The study has argued for greater collaboration among South Asian countries in addressing climate change and food security issues and suggested that development strategies must come from within the region though technical and financial assistance can come from international aid agencies.

Initiatives such as this project which try to provide better researched information for supporting coordinated efforts to address climate change concerns in the region (particularly its impact on food security) make a positive contribution toward regional integration and concomitant socio-economic dividends including generating much-needed peace dividends. I congratulate CUTS and hope that more and more initiatives having practical implications like this will be undertaken to contribute toward a better regional development.

Nitin Desai
Under Secretary General to the United Nations
(1997-2003)

Preface

Climate change is threatening the humanity by destabilising agriculture and other means of livelihood around the world. In our region the rapid meltdown of the Himalayan glaciers is not only raising sea-levels but also intensifying flooding. This phenomenon is affecting the poor communities disproportionately because of their heavy reliance on natural vegetation for farming and other means of subsistence. Furthermore, they have limited coping abilities.

While countries and regions lying in the Hindukush Himalaya are facing more frequent flood due to glacial lake outbursts, low-lying countries in South Asia are winessing a rise in sea-levels. Glacial lake outbursts in Nepal and Bhutan intensify flash-flood, devastating livelihoods of poor communities. Low-lying countries like Bangladesh and coastal regions of India are suffering from rising sea-levels. The inundation of sea water salinate agriculturally productive land. The salination not only destroys crops but also livestock of small and marginal farmers.

Given these realities of South Asia's vulnerability to climate change, CUTS International conducted a perception survey among small and marginal farmers to understand levels of their awareness on climate change and its impact upon their livelihoods. This study presents South Asian farmers' knowledge on climate change and their subsequent adaptation and mitigation strategies during climatic crises. If they are aware, are they adapting to climate change? If yes, what kind

of climate change adaptation strategies are they practicing? And what governmental and intra-governmental policies are necessary to address issues of climate change and food security in the region? Such burning questions are being addressed in this study on climate change and food security in South Asia.

An interesting finding of the study is that farmers of the region perceive climate change phenomena as climate variability. Small and marginal farmers do not have much understanding about global warming. But they have observed significant changes in weather conditions over the past several years. And these seasonal changes have negatively affected their cropping patterns, livestock, and livelihood in general. Since farmers largely understand climate variability, they have been practicing adaptation methods on their own based on their common sense. But there is a significant gap between such adaptation methods and climate change mitigation strategies which are mainly followed by governmental agencies.

Because of climate change, volatility in food production has emerged as the principal problem faced by small and marginal farmers. Due to decline in production and productivity, farmers are migrating to urban areas in search of alternative livelihoods. Nevertheless, a significant amount of migration is seasonal, implying that farmers do return home for cultivation during the monsoon season.

In order to minimise the impact of climate change on rural livelihood, South Asian governments need to focus primarily on pro-poor adaptation policies. Millions of poor people in the region live along coastal areas and floodplains of tributaries. Land reform policies should focus on bringing them out of vulnerable zones. Small and marginal farmers should be empowered through microfinance loans so that they can upscale adaptation methods. Mitigation strategies should be made coherent with adaptation methods.

At the regional level, the relevant South Asian Association for Regional Cooperation (SAARC) Declarations must be implemented with vigour. The SAARC Food Bank initiative must be implemented with greater emphasis and coordination so as to help poor consumers during food crises. The SAARC countries must collaborate in sharing knowledge and transferring technology as a regional mitigation strategy. If precautionary measures are adopted well in advance, then the climate change impact can be minimised to a great extent.

Similarly, the concept of SAARC Seed Bank must be promoted. The region needs climate resilience agriculture. Poor and marginal farmers should have access to better quality seeds that can resist the vagaries of climate change. And this is possible through the advancement of seed technology and the promotion of the SAARC Seed Bank.

Intra-regional trade can greatly enhance food security in South Asia. At present, the region remains the least integrated compared to other regional blocs in the world. If South Asian countries trade agricultural produce extensively among themselves, then the region's food security concerns can be addressed in a sustainable manner. And this can be facilitated by removing intra-regional trade barriers.

We hope that this study will impart a greater understanding about these issues among the policy-makers, researchers, civil society organisations (CSOs) and media. However, it has its own limitations. It is based on a small sample size of 1,200 farmers, drawn from only three agro-climatic zones in four countries, viz. Afghanistan, Bangladesh, India and Pakistan. Therefore, we have made some general observations as against specific policy conclusions.

Finally, I would like to thank Oxfam Novib, The Netherlands and Oxfam India for their support in implementing this project. Our partners have done a commendable job in addressing this complex subject and

implementing it in difficult terrains. I also thank Afghan Development Association, Afghanistan; Practical Action, Bangladesh; Centre for Community Economics & Development Consultants Society, India; and Sustainable Development Policy Institute, Pakistan for partnering with us on the project. And I thank my colleagues at the CUTS Centre for International Trade, Economics & Environment for their diligence and hard work.

Pradeep S Mehta
Secretary General
CUTS International

Executive Summary

Changing trends of Mother Nature have perilous impact upon food security. While earth's surface temperature has increased, precipitation has decreased significantly across much of the globe in recent years. As such, unprecedented droughts and heavy floods have become common phenomena these days. Such climatic crises not only affect crop productivity but also food prices and supply chain infrastructure, thereby affecting food security.[1] Climatic crises further destabilise food security by deepening poverty among poor communities around the world.

Given South Asia's geographical location and high incidence of poverty, the region suffers extremely from climate change. The increased temperatures have not only affected cropping seasons but also melted the Himalayan glaciers at an alarming rate. These changes have surged up flooding and raised sea levels, severely impacting rural livelihoods in the region. Furthermore, poverty is deep and widespread in the region. Approximately 600 million South Asians live on less than US$1.25 a day.[2] During climatic crises, millions of poor people get disproportionately affected, mainly because of their heavy reliance on natural vegetation such as coastal areas for sustenance.

Despite the region's insignificant global per capita carbon emissions, more vulnerable South Asian countries like Afghanistan and Bangladesh face maximal impact of climate change upon food security. Erratic rainfall patterns and rapid

meltdown of glaciers have severely affected Afghanistan's struggling economy. Crop productivity has declined, leading Afghan farmers to switch to drought hardy cultivation. Climate change in Bangladesh had exacerbated the volatility of agricultural production in the past and continues to adversely affect agricultural production in the present. Millions of Bangladeshis rely heavily on coastal region natural resources for sustenance, and rising sea levels have seriously threatened their livelihoods.

Similarly, climatic variations in India have an unparalleled impact upon the poor and marginalised groups of population. Vast majority of rural Indians rely on rain-fed agriculture. Over the past several decades, climate change has negatively impacted the livelihoods of both farmers and fishermen in India. Furthermore, simulation studies of climatic models portray a negative impact of future climatic variations on agricultural output.

Pakistan, too, suffers from grave consequences of climate change on food security. With the rise in global temperature, the snow-capped Himalayan Mountains in the north are melting at an alarming rate. Not only arid and semi-arid areas of Pakistan but also coastal areas of the Arabian Sea in the south are vulnerable to climate change. Recurring natural hazards such as flash-floods have severely devastated agricultural output, worsening food security in the country.

This study on Climate Change and Food Security in South Asia mainly focuses on farmers' perception of climate change and its imminent impact upon their livelihoods. It covers four countries – Afghanistan, Bangladesh, India and Pakistan. It aims at addressing food insecurity and livelihood threats in South Asia by changing the region's cultivation practices and operationalising the regional food bank.

In each of the four project countries – Afghanistan, Bangladesh, India, and Pakistan – CUTS partner organisations

undertook survey of farmers. The survey consists of a total of 1,200 small and marginal farmers (300 in each country), including those who are net consumers and are dependent upon other alternatives for earning their livelihoods. The sample for each country is equally divided into three sub-samples drawn from three agro-climatic zones. To ensure that each sub-sample is representative of the selected country, it is drawn from three districts and about ten villages in each climatic zone. The official country-level data relating to households below and above the poverty line are used for surveying small and marginal farmers.

Based on the survey results and their analyses, the study provides some policy mechanisms to address the impact of climate change upon food security. It suggests measures such as adopting climate-resilient agriculture, realising regional food bank, and increasing the volume of intra-regional trade.

It also aimed at disseminating a better knowledge on the subject matter to policy-makers, researchers, CSOs and the media, particularly those who are working on agricultural issues. It will enable many rural grass-roots CSOs to better understand issues emanating from climate change and tailor their actions accordingly, so as to better serve the vulnerable communities in the region.

Our perception analyses have shown that climate change has adversely affected farmers across the Indian sub-continent. Recurrent natural hazards such as droughts and heavy floods have afflicted the region's poor population disproportionately. Farmers have reported shortened rainy seasons and increased temperatures over the years. They have lamented the decline in crop yield as a result of shortened cropping seasons. Climate change has severely impacted agriculture and resulted in a substantial decline in subsistence farming across all select South Asian countries.

Under such circumstances, farmers across the region have begun adapting to climate change. They have practiced coping strategies such as crop insurance, heavy reliance on subsidised fertilisers and pesticides and even migration to nearby cities in search of alternative livelihoods. They have sown improved variety of seeds. In India, farmers' participation in government employment schemes has increased as well.

Although farmers across the region have begun adapting to climate change, the farming communities largely understand climate variability and not climate change. As such, their adaptation strategies aim at enhancing crop productivity and reducing crop loss via cultivation of crops that are best suited to appropriate climatic zones. However, farmers need to adopt water and soil conservation measures to conserve the environment from further degradation. This will provide them with plenty of water even during dry seasons.

At the local level, the government needs to formulate both pro-environmental agricultural and pro-poor policies to better address a plethora of issues emanating from climate change. In order to better adapt to climate change, South Asian economies need to invest in research and development of climate-resilience agriculture. The region can seek foreign technical expertise in climate change mitigation and adaptation strategies.

For example, the Asian Development Bank assists the South Asian countries like Afghanistan, India, and Pakistan by developing measures to deal with the increased summer drought and competing irrigation and water supply demands. These measures include cultivation of drought-resistant crops, improvement of irrigation efficiency, enhancement of water resources management, rehabilitation of degraded forests and pasturelands and protection of watershed.[3] Respective governments of the South Asian region need to prioritise initiatives that increase the poor's asset base and limit their reliance on natural vegetation for subsistence.

At the regional level, the member countries need to increase the transfer and share of SAARC technology to promote economic growth and regional cooperation in the region. The region must work toward realising SAARC Food Bank to better serve the affected member country in times of food crises. Since intra-regional trade plays a vital role in achieving economic prosperity of the region, the respective SAARC governments must work towards liberalising agricultural trade. This enables them to spread the risks of climate change and thus increase resilience to its impacts.[4]

Endnotes

1 Gregory, P. J., J. Ingram, and M. Brklacich (2005), *Climate Change and Food Security Phil. Trans. R. Soc. B* 2005 360, 2139-2148

2 World Bank (2009), *Why is South Asia Vulnerable to Climate Change?* http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/0,,contentMDK:21991827~menuPK:2246552~pagePK:2865106~piPK:2865128~theSitePK:223547,00.html

3 Asian Development Bank (2010), *ADB Climate Change Programmes Facilitating Integrated Solutions in Asia and the Pacific*

4 Asian Development Bank and International Food Policy Research Institute (2009), *Building Climate Resilience in the Agricultural Sector of Asia and the Pacific*

1 Introduction

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Climate change has now become one of the most important operative terms used in the world development discourse, and rightly so, given the gravity of this phenomenon in terms of its predicted adverse effects on human lives and property across the globe. The Human Development Report of 2008 describes climate change as the defining human development issue of our generation. It sees the phenomenon as a threat to the freedom of people, in terms of limiting their abilities to making choices which enable them to lead lives that they value [United Nations Development Programme (UNDP), 2008]. Despite this broad awareness about the threat of climate change looming large over the existence of life forms in our planet, information about its extent, understanding about its effects and agreement about its solutions are still at a nascent stage.

At the international level, the Intergovernmental Panel on Climate Change (IPCC) is mandated with the task of assessing the scientific, technical and socio-economic information relevant for understanding the risk of human-induced climate change. Evidences collected so far indicate considerable rise in average global temperature and consequences thereof are manifested worldwide through melting glaciers, more precipitation, increasing incidence of extreme weather events and shifting seasons. These manifestations have been sensed as grave threats. The biggest concern raised by climate change,

however, is its predicted impacts on agricultural systems across the world, and rightly so, because of the direct bearing of the same on global availability of food.

The IPCC, in its Fourth Assessment, has projected considerable increases in resource drought risk in certain parts of the world, which are important agrarian strongholds, a trend which is expected to become more widespread in the coming two decades.[1] It is well recognised that there is a circular causal link starting with economic activities generating greenhouse gas (GHG) emissions and excessive concentration of these gases, leading to environmental damages and climatic aberrations, and subsequently back to overheating of economic activities. Agriculture has a very significant place in this link. As managed ecosystems, agricultural systems act as net sink of carbon dioxide as well as a net source.

Agriculture has been accused of being a major direct source of emission of greenhouse gases, as much as it is held responsible for land reformation, resulting in massive deforestation, and thereby hindering natural recycling of greenhouse gases. At the same time, agriculture is the worst affected by climate change and, therefore, is at the top of the receiving end of the phenomenon.

An intricate connection between climate change and food security plays out through the former's effects on agriculture. A larger issue that arises is the difference in the impact on agrarian sectors of different regions across the globe, rendering certain nations net gainers and others net losers. Studies have shown that the developing countries belonging to the tropical regions, home to an overwhelming majority of the poor and venerable agrarian dependents, will be the worst hit and thereby weakening their terms of trade position *vis-à-vis* developed countries and further deteriorating the already prevalent unacceptable levels of food insufficiency and hunger existing in the world as a consequence.[2]

The global scale of the issue, irreversibility of most of its effects, as well as its complex interaction with demographic, climatic, environmental, economic, health, political, institutional, social and technological processes mean that it has crucial international and intergenerational implications, in terms of achieving equitable and sustainable development goals. Massive investments in infrastructure, urban development and industrialisation are staple prescriptions for economic development and are deemed necessary for reducing disparity, eliminating poverty and promoting social cohesion.

However, heavy dependence on the natural resource base, deteriorating urban landscapes, swelling industrial wastes and chemical pollution, etc., compound the rate of change in climate and, therefore, environmental sustainability of current development paradigms is questioned. Though it is unanimously recognised that the price of the solutions to climate change is more affordable than the cost of inaction, relevant policy-making bodies at the national and international levels are yet to zero in on concrete strategies for mitigation and adaptation.

Given this context, the purpose of this study is to understand the impact of climate change on agriculture in four South Asian countries, i.e. Afghanistan, Bangladesh, India and Pakistan, and link it to the issue of mitigation and adaptation, with a focus on food security and livelihoods. The study aims to address the rural poor in these four countries and develop insights into the problems in the context of risks posed by a changing climate. It also attempts to accumulate available literature on the adaptive practices being implemented in these countries. This is expected to assist advocacy groups in spreading knowledge and encouraging policy in support of adaptation by the poor rural communities across South Asia.

This chapter deals with the analysis of the *status quo* of our understanding of climate change and food security,

statistical and scientific evidences of their occurrence as well as channels of linkages between the two. Sections 1.1 and 1.2 provide a comparative perspective on the main definitions of climate change and food security, respectively, as well as some of the major evidences on their incidences. Section 1.3 deals with theoretical exposition of linkages between climate change and food security.

1.1 Climate Change

Though 'climate change' has been a widely discussed phenomenon globally for more than two decades now, there exist divergences in perceptions about the same in terms of its extent and effects. The essential challenge while trying to understand climate change is to distinguish between natural variations in climate cycles and gradual long-term variations that pose a threat to existence of life forms in the planet caused by human activities or controllable/endogenous factors. However, such a segregation is essentially difficult since world's climatic conditions are dictated by complex interactions of numerous geo-ecological sub-systems as well as both controllable (endogenous) and uncontrollable (exogenous) factors (CICERO-UNEP Report, 2000). Hence, scientific assessment of the causes and effects of climate change, which is crucial from the point of view of seeking solutions to the problem, is a daunting task.

Attempts to define climate change are also limited by these complexities associated with the issue. In popular understanding, climate change is the consequence of rise in temperature in the earth's atmosphere, commonly known as global warming, resulting from breaching the permissibility of concentration of GHGs and the consequent trapping of radiations in the atmosphere. It is generally accepted, based partially on observations and partially on scientific evidences, that global warming leads to erratic weather patterns, melting

of glaciers, etc., which subsequently harm the delicate ecological balance of the planet. This understanding equivocally attributes the root cause of climate change to human activities, unbearable levels of emission of GHGs being the result of such activities.

Climate change in IPCC usage refers to 'change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer' (Climate Change 2007: Synthesis Report). The IPCC refers to any change in climate over time, whether due to natural variability or as a result of human activity and further notes three independent/interlinked causes of climate change: a) natural internal processes, b) external forces[3] and/or c) continuous anthropogenic changes in the composition of the atmosphere or in land use.

This usage differs from that by the United Nations Framework Convention on Climate Change (UNFCC), which defines climate change as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.[4]

An important difference between these two alternative definitions is the emphasis given on direct or indirect involvement of human activities in climate change. While the IPCC, which is entrusted with scientific evaluation of climate change, is not particular about the distinction between natural variability and human-induced changes in climatic conditions, the UNFCC is specifically focussed on distinguishing the changes that are induced by human activities or endogenous factors. This is so because the mandate of the UNFCC primarily covers policy-making at the international level to counter climate change which can target only endogenous/

controllable factors and, therefore, singling out endogenous causes of climate change is essential.

Observations indicate that, over the last century, the global average surface temperature has risen by 0.74 degrees and, while human contribution cannot be estimated, it is noted that both natural and human causes have led, and will lead, to high temperatures and associated effects.[5] Some projections anticipate temperature rise between 1 and 3.5 degrees (WTO-UNEP, 2009). It has also been noted that an average increase in temperature between 1.8 and 2.0 degrees is an inevitable situation. This is because GHG emissions will remain in the atmosphere for long periods of time and affect it even as ongoing emissions are abated *(ibid)*. Concentrations of these emissions can lead to various adverse consequences. Box 1 presents some of the important scientific evidences on climate change.

Abrupt, non-linear change is considered the most distinctive feature associated with human-induced climate change (WRI, 2008). However, there is no common definition of abrupt change. From a geological perspective, any change occurring from a few decades to a few centuries may be viewed as abrupt; from an ecological perspective, changes in climate that result in the widespread displacement or loss of a significant number of species may be considered abrupt; and from a societal perspective, changes in climate occurring within one to two human generations which result in drastic disruption to the way current civilisation is organised and functions might be considered abrupt.[6] Should abrupt climate change occur, human and ecological systems may fail to adapt.

**Box 1: Evidence Based Observations on Climate Change*
IPCC, IVth Assessment, 2007**

- 1995-2006 period ranks among the 12 warmest years in the instrumental record of global surface temperature since 1850. The linear warming trend over the 50 years, from 1956 to 2005 (0.13 °C per decade), is nearly twice that for the 100 years from 1906 to 2005.

- Average Arctic temperatures have increased at almost twice the global average rate in the past 100 years. Land regions have warmed faster than the oceans. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000m and that the ocean has been taking up over 80 percent of the heat being added to the climate system.

- Increases in sea level are consistent with warming. Global average sea level rose at an average rate of 1.8 (1.3 to 2.3) mm per year over 1961 to 2003 and at an average rate of about 3.1 (2.4 to 3.8) mm per year from 1993 to 2003. Since 1993, thermal expansion of the oceans has contributed about 57 percent of the sum of the estimated individual contributions to the sea level rise, with decreases in glaciers and ice caps contributing about 28 percent and losses from the polar ice sheets contributing the remainder.

- Observed decreases in snow and ice extent are consistent with warming. Satellite data since 1978 show that the annual average Arctic sea ice extent has shrunk by 2.7 (2.1 to 3.3) percent per decade, with larger decreases in summer of 7.4 (5.0 to 9.8) percent per decade. Mountain

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glaciers and snow cover, on average, have declined in both the hemispheres. The maximum areal extent of seasonally frozen ground has decreased by about seven percent in the Northern Hemisphere since 1900.

- At continental, regional and ocean basin scales, numerous long-term changes in other aspects of climate have also been observed. Trends from 1900 to 2005 have been observed in the precipitation amount in many large regions. Over this period, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia, whereas precipitation declined in the Mediterranean, southern Africa and parts of southern Asia.

