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Climate Change: Concern for Food Security in India

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Abstract: The problem of climate change and its outcomes are the matter of great concern all over the world because it has the capability to make life vulnerable on earth. In developing countries like India global climate change has been the most burning issue. Climate Change is projected to have extensive effects on a number of economic, environmental and social issues, comprising agricultural production and food security. Food security is a matter which closely traces upon the well-being of the majority of our people. In many countries, it is under threat from more frequent extreme weather and unpredictable changes in rainfall. Therefore an effort has been made here to study the impact of climate change on the food security of India. The study revealed that climate change can negatively affect the all three dimensions of food security that is food availability, accessibility, and utilization.

Keywords: Climate Change, Indian Agriculture, GHG Emission, Temperature& Food Security.

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I. INTRODUCTION

Since about 1850 the mean global temperatures have been increasing, mainly due to the accretion of greenhouse gases in the atmosphere. The main reasons behind this are the burning of fossil fuels (coal, oil, and gas) to meet up increasing energy demand, and the extension of intensive agriculture to meet rising food demand, which is often accompanied by deforestation (FAO, 2008). The process of global warming shows no signs of reduction and it is expected that it will bring long term changes in weather conditions. In the 21st century, Climate change has become one of the major global environmental challenges faced by the world with consequences on the sustainability of food production which is the need of the hour. In recent years, it has been at the centre of scientific and political debate, today, more than at any time in the past there is an approximately undisputed consensus among scientists, policy-makers, politician, administrators and the common people alike that climate has changed and that it is still changing (IPCC, Climate Change 2007: Synthesis Report, 2007). But, scientists have become more confident that greenhouse gases will lead to a rise in global temperature (Haughton et al 1996).

There is an increasing concern about the economic impact of climate change on agriculture (Watson et al, 1996). Recent efforts to project the effects of current national policies indicate that there is about a 40 percent chance of exceeding 4°C warming above preindustrial levels by about 2100. Critically, timing is of the essence. The risks for human lives and development trajectories increase with the rising temperatures, and various impacts will soon be locked in for decades, if not for centuries to come. For example, if present temperatures were to be maintained, the world would be devoted to around 2.3 m of sea-level rise over the next 2,000 years. On the other hand, sea levels would rise to around 3.6 m under a 2°C warming scenario and to approximately 8 m over the same period under a 4°C scenario (Levermann et al.2013). It is also important to note that greenhouse gas emissions and concentrations leading to a warming of 4°C by 2100 (IPCC, 2013, Summary for Policymakers, 2013). Due to these changes, there will be negative impacts on the four dimensions of food security i.e. food availability, food accessibility, food utilization and food system stability. In global food markets effects have already being felt, and are expected to be particularly important in some rural locations where crops fail and yields decline. Impacts will be felt in both rural and urban locations where supply chains are interrupted, market prices increase, purchasing power falls, assets and employment opportunities are lost, human health is at risk and affected people are unable to cope with these problems.

1.1 Objectives

- Analyse the impact of climate change on availability of food
- Analyse the impact of climate change on accessibility of food
- Analyse the impact of climate change on utilization of food

II. CLIMATE CHANGE

Climate change has now become one of the most important effective terms used in the world development discussion, and rightly so, given the severity of this phenomenon in terms of its predicted adverse effects on the lives of human and assets across the world. Climate change in IPCC usage refers to a change in the state of the climate that can be recognized (e.g. using statistical tests) by variations in the mean and/or the changeability of its properties and that continues for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural inconsistency or as a result of human activity. The Intergovernmental Panel on Climate Change (IPCC) has concluded that the impact of anthropological activities on climate is unequivocal (IPCC 2007).

2.1 Climate Change in India

In many parts of India, episodic droughts and cyclonic storms have become more frequent. Monsoon seasonal rainfall has decreased by 6 to 8% of the regular in eastern Madhya Pradesh, north-eastern India and several 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). In addition, sea level has risen between 1.06 to 1.75 mm per year (IPCC, 2007). Such varying climatic patterns will dominate India even towards the end of the 21st century. India will experience deep rainfall, leading to enormous soil erosion and landslides. 'As the number of rainy days will reduce by 15 days, the intensity of rainfall will increase by one to four mm per day' (Lal et al., 2010). But it is seen that the intensity of rainfall will increase in rain abundant areas, leading to flooding and loss of fertile soil. Areas like Rajasthan, Madhya Pradesh, Gujarat, and Andhra Pradesh are drought prone which will receive less rainfall, resulting in severe droughts (Lal et al., 2010). Furthermore, 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^{o}C per 100 years and ground level waters are falling by one to three meters per year (Sehgal, 2009).

