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Climate Change and Food Security: Nepal Perspective

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ABSTRACT

Global warming induced heat waves, drought, and flooding constitute a global food security emergency for us all today. Negative impacts of climate change on crop and terrestrial food production have been more common than positive impacts. Climate change is posing a threat on present and future food security in low-income countries. But, the actual effect of the climate change on food security is not known. Climate change will affect all four dimensions of food security, namely food availability, access to food, stability of food supplies, and food utilization. The percent of the emission of greenhouse gases that are held responsible for the climate change is very negligible in Nepal which is only about 0.025% of annual greenhouse gas emissions. However, Nepal is highly vulnerable to climate change impacts. Increase in temperature cause more damage on agricultural sectors in terai region and will be more favorable to agriculture in the hills and mountains of Nepal. Number of food deficient population has increased remarkably in the recent decades due to various reasons. Global predictions show slight increase in the food production with respect to estimated climate change but our food production which is based on the rain fed depending on the weather pattern, even small and short period weather extremities will badly effect the production and supply. Nepal being a least developed country, it is moving towards vulnerable situation due to climate change. As it is known, its effects cannot be completely controlled but effective planning and change in human habit towards a low carbon economy can slower down possible disasters.

Key Words: Climate change, Food security, Global warming, Greenhouse gas, Mitigation, Adaptation.

1. INTRODUCTION

Nepal is a land-locked country located in South Asia between India and China. It contains 8 of the 10highest mountain peaks in the world, including Mount Everest (at 8848 m), although some of its low lyingareas are only about 80 m above sea level. The country is divided into three broad ecological zones, i) Terai, an extension of Indo-Gangetic plain in the south, ii) hills and valleys in the middle, and iii) the lofty Himalayas in the north. The mountains, hill and terai regions are home to 7, 46 and 47 per cent of Nepal's population respectively (CBS, 2004). Nepal is divided into five geographic regions: Terai plan, Siwalikhills, Middle Mountains, High Mountains (consisting of the Main Himalayas and the Inner HimalayanValleys), and the High Himalayas. The agriculture sector of Nepal dominates the economy providing about 35% of the GDP and employs more than the manufacturing, service and tourism sectors combined. Agriculture absorbs about 75% of Nepal'slabor force and three-quarters of all households are employed in the sector. About two-thirds of agriculture GDP comes from the crops sub-sector with the remainder from the livestock sub-sector. Close to 16% of the country is arable land (NPC, 2010). In addition to its effects on greenhouse gases, agriculture affects ecosystems by the use and release of limiting resources that influence ecosystem functioning, (example: release of pesticides and conversion of natural ecosystems to agriculture). The Food and Agriculture Organization (FAO, 2002) defines food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Climate change will affect all four dimensions of food security, namely food availability (i.e., production and trade), access to food, stability of food supplies, and food utilization. Changes in temperature and precipitation associated with continued emissions of greenhouse gases will bring changes in land suitability and crop yields.

The atmosphere surrounding the earth is made up of nitrogen (78%), oxygen (21%) and the remaining 1%, is made up of trace gases that include carbon dioxide, methane and nitrous oxide. These gases also called greenhouse gases act as a blanket and trap heat radiating from the earth and make the atmosphere warm. Beginning with the industrial revolution global atmospheric concentrations of these greenhouse gases have increased markedly as a result of human activities. Global warming is increasing rapidly and there is widespread consensus that the current trend is caused by increased emissions of various greenhouse gases such as carbon dioxide, hydroflurocarbons, per fluorocarbons, Sulphur hexafluoride, methane and nitrous oxide.

Agriculture typically plays a larger role in developing economies than in the developed world. Nepal's economy depends on agriculture. A total of 3091000ha area is cultivated for agriculture, and it accounts for 38.15% of the gross domestic product (GDP). The country is susceptible to disasters, including flash flood, GLOF and melting snow in the mountains and droughts and inundation in the Terai (AEU, 2001).