- Globally, the area affected by drought has *likely* increased since the 1970s. Some extreme weather events have changed in frequency and/or intensity over the last 50 years:
  - It is *very likely* that cold days, cold nights and frosts have become less frequent over most land areas, while hot days and hot nights have become more frequent.
  - It is *likely* that heat waves have become more frequent over most land areas.
  - It is *likely* that the frequency of heavy precipitation events (or proportion of total rainfall from heavy falls) has increased over most areas.
  - It is *likely* that the incidence of extreme high sea level has increased at a broad range of sites worldwide since 1975.

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- There is observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970 and suggestions of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater. Multi-decadal variability and the quality of the tropical cyclone records prior to routine satellite observations in about 1970 complicate the detection of long-term trends in tropical cyclone activity.

- Average Northern Hemisphere temperatures during the second-half of the 20th century were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least the past 1300 years.

Source: IPCC (2007), Climate Change 2007: Synthesis of Contribution of Working Groups I, II and III to the Fourth Assessment Report

**Statements are based on likelihood assumptions adopted by the IPCC Working Groups. For details of likelihood assumptions and probability standards, see IPCC (2007), Treatment of Uncertainty, Pg: 27*

1.2 Food Security

The Food and Agricultural Organisation (FAO) has estimated that the total number of undernourished people in the world will decline by 9.6 percent to 925 million in 2010, after continuously increasing during the preceding five years (FAO, 2010). Though this is a positive sign and a welcome respite, this number remains unacceptably high at 16 percent of the world's population and far above the hunger reduction targets set at the World Food Summit in 1996, as well as by the MDG.[7] Developing countries account for 98 percent of the world's undernourished people and have a prevalence of undernourishment of 16 percent.

The origin of the operative term 'food security' may be traced back to the Universal Declaration of Human Rights in 1948, under the aegis of the United Nations, which recognised the right to food as a core element of standard of living. However, the literature on food security exploded since the publication of the report of the World Food Conference held in 1974 consequently to the global food crisis of 1972-74. Theoretical and empirical examination of the issue gathered momentum further in the early '80s, with the publication of Sen's entitlement approach to famine as well as a series of studies commissioned by the World Food Council (WFC), the FAO and the World Bank.[8]

Many different definitions of food security emerged from this body of literature, the most widely used at present being that adopted by the FAO during the World Food Summit held in 1996. The differences between various approaches which evolved over time stem from different priorities concerning food security during various time periods in history and different levels of understanding about the way of determining whether the population in question is food insecure.

The World Food Conference of 1974 defined food security solely in terms of food supply – assuring the availability and price stability of basic food at the international and national levels. The conference declared that food security is the 'availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices'.

FAO, in 1983, introduced the concept of access to food, leading to a more refined definition based on the balance between the demand and supply-side of the food security equation. It stated the objective of food security initiatives as 'ensuring that all people at all times have both physical and economic access to the basic food that they need' (FAO, 1983).

The World Bank Report on Poverty and Hunger (World Bank, 1986) further modified the prevailing definitions by distinguishing between chronic and sustained food insecurity associated with problems of structural mismatches and transitory food insecurity which involves periods of intensified food insecurity caused by natural disasters, economic collapses, conflicts and others (Clay, 2002).[9]

The World Food Summit of 1996, held under the auspicious of the FAO, adopted an integrated definition, taking cues from previously developed approaches, which recognises the multidimensional nature of food security and includes food access, availability, quality, usage and stability as key components of food security. Accordingly, 'food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (FAO, 1996).

As per this generally used working definition, there are four dimensions of food security, viz., food availability, stability of food supply, access to food and food utilisation. The first dimension relates to the availability of sufficient food, i.e. to the overall ability of the agricultural system to meet food demand. The second dimension, stability, refers to temporal aspect of food supply and accounts for the assertion that food must be available at all times. The third dimension, access, covers access by individuals to adequate resources to acquire appropriate foods for a nutritious diet. Finally, utilisation encompasses all food safety and quality aspects of nutrition; its sub-dimensions are, therefore, related to health, including the sanitary conditions across the entire food chain.

Expressed in general terms, there are two basic pillars of food security to which all these aspects may be related:

- Availability – Physical availability of sufficient, safe and nutritious food that meets dietary needs and thus represents both quantity and quality necessary for food security.
- Accessibility – Economic access or entitlement to sufficient, safe and nutritious food through purchase, exchange and claims.

All variants of definitions of food security used today rest on these two pillars, the theoretical foundations of which were developed through the entitlement approach (Young et al, 2001). Sen argued that shortage of food available need not be the only cause of famine, as denial of access to food because of what he calls 'failure of entitlement' could lead to hunger casualties despite physical availability of food (Sen, 1981).[10] Thus this approach is a significant departure from the earlier understanding that the availability of food is the overriding determinant of famine. It also puts the aspect of accessibility above availability as the former covers both aspects, in the sense that access will be automatically curtailed in case of non-availability (Devereux, 2001).

The entitlement approach is based on three conceptual constructs, namely, (i) the endowment set, (ii) the entitlement set, and (iii) the entitlement mapping. Endowment set is the combination of all those legally owned resources by a person including both tangible assets, such as land, equipment, animals and intangibles such as knowledge and skill, labour power or membership of a particular community. Entitlement set is defined as the set of all possible combinations of goods and services (not just the one actually being enjoyed) that a person can legally obtain by using the resources of his endowment set. The use of the resources to get final goods and services may be either in the form of production, exchange or transfer. Entitlement mapping is the rate at which the resources of the endowment set can be converted into goods and services included in the entitlement set.

A person suffers from failure of food entitlement when his/her entitlement set does not contain enough food to enable him/her to avoid starvation in the absence of non-entitlement transfers, such as charity.[11] In other words, entitlement mapping process fails for a person in terms of the inability of his/her endowment set to fetch sufficient food for her. Since entitlement set is derived using the endowment set, entitlement failure and thus famine can occur either through some adverse change either in endowment set (affecting economic access) or in the entitlement set (affecting physical availability) or both [Osmani (1993), Nayak (2000)]. Lack of food experienced by population groups irrespective of food availability at national level is a classic case of entitlement failure.

The key to analysis of food security under this conceptual framework is identifying shifts in entitlement mapping, owing to changes in the composition of endowment and entitlement sets, which leads to entitlement failure. The rationale of the entitlement approach is neither to suggest nor deny any particular hypothesis about the causes of famines, but to direct the search for causes by identifying and assessing the changes in endowments and entitlements and hence this approach is essentially a framework of analysis (Nayak, 2000). This framework inspires us to think beyond the popular notion that famines are caused by mere reduction in availability of food while not denying that famines can be caused by food availability decline. Alternatively, the broad contestable hypotheses that come to the fore through entitlement approach may be stated as follows:

> *Decline in food availability plays a role in causing famine mainly by worsening the entitlement mapping of a person through rise in price of food and not necessarily through non-availability.*

A host of similar analytical methods have been used by international agencies which consider economic issues as the cause of food insecurity as much as or even important than non-availability. Oxfam's livelihood approach and Save the Children (SC)-UK's food economy approach to food security are two such notable examples. For Oxfam, the main aim is to assess risks to livelihoods and its approach seeks to identify a variety of interventions that protect livelihoods that guarantee long-term food security.[12]

Such interventions, which are different from methods to meet food aid needs, may include food aid, but other measures range from de-stocking and fodder distribution to cash-for-work and seeds and tools distributions (Boudreau, 1998).

Livelihood approaches, enabling policy responses focused on the promotion and recovery of livelihood options, are now popular to international organisations' development programmes. They are increasingly applied in emergency contexts and include the concepts of vulnerability, risk-coping and risk management. This approach has mainstreamed the analysis of food insecurity as a social and political construct (Devereux 2000).

To estimate the severity of food insecurity, livelihood approach takes into account shifts in food entitlements and nutritional status. The food economy approach, by contrast, judges severity by the size of the food deficit (Young et al, 2001). An important aspect of the food economy approach is the attention given to explaining, context by context, the relationship between poverty and vulnerability, wherein there is a clear distinction between these two terms (Boudreau, 1998). Vulnerable groups also include those who are not poor at a given point of time but face high risk of food insecurity even with a slight change in their endowments or entitlements.

More recently, the ethical and human rights dimension of food security has come into focus. Adding on the relevant

provisions of the UN Declaration of Human Rights in 1948, the formal adoption of the Right to Adequate Food marked a milestone achievement by the World Food Summit of 1996. Article 11 of the International Covenant on Economic, Social and Cultural Rights states that 'whenever an individual or group is unable, for reasons beyond their control, to enjoy the right to adequate food by the means at their disposal, States have the obligation to fulfil that directly'. This points towards the possibility of a rights-based approach to food security (Schutter, 2009).

Currently, over 40 countries have the right to food enshrined in their constitution and FAO estimates that the right to food could be judicial in some 54 countries.[13]

1.3 Inter-linkages between Climate Change and Food Security

Climate is the primary determinant of agricultural productivity and, in this respect, climate and food availability are fundamentally interlinked. Considering agricultural systems are managed ecosystems heavily dependent on climatic conditions and given the elemental role of agriculture in human welfare, the single most important concern raised by climate change is its potential impacts on agricultural productivity. This concern has motivated a substantial body of research on possible physical effects of climatic change on agriculture, such as changes in crop and livestock yields, as well as the economic consequences of these potential yield changes.

Following from studies linking climate change, agriculture and food security, climate change is expected to influence crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems.[14] It will lead to drier weather, shorter growing seasons and is predicted to reduce the area of cultivable land, render certain crops uncultivable, increase incidence of crop loss owing to flood,

erratic rainfall, extreme weather events and related calamities. There could also be alternative and directly opposite effects of climate change on agriculture. Crop and livestock yields are negatively affected by changes in climatic factors such as temperature and precipitation and the frequency and severity of extreme events like droughts, floods, and wind storms. In addition, carbon dioxide is fundamental for plant production and its rising concentrations may have the potential to enhance the productivity of agro-ecosystems. Climate change may also change the types, frequencies and intensities of various crop and livestock pests, the availability and timing of irrigation water supplies and the severity of soil erosion (Adams et al, 1998).

In the light of analytical evidences and predicted impacts, climate change will affect food security through its four dimensions (Box 2). Also, the effects will be through both the channels of availability and accessibility.

On the one hand, it will affect long-term as well as short-term food security, through the dimension of food availability, while long-term effects will be driven by shrinking of yield rates and arable land, supply shocks owing to natural calamities will set short-term effects in motion.

On the other hand, negative impacts of climate change on food security induced through lack of accessibility may result with or without the occurrence of non-availability. Decrease in production and supply of food items puts inflationary pressure on markets even when such decrease is not large enough to cause non-availability or the incidence of per capita availability of food falling below per capita sufficiency. Food inflation severely affects the affordability of vulnerable population and, in turn, their accessibility to food markets.

These linkages between climate change and food security can be treated analytically through the framework offered by the entitlement approach. To begin with, it is useful to consider entitlement failures that may occur due to climate change at

Box 2: Climate Change Affects All Four Dimensions of Food Security

Food production and availability: Climate affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes and thus demand for agricultural produce. Changes in land suitability, potential yields (e.g., CO^2 fertilisation) and production of current cultivars are likely. Shifts in land suitability are likely to lead to increases in suitable cropland in higher latitudes and declines of potential cropland in lower latitudes.

Stability of food supplies: Fluctuation in crop yields and local food supplies will adversely affect the stability of food supplies. Climatic fluctuations will be most pronounced in semi-arid and sub-humid regions and are likely to reduce crop yields and livestock numbers and productivity. As these areas are mostly in sub-Saharan Africa (SSA) and South Asia, the poorest regions with the highest levels of chronic undernourishment will be exposed to the highest degree of instability.

Access to food: Falling real prices for food and rising real incomes over the last 30 years have led to substantial improvements in access to food in many developing countries. Possible food price increases and declining rates of income growth resulting from climate change may reverse this trend.

Food utilisation: Climate change will affect the ability of individuals to use food effectively by altering the conditions for food safety and changing the disease pressure from

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vector, water and food-borne diseases. Climate change may initiate a vicious circle where infectious diseases cause or compound hunger, which, in turn, makes the affected population more susceptible to those diseases.
Source: Schmidhuber and Tubiello (2007)

the national level and at the international level separately. This is so because, though the effects of climate change on food security at both levels are deeply interlinked and similar, as it globally transmits across borders, the scale of the effects are different from each other.

1.4 Climate – Food Linkages in the National Context

Following the entitlement approach, within national boundaries, negative impacts of climate change on agrarian sectors may lead to food insecurity for certain sections and/or whole of the populace by shifts in their endowment set and/or entitlement set.

- Changes in Endowment Set – Changes in access to common resources or inputs for agriculture sectors (falling ground water tables, inadequate rainfall, shifting seasonal durations, shrinking arable land, etc.) lead to declining output, falling real incomes and thereby count down the endowment set of people dependent on agriculture. However, the net gains of producers depend on how gains from rise in price of food items, because of supply shocks, offsets losses from fall in output.
- Changes in Entitlement Set – Decline in agricultural produce has a direct implication in terms of reduction of food items in the entitlement set.
- Changes in Entitlement Mapping – Changes in the entitlement and endowment sets of individuals or households alter the rate at which and channels through which resources

in the endowment sets are used or converted for accessing food items in their entitlement sets and thereby reset the conditions of their accessibility to food.

In this exposition, the most notable feature is that the endowment set mainly changes only for agricultural producers and the effect of this change on their real income and subsequent access to food depends on two forces acting in opposite directions, viz., fall in quantity and rise in price of their agricultural output. But, rise in the price of agricultural output has not been known to have much positive influence on real income, purchasing power and living standards of marginal agriculture dependents. Ironically, the majority of food insecure people in the world are dependent on agriculture fully or partially for their livelihoods. Out of those who suffer from hunger in the world – counting over 10 crores – about 80 percent are dependent on primary activities, including farming, fishing and forestry.[15]

A strong majority of the small landholders in the developing countries are either net buyers of food or just self-sufficient (World Bank, 2008). There are about 70 crore farm labourers in the world engaged in producing food which is too expensive for them to purchase in many cases (Schutter, 2009). This shows that fall in output and rise in price negatively affect the endowment and entitlement sets and render a large vulnerable group defenceless to food insecurity.

The literature of famine arising out of Africa's crises in the 1970s stressed the importance of markets in determining whether people go hungry and contributed to the view that poor farmers are often highly dependent upon cash transactions and other forms of exchange for their access to food (Boudreau, 1998). Vulnerability of agrarian dependents on falling agricultural output and imperfections in distribution as a major cause of food insecurity are well documented in the literature.

Further, the analysis of hunger during crisis and recovery brings to the fore the fact that effects of food market shocks on hunger do not disappear when the crisis is over. Affected households deal with shocks by selling assets, which are very difficult to rebuild, by reducing food consumption in terms of quantity and variety and by cutting down on health and education expenditures and all these have long-term negative effects on quality of life and livelihoods (FAO, 2010).

Given these ground realities, negative impacts of climate change on food production and resultant food inflation together fortify the chance of reduction in real income and thereby directly threaten food security of people belonging to the lowest income strata.

Thus, by changing the entitlement mapping process, climate change has the potential to generate acute famine even before it causes reduction of food supply to a point when actual non-availability of sufficient food per capita occurs.

1.5 International Dimensions of Climate – Food Linkage

A larger added risk for this to happen arises from the fact that developing countries of the global south will be the worst affected because of climate change and an overwhelming majority of the vulnerable agrarian dependents reside in these countries.[16] Global assessments of the potential impact of climate change on world food supply suggest that developing countries are likely to bear the brunt of the crisis of decrease in global crop production due to doubling of the atmospheric carbon dioxide concentration. Simulation exercises carried out on the effects of adaptive measures by farmers imply that such efforts will do little to reduce the disparity between developed and developing countries in climate change impacts.[17]

Quantitative studies analysing the impact on global food production, prices and land usage show that climate change-induced crop yield change affects food production of countries to varying degrees, depending on the location of farming activities (Lee, 1994).[18]

Differentiated yield changes of crops may lead to reallocation of agricultural land among uses. Developing countries would be more adversely affected by climate change than developed countries due to shifting cropping patterns and yield rates, developed countries being mostly located in higher latitudes and climate change benefits the crop yield of these areas.

Considering also the fast growing population in the developing world, developed countries are expected to serve as the world's key food exporters by 2020, should climate change occur as projected in the 2nd assessment scenario of IPCC *(ibid)*.

Further empirical studies on the economic effects on world agriculture under alternative climate change scenarios provide the results that aggregate economic welfare losses, following altered world patterns of consumption and production of agricultural commodities, are likely to be borne by developing countries and least developed countries of SSA, South and East Asia.[19]

In broad terms, climate change will increase the risks to and reduce the productivity of developing country agriculture. In contrast, production could be boosted in developed countries, so that the distribution of world food production may shift. Certain results suggest reductions in production in developing countries between the range of 5-10 percent, accompanied by similar increases of production in northern developed regions, especially North America and Russia (Fischer *et al,* 2005).

Developing countries are likely to become more dependent on imports from the rich world, with their farmers losing market shares in agricultural trade. By 2080, the number of additional people at risk of hunger could reach 600 million – twice the number of people living in poverty in SSA today (UNDP, 2008).

Given these predictions and extrapolating the entitlement mapping scenario presented in the preceding section to the international level, both aggregate endowment and entitlement sets of tropical developing countries and temperate developed countries will undergo very significant changes. The most notable change is that the former group's gross domestic product, a significant part of which is agricultural income, will shrink on account of falling agricultural output. Such a trend will worsen the terms of trade between developing and developed countries in favour of the latter group, compromising the food sufficiency of poor countries where occurrence of hunger has already been the highest and hence causing further damages to their ability to feed their own population.

Therefore, the effects on food security and incidence of famine at the global level face the added dimension of risk that, in all probability, the most vulnerable and poor countries will suffer from loss of agricultural output because of climate change.

1.6 Policy Challenges

Economics of climate change, so far, has been focused on analysing implications of emissions for growth, calculating the social costs of carbon, exploring the options of taxing the responsible agents on this basis and assessing the costs and benefits of alternative options for adaptation and mitigation. The grave consequences facing global food security, as

examined in the preceding sections imply that time has come to think beyond these conventional approaches and resort to more nuanced analysis and strategies.

Climate change, like other environmental problems, involves an externality; the emission of greenhouse gases damages others at no cost to the agent responsible for the emissions (Stern, 2006). The standard theory of externalities prescribes appropriate taxation of the emitter, clear definition of property rights for holding emitters accountable and other direct regulatory actions as solutions. But here, we have many jurisdictions, weak representation of those most affected (future generations), long-term horizons, a global scale, major uncertainties, important interactions with other market failures and hence a much deeper and more complex economic policy problem is at hand, which calls for a departure from conventional approaches.

In addition, the nature of the problem of climate change in terms of its causes and effects implies that a broad range of ethical perspectives are likely to be involved, including issues of consequentialism, equity, fairness, justice, freedom, rights, sustainability and stewardship *(ibid*). Adding the fundamental right to safe and secure access to food to this list means that the new approach towards global policies and strategies must cover a very broad range of disciplines, including environmental management, growth and development, innovation and technological change, international developmental institutions, demography and migration, public finance, information and uncertainty as well as a host of other subjects connected with these.

The earth's atmosphere does not differentiate greenhouse gases by country of origin. As a common asset, neither can property rights over it be distributed. It follows that no one country can win the battle against climate change acting alone (UNDP, 2008). While international collective action to address

climate change remains an inevitable necessity, the path to such a collective action must be preceded by assessment of their own policy positions and priorities by individual countries and regions. Adoption of strategies for food security and the realisation of right to food for every individual, an obligation of individual states, must be amongst such priorities. This would help build equitable long-term international agreements that address both climate change and food insecurity with clearly defined and jointly endorsed responsibilities of parties obliged by it, leading to much needed positive results.

Endnotes

1 See IPCC (2007) and Parry *et al*. (2007) for detailed report.
2 Comparative effects on developing and developed country groups is dealt with in Tobey et al. (1993), Reilly et al. (1994), Rosenzweig and Parry (1994) and Mandelsohn (2000). For prospective changes in pattern of world production and trade in food items see WTO-UNEP (2009) and Schutter (2009).
3 External forces refer to external, natural events outside the climate system causing a change in this system, e.g. volcanic eruptions, solar variations, etc.
4 Article 1, the United Nations Framework Convention on Climate Change, 1992.
5 For details, *see* WTO-UNEP (2009) and CICER-UNEP (2000).
6 Some possible abrupt physical and ecological events that have been predicted include: a dramatic reorganisation of the thermohaline circulation (the ocean's conveyer belt effect that moves equatorial heat to the north, warming Europe), rapid de-glaciation and melting of permafrost or increases in soil respiration leading to fast changes in the carbon cycle (WRI, 2008).
7 The World Food Summit's goal is to reduce, between 1990–92 and 2015, the number of undernourished people by half. Millennium Development Goal 1, target 1C, is to halve, between 1990 and 2015, the proportion of people who suffer from hunger.