III. FOOD SECURITY AND DIMENSIONS

Even though previous study counted at least 30 definitions of the term "food security" (Maxwell and Smith 1992), the benchmark understanding of the term is generally that of FAO (FAO, The State of Food Insecurity in the World, 2001): "Food security is 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". This definition is then typically subdivided food security into three main components: food availability, food access, and food utilization. Availability aspects related to the physical presence of food; accessibility related to having the means or resources to acquire food through production or purchase or through import; and utilization refers to the suitable nutritional content of the food and the ability of the body to utilize it effectively.

IV. CLIMATE CHANGE AND FOOD SECURITY

Global climate change such as the shift in pattern and intensity of rainfall and variations in temperature can reduce agricultural yield and damage infrastructure leading to slower economic growth and increasing poverty threatening food security. Predicted flood and drought could cause many people to lose their livelihood, by migrating or displacing, while increasing temperature could increase the incidence of vector borne diseases and lead to heat related insufficiency of death and water. However a large section of the society suffers from food and nutrition insecurity in India, the worst affected groups are landless people with little or no land to depend upon, petty self-employed workers and destitute including beggars traditional artisans, and providers of traditional services. The food insecure families in the urban areas are those whose working members are generally employed in poorly-paid occupations and informal labor market. These workers are mostly engaged in seasonal activities and are getting very low wages that just ensure bare survival.

India has many reasons to be worried about climate change because a majority of the people depend on climate sensitive sector i.e. agriculture, forestry, and fishing for livelihood. If not addressed in time, the existing problem of food security in our country will become more severe due to change in the climate. For a country like India, it will become more difficult to ensure food security under the changing climate where more than one-third of the population is estimated to be extremely poor and one-half of all children are malnourished in one way or another (Dev and Sharma, 2010). To study the impact of climate change on Indian agriculture sector is quite complex as many factors are concerned in this phenomena. For the detail discussion about the impact of climate change on food security we have taken the three components of food security and discuss the impact of climate change on these components in the Indian context.

4.1 Impact of Climate Change on Production of Food

The estimate of climate change impacts on agricultural production, food supply and agriculture based livelihoods must be taken into account the characteristics of the agro ecosystem where particular climate-induced changes in biochemical processes are occurring, in order to determine the degree to which such changes will be positive, negative or neutral in their effects (FAO, The State of Food and Agriculture, 2008). Greenhouse fertilization effect will create local beneficial effects where a higher level of atmospheric CO2 stimulates plant growth. This is likely to occur primarily in temperate zones with yield expected to increase by 10 to 25% (IPCC, Climate change 2007: Mitigation of Climate Change, 2007). These effects are not expected to influence projections of world food supply, (Tubiello et al., 2007). But the tropical type of Climatic condition prevails in India so here most likely the greenhouse fertilization will have negative impacts. The impact of increased mean temperature will be experienced differently, depending on location (leff, Romand Kutty and Faley, 2004) for example, Moderate warming (increase of 1 to 3oC in mean temperature) is expected to benefit crop and pasture yields in temperate regions while it is likely to have negative impacts in tropical and seasonally dry regions like India, particularly for cereal crops. Warming of more than 3oC is expected to have negative effects on production in all regions (IPCC, 2007c). For example, cereals and fruits productivity could be spoiled by a few degrees of temperature above or below a certain threshold (Wheeler et al., 2000).

An average of 500 climate-related disasters are now taking place each year compared with 120 in the 1980s; the number of floods has increased six fold over the same period (Oxfam, 2007). Increasing intensity and frequency of storms, altered hydrological cycles, and precipitation variance in India also have long term impacts on the feasibility of current and future food availability. Constraints on water availability are a growing concern, which the problem of climate change will further make worse. Conflicts over water resources will have implications for both food production and people's access to food in conflict zones (Gleick, 1993). Even today, in India we can see several cases of water dispute which are inter-state and intra-state and in future because of climate change the scarcity of water will be further increased. All these factors will further create the problem of food availability. Prolonged and recurring droughts can cause loss of productive assets, which undermines the sustainability of livelihood systems. In India, the majority of population's livelihood depends on rain fed agriculture where approximately 70% cultivated land is practiced under the system of dry land farming. Drought and deforestation may increase fire danger, resulting into the loss of the vegetative cover needed for grazing and furrow.