2. IMPACTS OF CLIMATE CHANGE ON AGRICULTURE

Nepal has various types of agricultural zones like plains, hills, mid hills, high hills and mountains. Changes in agri-zones lead to the change in cropping pattern of the zone. Climatic parameters have potential impact to change the ecological distribution of agricultural crops. If shifting of climatic zones occurred rapidly due to climate change, extinction of biodiversity might be severe. Effects are mainly on cold-water fish, herbs, pasturelands, tree lines (apple trees) and livestock (Chauri). Increase in temperature cause more damage on agricultural sectors in Terai region and will be more favorable to agriculture in the hills and mountains. As temperature increases, cropping pattern as well as vector born disease of human and livestock's can be expected to shift in higher eco zones too. Some lands, which are presently undesirable due to different weather factors, may be desirable in near future. For example: maize, chilly, tomato and cucumber are now being adopted in Mustang district of the country**.** Additionally high humidity provides a conducive environment for breeding of insects, bacteria and fungi leading to the rise of tropical diseases and also crop destroying pests become more prevalent (Regmi and Adhikari, 2007; Pabitra Aryal, 2015).

3. CLIMATE CHANGE AND FOOD SECURITY

The Food and Agriculture Organization defines food security as a "situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO,2002). This definition comprises four key dimensions of food supplies: availability, stability, access, and utilization. The first dimension relates to the availability of sufficient food, i.e., to the overall ability of the agricultural system to meet food demand. Its sub dimensions include the agro-climatic fundamentals of crop and pasture production and the entire range of socio-economic and cultural factors that determine where and how farmers perform in response to markets. The second dimension, stability, relates to individuals who are at high risk of temporarily or permanently losing their access to the resources needed to consume adequate food, either because these individuals cannot ensure *ex ante* against income shocks or they lack enough "reserves" to smooth consumption *ex post* or both (Schmidhuber and Tubiello, 2007). An important cause of unstable access is climate variability, e.g., landless agricultural laborers, who almost wholly depend on agricultural wages in a region of erratic rainfall and have few savings, would be at high risk of losing their access to food. However, there can be individuals with unstable access to food even in agricultural communities where there is no climate variability, e.g., landless agricultural laborers who fall sick and cannot earn their daily wages would lack stable access to food if, for example, they cannot take out insurance against illness. The third dimension, access, covers access by individuals to adequate resources (entitlements) to acquire appropriate foods for a nutritious diet. Entitlements are defined as the set of all those commodity bundles over which a person can establish command given the legal, political, economic, and social arrangements of the community of which he or she is a member. Thus a key element

is the purchasing power of consumers and the evolution of real incomes and food prices. However, these resources need not be exclusively monetary but may also include traditional rights, e.g., to a share of common resources. Finally, utilization 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. It is not enough that someone is getting what appears to be an adequate quantity of food if that person is unable to make use of the food because he or she is always falling sick (Schmidhuber,2006).

4. REVIEW AND DISCUSSION

Global Scenario of Climate Change

Current scenario

The global atmospheric concentration of carbon dioxide, a greenhouse gas (GHG) largely responsible for global warming, has increased from a pre-industrial value of about 280 ppm to 379 ppm in 2005. Similarly, the global atmospheric concentration of methane and nitrous oxides, other important GHGs, has also increased considerably. The increase in GHGs was 70% between 1970 and 2004 (IPCC, 2007). Eleven of the last twelve years rank among the 12 warmest years in the instrumental record of global surface temperature since 1850. The mean earth temperature has changed by 0.74°C during 1906 – 2005 (IPCC, 2007). Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. During last 50 years, cold days, cold nights and frost have become less frequent, while hot days, hot nights, and heat waves have become more frequent. The frequency of heavy precipitation events has increased over most land areas. Global average sea level rose at an average rate of 1.8 mm per year over 1961 to 2003. This rate was faster over 1993 to 2003, about 3.1 mm per year (Aggarwal, 2008).