8 For more details see Maxwell and Smith (1992).
9 This development was influenced by Amartya Sen's seminal work on entitlement approach to famine (Sen, 1981).
10 A detailed exposition can also be found in Sen and Dreze (1989).
11 Sen, 1981.
12 Oxfam defines food security as: when everyone has at all times access to and control over sufficient quantities of good quality food for an active healthy life. For an analytical exposition of livelihood approach *see* Boudreau, 1998.
13 In 2004, a set of voluntary guidelines supporting the progressive realisation of the right to adequate food in the context of national food security were elaborated by an Intergovernmental Working Group, under the auspices of the FAO Council, helping to promote legal adoption of Right to Food in many countries.
14 Details of linkages and research evidences can be found in Moench et al (2003), Ludi (2009), IFPRI (2009).
15 On an average, farmers are poorer than non-farmers and rural households have lower average income than non-rural households in developing countries. The ratio of rural incomes to non-rural incomes ranges from 40-75 percent within developing countries' group (Aksoy, 2005).
16 The majority of the world's undernourished people live in developing countries. Two-thirds live in just seven countries (Bangladesh, China, the Democratic Republic of the Congo, Ethiopia, India, Indonesia and Pakistan) and over 40 percent live in China and India alone (FAO, 2010). Also, see Rosenzweig *et al.*, 1993.
17 See Rosenberg and Parry (1994),
18 Lee (2009) uses a multi-region, multi-sector computable general equilibrium (CGE) model, which considers crop suitability of land in the optimal reallocation decision of land between uses, to simulate as projected under the IPCC SRES Scenario Assessment 2.
19 See Tobey et al. (1993), Reilly, Hohmann and Kane (1994), Shah *et al.*, (2008).

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2 Global Scenario: Climate Change and the State of Food Security

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The increasingly rapid pace of global industrialisation and urbanisation have significantly warmed earth's atmosphere over the past few decades. The surface temperature increased by 1.22 degree centigrade between 1955 and 2005. The year 1998 remained the hottest year, thus making the 1990s the warmest decade (World Bank, 2009). Most alarmingly, temperature will continue to rise by 0.2 degree centigrade for the next two decades (IPCC, 2007).

Because of global warming, earth's weather patterns will change drastically. While precipitation will increase at high altitudes, causing flash floods, it will decrease in sub-tropical areas, resulting in severe droughts (Oxfam, 2009). Tropical cyclone will increase by 10 to 20 percent, with a rise in sea surface temperature of two to four degrees centigrade, relative to current base temperature. Snow cover will melt and sea level will rise as a result of past and future emissions of CO_2. Furthermore, storm surge heights will increase due to stronger winds, increased sea surface temperature and low pressure (World Bank, 2009).

Such changing weather patterns will disproportionately affect millions of poor livelihoods around the world. Almost 98 percent of the world's hungry population subsist in the

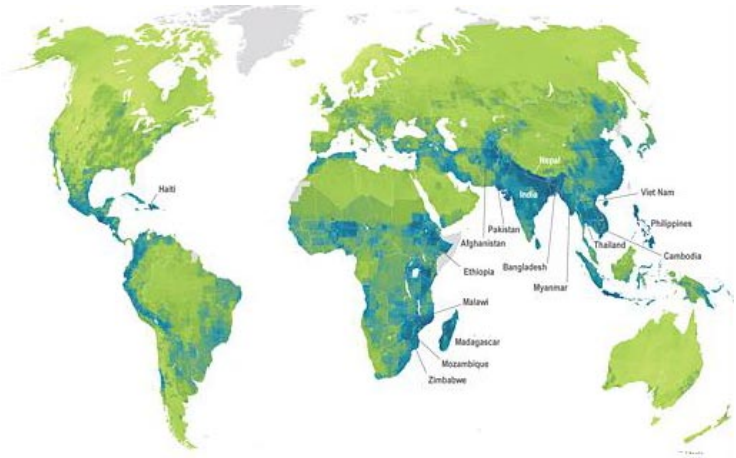
developing world, where the rate of undernourishment is 16 percent. SSA countries account for 30 percent of the undernourished people.

'Two-thirds of the world's hungry population live in just seven countries (Bangladesh, China, the Democratic Republic of the Congo, Ethiopia, India, Indonesia and Pakistan)' [FAO, 2010]. In these countries, rain-fed agriculture remains the key livelihood strategy for millions of small farmers. But, with increasingly erratic rainfall patterns, agriculture will be severely affected (United Nations, 2010). Furthermore, in times of natural calamities like droughts, poor rural farmers will be faced with limited coping strategies. Hence, climate change will negatively impact millions of poor livelihoods, worsening food insecurity.

2.1 South Asia: Climate Change and Millennium Development Goal (MDG)

The region suffers extremely from climate change, mainly due to its geographical diversity and high incidence of poverty. With majestic beauty, South Asia ranges from the Himalaya Hindu Kush mountain belt to low-lying riverine land. The thundering rivers gushing from the Himalayas not only sustain natural vegetation but also support millions of livelihoods living along the floodplains of their tributaries. But, over the past several decades, Himalayan glaciers have retreated alarmingly. This phenomenon has resulted into massive flooding and sea level rise, affecting millions of livelihoods (World Bank, 2009). The map (see Page 33) shows the level of vulnerability of South Asian Region (SAR) to climate change.

Climate Change Vulnerability Index 2011



Legend
Extreme risk
High risk
Medium risk
Low risk
No Data

Rank	Country	Rating
1	Bangladesh	Extreme
2	India	Extreme
3	Madagascar	Extreme
4	Nepal	Extreme
5	Mozambique	Extreme

Rank	Country	Rating
6	Philippines	Extreme
7	Haiti	Extreme
8	Afghanistan	Extreme
9	Zimbabwe	Extreme
10	Myanmar	Extreme

Source: Maplecroft

Table 1 shows the nature of climatic risks faced by South Asian economies.

Table 1: Water Resources in South Asia: Climate Change Issues and Priority Areas

Country	Climate-change Priorities	Scale and Magnitude	Priority Focus Areas
Afghanistan	Glacier melting in the Himalayas	Regional	Himalayan Hindu Kush
	Lake outburst	Local to national	Hill and mountain areas
	Floods and droughts	National to regional	Helmand and Kabul basins
Bangladesh	Floods	National to regional	Ganges, Brahmaputra, Meghna basins
	Increase in natural disasters	National to regional	Coastal zones
	Saltwater intrusion	Local	Coastal zones
Bhutan	Glacier melting in the Himalayas	Regional	Himalayan Hindu Kush
	Lake outburst	Local to national	Hill and mountain areas
	Floods	National to regional	Ganges tributary basins
	Droughts	Local to national	Throughout
India	Glacier melting in the Himalayas	Regional	Himalayan Hindu Kush
	Floods	National to regional	Ganges, Brahmaputra, Meghna basins
	Droughts	Local to national	Throughout
	Increase in natural disasters (cyclones)	National to regional	Coastal zones
	Saltwater intrusion	Local	Coastal zones
Maldives	Increase in natural disasters (cyclones and sea-level surges); loss of land mass	Local to national	Throughout
Nepal	Glacier melting in the Himalayas	Regional and national	Himalayan Hindu Kush
	Lake outburst	Local to national	Hill and mountain areas
	Floods	National to regional	Ganges tributary basins
	Droughts	Local to national	Throughout
	Saltwater intrusion	Local to provisional	Coastline
	Wetland desiccation and degradation	Local to national	The Ramsar Sites
Pakistan	Glacier melting in the Himalayas	Regional	Himalayan Hindu Kush
	Increased water scarcity and droughts	Local to national	Indus basin
	Saltwater intrusion	Local	Coastal zones
Sri Lanka	Increase in natural disasters (cyclones and sea-level surges)	Local to national	Coastal zones

Natural calamities have become more common these days, risking the attainment of MDGs within the agreed time period. One of the key MDGs is to halve extreme poverty and hunger by 2015. But, such is the scenario in South Asia: The region is home to one-fifth of the world's population. Vast majority of people live in extreme poverty and, because of insufficient calorie intake, significant percentage of children suffers from malnutrition. The region's poor rely on natural vegetation for subsistence. And, during natural calamities, they get disproportionately affected due to disease outbreak and food supply deficiency.

Table 2: 2010 Progress on Millennium Development Goal 1 (MDG1)-Hunger Target				
Already met MDG1	**On track toward achieving MDG1**	**Insufficent progress**	**No progress or deterioration**	**Not relevant (hunger below 5% in 1990)**
Armenia	Angola	Bangladesh	Botswana	Algeria
Azerbaijan	Benin	Bolivia	Burundi	Argentina
Chile	Brazil	Central African Republic	Congo, Dem. Rep	Costa Rica
Congo, Rep	Burkina Faso	Cote d' Ivoire	Gambia	Egypt
Cuba	Cambodia	Dominican Republic	Guatemala	Iran
Gabon	Cameroon	El Salvador	India	Jordan
Georgia	Chad	Eritrea	Korea, DPR	Kazakhstan
Ghana	China	Guinea	Liberia	Korea, Rep.
Guyana	Colombia	Haiti	Madagascar	Lebanon
Jamaica	Ecquador	Indonesia	Pakistan	Libya
Kuwait	Ethiopia	Kenya	Swaziland	Malaysia
Mali	Honduras	Laos	Tanzania	Mexico
Morocco	Kyrgyzstan	Lesotho	Trinidad & Tobago	Saudi Arabia
Myanmar	Malawi	Maldives	Uganda	Syria
Nicaragua	Mauritania	Mongolia	Uzbekistan	Tunisia
Nigeria	Mauritius	Nepal	Yemen	Turkey
Uruguay	Mozambique	Panama	Zambia	United Arab Emirates
Viet Nam	Namibia	Rwanda		
	Niger	Senegal		
	Paraguay	Sierra Leone		
	Peru	Suriname		
	Phillipines	Tajikistan		
	Sri Lanka	Turkmenistan		
	Sudan	Venezuela		
	Thailand	Zimbabwe		
	Togo			

Source: www.fao.org/fileadmin/templates/es/Hunger_Portal/MDG_Progress_per_country.pdf

2.2 Afghanistan: Climate Change and the State of Food Security

2.2.1 Climate Change

Significant climatic variations have occurred in Afghanistan in the last several decades. Since 1960, the country's temperature has risen by 0.6 degree centigrade at an average rate of 0.13 degree centigrade per decade (Savage et al., 2009). The country has observed exceptionally hotter days and warmer nights in recent years. Presently, the country suffers from severe droughts, with little or no precipitation at all. Mean rainfall has decreased by 6.6 percent per decade since 1960 (UNDP, 2008a).

Future climatic patterns of Afghanistan show that the country is set to suffer from increased temperatures. There will be a predicted increase of 2.0 to 6.2 degree centigrade by 2090s (UNDP, 2008a). Future days and nights, especially during summer seasons, are expected to be extremely hot. Overall, the country will experience drier seasons, as rainfall is expected to reduce over the coming years (Savage et al., 2009).

Furthermore, the country will be hard-hit by severe droughts, turning vast swathes of land into desert. Increased temperatures will continue to dominate the country's weather patterns for several years to come.

2.2.2 Food Security

The present day food security scenario in Afghanistan is very bleak. Vast majority of rural Afghans suffer from food deprivation. Statistical findings show that approximately 61 percent of the population consumes poor to very poor food. Around 30 percent of the Afghan population does not have sufficient food to sustain daily life. And, approximately 20 percent of the Afghan population suffers from chronic food insecurity (USAID, 2007). The National Risk and Vulnerability

Assessment (NRVA, 2005) summarises food insecurity in Afghanistan as follows: 'At the household level, food insecurity in Afghanistan is largely caused by inadequate access to food resulting from low household incomes' (World Bank, 2005).

Historically, the country used to be a net supplier of fresh and dry fruits; but years of civil strife and severe droughts have devastated the country's agricultural production, worsening food security. Nonetheless, in recent years, the World Food Programme (WFP) and the European Commission Humanitarian Aid Office, in conjunction with the Government of Afghanistan, have been working towards securing food security in the country (Mittal and Sethi, 2009).

2.2.3 Impact of Climate Change on Food Security

Despite Afghanistan's insignificant contribution to global GHG emissions, it faces a maximal impact of climate change on food security. Ravaged by years of foreign occupation and civil strife, the country lacks meteorological data on climate change and food security. But, there exist foreign meteorological data, which indicate that changing climatic patterns have severe impact upon Afghanistan's agriculture, consequently affecting its food security. Climatic models suggest that drought will be an accepted norm in Afghanistan by 2030, as opposed to a cyclical event (Savage et al., 2009).

Moreover, with an ongoing retreat of the Himalayan glaciers, the country faces periodic floods and a loss of natural vegetation. The earlier retreat of glaciers and the erosion of alluvial soil will result in high crop failures, due to shortages of water supply and fertile land for cultivation. Hence, crop productivity will decline, 'leading Afghan farmers to switch to drought hardy cultivation, including opium poppy' (Savage et al., 2009).

Erratic rainfall patterns and rapid meltdown of glaciers will severely affect Afghanistan's struggling economy. Agriculture

is the principal occupation of nearly 70 percent of Afghanis and accounts for approximately 40 percent of the country's GDP. Nevertheless, only 12 percent of Afghanistan's total land mass is arable. Out of the 12 percent of total arable land, only four to five percent is irrigated, while seven percent is rain-fed and cropped opportunistically [United Nations Development Programme (UNDP)]. With erratic rainfall patterns, rain-fed agriculture of Afghanistan will be hardest hit. And, rapid meltdown of glaciers will initially cause an overflow of water in the *Helmand River,* resulting into severe floods. Subsequently, there will be 'drastic declines in water supplies in the *Helmand River*, drying up 99 percent of its downstream *Sistan* wetlands' (UNDP). This will have an irreparable loss on Afghanistan's agriculture, which is the mainstay of nation's economy.

2.3 Bangladesh: Climate Change and the State of Food Security

2.3.1 Climate Change

With the increased frequency of natural calamities, Bangladesh has suffered considerably over the past several years. Cyclones have increased from five per decade in 1901 to 48 per decade in 2000. Flooding has increased from 0.6 per year in 1960 to 2.9 per year in 1990.[1] Because of increased flooding and cyclones, massive loss of human lives and property has occurred between 1991 and 2003.

Climatic models show that the country will suffer more as a consequence of global warming. A median warming of 1.1, 1.6 and 2.6 degrees centigrade are expected in '30s, '50s, and '80s, respectively. The intensity of flooding will increase by 10 percent in coming decades. And, a projected 15 cm rise in sea level will perennially flood six percent of the total area (Yu et al., 2010). Most of the coastal areas of Bangladesh are within a distance of one metre from the sea level. Given the scenario of rising sea

level, 'just 1 metre rise in sea level will inundate 17 percent of Bangladesh' (Government of Bangladesh, 2009).

2.3.2 Food Security

Despite being afflicted by serious famines in the past, Bangladesh today has emerged as an agriculturally self-sufficient country. Agriculture is the principal occupation of nearly two-thirds of Bangladeshis and contributes to 20 percent of nation's GDP. Rice is the main cultivated crop that is sowed and harvested on approximately 10 million hectares (FAO). The cropping seasons in Bangladesh are classified as Aman season (November-February), Boro season (March-June) and Aus season (July-October). During the Aman season, Aman rice is cultivated; during the Boro season, Boro rice, wheat and pulses are cultivated; and during the Aus season, Aus rice and jute are cultivated (Zeller et al., 2001).

In order to secure food for all, Bangladesh underwent intensive food reforms over the past few decades. Food reforms were initiated by employing latest agricultural technologies, subsidising fertilisers and introducing new breeds of seeds from foreign laboratories. The government expanded irrigation networks and liberalised import of agricultural commodities, thus easing food deficit. Successive Bangladeshi governments prioritised food security and invested in enhancing agricultural productivity of the country (Titumir and Basak, 2010).

But, even after achieving agricultural self-sufficiency, the country still ranks near the bottom in Global Hunger Index (GHI). Vast majority of children are malnourished. One of the key reasons affecting its food security is food price inflation. In Bangladesh, approximately half of the country's population live below the national poverty line. A significant portion of their income is spent on food. As such, amid growing food price inflation and natural calamities, such as flash floods, poor Bangladeshis are destined to be hit the hardest.

2.3.3 Impact of Climate Change on Food Security

Climate change in Bangladesh had exacerbated agricultural production in the past and will continue to adversely affect agricultural production in the future. The country is situated as a low-lying riverine between the foothills of the Himalayas and the Indian Ocean. The movement of three major rivers, namely, the Ganges, Brahmaputra and Meghna (GBM), has a significant effect on crop productivity. An overflow in these river tributaries causes flooding in Bangladesh during cropping seasons of the year, severely affecting crop productivity (Yu et al., 2010).

For example, the 1998 flood resulted into the loss of more than two metric tonnes (Mt) of crop production. Simulation studies of climatic models portray a negative impact of future climatic variations on agricultural output. With rise in temperatures and sea levels, *Boro* production will decline by three percent and five percent in 2030s and 2050s, respectively.

In coming decades, the southern sub-region will experience a loss of 10 percent in wheat yield during *Aus* and *Aman* seasons and a loss of 18 percent in wheat yield during the *Boro* season. The country will suffer an average loss of 7.4 percent in rice yield over the 2005-50 simulation period. Most alarmingly, 'climate variation will cost the country's agricultural sector US$26bn (in discounted terms) in lost agricultural GDP during the 2005-50 period' (Yu et al., 2010).

With the rising sea level, millions of livelihoods in Bangladesh are under serious threat. Poverty-ridden Bangladeshis rely heavily on coastal region natural resources for sustenance. About 32 percent of Bangladesh is comprised of coastal regions and is home to 35.1 million people (Pervaiz, 2009). It is estimated that '65 percent of the 250-square kilometre area in the coastal island of Kutubdia, 227 sq km in Bhola and 180 sq km in Swandip in Bangladesh have already gone under water because of the sea- level rise'(Pervaiz, 2009).

2.4 India: Climate Change and the State of Food Security

2.4.1 Climate Change

Periodic droughts and cyclonic storms have become more frequent in many parts of India. Monsoon seasonal rainfall has decreased by six to eight percent of the normal in eastern Madhya Pradesh, north-eastern India and some parts of Gujarat and Kerala over the past century (Lal et al., 2010). Storms have become more common in India, especially in West Bengal and Gujarat. They have increased at a rate of 0.011 events per year (Sehgal, 2009).

Furthermore, sea level has risen between 1.06 to 1.75 mm per year (IPCC, 2007). Such changing climatic patterns will dominate India even towards the end of the 21st century. India will experience intense rainfall, leading to massive soil erosion and landslides. 'While the number of rainy days will decline by 15 days, the intensity of rainfall will increase by one to four mm per day' (Lal et al., 2010). But the intensity of rainfall will increase in rain abundant areas, leading to flooding and loss of fertile soil.

Drought prone areas like Rajasthan, Gujarat, Madhya Pradesh and Andhra Pradesh will receive less rainfall, resulting in severe droughts (Lal et al., 2010). Moreover, India's rising surface temperatures over the years will rapidly meltdown the Himalayan glaciers. Studies show that the temperature is increasing at a rate of 0.21 degrees Celsius per 100 years and ground level waters are falling by one to three meters per year (Sehgal, 2009).

2.4.2 Food Security

Since time immemorial, agriculture has persisted as one of the mainstays of India's economy. It is the principal occupation of approximately 52 percent of the total labour force and

accounts for 17.5 percent of nation's GDP. Because of its great geographical variation, India has been classified into 15 agro-climatic regions. These regions can broadly be classified into the Himalayan regions, the Gangetic plains, plateaus and hills, coastal plains, ghats, the dry region and the island region (FAO, 1999). Some of the major crops grown in India are wheat, rice, corn, maize, millets, pulses, oilseeds, jowar and sugarcane. Over the past several decades, India's agricultural sector has boomed, achieving food self-sufficiency.