Table-1 Per Capita Net Availability of Foodgrains (Per Day) in India (Grams/Day)

Year	Rice	Wheat	Other Cereals	Cereals	Gram	Pulses	Food Grains
1951	158.9	65.7	109.6	334.2	22.5	60.7	394.9
1961	201.1	79.1	119.5	399.7	30.2	69	468.7
1971	192.6	103.6	121.4	417.6	20	51.2	468.8
1981	197.8	129.6	89.9	417.3	13.4	37.5	454.8
1991	221.7	166.8	80	468.5	13.4	41.6	510.1
2001	190.5	135.8	56.2	386.2	8	30	416.2
2002	228.7	166.6	63.4	458.7	10.7	35.4	494.1
2003	181.4	180.4	46.7	408.5	8.5	29.1	437.6
2004	195.4	162.2	69.3	426.9	11.2	35.8	462.7
2005	177.3	154.3	59.4	390.9	10.6	31.5	422.4
2006	198	154.3	60.5	412.8	10.7	32.5	445.3
2007	194	157.8	55.5	407.4	11.9	35.5	442.8
2008	175.4	145.1	54.1	394.2	10.6	41.8	436
2009	188.4	154.7	63.9	407	12.9	37	444
2010	182	168.2	51.4	401.7	13.5	35.4	437.1
2011	181.5	163.5	65.6	410.6	14.6	43	468.2
2012	190.2	158.4	60	408.6	13.5	41.7	463.8
2013	197.4	183.1	52.7	433.2	15.3	43.3	491.9
2014	198	183	61.8	442.9	16.3	46.4	489.3

Source: Directorate of Economics and Statistics

As shown in the Table-1 the per capita net availability is assessed to have increased by only 23 percent over a 63- year period from 1951 to 2014. Though, the net availability of food grain has declined from 468.7 gm per day in 1961 with only 437.1 gm per day as reported in the year 2010 but improved significantly to 489.9 gm per day in the year 2014. This implies that significant increase in food grain production has not been able to keep up with the increase in population. There has been a steady decline in net per capita food grain availability from 1991 to 2010, with the levels falling from 510.1 gm per day in 1991 to only 437 gm per day in 2010. It is also seen from Table 1 that net availability of cereals declined from a level of 468.5 gm per day in 1991 to a level of 442.9 gm per day in 2014. The net availability of pulses which is a major protein source in the Indian diet also declined significantly during the same period. It was 41.6 gm per day in 1991, which fell to a level as low as 35.4 gm per day in 2005 but improved significantly to 46.4 gm per day in the year 2014 though it is still below the specified standards.

4.2 Impact of Climate Change on Accessibility of Food

Food is distributed through the market and non-market distribution mechanisms. Factors that determine whether people will have access to food through markets are considered in the affordability aspects. These factors include income-generating facility, the amount of compensation received for products and goods sold or labor and services rendered and the proportion of the price of a minimum daily food basket to the average daily income (FAO, The State of Food Insecurity in the World, 2008). Nonmarket mechanisms include production for self-consumption, food preparation and allocation of food practices within the family, and from various public food distribution schemes. Approximately 70% population of India lives in rural areas. For rural India where people who produce a considerable part of their own food, the impact of climate change on food products can decrease availability to the extent that distribution choices have to be made within the household. A family might decrease the daily quantity of food consumed evenly among all household members, or distribute food preferably to certain members often the able-bodied male adults who are assumed to need it the most to stay fit and healthy or continue working to maintain the family. Nonfarming may low the income of rural and urban households whose incomes go down below the poverty line because of climate change impacts will face similar choices. Allocation issues resulting from climate change are therefore likely to become more significant in urban areas over time.

Urban agriculture has an inadequate ability to contribute to the benefit of poor people in India because the bulk of their constant food requirements still need to be transported from rural areas (Ellin and Sumberg, 1998). In many countries the ratio of the minimum daily food basket to the average daily income is used as a determinant of poverty (World Bank Poverty Net, 2008). When this ratio falls below a certain standard, it signifies that food is affordable and people are not poor; when it exceeds the established threshold, food is not affordable and people are having difficulties in obtaining enough food to eat. This standard is an indicator of chronic poverty, and can also be used to conclude when the population has fallen into temporary food insecurity. Owing to decreased food supply and increased prices to a rapid fall in household income or to both. Most food is not produced by individual households but acquired through buying, trading, and borrowing. Climate impacts on income-earning may affect the availability of certain food products, which may dominate their price. Due to the high price, certain foods are unaffordable and can have an impact on individual's nutrition and health. Changes in the demand for seasonal agricultural labor caused by changes in production practices due to climate change can affect income generating capacity positively or negatively. On one hand, farm automation may decrease the need for seasonal labor in many places, whereas on the other hand crop failure due to natural calamities (drought, flood, and frost) caused by climate change also reduces labor demand (FAO, 2008). Food preferences decide the kinds of food households will attempt to obtain. Changing climatic conditions many affects both the physical and the economic availability of certain chosen food items, which might make it impossible to meet some preferences. Change in availability and relative prices for major food items may result in people either changing their food basket or spending a bigger percentage of their income on food when prices of preferred food items increase.