Future projections

The projected temperature increase by the end of this century is likely to be in the range 2 to 4.5°C with a best estimate of about 3°C, and is very unlikely to be less than 1.5°C. Values substantially higher than 4.5°C cannot be excluded. It is likely that future tropical cyclones will become more intense, with larger peak wind speeds and heavier precipitation. For the next two decades a warming of about 0.2°C per decade is projected. Even if all future emissions were stopped now, a further warming of about 0.1°C per decade would be expected. Himalayan glaciers and snow cover are projected to contract. It is very likely that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent. Increases in the amount of precipitation are very likely in high-latitudes, while decreases are likely in most subtropical land regions, continuing observed patterns in recent trends. The projected sea level rise by the end of this century is likely to be 0.18 to 0.59 meters. Average global surface ocean pH is projected to reduce between 0.14 and 0.35 units over the 21st century (IPCC, 2007).

Nepal's Scenario of Climate Change

Nepal's temperature has increased by 1.8°C during last 32 years. In Nepal average temperature increase was recorded as 0.06°C per year andthat in Terai and Himalayas was 0.04°C and 0.08°C/year respectively (Shrestha et al., 1999). It may be due to solar radiation absorbed by glacial lakes as well as radiation absorbed by land because of snow melting in the Himalayan region. Rainfall was recorded minimum in the year 1972, 1977, 1992 and 2005 and maximum in the year 1975, 1985 and 1998 respectively (Malla, 2008). Erratic rainfall events (i.e. higher intensity of rains but less number of rainy days and unusual rain) with no decrease in total amount of annual precipitation have been experienced. Such events increase possibility of climatic extremes like irregular monsoon pattern, droughts and floods. For example, there were rain deficit in eastern Terai and western regions, normal rain in far western region and heavy rain in the mid-western region creating flood, landslide and inundation (Malla, 2008).

Climate change and Food security in Nepal

Climate change will hit hardest on the food security in Nepal through various aspects. Number of food deficient population has increased remarkably in the recent decades due to various reasons. Global predictions show slight increase in the food production with respect to estimated climate change but our food production having based on the rain fed depending on the weather pattern, even small and short period weather extremities will badly effect the production and supply. Heavy dependence on agriculture makes Nepal's economy very sensitive to climate variability (World Bank, 2002). Over 40% of the GDP is dependent on agriculture (MOAC, 2007).

Food and Agriculture Organization's (FAO, 2002) Food Price Index surpassed the upper bound reached during the peak of the food crisis in 2008. The World Bank says global food crisis has reached "dangerous levels". In Nepal, the World Food Program (WFP) argues that about 3.7 million people are at risk of food insecurity.

Domestically, food prices are fast outstripping overall general prices. The Food Price Index (FPI) has been continuously dragging up Consumer Price Index (CPI), whose annual percentage change is a popular measure of inflation. Since Nepal does not produce enough food to satisfy domestic demand, it has to import food equal to domestic production deficit. So, shocks in production, supply and prices of agricultural goods at the global level affect food prices in our local markets as well. There was 316,000 metric tons food deficit in 2010, an increase by 139 percent from 2009, according to the WFP. As the demand for food is fairly price inelastic, even if prices increase, Nepal will be importing at least the same amount of food, but it will have to spend substantially more, which will further widen total trade deficit (FAO, 2002).

Agriculture is the main base of food security in Nepal. Besides, it provides employment, income and economic base as 41% of the country's GDP comes from agriculture (Gill, 2003). Climate change affects agriculture through its impact on crop yields; forests which feed on the agriculture are vulnerable to the change on forest composition, geographic range of forest, forest health and productivity.In 2008-09, Nepal was hit by the effects from a major drought, which had an impact on more than 3.4 million people. This illustrates the potentially damaging effects that climate variability could have on the country's food production, access to markets and livelihoods (CGIAR, 2013).

Mitigation

Climate change has been a cause of serious concern if the agricultural sector has to grow in the context of country's overall economic growth, to respond to rural households' livelihood, country's food security and poverty alleviation.