But, despite achieving food self-sufficiency in the last 30 years, India's food security has worsened over the past 15 years. After Independence, the Indian Government initiated major reforms in food policies to achieve food self-sufficiency. High yielding varieties (HYV) of wheat were adopted and major irrigation facilities were built. Consequently, there was a remarkable improvement in wheat and rice output during the '70s. This era is termed as the Green Revolution. However, over the course of time, agricultural growth has been slower, making an average Indian food insecure. The current availability of cereals per capita in India is only 390 grams per day, which is less than what is needed for a healthy life (Mitra, 2010). 'For a healthy life, per capita availability of cereals and pulses per day should be at least 510 grams per day' (Mitra, 2010). Moreover, with increased population, not only consumption of food has increased exponentially but also arable land has been diverted to urbanisation, thus risking food security.

Contrary to such findings, critics argue that, in India, the rate of growth in agriculture has been higher than the population growth rate (Mitra, 2010). And, unlike other South Asian countries, India is a net food exporter. Nonetheless, India ranks considerably low in Global Hunger Index (IFPRI, 2010). High incidences of malnutrition among children and anaemia among women are prevalent in rural India (WFP,

2008). As such, food may be abundant in the country, but vast majority of rural Indians do not have access to sufficient and nutritious food at all times.

2.4.3 Impact of Climate Change on Food Security

In recent years, climatic patterns across India have changed and changes have negatively impacted agricultural sectors in the country. Due to increased heat waves, days are getting hotter and nights warmer. These changes have affected summer monsoon precipitation, which, in turn, has affected food productivity. While rainy and winter seasons have shortened, summer season has extended, with a record temperature as high as 48 degrees centigrade in Rajasthan and adjoining states. Such rising temperatures and falling rainy seasons have resulted in the destruction of sown seeds and crop failure, worsening food security.[2]

Climatic variations have an unparalleled impact upon poor and marginalised groups of the population. Vast majority of rural Indians rely on rain-fed agriculture. When rainfall patterns become more erratic and shorter, farmers are more vulnerable to many risks, including droughts, diseases and unpredictable market irregularities. In their research analysis, Oxfam India, along with several NGOs, report farmers' perceptions of climate change and crop productivity. According to farmers, crop productivity has declined due to decreased rainfall. Sowing season has shifted due to changed monsoon seasons. And, pests and diseases have increased due to increased humidity and temperatures.[3]

Not only farmers but fishermen too in India have been adversely affected by climate change. India has the most densely populated coastal region in the world (UN World Resource Index, 1998), meaning that vast majority of rural Indians depend on coastal natural vegetation for subsistence. But, with climate change, their livelihoods are at serious risk. The rise

in temperatures and release of industrial effluents into the sea have resulted in the depletion of fish (Sridhar, 2002). Moreover, with the rising sea level, the upstream salinity in the sea will increase over the years. And, this will 'adversely affect river-based fisheries, expand the range of warmer water species and contract colder water species' (Sud, 2009).

Simulation studies of climatic models portray a negative impact of future climatic variations on agricultural output. For instance, in most places of north India, grain yields will decline by 15-17 percent for every two-degree centigrade rise in temperature. In Rajasthan, production of pearl millet will decline by 10-15 percent for every two-degree centigrade rise in temperature. In Madhya Pradesh, soybean yields will decline by five percent for every three-degree centigrade rise in temperature. Overall, an increase of two-degree centigrade in temperature will reduce rice production by about 0.75 tonne per hectare and an increase of 0.5-degree centigrade in winter temperature will reduce wheat production by about 0.45 tonne per hectare (Lal et al., 2010).

In Jharkhand, Orissa and Chhattisgarh, severe droughts will reduce rice production by 40 percent of the total production. And, in Gujarat and Maharashtra, the rising sea levels will inundate and salinise coastal regions, thereby affecting agricultural productivity of the coastal regions (Lal et al., 2010).

2.5 Pakistan: Climate Change and the State of Food Security

2.5.1 Climate Change

There have been marked climate changes in Pakistan over the past few decades. In arid coastal areas, arid mountains and hyper-arid mountains, surface temperature has risen by 0.6 to one degree centigrade. In the coastal belt and hyper-arid plains, there has been a 10 to 15-percent decline in both winter and summer rainfall. Furthermore, the country has

experienced a rise of 18 to 32 percent in monsoon rainfall in sub-humid and humid areas. Severe cyclones along the coastal lines of the Arabian Sea have been frequent events in Pakistan (Farooqi et al., 2005).

Severe weather patterns have hard-hit Pakistan time and again. The country had the worst flood in *Jhelum River* in 1992. With a record snowfall in northern areas and heavy rains in Balochistan, the country had one of the worst natural disasters in 2005 (Mahmood, 2008). And, again in 2010, Pakistan had the worst flood, which inundated approximately one-third of the country and resulted into massive loss of human lives and properties.

Climatic models predict that variations in temperatures and precipitation will be common phenomena in coming decades. Pakistan will face rising temperatures during the next-half of the 21st century. However, rainfall patterns are not expected to be uniform throughout the country. While the northern region is expected to have increased precipitation, the southern coastal regions and western Balochistan are expected to have decreased precipitation over coming decades (Farooqi et al., 2005).

2.5.2 Food Security

Like other South Asian economies, Pakistan, as well, has an agro-based economy. Agriculture is the main occupation of approximately 45 percent of the total labour force and accounts for 21.8 percent of the country's GDP.[4] The country has been classified into 10 agro-ecological zones (FAO, 2007). Some of the major crops grown in Pakistan are wheat, rice, sugarcane and cotton. During 1970s, the country's agricultural sector had boomed with the introduction of HYV seeds, implementation of latest farm technologies and construction of irrigation canals. This era is often termed as the Green Revolution.

Nonetheless, Pakistan's present state of food security is disappointing. In 1998 and again in 2003, The WFP Pakistan conducted a research study to analyse food security in the country. The findings of the research show that there is a considerable gap in food security between the urban and rural Pakistan. Rural Pakistan is relatively food insecure than urban Pakistan. Most alarmingly, food insecurity is prevalent in states which produced surplus cereals. This is mainly due to lack of availability of cereals with increased population (Mittal and Sethi, 2009). Food price inflation has further worsened food security in the country and the Government of Pakistan considers it as a serious threat to national economy (Babu and Bhalachandran, 2008).

2.5.3 Impact of Climate Change on Food Security

Pakistan, too, suffers from grave consequences of climate change on food security. With the rise in global temperature, the snow-capped Himalayan Mountains in the north are melting at an alarming rate. The Gangotri glacier is retreating 98 feet per year.[5] Such melting of glaciers has resulted in the loss of agricultural output. In the past, severe cyclonic storms in coastal areas and worst droughts have adversely affected Pakistan's agricultural output. Mahmood (2008) writes that increased heat waves across the Indian Sub-Continent in 2005 reduced agricultural yields by 10 to 40 percent of the harvests for that year (Mahmood, 2008).

Simulation studies of climatic models portray a negative impact of future climatic variations on agricultural output. In all climatic zones of Pakistan, except humid zones, wheat productivity will decline with the rise in global temperature. For example, in arid southern plains, a five-degree centigrade rise in temperature over the baseline will decline wheat yield by 1000 kg/hectare. But, in humid northern mountains, a five-degree centigrade rise in temperature over the baseline will

increase wheat yield by 900 kg/hectare. With the rising temperatures, the growing season will shrink by 14 days in southern semi-arid areas and by 35 days in humid northern mountains (Mahmood, 2008). This implies a total loss of agricultural output in rain-fed areas of Pakistan. Similarly, in southern semi-arid plains, a five-degree centigrade rise in temperature over the baseline will decline rice productivity by 1400 kg/hectare. But, rice and wheat productivity will increase with rising emissions of CO_2 (Mahmood, 2008). Nevertheless, net agricultural productivity will decrease with increasing environmental degradation.

Not only arid and semi-arid areas of Pakistan but also coastal areas of the Arabian Sea in the south are vulnerable to climate change. In the past, coastal inhabitants enjoyed fishing and

Table 3: Agriculture and Food Security Indicators

Countries	Contribution of Agriculture to GDP (in percent)	Ag. labour force as percentage of total labour force	Poverty headcount ratio at US$2 a day (PPP)	% of undernourished population
Afghanistan	40	59.8		
Bangladesh	19.1	45.21	81.33	27
Bhutan	21.9	96.71	49.49	Na
India	19.0	55.75	75.59	21
Maldives	6	15.33	Na	Na
Nepal	32.9	87.73	77.57	16
Pakistan	20.4	41.33	60.31	26
Sri Lanka	13.2	47.27	39.74	19
Total	-	53.7	73.40	-

Source: Figures in this Table are from UNCTAD Handbook of Statistics 2010 and World Bank World Development Indicators Database; na: not available

Table 4: Climate Risks by Country

	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Pakistan	Sri Lanka
Sea-level rise	–	√	–	√	√	–	√	√
Glacier retreat	√	√	√	√	–	√	√	–
Temperature increase	√	√	√	√	√	√	√	√
Floods more frequent	?	√	√	√	√	√	√	?
Drought more frequent	√	√ (some areas)	?	√	–	?	√	?

Likely: √ Not Present: – Unknown: ?

Source: Table E.1 World Bank, 2009. "South Asia: Shared Views on Development and Climate Change."

Table 5: Reported Natural Disaster Impacts in South Asia (1990-2008)

Country	Population[56] ('000)	Deaths ('000)	People Affected ('000)	Population Affected (%)[57]	Damage (US$millions)
Afghanistan	22,615	6.1	5,410	23.9	69,060
Bangladesh	143,990	155.3	145,713	101.2	12,984,000
Bhutan	602	0.2	66	11.0	3,500
India	1,071,608	53.4	885,244	82.6	25,743,100
Maldives	279	0.0	2	0.7	500,100
Nepal	25,278	4.6	2,796	11.1	245,100
Pakistan	162,662	9.4	27,943	17.2	3,573,054
Sri Lanka	19,258	0.5	6,331	32.9	1,670,070
Total	**1,368,327**	**229.5**	**1,073,504**	**78.5**	**44,787,984**

Source: Emergency Events Database (EM-DAT: The OFDA/CRED International Disaster Database) (http://www.em-dat.net) and United Nations World Population Prospects (http://esa.un.org)

Source: Table 8.1 World Bank, 2009. "South Asia: Shared Views on Development and Climate Change."

some subsistence agriculture. But, in recent years, subsistence agriculture has been hard-hit by salinisation and inundation of sea water. Moreover, the quality of drinking water has been deteriorating with the intrusion of sea water (Abbass, 2009). Tables 3 and 4 summarise food security, climate risks and natural disaster impacts in South Asian economies.

2.6 South Asia: Intra-regional Trade

While South Asian countries have heavily traded with the outside world, the intra-regional trade has been disappointingly low due to a host of trade barriers, protectionism and distrust among member countries. In fact, it is the least integrated region in the world. This is clearly borne out in Table 6. SAARC countries export 92 percent and import 95 percent of food products from non-SAARC countries. But, the intra-regional food trade is merely five percent of its total trade.

Hence, in order to promote economic growth and prosperity of the region via trade liberalisation, the SAARC member countries signed the SAFTA charter in Dhaka in 1993. This agreement essentially came into force from January 01, 2006. Under this charter, the member countries have agreed to gradually phase out tariffs on goods, with the exception of items in the sensitive list. This is indeed a positive step towards greater economic cooperation and stability in the region. Since countries specialise and trade goods in which they have comparative advantages, trade liberalisation will inevitably enhance consumer welfare and boost the region's economy.

But, critics argue that many South Asian economies have similar comparative advantages over the production of both agricultural and non-agricultural products, given the similar nature of factor endowments and cost structure (Hassan, 2000). Nonetheless, even in the absence of comparative advantage, the region benefits by trading goods that have achieved economies of scale (Hassan, 2000).

'SAFTA allows the participating countries to achieve larger economies of scale in production, attain specialiaation, increase competitiveness and diversify their export base, thus assisting domestic economic reform' (Khoso et al., 2011). Since intra-regional trade plays a vital role in achieving economic prosperity of the region, the respective SAARC governments must work toward realising the SAFTA charter without any political and bureaucratic barriers.

Table 6: SAARC Food Trade in 2005 and 2009 (in thousands of US$)								
	Exports				Imports			
	Export Food share in Total Exports (in percent)		Destination in 2009 (in percent)		Food Import share in Total Imports (in percent)		Origin in 2009 (in percent)	
	2005	2009	SAARC	Other	2005	2009	SAARC	Other
Afghanistan	-	55.51	-	-	-	7.70	-	
Bangladesh	5.94	3.38	-	-	12.65	17.85	-	-
Bhutan	10	5.97	0.17	99.83	14.36	14.16	97.39	2.61
India	7.51	6.12	5.56	94.44	3.29	3.72	2.10	97.90
Maldives	65.78	96.51	0.08	99.92	13.90	20.09	37.25	62.75
Nepal	18.35	22.57	0.98	99.02	13.50	11.44	34.80	65.20
Pakistan	11.55	16.46	0.71	99.29	8.63	9.42	6.36	93.64
Sri Lanka	20.34	23.94	0.52	99.48	10.88	14.23	19.57	80.43
Total	8.56	7.41	8.02	91.98	5.03	5.50	5.24	94.76
Source: ITC Trade Map								

2.7 Conclusion

Plagued by deep poverty and backwardness, food insecurity widely prevails in many South Asian economies. All South Asian countries, except India, are net food importers. High incidences of malnutrition among children and anaemia among women are prevalent in the region. South Asia alone accounts for approximately 40 percent of the world's hungry population (IFPRI, 2010). And, most disturbingly, the state of food security has further worsened due to declining agricultural growth (1993-2006) and increasing population over the past several years (Mittal and Sethi, 2009).

Besides deep poverty, climate change has further destabilised these economies, plunging them into food security crises. With rise in global temperatures, natural calamities like droughts and floods have become recurrent phenomena. The region heavily relies on rain-fed agriculture and, with erratic rainfall patterns, agriculture has been severely affected in recent years. Moreover, rising temperatures are expected to negatively affect crop productivity. Such human-induced changes in earth's atmosphere have worsened food security.

While some developing countries have made considerable progress towards securing food security, many South Asian countries still lag far behind in hunger reduction. For example, developing countries like Armenia and Chile have already achieved MDG 1, i.e. halving extreme poverty and hunger by 2015. Ethiopia, Peru and other developing countries are on track towards achieving MDG 1. But, South Asian countries like Bangladesh, India and Pakistan lag far behind the rest of the world in hunger reduction (FAO, 2010).

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3 Farmers' and Other Stakeholders' Perception about Climate Change and its Impact on Food Security

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In order to understand and map the nature and type of problems faced by farmers and identify areas for further research that will assist in addressing food insecurity in South Asia, CUTS International has undertaken the present *Scoping Study* covering four countries of South Asia – Afghanistan, Bangladesh, India and Pakistan. This study is based on small and marginal farmers. The long-term objectives of the study are to help address food insecurity and livelihood threats in South Asian countries by changing cultivation practices and operationalising regional food bank.

3.1 Intermediate or Short-term Objectives

- To understand if there is any decline in crop yield experienced by farmers;
- To understand the real causes of decline in crop yield in South Asia;
- To deduce whether awareness exists among small and marginal farmers and related NGOs in South Asia about the negative impact of climate change on crop yield;
- To ascertain measures required to ensure sustainable livelihoods of small and marginal farmers;

- To ascertain stakeholders' perceptions regarding effectiveness of international cooperation in technology transfer and whether its adaptation and other related activities can be helpful in alleviating the negative impact of climate change on agricultural production in South Asia; and
- To ascertain if there is any need to reform the multilateral/ regional system for trade/aid in food grains in reducing the adverse impact of climate change.

3.2 Major Concepts

- Small and marginal farmers' perceptions about factors leading to variation in crop productivity;
- Farmers' perceptions about measures that can help them not only in minimising the impact of climate change on food security but also in increasing crop yield;
- Perceptions of grassroots' NGOs, sociologists and agronomists regarding the impact of climate change on food security; and
- Stakeholders' perceptions regarding the regional Food Bank to secure food security in the region.

3.3 Methodology

3.3.1 Farmers' Sample Size and Distribution

In each of the four project countries – Afghanistan, Bangladesh, India and Pakistan – one local partner was identified and engaged to support CUTS in undertaking a survey of farmers. A total of 1200 small and marginal farmers (300 in each country), including those who are net consumers and also depend on others for earning their livelihoods, were sampled. The sample for each country was equally divided[1] into three sub-samples drawn from three agro-climatic zones. To ensure that each sub-sample is representative of the region chosen, it was drawn from three districts and about ten villages

in each zone, with focus on small and marginal farmers. The official country level data relating to households below and above the poverty line were used for surveying small and marginal farmers.

3.3.2 Selection of Regions

The choice of regions for the sample survey in each country was the outcome of consultation between the local partners and CUTS. However, the selection was largely based on three broad criteria, as outlined below:

(a) Selection should be geographically representative.
(b) It should cover at least three agro-climatic zones.
(c) The selected region should be producing at least one staple crop.

Based on the above criteria, following agro-climatic zones were selected for the study:

Box 3: Sample Distribution

Afghanistan	Southwestern Hot dry Zone (Kandahar)	Dand	100
	Wet/Moist Hot Zone (Nangarhar)	Khewa	100
	Central Colder High Altitude Zone (Panjshir)	Rukha	100
	Sub-total		***300***
Bangladesh	North-western Drought Prone Area	Dinajpur	77
	North-western Flood Prone Area	Gaibandha	40
	North-eastern Haor/Flash Flood Prone Area	Sunamgonj	83

Contd...

	Southwestern Coastal Area/ Cyclone & Saline Affected Area	Satkhira	100
	Sub-total		***300***
India	Semi-arid zone (Rajasthan)	Tonk	100
	Western coastal region (Maharashtra)		100
	Humid wet agro-ecological region (U.P.)	Jhansi	100
	Sub-total		***300***
Pakistan	Northern ecological zone (Gilgit)	Gilgit	100
	Arid zone (Punjab)	Bhawalpur	100
	Lower Indus Plain (Sindh)	Badin	100
	Sub-total		***300***
	Total Sample *(four countries)*		**1200**

3.3.3 Administering Farmers' Survey

Based on sample selection, a detailed questionnaire was prepared. Farmers were surveyed by administering the questionnaire. They were asked whether they have noticed any significant decline in crop yield in the recent past. If the answer was affirmative, an effort was made to ascertain the causes of this decline and whether they associate such decline with weather variability (climate change) and/or social, economic and technological barriers. Respondents were asked whether or not they have practiced climate change adaptation measures such as water conservation and flood control initiatives. The survey was based on personal meetings between farmers and survey teams.

3.4 Analysis of Farmers' Perception

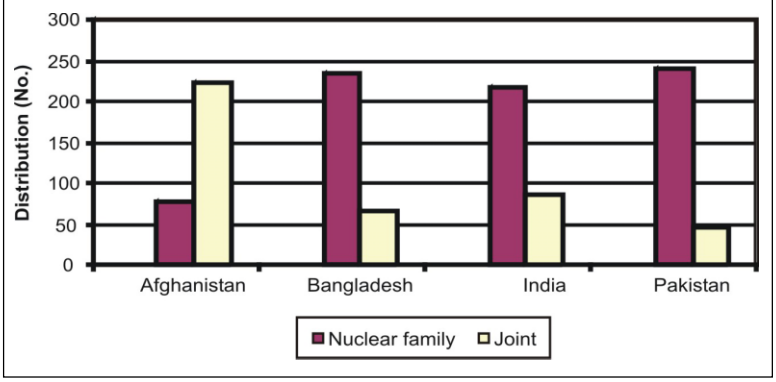
The report seeks to highlight the following aspects of climate change and food security:

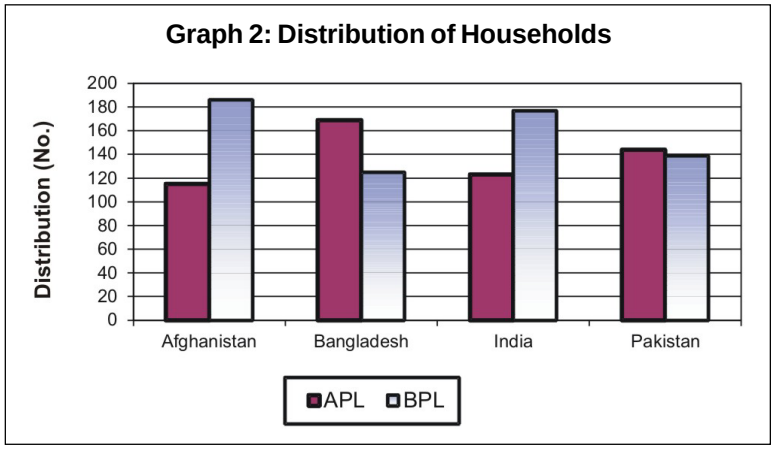
- Major issues facing small and marginal farmers as consequences of climate change;
- Major livelihood issues which are not the consequences of climate change;
- Factors impacting crop yield;
- Measures that address declining crop yield; and
- Stakeholders' perceptions about the need for a programme on international cooperation based on technology transfer to mitigate climate change and ensure food security in the region.