4.3 Impact of Climate Change on Utilization of Food

Food insecurity is linked with malnutrition. The people who are unable to consume nutritious and ample food does not satisfy all their nutritional requirements. Nutritional status is also adversely affected due to low small scale horticulture production resulting from scarcity of water or labor and decline in the availability of mild foods. In general, however, the main impact of climate change on nutrition is possible to be felt indirectly, through its effects on income and ability to purchase in order to spread their food basket. In India, climate change will cause new patterns of pests and diseases to appear, affecting plants, animals, and humans, and posing a new threat to food security, food safety, and human health. Increased incidence of water-borne diseases in food-prone areas like U.P, Bihar, Bengal, Orissa, Andhra Pradesh, Maharashtra etc; changes in vectors for climate reactive pests and diseases, and appearance of new diseases could affect both the food chain and peoples

physiological capacity to attain necessary nutrients from the foods consumed. These will expose crops, livestock, fish, and humans to new risks to which they have not yet adopted. They will also put new pressures on care giver within the home. Due to climate change, Malaria, in particular, is expected to increase its distribution (IPCC Fourth Assessment Report, 2007). In the coastal area of India, more people may be exposed to vector-and water-borne diseases through flooding associated with sea-level rise. Food safety may be compromised in various ways. Increasing temperature may cause food quality to depreciate unless there is increased investment in cooling and refrigeration processing of perishable foods to expand their shelf-life.

Table-2 Mean Per Capita Consumption of Calories, Protein and Fats for Rural and Urban Households in India (per capita/day)

Year	Calories (kcal)		Protein (gms)		Fats (gms)	
	Rural	Urban	Rural	Urban	Rural	Urban
1983-84	2240	2070	63.5	58.1	27.1	37.1
1987-88	2233	2095	63.2	58.6	28.3	39.3
1993-94	2153	2073	60.3	57.7	31.1	41.9
1999-00	2148	2155	59.1	58.4	36	49.6
2004-05	2047	2021	55.8	55.4	35.4	47.4
2009-10	2147	2123	59.3	58.8	43.1	53

Source:*NSSO reports* (various rounds)

In assessing the adequacy of food and nutrition the trends in the per capita calorie, protein and fat intake of the population are often used. Table-2 indicates the trend of per capita intake of calorie, protein and fat intake for the period 1983-84 to 2009-10. A dissimilar trend has been found for calorie and protein intake between rural and urban population. The per capita calorie and protein intake for the rural population declined from a level of 2240 kcal and 63.5 gm per day in 1983-84 to 2147 kcal and 59 gm per day in 2009-10 respectively. However the per capita intake of fat increased steadily over time for both rural and urban population. The per capita calorie and protein intake for the urban population increased marginally from 2070 kcal and 58.1 gm per day in 1983-84 to 2123 kcal and 58.8 gm per day 2009-10 respectively. Both numbers are still below a Planning Commission benchmark of 2,400 kilocalories per day. However the per capita intake of fat increased steadily over time for both rural and urban population.

V. CONCLUSION

The problem of climate change and its outcomes are the matter of great concern all over the world because it has the capability to make life vulnerable on earth. In developing countries like India, climate change has been the most burning issue for agriculture practices. The changing temperature and rainfall patterns and increasing carbon dioxide level will definitely have significant effects on agriculture and thus on food security of India. The significance of its dimensions and the overall impact of climate change on it will differ across regions and over time. Unbalanced use of nutrients, low water use efficiency, continued high demographic pressure, changes in pest/disease patterns, soil erosion, degradation and poor health, etc. would further worsen the situation. In the likely event of enhanced adverse impacts of climate change on agriculture in developing countries like India, where poverty is also concentrated, mitigation and adaptation strategies would demand far greater research and development effort, and financial, institutional and policy support.

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