1. Improve inventories of emission of greenhouse gases using state of art emission equipment coupled with simulation models, and GIS for upscaling.
2. Evaluate carbon sequestration potential of different land use systems including opportunities offered by conservation agriculture and agro-forestry
3. Identify cost-effective opportunities for reducing methane generation and emission inruminants by modification of diet, and in rice paddies by water and nutrient management.
4. Renew focus on nitrogen fertilizer use efficiency with added dimension of nitrous oxides mitigation
5. Assess biophysical and socio-economic implications of mitigation of proposed GHG mitigating interventions before developing policy for their implementation
6. Evolving policy and programs to manage and mitigate risks due to climate change.
7. Improving early warning systems followed by effective monitoring and evaluating its impact.
8. Developing climate impact modules that give a better understanding of how climate change may affect crop, livestock and fish farming and forestry at a local level in order to be well prepared.
9. Developing a database on climate, soil and water use and crop yields to assess, map and monitor land-use performance under given technology conditions.
10. Assessment of how vulnerable our food system is and how we can adapt agriculture, livestock, fisheries and forestry to future climate-related disasters.

Adaptation

Adaptation to climate change will need to focus on strengthening measures, such as early warning systems; systems to identify climate change "hot spots" and disaster risk management; and evolving sustainable and eco-friendly farming practices.

1. Developing new genotypes
   - Intensify search for genes for stress tolerance across plant and animal kingdom
   - Intensify research efforts on marker aided selection and transgenic development for biotic and abiotic stress management
   - Develop heat and drought tolerant genotypes
   - Attempt transforming C3 plants to C4 plants
2. Developing new land use systems
   - Evolve new agronomy for climate change scenarios
   - Explore opportunities for maintenance /restoration/ enhancement of soil properties
   - Use multi-purpose adapted livestock species and breeds
3. Enhancing value-added weather management services
   - Enhance research on applications of short, medium and long range weather forecasts for reducing production risks.
   - Develop knowledge based decision support system for translating weather information into operational management practices
   - Develop pests and disease forecasting system covering range of parameters for contingency planning and effective disease management.
4. Develop a compendium of indigenous traditional knowledge and explore opportunities for its utilization
5. Promotion of " best crop-livestock-fish farming practices" through farmers' capacity building and networking
6. Conceptualization and Implementation of "National Adaptation Program of Action on Climate Change"
7. Developing contingency plans to cover new and evolving risk scenarios.

5. CONCLUSION

Climate change is posing a threat on present and future food security in low income countries. However, the actual effect of the climate change on food security is stillunknown. The percent of the emission of greenhouse gases that are held responsible for the climate change is very negligible in Nepal which is only about 0.025% of annual greenhouse gas emissions. However, Nepal is highly vulnerable to climate change impacts. Temperatures are likely to increase more in high mountain areas than elsewhere. Global climate change will also likely shift monsoon precipitation patterns in ways that will threaten Nepal's current agricultural practices, infrastructure, bio-diversity etc. Climate change is real and underway, so there is a need of impact identification and adoption to cope with vulnerabilities in agricultural sector. Nepal being a least developed country, it is moving towards vulnerable situation due

to climate change. As it is known, its effects cannot be completely controlled but effective planning and change in human habit towards a low carbon economy can slower down possible disasters. Enriched CO_2 has shown positive impact on yield of major crops in all geographical zones. However, some research findings from other countries showed reduction in grain and food quality. Increase in temperature and CO_2 levels is also threatening to bring hidden-hunger problem in human by lowering essential nutrients contents in food crops. It is concluded that overall impact of climate change in agricultural sectors will have negative impacts in the long run. To lower the negative impact and to move towards sustainability, principles of agro-ecology should be integrated in to all spheres of programming, in result we should not compromise the ability of future generations to meet their own needs but rather promote the preservation and regeneration of resilience food systems. Nurturing enormous mutual understanding, maintaining rigorous data collection and mutual collaboration with local people and all members of society will help Nepal to become a food secure country.

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