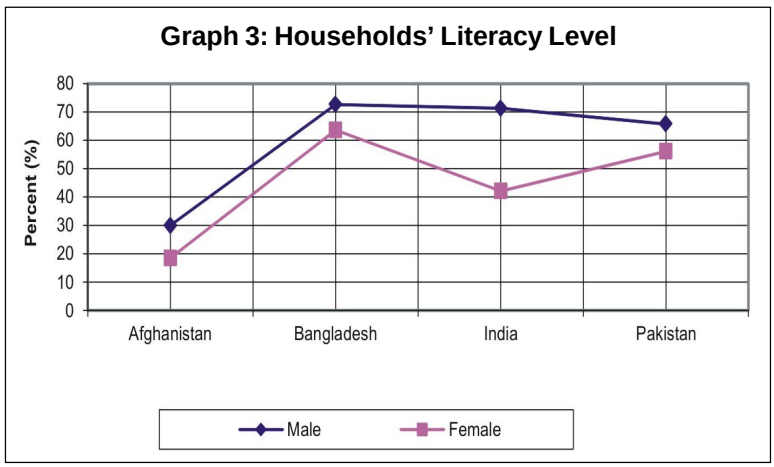
3.4.1 Household Characteristics

To make the sample representative of the SAR, a mix of households, nuclear and joint, were selected for survey in each of the select countries. The sample also covered both people living below and above the poverty line. In South Asia, a large number of farmers are illiterate. In order to capture an overall view of rural perspectives, care was taken to cover both literate and illiterate households. Some basic characteristics of the selected households such as family type, economic condition and literacy levels are depicted in the following graphs.

Graph 1: Household Characteristics







3.5 Households' Perception about Climate Change and its Impact upon Livelihoods

How Farmers Identify Climate Change?

South Asian farmers identify climate change as change in weather patterns such as increased temperature, lengthened summer seasons, erratic and more intense rainfall, increased hailstorm and others. According to farmers, these phenomena

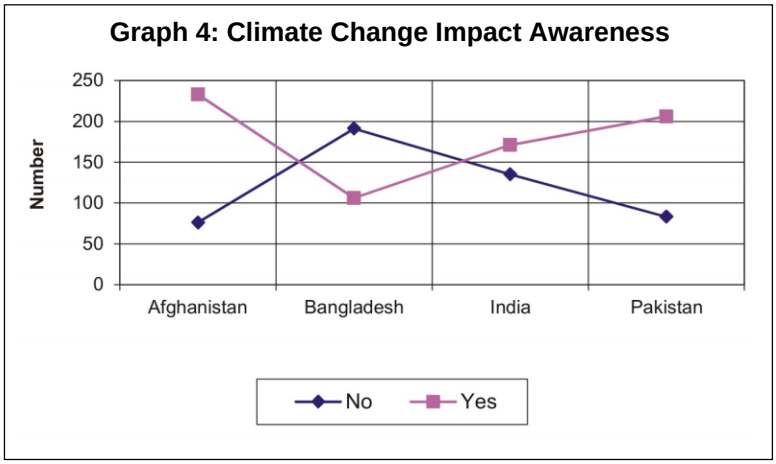
often destroy crops, resulting in the declined production, reduced income, increased poverty trap and other economic hardships.

What makes the region more vulnerable is the fact that these farmers are not in a position to effectively counter the challenges emanating from climate change and its resulting consequences. Their adaptive capacity is found to be very low, mainly due to low economic capacity, low information and knowledge base, absence of alternative opportunities, low level of government and non-governmental interventions and others. These attributes have made lives and livelihoods of farmers more vulnerable. Some details relating to farmers' perception about climate change and its impact on their livelihoods are enumerated in the following sections.

Perception about Climate Change Impact

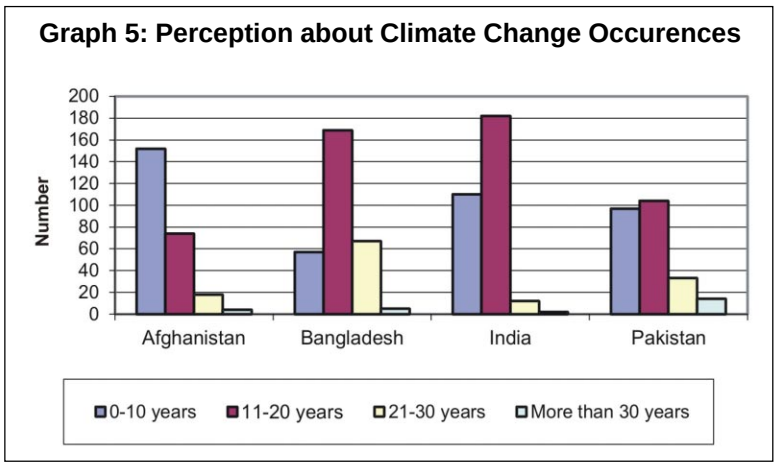
Majority of respondents appear to be aware of climate change and its impact upon their livelihoods (Graph 4). Data reveal that awareness about climate change impact among farmers is higher in Afghanistan and Pakistan than in India and Bangladesh. Out of these four countries, Bangladesh is the only country where a major proportion of surveyed farmers were unaware of climate change impact. This may be due to terminological error. At the aggregate level, data reveal an interesting finding that the level of awareness across countries is not correlated with the level of literacy (Graph 3). For example, in Afghanistan, the awareness about climate change impact is very high. But, Afghanis lag behind other South Asians on literacy level. This establishes the fact that people's awareness about climate change impact is more influenced by practical experiences than by prevailing literacy rates.

The survey data demonstrates significant variations in the level of impact awareness and occurrences of climate change across the select countries.



Perception about Climate Change Occurrences

People's perception about climate change occurrences has varied with time across countries. At the aggregate level, nearly half of the respondents feel that there is a definitive shift in climate change occurrence during the last 11-20-year period. About one-third of the respondents opine that climate change occurrence is taking place over the past one decade. At the country level, a majority of farmers in Bangladesh, India and

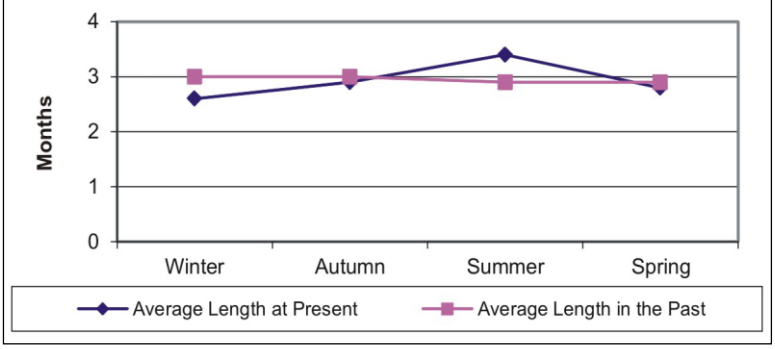


Pakistan are of the opinion that climate change has gained momentum over the last two decades (Graph 5). These perceptions might have been influenced by more pronounced occurrences of floods and droughts in recent years.

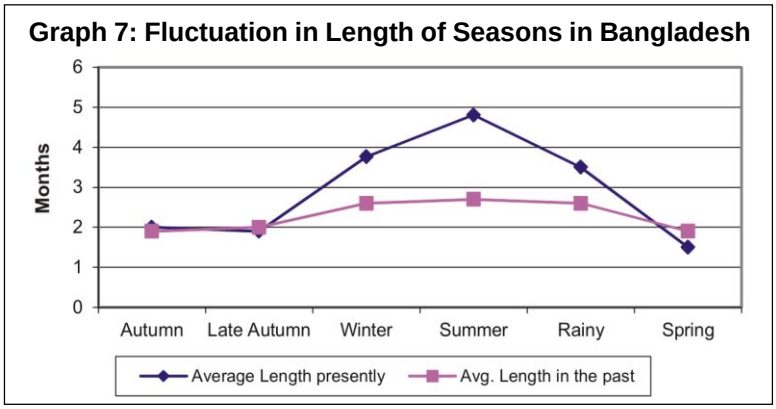
Perception about Change in Cropping Seasons

Climate change in South Asia duly gets reflected by people's perception about change in seasons – say months covering a season. In the case of Afghanistan, there is a shift in duration of all other seasons, with the exception of autumn. Most significantly, winter appears to have shrunk considerably (Graph 6). The survey also reveals that the length of summer has increased and the season has extended forward to cover parts of rainy season. This change in duration of summer and other seasons is adversely impacting cropping patterns and life cycle of crops in the country.

Graph 6: Fluctuation in Length of Seasons in Afghanistan



The situation in Bangladesh is not quite different from Afghanistan. The lengths of winter, summer and rainy seasons have increased and, on the other hand, the length of spring has decreased. It is expected that an increase in the length of summer season will adversely influence the plantation of next crop and an increase in the length of rainy season will adversely



impact the timely ripening and harvesting of crops. In fact, change in seasons is expected to impact the whole cropping cycle. Additionally, analysis of farmers' perception in different agro-climatic zones of the country shows that climate change impacts will be different for different zones in the country.

Similar weather patterns are observed in India and Pakistan as well. Farmers have reported increased summer season and decreased winter and rainy seasons. In India, summer season has expanded by more than a month. This has shortened other important seasons, especially the rainy season. Farmers are now being pushed toward adapting to new strategies by changing their cropping patterns and taking other initiatives to cope up with the scenario.

Perception about Frequency and Intensity of Natural Hazards

The change in seasons is taking place along with increased frequency and intensity of natural hazards. The respondents were requested to respond whether they have experienced any change in frequency and intensity of these natural hazards.

Although each of the above mentioned 11 natural hazards has varying impact on different countries, both frequency and intensity of natural hazards have increased in all the countries (Graph 8). In Afghanistan, rainfall, dust storm and drought

Box 4: Types of Natural Hazards	
1. Drought	7. High intensity rainfall
2. Flood	8. Earthquake
3. Cyclone	9. Hailstorm
4. Dust storm	10. Landslide
5. Frost	11. Fire
6. Storm surge	

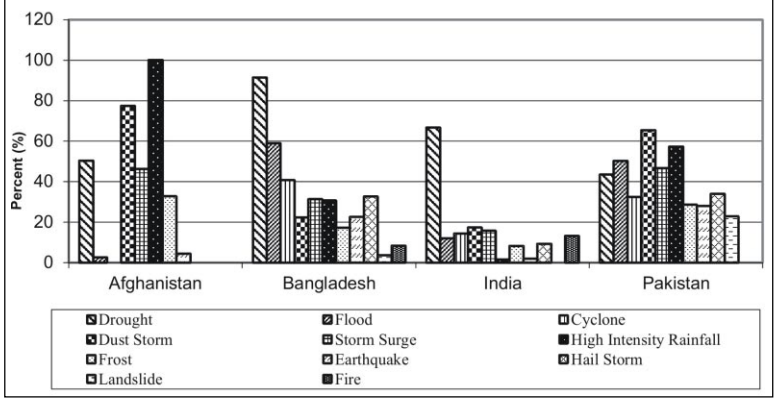
are the main natural hazards adversely impacting the lives and livelihoods of rural people, especially the small and marginal farmers. Frequencies of these disasters in Afghanistan have increased considerably.

In Bangladesh, drought, flood and cyclone continue to devastate livelihoods of small and marginal farmers much more frequently. In India, drought is considered to be the most frequently occurring natural hazard. Nearly two-thirds of the respondents opine that the frequency of drought has increased over the last few years.

Farmers' perception about natural hazards in Pakistan is found to be more widespread. They believe that the frequency of natural hazards has increased alarmingly. More than 20 percent of the respondents feel that almost all types of natural hazards are occurring much more frequently than the previous decades. About 40-65 percent of the respondents feel that the frequencies of dust storm, rainfall, flood, storm surge and drought have increased over the base period.[2]

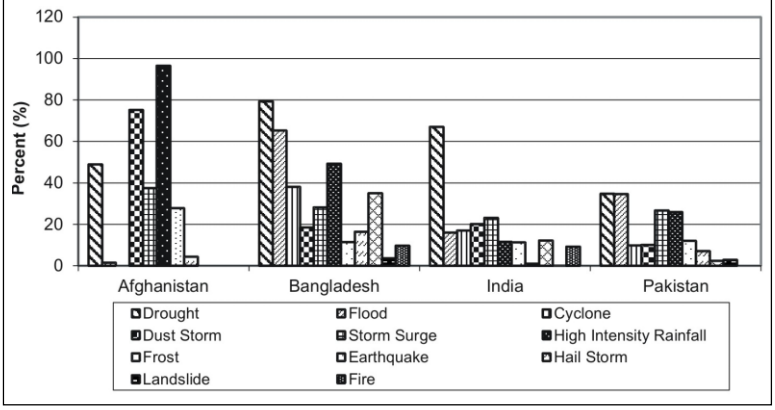
When asked about the intensity of natural hazards, respondents across all countries indicated that the intensity of natural hazards has increased over the base period. But, there are visible variations in responses on intensities of different types of natural hazards in these countries (Graph 9).

Graph 8: Frequency of Natural Hazards in South Asia



In Afghanistan, nearly 100 percent of the respondents feel that the intensity of rainfall has increased and about 50-80 percent of the respondents feel that the intensities of drought and dust storms have increased over the base period. In Bangladesh, about 20-80 percent of the respondents believe that the intensities of drought, flood, cyclone, storm surge, rainfall and hailstorm have increased.

Graph 9: Intensity of Natural Hazards in South Asia



Drought and storm surge are two major natural calamities affecting India. More than 20 percent of the respondents in India opine that the intensity of storm surge has increased over the base period. Over 80 percent of the respondents feel that the intensity of drought has increased over the years.

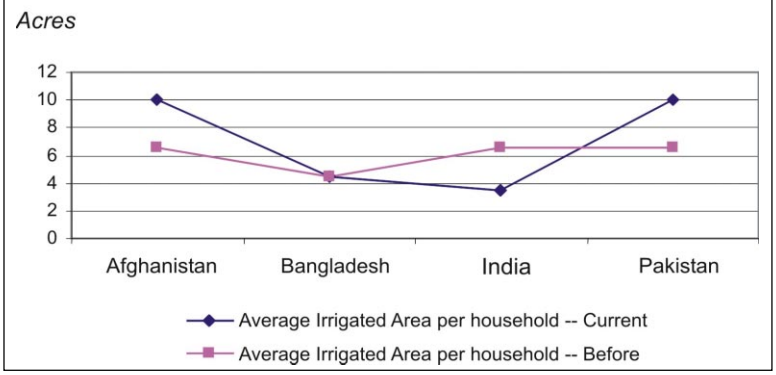
In Pakistan, 20-40 percent of the respondents opine that the intensities of drought, flood, storm surge and rainfall have increased over the base period. Less than 20 percent of the respondents feel that the intensities of remaining natural hazards have increased over the years.

Impact of Changing Seasons on Agriculture, Productivity and Food Availability

Impact on Irrigated Area

A decline in average irrigated area can indicate two things. First, there is a decline in the underground water level as a result of disturbance in water cycle. Second, there is a decline in affordability as a result of increased cost of irrigation. The perception survey reveals that in all the countries, the underground water level has decreased alarmingly. Thus, any decline in the average irrigated area can be due to disturbed water cycle and shortened rainy season.

Graph 10: Trend in Average Irrigated Area

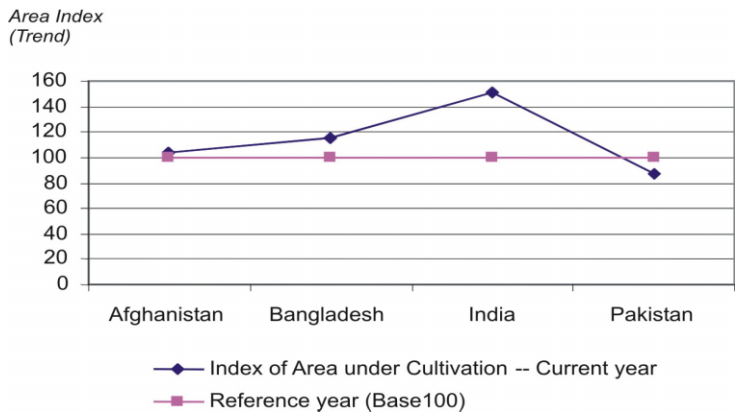


At the country level, the trend indicates that average irrigated area in Afghanistan and Pakistan has increased considerably (Graph 10). However, data show that there is no increase in productivity, despite an increase in average irrigated area. While India has experienced a decline in average irrigated area, Bangladesh has experienced no change.

Impact on Area under Cultivation

Data show that current area under cultivation has increased over the base year (base year taken as 100) across all the selected countries, except for Pakistan. The increase appears to be the highest in India, followed by Bangladesh and Afghanistan. This may be due to reclamation of earlier unused land. Data may also have included both sown and unsown area.

Graph 11: Trend in Area under Cultivation

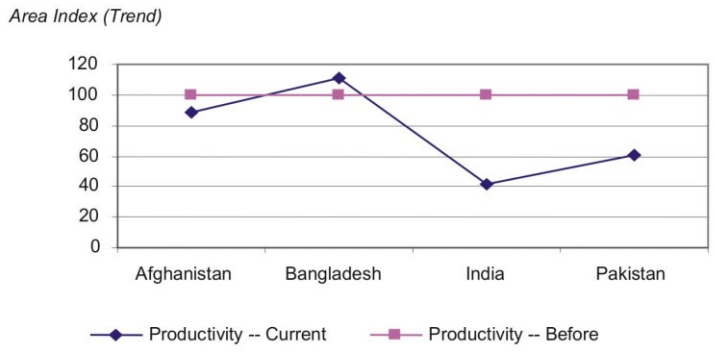


Impact on Productivity

Agricultural productivity in India has declined considerably and this appears to be more prominent than in any other country included in the present study. Farmers' perception in India and Pakistan shows that the decline in productivity is more than 40 percent. In Afghanistan, the decline in

productivity is about 10 percent. Bangladesh is the only country which has realised an increase in productivity over the base period (Graph 12).

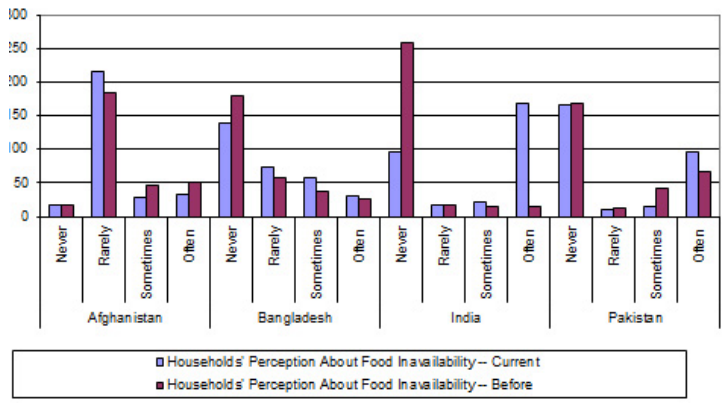
Graph 12: Comparing Productivity over the Base Year



Impact on Food Unavailability

Small and marginal farmers in all the selected South Asian countries feel that food unavailability issue has escalated, compared to the base period (Graph 13). In Pakistan, about 25 percent of the respondents feel that it has now become a

Graph 13: Households' Perception on Food Unavailability

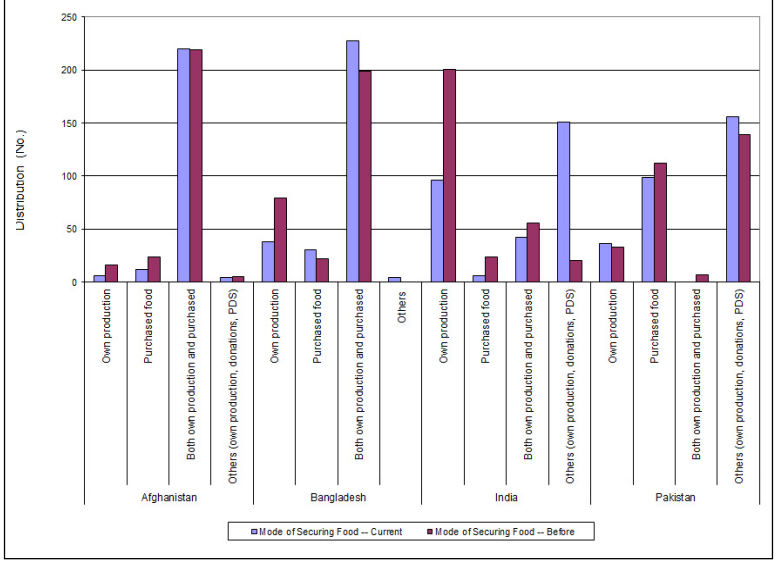


common phenomenon. Farmers' responses from Afghanistan, Bangladesh and India also indicate that food unavailability issue has become much more pronounced than before.

Impact on Change in Mode of Securing Food

Data indicate that there is a definitive change in the mode of securing food over the base period. An increased number of people appear to be dependent on both own agricultural production and the market for food. Farmers' dependence on own agricultural production has significantly declined in three countries, namely, India, Bangladesh and Afghanistan. As such, farmers' dependence on the market for food has increased. It is further expected that this increased market dependence will continue and become more pronounced with the increased impact of climate change in near future.

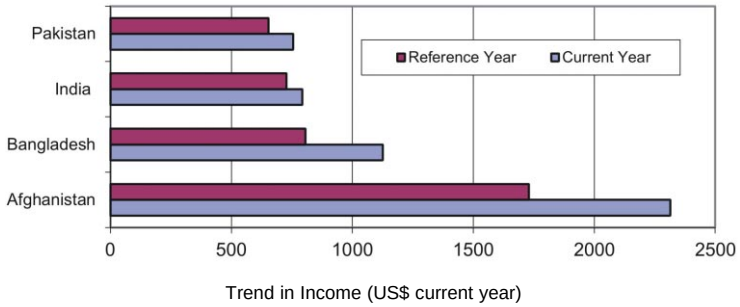
Graph 14: Mode of Securing Food



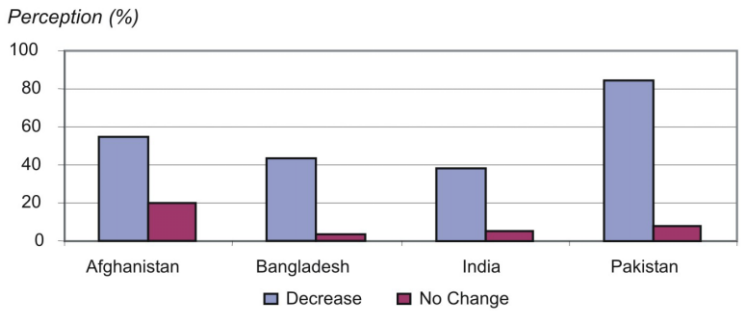
Impact on Income Levels

With the ongoing climate change, the real income level of small and marginal farmers across the selected South Asian countries has decreased over the base year income (Graph 16).

Graph 15: Farmers' Perception about Average Income (US$ current year)



Graph 16: Trend in Real Income Level



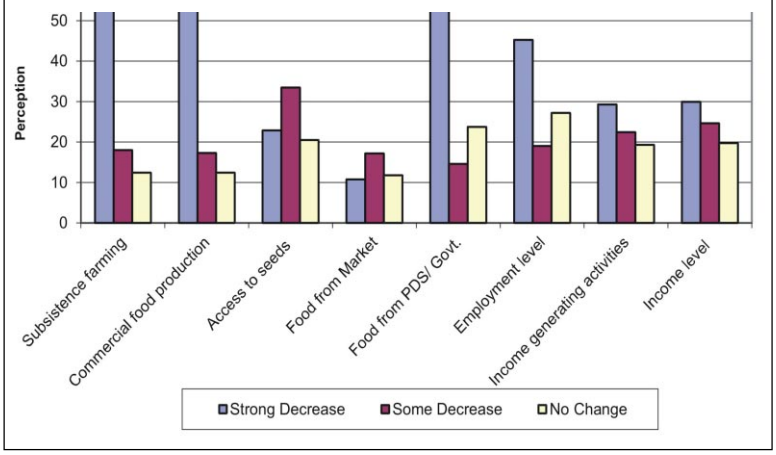
Impact on Factors that Influence Livelihood

Household responses reveal that weather variability has affected rural dynamics to a considerable extent. At a disaggregated level in Afghanistan, changing seasons have impacted agriculture and led to substantial decline in subsistence farming, commercial food production and food availability from public distribution system (PDS).

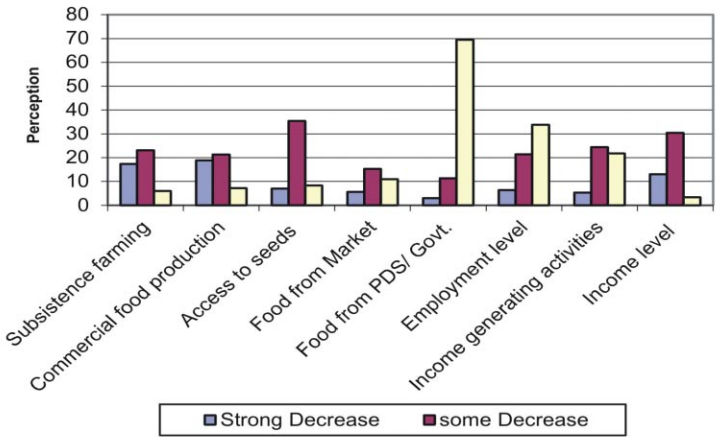
In Bangladesh, changing seasons have resulted in significant decline in seed accessibility, commercial food production and subsistence farming.

In India, over 70 percent of the respondents feel that subsistence farming has declined as a result of the changing weather patterns. The situation is not much different in Pakistan, where two-thirds of the respondents feel that there is a significant decline in subsistence farming. And, all these factors have, in turn, negatively impacted the income level of local communities (Graphs 17-20).

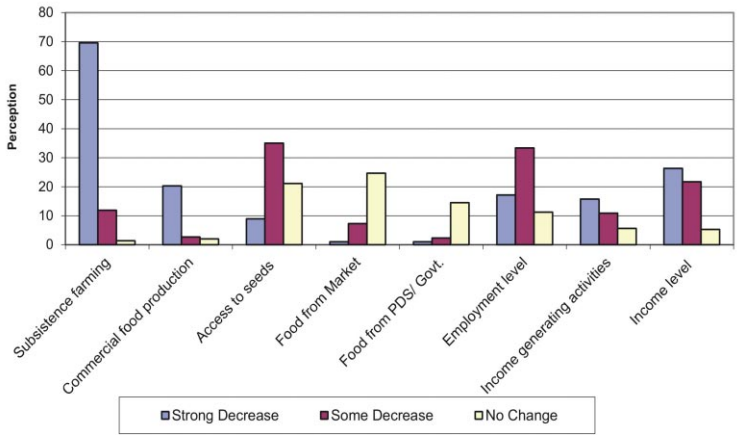
Graph 17: Households' Perception about Factors that Influence Livelihood in Afghanistan (in percent)

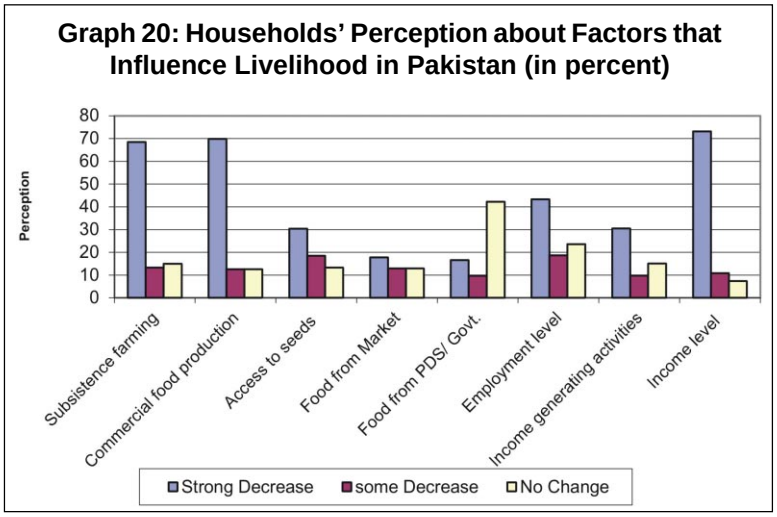


Graph 18: Households' Perception about Factors that Influence Livelihood in Bangladesh (in percent)



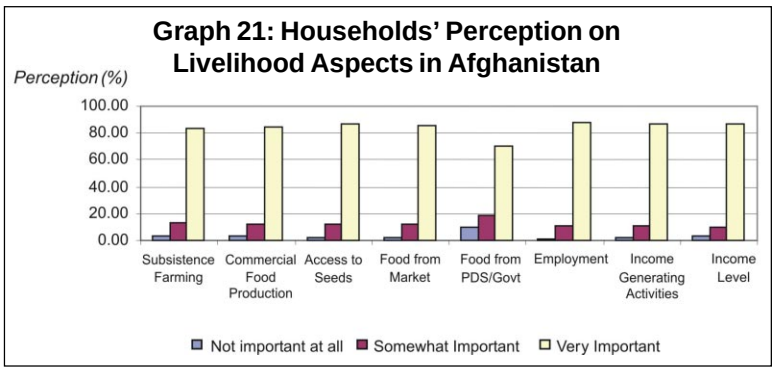
Graph 19: Households' Perception about Factors that Influence Livelihood in India (in percent)





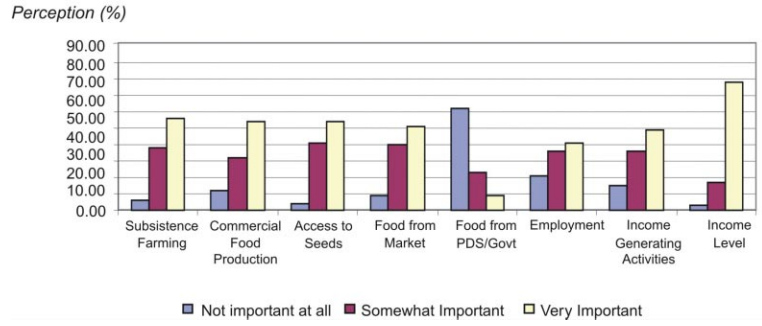
Farmers Perception on Livelihood Aspects

With regard to livelihood aspects, such as subsistence farming, commercial food production, employment and income level, a large number of farmers across four countries stated that they attach very high importance to these factors. But, slight variations persist in the perception of livelihood aspects across countries. Nonetheless, there is a great uniformity on the importance of these livelihood aspects in all the surveyed countries (Graph 21-24).

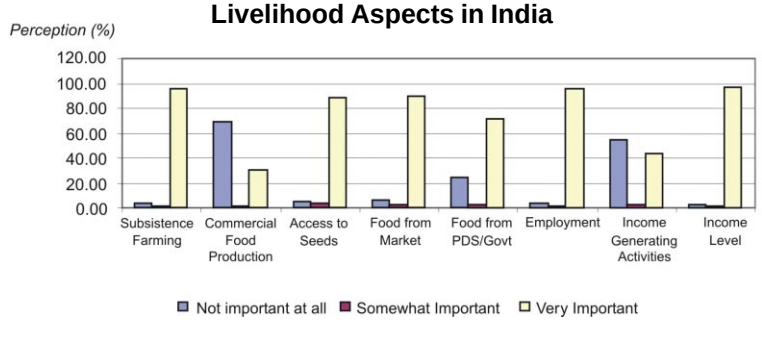


Note: PDS (Public Distribution System)

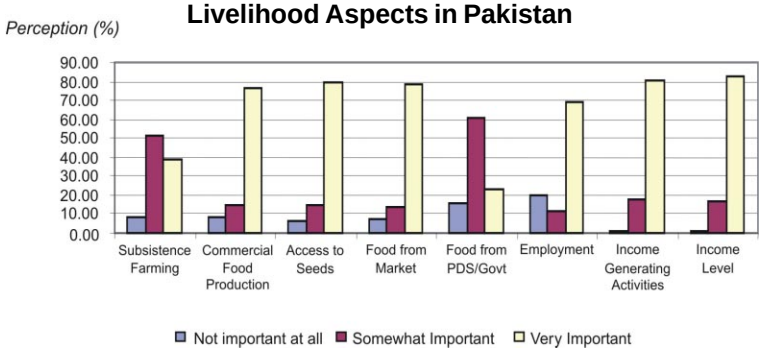
Graph 22: Households' Perception on Livelihood Aspects in Bangladesh



Graph 23: Households' Perception on Livelihood Aspects in India



Graph 23: Households' Perception on Livelihood Aspects in Pakistan

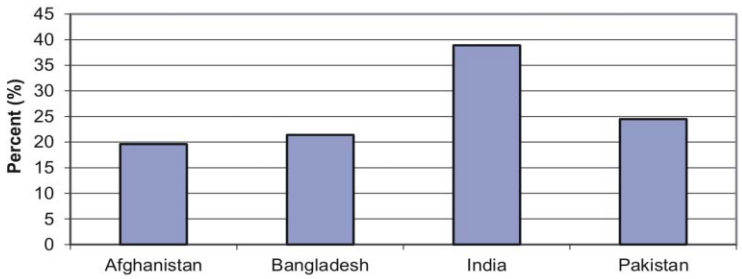


Impact on Migration

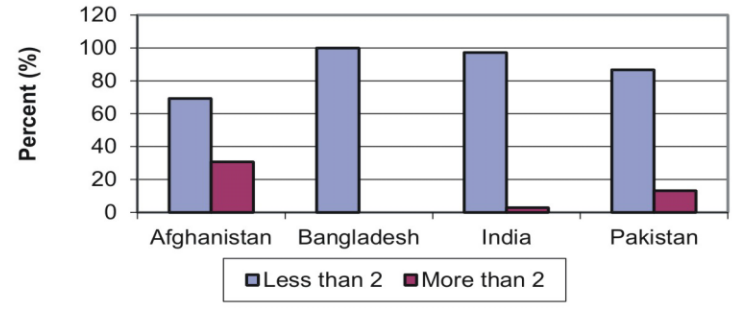
The field survey shows that household members are migrating to nearby cities due to climate change. Most of these migrations are for alternative livelihood and income-generating opportunities, as part of their adaptation measures to climate change. This is true for all the selected South Asian countries.

Out of the four countries selected for the study, about two-fifths of households in India have reported that household members are migrating to nearby cities for alternative livelihoods. In the other three countries, responses on migration vary in the range of 20 to 25 percent (Graph 25). Majority of households have indicated that less than two members per family have been migrating to cities (Graph 26). In Bangladesh and India, this segment has a 100-percent share (Graph 27).

Graph 25: Trend in Migration



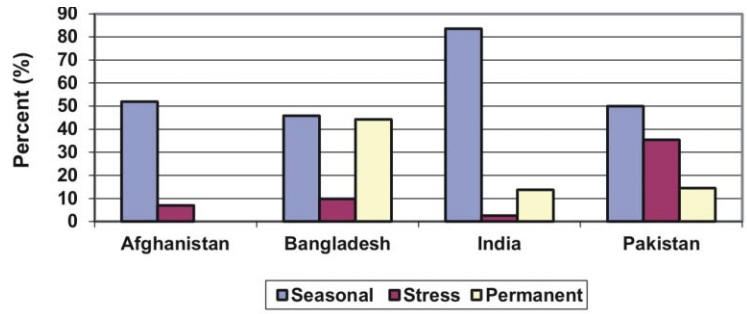
Graph 26: Intensity of Migration



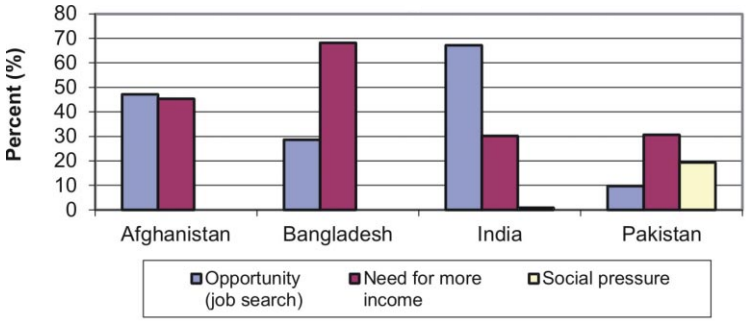
Seasonal migration is most rampant compared with other types of migration in all the four countries. But, this observation is much more prominent in India than in other South Asian countries. This activity shows that small and marginal farmers attach high importance to farming, as they return home during monsoon seasons for farming (Graph 28).

Responses to the reasons for migration vary across countries. The primary reason for migration in Afghanistan and India is for job search, whereas in Bangladesh and Pakistan, the primary reason for migration is the need for more income (Graph 29).

Graph 27: Type of Migration



Graph 28: Reason for Migration



Impact on Livestock and Fishing

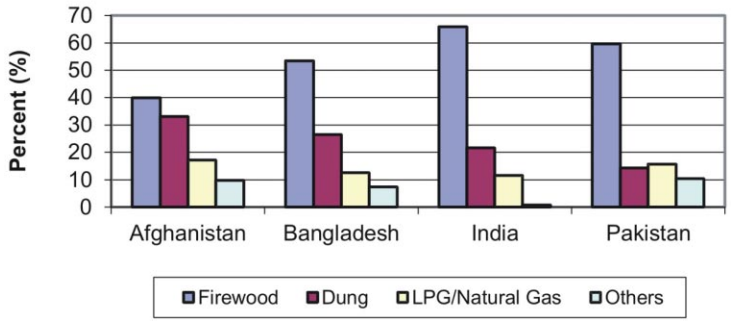
Livestock is an important source of livelihood for farmers in South Asia. It has played a significant role in ensuring households' livelihood in earlier periods. But, during the survey, it was observed that weather variability and increased temperatures have led to significant decline in pastureland and animal feedstock. Such developments have forced farmers to sell their livestock, which, in turn, has increased their dependence on technology that they cannot afford. Furthermore, decline in livestock and cattle manure has increased their dependence on fertilisers and pesticides.

In the case of fishing, some positive developments have taken place. In some coastal areas, fishermen have reported an increase in the fish catch over the years. For example, the fish catch per day has increased in Bangladesh as a result of the advancement of the rainy season. And, this has helped a segment of farmers, to some extent, by protecting their lives and livelihoods in the face of climate change.

Continued Dependence on Firewood for Cooking

Data analyses show that the declining level of income, coupled with other livelihood issues such as declining production and productivity, make farmers more dependent on firewood and cattle dung as cooking fuel. This is evident in all the countries covered under the present study. In the case of three countries, namely, Bangladesh, India and Pakistan, it is observed that this dependence is above 80 percent. The situation is also not much different in Afghanistan. Over 75 percent of Afghan farmers use firewood and cattle dung as cooking fuel.

Graph 29: Continued Dependence on Firewood for Cooking



Adaptation Strategies Practiced by Farmers to Reduce Climate Change Impacts

South Asian countries, which are characterised by high incidences of food insecurity and poverty, are yet to take comprehensive steps to help farmers reduce adverse impact of climate change on their lives and livelihoods. Support from the respective governments is limited to a certain level. In such a scenario, farmers are trying to adapt to the emerging conditions on their own.

Some major adaptation practices followed by farmers in South Asia are as follows:

i. Migration to nearby cities in search of alternative livelihoods;
ii. Increased dependence on subsidised fertilisers and pesticides;
iii. Increased participation in government employment schemes (especially in India);
iv. Crop insurance;
v. Usage of improved variety of seeds;
vi. Increased dependence on loans;
vii. Increased use of cattle dung as cooking fuel;

viii. Creation of sanitation facilities and water storage capacitates; and
ix. Increased dependence on pond/river fishing.

Endnotes

1 There was one exception to this. In the case of Bangladesh, four agro-climatic zones were selected, with total sample size remaining the same (300).
2 Base period varies for each of the regions, depending on recall capacity of the respondents.

4 Findings from Other Stakeholders' Survey

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Besides small and marginal farmers, grassroots NGOs, research and extension agencies, agronomists and sociologists were also surveyed. International think tanks primarily focussed on agricultural issues were also surveyed through direct contacts and emails. Their views on setting up a regional food bank to address the issues of food insecurity and livelihood threats were assessed. The selection of individuals/institutions for the survey in each country was based on a background check to identify individuals/institutions of repute in each category. The questionnaires for other stakeholders also sought their opinions on international cooperation in technology transfer to mitigate the adverse impact of climate change on agricultural yield.

4.1 Perception about Occurrence of Climate Change

Experts have highlighted variation in temperature, variability and reduction in precipitation, alteration in seasons and weather patterns as major climate changes. However, as in farmers' survey, there is no clear opinion about the reference period, but most of them have reported that climate change has been observed over the last 10-30 years. They have predicted an increase in the occurrence of floods, droughts and heat/cold waves in coming years.

However, some notable differences have been reported in climate change in these countries. In certain regions of Afghanistan, an increased intensity of rainfall has been observed. In India, heavy rainfall has been reported. Rainfall patterns have been changing on a year-to-year basis. Heavy rainfall causes soil run-off. And, due to improper rain water harvesting, excess water received is generally not stored for future consumption. In Bangladesh and some coastal parts of India and Pakistan, coastal and river bank erosion have been observed. Experts opine that a multitude of policy actions must be framed to address climate change.

4.2 Perception of Climate Change Impact

Climate change is commonly perceived as a combination of various phenomena, including change in duration and intensity of seasons, increase in average atmospheric temperature and increase in frequency of natural calamities. These, in turn, negatively impact both production and productivity of crops, leading to increased food insecurity.

In South Asia, climate change is perceived primarily based on its depleting effects on water resources. Its impact is felt largely by agrarian communities, as their dependence on water resources is higher than any other groups. Furthermore, large tracts of arable land in the region are rain-fed and are dependent on natural water resources.

It is unanimously recognised that climate change will affect all the four dimensions of food security: food availability, food accessibility, food utilisation and food systems stability. It will have an impact on human health, livelihood assets, purchasing power, food production, distribution channels and market flows. The resultant impact will be both short term and long-term.

4.3 Perception about Reasons for Climate Change

The single most important reason for climate change is the growing consumerism and fast changing lifestyles. Experts trace back the advent of climate change to misplaced development paradigms which give prime importance to quantity of output. Erosion of social accountability and responsibility in consumerist societies is leading to unsustainable extraction of natural resources, causing resource depletion and environmental hazards.

Some experts drew the example of India's experience of the Green Revolution, which helped to uplift the state of agrarian economies in India and gave a massive boost to India's progress towards food self-sufficiency. The Green Revolution model is criticised by many, citing that it has led to over-usage of land and gradually reduced agricultural productivity by encouraging usage of unsustainable cultivation methods and practices. Major reasons for environmental degradation and consequent changes in climate are:

- Adoption of chemical-intensive agriculture, usage of synthetic fertilisers and neglect of traditional farming practices and systems;
- Disintegration of the traditional combined farming system of agriculture and animal husbandry; and
- Usage of tractors and the practice of deep ploughing.

Agricultural sector accounts for 18-20 percent of India's total GGH emissions. And, several experts opine that there are many indirect channels through which agricultural practices have contributed to global warming. Enteric fermentation of cattle contributes significantly to emissions from agriculture (nearly 60 percent). Dams with large areas of inundation lead to methane production.

4.4 Perception about Adaptive Steps Taken by Farmers

Experts have noted that, in the absence of any comprehensive governmental policies at the national and international levels, measures to guard against climate change are predominantly visible only at the local level amongst farming communities in South Asia. Such initiatives are largely adaptive in nature. Major adaptation practices include changes in crop cultivation, particularly from rice and wheat to minor millets such as finger millet and pearl millet, which are less sensitive to ambient temperature and carbon dioxide content. However, mitigating strategies such as reducing methane emissions from rice fields, better cattle management practices to reduce enteric fermentation are not adopted in the region.

Emerging trends in the region show increased focus on rain-fed agriculture, water harvesting as well as soil and moisture conservation practices. Farmers have intensified tree plantation in arid and semi-arid regions. They have increased the usage of bio-fertilisers to boost productivity. More importantly, there is a regeneration of interest in mixed cropping and integrated farming of short duration crops.

While a large percentage of agrarian dependents are seasonally migrating in search of alternative jobs, crop diversification and usage of advanced technology have also been rising in the region. Demand for new and improved varieties of crops has considerably gone up in India and Bangladesh. Farmers are seeking help from government-run utilities for recycling local natural resources.

4.5 Perception about What Farmers Need to Do?

Specialists working in the area of agricultural sector are of the opinion that communities at large understand only climate variability and not climate change. Therefore, they will adopt only those techniques that help them enhance productivity and reduce crop loss by cultivating crops that are best suited to that region.

There are no specific guidelines that can be provided to farmers/fishermen across the nations to follow. However, some practices that should be generally used are replacement of water-intensive crops, adoption of water and soil conservation measures and usage of crops which are less sensitive to temperature and carbon dioxide concentrations. Diversification of crops and insurance must be used as hedging strategies.

4.6 Perception about What Should Be Done by Governments – Local and International Levels

Given that farmers rely on adaptive strategies because of inherent constraints and that mitigation is equally important, government strategies and policies must be oriented more towards mitigation. Pro-environmental agricultural policies and pro-poor policies must be formulated at the national and regional levels.

At the international level, attention should be given to reach consensus among all nations on sincere enforcement of policies and laws tailored for mitigating climate change. International agencies must bring in region-specific expertise to solve problems of the given country. Efforts should be made to bridge the gap of SAARC governments toward cooperation in the fields of technology transfer and human capacity development.

A corpus fund should be created at the international level to help national governments raise resources that specify adaptation strategies suitable to the country. International agencies like United Nations Framework Convention on Climate Change (UNFCCC) must help facilitate trans-boundary learning to quickly disseminate techniques to be applied in local environments with suitable modifications.

5 Regional and International Cooperation

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5.1 Climate Change: Introduction to Collaborative Efforts

Climate change needs immediate attention as an environmental and a developmental issue. The phenomenon has most evident implications for bio-diversity and environment. However, upon deeper analyses of its impact on humans, the scope of the problem broadens and involves many developmental problems such as food security, unavailability of water and increased health issues.

Evidence proves that global warming will lead to flooding of water bodies, at first, due to excess melting of the glaciers. Eventually, after glacial run-off, these sources will dry up, thus reducing the availability of water for human consumption and other essential activities such as agriculture. Global warming will have an adverse impact on crop yield, soil nutrition and agricultural output due to factors such as lack of water, extreme unfavourable weather conditions and erratic rainfall and seasonal patterns.

Overall, food security of the world's population will be jeopardised. Continuously growing population and human needs, coupled with climate change, will increase the pressure on existing natural resources and restrict natural replenishment of such resources. Under these circumstances, achievement

of target goals for development, known as MDGs,[1] will be significantly hampered.

Ensuring environmental sustainability is one amongst the MDGs. The attainment of this goal and efforts to curb climate change are intertwined. The steps taken in the form of bilateral, regional and international initiatives to ensure either of the above mentioned areas would have positive consequences for the other one. Another goal of ensuring food security has definite implications from the steps taken in favour of the above two goals. Presently, the world is involved in making continuous efforts to achieve both environmental sustainability and food security.

5.2 Scope for Cooperation for Climate Change and Food Security: South Asian Context

The magnitude of the impact of climate change on food security will differ among countries due to their geographical location in various climatic zones. In the SAR, approximately half of India is located in the tropical zone and the rest of the region is located right above the tropical cancer. Since the tropical cancer already experiences high temperatures, it will be amongst the first ones to witness adverse impact of global warming and climate change.

The phenomenon of climate change is expected to have negative effects on agriculture, fish population, livestock, forestry and bio-diversity of this region. The gravity of the situation increases due to limited adaptability of these countries, given the developing nature of their economies. Financial and material resources available to these countries are primarily allocated to priority sectors such as education, poverty alleviation and public health. Progress in research and development (R&D) of technologies and implementation of measures to minimise the impact of climate change on the economy falls short of actual requirement.

The SAR is in need of immediate steps for adaptation to and mitigation of climate change. With respect to reduction of the impact of climate change on agriculture and food security, the key areas which need primary attention can be categorised as follows:

1. Environmental Impact Assessment;
2. Research and Development;
3. Information Sharing and Documentation of Best Practices;
4. Financial and Technical Advancement;
5. Climate Change Risk Management;
6. Resource Conservation;
7. Provisioning of Food (developmental food aid); and
8. Creation of Low Carbon Economies.

In the above mentioned fields, there is a huge potential for both regional and international collaboration and cooperation. This region is comprised of developing countries which are generally associated with low level of economic growth and R&D. Thus, technical and financial transfers have to be ensured through agreements at an international level, where advanced nations with a broader scientific and financial resource base can contribute.

5.3 Regional Cooperation in South Asia

South Asian nations have been engaged in mutual cooperation, with the aim of achieving economic and social prosperity for the region. Collective action for promoting regional prosperity and welfare commenced in 1985, in the form of SAARC.[2]

Initial interactions among these nations had a smaller scope, with collaborative actions in nine mutually agreed upon areas, largely concerned with economic growth. However, gradually the areas for cooperation have expanded to involve various fields, with the view of holistic development. Amongst these, environment has also been an important area of collaboration

since 1987. Nations realised that natural endowment of resources has a critical contribution in achievement of their developmental goals.

In South Asia, all the countries are primarily agrarian economies. Agriculture has approximately 49.4 percent share in the total employment in South Asia. Phenomena like climate change and natural disasters undermine the prospects of economic growth due to their adverse impact on agriculture. Therefore, nations realised the urgent need to preserve and protect fragile ecosystems and safeguard the bio-diversity of this region by channelising resources jointly to take preventive steps.

Agriculture was among the five key areas of cooperation identified by the South Asian nations. Sharing of technologies, plant and seed varieties and collaborative research with scientists from across the borders have been carried out in the past. Expert groups have been formed which can ensure timely progress of such steps. Thus, in the light of climate change, SAARC member nations took the following initiatives.

5.3.1 Documentation

SAARC member nations followed a strategic approach towards tackling the problem of climate change and natural disasters. At the outset, various studies were conducted in the region to understand the causes and impacts of climate change on the region.

The first study was completed in 1991 on the "*Causes and Consequences of Natural Disasters and the Protection and Preservation of the Environment*".[3] This study primarily took stock of the nature and dimensions of environmental problems being faced by individual nations in this region.[4] The report highlights that, apart from natural disasters, environmental degradation is largely being caused due to two types of factors. The first set relates to underdeveloped conditions and abject

poverty prevalent in the region. The second set relates to "unintended side-effects of efforts to achieve rapid economic growth".[5]

The study approaches the problem of environmental degradation by mapping priority areas for action in the light of resource constraints. Apart from a few constraints, such as over-population and lack of resources, problems of these countries were quite distinct. According to the report, Bangladesh, Maldives and Nepal face low resources to human beings ratio, whereas, in India, the problem is lack of realisation of the significance of environmental sustainability. The study makes recommendations after due consideration of the level of individual countries' development level and the progress made in the field of environmental protection. There are common and differentiated actions suggested for each nation.

Key suggestions provided in the report are:

1. Establishment of Environmental Impact Assessment System, Pollution Control and Monitoring System;
2. Programmes to ensure that urban and rural dwellings are environmentally sustainable and restore ecologically degraded areas;
3. Conservation of natural resources and biological diversity of the region; and
4. Development of alternative fuel sources and reduction of reliance on fuel wood.

A second study was conducted on "Greenhouse Effect and its Impact on the Region" and was completed in 1992.[6] This study was conducted with the objective of providing a basis for a cooperative action plan for the South Asian nations. The study accounts for the sources of greenhouse gas emissions in the SAARC nations and the impact of these emissions on the environment. The report highlights that, in SAARC member nations, the energy sector has the highest contribution to emissions, which is largely based on coal and biomass.

The report specifically draws attention to the substantial impact of the greenhouse effect on agriculture. Sizeable area under agriculture is expected to be lost due to rise in sea level by one meter, inundation in low-lying areas in the mainland, increased salinity, damage to coastal structures and altered rainfall patterns. Such changes are expected to deteriorate the already existent imbalance of food supply and demand in these economies.

Both reports highlight that there is a shortage of information about the causes and impacts of climate change and GHG emissions. Also, the resources available to individual nations to tackle the situation are in short supply. Thus, the countries in this region must collaborate and join their resources to enhance their capability. It is only upon attaining successful regional collaboration that they must "call upon the global community for what is not available".[7]

5.3.2 Institutional Setup for Climate Change Adaptation and Mitigation

Based on the findings of the regional studies, SAARC member nations setup a *Technical Committee on Environment* in 1992, the scope of which was later expanded to cover forestry. The committee was setup with the aim of identifying the measures consistent with the recommendations made by the above mentioned studies. Also, the committee was also made responsible to decide upon the modalities required for implementation of such measures, examine their progress and ensure greatest efficiency. Since its formation, the committee has met a number of times. The last meeting was in October 2010. The agenda of these meetings is to assess the progress of SAARC plans to ensure environmental sustainability and review the scope of its actions.

An intergovernmental initiative, called 'South Asia Cooperative Environment Programme', was undertaken in

1982 by South Asian nations for "protection, management and enhancement of environment in the region".[8] This programme plays a critical role in promoting regional cooperative activities in the field of environment, such that the activities are most beneficial to individual nations and collectively to the region.

Another important aspect of this programme is to ensure coordination between national, regional and international institutions involved in environmental activities in the SAR. Adaptation to climate change is an important field of action. Its aim is to tackle climate change by taking appropriate actions for solving trans-boundary environmental concerns such as pollution control. Its actions and collaborations have a direct impact on solving the problem of climate change and thus indirectly contribute to enhancing food security in the region.

5.3.3 Action Plans for Climate Change

In 1997, the *SAARC Environmental Action Plan* was adopted. This plan laid out the modalities and parameters for cooperation among the South Asian nations to limit and adapt to climate change. It presented an outline for cooperation amongst South Asian nations, with the purpose of environmental protection. Some suggested practices were expected to enhance the adaptability of agriculture and also reduce anthropogenic impact on climate change, ultimately resulting in mitigation.

More recently, *SAARC Action Plan on Climate Change* was launched in July 2008, under the aegis of the Technical Committee on Environment and Forestry. This plan, in the period of 2009-2011, aims to enhance South-South cooperation for climate change mitigation and adaptation. It also seeks to encourage regional level action plan through national level activities and generate support for global negotiation process so that the South Asian nations have the

same understanding and their individual stances also reflect the region's concerns.[9]

Adaptation in agricultural sector is a significant part of focussed thematic areas of the action plan. It aims to increase climate modelling in the region. Such models would help in accurate assessment of the impact of climate change in the region and thus ensure high effectiveness of adaptive measures implemented in the field of agriculture and other areas. The aim to ensure successful implementation of the action plan has been reiterated in the "Thimphu Statement on Climate Change" made recently at the 16th SAARC Summit held at Thimphu in April 2010.

5.3.4 Financial and Technical Cooperation

As mentioned earlier, the SAR is largely constituted of developing nations, with high average density of population. As a result, they face severe resource constraints. Despite such circumstances, these nations have agreed to pool resources to fight against climate through mitigation and adaptation measures. Merging financial resources and sharing technological advancements have been agreed upon. Resource-sharing will be done for short, medium and long-term mitigation and adaptation, especially with the objective of enhancing food security in the region.

The first 'South Asia Food Security Programme' was approved in 2008, with the aim of filling the gaps in crop management practices, which are responsible for inadequate crop yields. This programme is a combination of ten projects in the regions, for which approximately US$25mn would be received from the Asian Development Bank, the International Fund for Agricultural Development and the UN Food and Agriculture Organisation.[10] This programme aims to enhance the role of science and technology in agriculture, with the objective of mitigating and adapting to the impacts of climate change.

Through collaboration in agricultural research, scientific interventions will be developed for each stage of the agricultural chain, such that agricultural practices are able to tackle erratic weather conditions without much harm to the yield. Countries also aim to collaborate in development of genetically modified seed varieties, new agricultural practices and nanotechnology, which will ensure that the crops can stand in difficult weather conditions.

SAARC Food Bank is yet another initiative which has been undertaken to enhance food security in the SAR. The food bank is maintained and replenished by SAARC member nations. This initiative has been taken in the light of insufficient agricultural production, which is expected to deteriorate further due to climate change.

The steps taken at the regional level have been holistic in their approach. The measures are well integrated and cover various aspects of climate change and attempt to curb its impacts on regional food security. However, given the limited resources available to these nations, these measures fall short of those required. As mentioned earlier, these nations face financial and technological constraints in adaptation and mitigation. These gaps can be filled with the help of international collaboration and assistance.

5.4 International Cooperation

Climate change is a phenomenon of global concern, since its impacts spread across national borders, irrespective of the country of origin. In popular opinion, the developed countries are largely held responsible for the accumulation of GHG in the atmosphere due to rapid industrialisation during the 20th century. The US and the European Union (EU) still have the highest carbon footprint in absolute as well as per capita terms. Thus, due to the burden of history and the present pattern of

production and consumption activities, the onus of tackling the problem of climate change falls on these economies.

Due to the historical growth trends and the high level of economic prosperity of the industrially advanced nations, the developing countries look up to them to seek assistance for climate change adaptation and mitigation. The assistance for environmental sustainability has a developmental aspect in the form of MDGs. Since the developed countries are also committed to the achievement of MDGs, such as food security, it becomes their responsibility to play a critical role in climate change adaptation. Thus, climate change adaptation to ensure food security is presently amongst the highest priority areas for global initiatives. Global initiatives have been taken at two levels: bilateral and multilateral. While these initiatives are important, international negotiations for climate change have also played a significant role.

5.4.1 International Negotiations and Institutions

Climate change negotiations, popularly known as climate change talks, have made substantial contribution to bringing different national governments to a common platform to discuss adaptation and mitigation. A large number of such conferences have been organised in the last three-and-a-half decades to construct a common plan of action. The United Nations, in association with other international organisations, organised the world's *First Climate Change Conference* in Geneva in 1979. The conference, largely scientific in nature, was organised with the objective of accumulating research on climate variability and analysing environmental data. Various studies have been conducted throughout the world to accumulate scientific evidence on climate change.

The Geneva conference led to the establishment of the Intergovernmental Panel on Climate Change (IPCC)[11] in 1988. The panel's assessment reports,[12] backed by many others,

indicate that there has been a consistent rise in the global temperature at an unnaturally high rate due to GHG emissions. The Montreal Protocol in 1989 and the Rio Agreement in 1992 were important breakthroughs which led to critical actions against reduction of the impact of anthropogenic activities on environment.

In 1992, during the Rio Summit (popularly known as the Earth Summit), the United Nations Framework Convention on Climate Change (UNFCCC) was agreed upon.[13] This convention led to the adoption of the most important agreement in the history of environmental protection, called the Kyoto Protocol. This protocol was agreed upon in 1997. The key achievement of this agreement is that it sets binding emission targets for industrialised nations. Also, it follows the principle of "common but differentiated responsibilities", which ensures that developed countries are given more responsibility for climate change adaptation and mitigation. However, over the last few rounds of negotiations, a few developing countries have also agreed to undertake voluntary actions to reduce their domestic emission intensities, subject to domestic monitoring and evaluation.

The terms of agreements decided upon in the last two rounds of climate change negotiations, in Copenhagen and Cancun, emphasise the contribution to be made by industrially advanced nations through provision of financial and technical assistance to the developing nations. Although these accords are not legally binding, but a consensus on an international platform on these terms must be counted as a critical step. These protocols also provide flexibilities to ratifying nations by allowing them to establish carbon sinks, trade in emissions and invest in other countries to assist them in adapting to climate change.

In the context of South Asia, we can evaluate the vital significance of these treaties and their conditions. All the

countries in the region are developing ones which, through the international agreement, receive differentiated treatment with regard to climate change adaptation and mitigation. Also, these nations become the recipients of technology and funds for this purpose.

Such technology transfers are significant for key sectors such as agriculture. Adaptation in this sector will play a substantial role in reducing threat to food security. Also, it will increase productivity of land and crop, which will, in turn, raise the incomes of farmers and rural population. Thus, their livelihoods and incomes will be secured.

It is primarily due to international negotiations such as the Conference of Parties organised by the UNFCCC that a number of industrialised nations are entering into bilateral and multilateral arrangements with the developing nations for adaptation and mitigation of climate change.

5.4.2 Bilateral Initiatives

Many developed countries have launched bilateral initiatives to assist developing countries in adapting and mitigating the impact of climate change on food security. Few of such arrangements entered into to enable and promote adaptation and mitigation in South Asia, with the ultimate aim of establishing food security in the region, are given below.[14]

Cereals System Initiative for South Asia[15]

This initiative was launched by the US Agency for International Development (USAID), in association with the Bill and Melinda Gates Foundation, in the year 2009. The primary objective of this programme is to increase the sustainability of agriculture, which will ensure food and income security of poor farmer families in South Asia. It involves spreading awareness and delivering high yielding stress-tolerant and disease and insect-resistant varieties of cereals. It also

focuses on implementing better crop and resource management practices. The programme seeks to increase research base in the region by providing funds for training scientists and professionals for agricultural research. Overall funding for the programme is approximately US$35mn.[16]

The initiative is expected to benefit nearly 6 million small farmers.[17] These farmers, with crop varieties resistant to extreme weather conditions and superior technology will be better prepared to face climate change and protect their livelihoods from its impacts. It will also create better prospects for solving the problem of food insecurity presently existent at a large scale in South Asia.

US-India Strategic Cooperation for Agriculture and Food Security

In Indo-US Agricultural Dialogue, both the nations agreed to cooperate bilaterally in four broad areas of agriculture and climate change resilience, namely, technologies to raise productivity for food security, management of natural resources, agricultural extension and innovation and, lastly, human resource development in the field of agriculture and building institutional capacity.[18]

Implementation of the planned measures will involve transfer of technology to achieve the above mentioned objectives, including generation of widespread awareness and ensuring availability, better agricultural practices, better irrigation facilities and water management techniques. Capacity building will be tested, adapted and scaled up in collaboration with the private sector. This programme aims to form ownership amongst various stakeholders in India.

Agricultural Assistance to Afghanistan and Pakistan

The US Department of Agriculture announced assistance programme for US$27.5mn for improving cooperation in

agriculture in Afghanistan and Pakistan, under the Food for Progress Program for these two countries.[19] The objective is to increase the productivity of agricultural land. Though the program was not launched in response to climate change, but its outcome will build resilience to environmental changes in coming years.

The United States is also making attempts to mechanise Afghani agriculture in order to improve output. In a joint effort between Afghanistan's Ministry of Agriculture, Irrigation and Livestock, the USAID and International Relief and Development, farming technology such as tractors are being provided to Afghani farmers.[20] The programme was largely funded by the US government, but, in order to create ownership of these assets, approximately 35 percent of the cost is borne by the farmers.

European Union-Pakistan Five Year Cooperation Plan

In June 2010, in the second EU-Pakistan Summit, both the nations agreed to collaborate further in the field of climate change adaptation and mitigation. Both the nations have decided to initiate dialogue on climate change, with respect to the Copenhagen Accord. The proposed plan is to build Pakistan's capacity to fight against climate change and reduce the impact of the same on agriculture and other sectors. However, this collaboration is still being discussed and the terms have not yet been decided upon.

Finland-Nepal Bilateral Development Cooperation

Finland and Nepal have been partnering in critical fields of cooperation. Nepal received a total of •10.2mn in 2009 as developmental aid from Finland.[21] Since 2009, the environment and natural resource sector has become the key focus of such bilateral cooperation. Both the governments are working for the establishment of regional food information

system in the Hindu Kush-Himalayan region. This system will help in minimising flood-related damage in Afghanistan, Bangladesh, Bhutan, India, China, Myanmar, Nepal and Pakistan. The governments have also launched a joint project called 'Finnish-Nepalese Project for Improved Capability'. This project aims to enhance the preparedness of Nepal towards increased risks from climate change and weather-related natural disasters.[22]

5.4.3 Multilateral Initiatives

As part of the treaties entered into at the international negotiations, developed countries have agreed to provide financial assistance to the developing and least developed nations to assist them in adapting to climate change. Under the recent 'Cancun agreements',[23] *Green Climate Fund* will be created under the United Nations. This fund will be utilised for the purpose of adaptation to climate change. A sum of US$30bn has been agreed upon to be provided as the *Fast Start Finance*. This fund is to be channelised for the period 2010-2012 and aims to put developing economies on the path of low carbon development.

In the long-term, finance for adaptation and mitigation will be raised to US$100bn per year. This goal is to be achieved by the year 2020. There is flexibility to provide these funds through public, private, bilateral and multilateral sources. Thus, governments of many developed countries channelise the funds through international organisations, institutions such as the World Bank (WB), the Global Environment Facility (GEF) of the United Nations Development Programme (UNDP) and the FAO of the United Nations (UN). These international organisations, through their network in the developing nations, such as governments, civil societies, and local organisations, ensure that the funds are utilised in the areas in need of assistance to enhance adaptability to climate change and reduce food insecurity.

The FAO assists developing countries in modernising and improving their agricultural, forestry and fishing practices, with the goal of ensuring good nutrition to all.[24] Funds received by the FAO are voluntary contributions from members and partners. Over 150 donors contribute to the FAO funds, which, in turn, are used for financing programmes across the world.

Since climate change has severe implications for food security around the world, the FAO has directed special attention to rural areas in developing countries for tackling the problem and facilitating adaptation and mitigation. It conducts large number of studies in the field of climate change in various developing countries in order to create a unique database of knowledge on the impacts of climate change on food security.

The FAO contributes to mitigation by imparting knowledge to farmers about better farm practices. It also assists in generation of opportunities which enable farmers to benefit from climate change adaptation. All these are done in addition to development and implementation of specific adaptation projects in the developing countries.

In South Asia, the FAO is implementing programmes related to disaster management and disaster preparedness for the agricultural sector (Bangladesh and Nepal), enhancing capacities for climate change adaptation (Nepal) and mainstreaming food security concerns into assessment of bio-energy potential (SAARC region).[25] In India, it has launched a programme called 'Gender-Sensitive Strategies for Adaptation to Climate Change: Drawing on Indian Farmers' Experiences.'[26]

The UNDP established the GEF in 1991, in order to fund developing countries' projects and programmes in protection of global environment. Though it is a UNDP initiative, but it is partnership between 10 developmental agencies.[27] The GEF brings together 182 countries to address the environmental

issues at a global level. It is the largest funder of projects aimed at improvement of environment and has allocated US$9.2bn.[28] In the SAR, the GEF funds are employed in bio-diversity conservation, eco-system management, creating and improvement of sustainable rural livelihoods, coastal and marine protection, etc.

Acknowledging the gravity of the consequences to be faced by developing countries due to climate change, the WB has involved itself in assisting member nations from the developing world in climate change adaptation activities, through building partnerships with governments and organisations. It has established a *Clean Energy Investment Framework* to help in the transition of the developing countries to a low carbon path of development.[29]

With regard to South Asia, the WB has devised a package of interventions which aim to reduce the impact of climate change on this region. These interventions have been formulated to maintain consistency with developmental objectives. It has introduced a large number of projects in the field of forecasting natural disasters, improving irrigation supplies and efficiency, adaptation to droughts, coastal zone management (especially for Maldives), watershed management and water resources management. While these projects have special focus on rural areas, programmes for the urban sector adaptation have also been launched, particularly in the coastal cities of South Asia.[30]

5.5 Gaps in Climate Change Adaptation Efforts

Effective efforts, with far-reaching objectives, have been made at various levels. Multiple programmes have been undertaken to reduce the impact of climate change on food security and to generate livelihoods in South Asia. These efforts have also succeeded, to a certain level, in combating climate change and the building capacity of the region. However, there

are a number of areas which have seen no/low intervention at the national, regional and international levels. Also, the rate of success and the efficiency of many efforts are quite low. The following points list such gaps in adaptation efforts:

a. Documentation of traditional knowledge available in South Asian nations in the field of agriculture has not been emphasised upon in the negotiations or in any agreements. Such knowledge, which is generally passed between generations, has a high utility to combat climate change and disperse its potential impacts on agriculture and food security.
b. Although the governments of SAARC member nations have discussed collaboration of resources for research, steps in this regard have not been undertaken. There is a huge potential for collaborative research. The scientific and agricultural research organisations in all these nations can combine resources and share knowledge. This will not only benefit smaller nations, such as Maldives, which have relatively lesser resources, but also the bigger ones, like India, in increasing the scope of knowledge.
c. The SAR is characterised by economic diversity, primarily due to differences in the level of development of the member nations. Climate change adaptation agenda and the steps taken to attain the same must ensure that nations which are relatively economically weaker get a higher preference at the regional and global levels. This requires an intra-region comparison of the strengths and weaknesses of each nation. Such comparison would require a detailed survey of the nations, their agricultural sector, farmers and others associated with the sector and an in-depth analysis of the state of affairs. A priority index must be created, based on the results of the analysis.
d. SAARC food bank has been made operational only as per the agreement among member nations. The actual

performance of the grain bank is questionable. The terms of the agreement regarding replenishment of the bank on a regular basis are not being fulfilled.

e. At the global level, the South Asian nations must have a united stand, which will empower them to raise their demands for adaptation assistance in specific priority sectors. Since agriculture is one of the most important economic activities, which is also most vulnerable to climate change, the nations must bargain for higher financial and technology transfers.
f. South Asian nations must also ensure that the assistance provided to them under international arrangements should be diverted to priority sectors, such as agriculture, than being utilised for promotion of low carbon growth strategy, which focuses mainly on the industrial sector.

5.6 Conclusion

Climate change adaptation has made substantial progress in the last two decades. Though recent rounds of negotiations have not been able to secure legally binding treaties, but they have created a platform for communication between the developed and developing nations. This channel has increased the scope of cooperation between the nations, which has resulted into multiple bilateral and multilateral initiatives. On the one hand, the developed nations have agreed to cut their own emissions and extend financial and technological assistance to developing countries. On the other hand, many erstwhile underdeveloped countries, which are now on the fast track to development, have taken a more amiable stand by agreeing to take voluntary actions for emission intensity reduction.

South Asian nations must channelise increasing proportions of resources towards the protection of the environment. India, which is exhibiting high growth rates year after year, can lead

the initiatives for climate change protection and assist its neighbouring countries in building their adaptive capacity. This region can also seek assistance for research and development and human resource development from nations in the neighbouring region, i.e. South-East Asia. Such collaborations will make developing countries self-sufficient and less reliant on assistance from developed countries.

Endnotes

1 MDGs are a set of eight goals adopted by world leaders in the year 2000, to provide concrete and numerical benchmarks for tackling extreme poverty in many forms. These goals, aimed to be achieved by 2015, set a framework to direct the efforts of entire international community towards the common end of ensuring that human development reaches everyone, everywhere. (as per United Nations Development Programme)

2 SAARC is the organisation of the eight countries constituting South Asian region: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. It was constituted for economic and political purposes and is a trade bloc.

3 SAARC Secretariat, *Regional Study on the Causes and Consequences of Natural Disasters and the Protection and Preservation of the Environment,* 1992. Available at http://www.saarc-sec.org/userfiles/Large%20Publications/CCNDPPE/index.php

4 Afghanistan was excluded from the study since it did not join SAARC until 2007.

5 Ibid, PP. 191.

6 SAARC, *Area of Cooperation: Environment,* Accessed on February 04, 2011. Available at http://www.saarc-sec.org/areaofcooperation/cat-detail.php?cat_id=54

7 SAARC Secretariat, *Greenhouse Effect and its Impact on the Region- Executive Summary,* PP. 10. Available at http://www.saarc-sec.org/userfiles/Large%20Publications/RSGEIOR/6RSGEIORExecutiveSummary.pdf

8 South Asia Cooperative Environment Programme, Website http://www.sacep.org/html/about_overview.htm

9 SAARC Disaster Management Centre, *SAARC Action Plan on Climate Change,* Available at http://www.nset.org.np/nset/climatechange/pdf/SAARC_Action_Plan.pdf
10 SciDev.Net, *South Asian nations team up for food security,* Printed on March 11, 2008. Accessed on February 07, 2011. Available at http://www.scidev.net/en/news/south-asian-nations-team-up-for-food-security.html
11 IPCC is an international body which carries out the assessment of climate change on a recurring basis. It was established by United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO).
12 IPCC has published four assessment reports (AR), one each in 1990, 1995, 2001 and 2007. These reports present summarized assessment of the scientific, socio-political and technical information available on climate change.
13 UNFCCC is an international treaty which was entered into by nations across the world. The objective of the treaty is to take measures to reduce global warming and to enable adaptability to inevitable changes in the environment. Presently, 194 countries are party to this treaty.
14 These are bilateral agreements. It does not include financial contributions made by these nations to international organisations such as the World Bank, the United Nations, and Global Environment Facility, etc.
15 International Livestock Research Institute, *Cereal System Initiative South Asia (CSISA)*, Available at http://www.ilri.org/csisa
16 USAID, New Partnership to Ensure South Asia's Food Security in the Face of Climate Change, January 23, 2009, Accessed on February 12, 2011. Available at http://www.usaid.gov/press/releases/2009/pr090123_2.html
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18 USAID-India, *Partnership Agreement for the Agriculture and Food Security Programme,* Available at http://www.usaid.gov/in/our_work/pa_fs.html
19 United States Department of Agriculture-Foreign Agricultural Service, *Agriculture Secretary Vilsack Announces US$27.5mn for Pakistan and Afghanistan Through Food for Progress Program*, May 06, 2009. Available at http://www.fas.usda.gov/scriptsw/PressRelease/

pressrel_dout.asp?Entry=valid&PrNum=0073-09

20 Afghanistan International Security Assistance Force, *Mechanization to Boost Afghan Food Production,* February 09, 2011, Available at http://www.isaf.nato.int/article/isaf-releases/mechanization-to-boost-afghan-food-production.html

21 Ministry for Foreign Affairs of Finland, *Finland's development cooperation with Nepal,* Available at http://formin.finland.fi/public/default.aspx?nodeid=15372&contentlan=2&culture=en-US

22 Embassy of Finland, Kathmandu, *Bilateral Development Cooperation,* Available at http://www.finland.org.np/public/default.aspx?nodeid=35082&contentlan=2&culture=en-US

23 Sixteenth Conference of Parties to UNFCCC was held in Cancun, Mexico, in December 2010. Instead of one legally binding treaty, a number of agreements called 'Cancun Agreements' were entered into by the member nations. All the agreements are voluntary in nature.

24 Food and Agriculture Organisation (FAO), *About FAO*, Available at http://www.fao.org/about/en/

25 FAO, *Climate Change Projects*, Available at http://www.fao.org/climatechange/projects/en/

26 FAO, *Gender and Climate Change in India,* Available at http://www.fao.org/climatechange/54818/en/

27 The agencies which are partners for the GEF are: the UNDP, the UN Environment Programme, the World Bank; the UN Food and Agriculture Organisation; the UN Industrial Development Organisation; the African Development Bank; the Asian Development Bank; the European Bank for Reconstruction and Development; the Inter-American Development Bank; and the International Fund for Agricultural Development.

28 Global Environment Facility, *What is the GEF,* Available at http://www.thegef.org/gef/whatisgef

29 The World Bank, Climate Change and the World Bank, Available at http://climatechange.worldbank.org/overview

30 The World Bank, *Current Adaptation Program in South Asia,* Available at http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/SOUTHASIAEXT/0,,contentMDK:21642038~pagePK:146736~piPK:146830~theSitePK:223547,00.html

6 Summary and Policy Recommendations

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6.1 Concluding Remarks

Food entitlement approach has substituted the traditional food-availability-decline (FAD) approach of famine. Sen argues that the 1943 famine in Bengal was not due to unavailability of food, but rather due to inaccessibility to food (Sen, 1976, 1977).[1] What principally mattered was whether or not people have enough command over food during food crises. Since a significant portion of poor's income is spent on securing food, the poorest of the poor cannot afford food in times of climatic and economic crises. Such a scenario destabilises food security, leading to famines in developing economies like South Asia.

Despite South Asia's insignificant global per capita carbon emissions, the region suffers extremely from climate change. This is mainly due to its geographical topology. High-altitude countries like Nepal, Pakistan and India suffer from glacier retreat due to increased temperatures. Low-lying countries like Bangladesh and some coastal regions of India suffer from sea-level rise. Furthermore, recurrent natural calamities such as flash-floods and droughts adversely affect agriculture, worsening food security in the region.

Perception analyses, undertaken in four select South Asian countries, have shown that farmers in the region are aware of climate variability and its impact upon agriculture. Across the region, farmers have reported observation of changed weather

patterns over the years. They have lamented the loss of crop yield due to changed weather patterns and recurrent natural hazards. In order to cope with climate change, farmers in the region have practiced adaptation strategies such as crop insurance, heavy reliance on subsidised fertilisers and even migration to nearby cities in search of alternative livelihoods.

The findings of this study are consistent with what other studies have deduced on the impact of climate change upon food security. Nonetheless, this study is different from other studies as it examines small and marginal farmers' perception on climate change and food security. While findings of majority of studies are based upon scientific analysis, the findings of this perception study are based upon small and marginal farmers' observations on climate change over the years.

6.2 Policy Recommendations

Poverty alleviation is vital to securing food security in South Asia. The poor communities are the ones who suffer the most from climate change. These people rely on natural vegetation for sustenance and face limited coping strategies in times of climatic crises. Hence, in order to minimise the impact of climate change on such vulnerable communities, poverty of the region must be addressed first. Initiatives such as land entitlement to poor communities and empowerment of small and marginal farmers through microfinance loans can be some of the effective measures to alleviate poverty. Such initiatives will increase the poor's asset base and limit their reliance on natural vegetation for subsistence.

Developing economies like South Asia must embrace the path of environmentally sustainable economic growth. Growth and poverty are intertwined with each other. In order to eradicate poverty, economic growth is indispensable. However, economic growth at the expense of natural resources is detrimental in the long-run. In South Asia,

industrialisation is occurring at the expense of natural resources. Furthermore, industrialisation is degrading the environment rapidly. If economic growth continues in that fashion, then future generations will suffer immensely. Hence, any developmental process must incorporate environmental aspects to achieve a sustainable economic growth in the region.

Furthermore, elimination of intra-regional trade barriers is essential for a sustainable economic development and greater cooperation in the region. Over the recent decades, South Asia has become a food surplus zone.[2] However, despite being a food surplus zone, vast majority of South Asian children and women suffer from malnutrition and anaemia, respectively. So, where does the surplus food of the region end up? While South Asian countries have extensively engaged in overseas trade, the intra-regional trade has been disappointingly low, due to host of trade barriers, protectionism and distrust among member countries. When intra-regional trade alone can address significant aspect of food insecurity, the respective governments of the region must not exhibit pessimism towards intra-regional trade. Let free trade prevail for an overall economic development of the region.

Bilateral Initiatives to Tackle Climate Change and Food Security

a. Food Bank – Despite being enacted several years ago, the SAARC Food Bank continues to remain at a nascent stage, mainly due to lack of effective initiation from member countries. Although the notion of bank implies profit, the SAARC Food Bank can be established as a non-profit humanitarian aid organisation. If the SAARC Food Bank can be materialised, then this will greatly enhance food security in the region. Most importantly, the region does not have to rely on foreign food assistance in times of natural calamities.

b. Intellectual Property Rights and Sharing of Knowledge and Experience – While India has been a leader in Intellectual Property Right (IPR) issues in the region, other South Asian economies lag far behind in this field. As such, other South Asian countries can learn from the Indian experience. Furthermore, an increased transfer and share of SAARC technology is essential for promoting economic growth and regional cooperation in the region.
c. Climate Resilience Agriculture – In order to better adapt to changing weather patterns, South Asian economies need to invest in research and development of climate resilient agriculture. There is a greater need for improved farming systems, diversification of agricultural products and development of breeds that adapt to climate change. The region can seek foreign technical assistance in this regard.

If greater economic cooperation is sought after in South Asia, then it is imperative that South Asians be aware of the importance of SAARC and its initiatives. Even after decades of SAARC establishment, vast majority of South Asians are practically unaware of SAARC and its declarations. By contrast, in Europe, Europeans are aware of the importance of the EU zone and participate in EU policies by voting in referendums. However, no such activities exist in South Asia. Hence, until and unless the civil society in the region is aware of SAARC and its greater manifestations towards economic development and regional cooperation, SAARC ministerial summits and subsequent declarations will have little significance at all.

Endnotes

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About the Project

The objective of this project is to understand food insecurity and larger issues of threats to farmers' livelihood in South Asia caused by declining crop yields resulting from climate change and other factors. In partnership with local organisations, it covers four countries – Afghanistan, Bangladesh, India and Pakistan. Farmers' perceptions about climate change and resultant adaptation practices are collected and analysed along with measures taken by governments. It highlights some macro-micro gaps on this subject and suggested some means to bridge them.

Details are available at: *www.cuts-citee.org/CCFS*

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Established in 1983 as a voice of the poor to express their developmental needs and aspirations, CUTS International *(www.cuts-international.org)* is a leading Southern voice and face of consumer empowerment through its rights-based approach and activities for influencing the process and content of inclusive growth and development.

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