

# Impact of Climate Change on Food Security in India

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**Abstract:** Global climate change has been the most burning issue in developing countries like India. Climate Change is expected to have extensive effects on a number of environmental, social and economic issues, including agricultural production and food security. Food security is a subject which closely touches upon the well being of the majority of our people. Food security in many countries is under threat from unpredictable changes in rainfall and more frequent extreme weather. In view of this, this paper tries to analyse the food security condition of India during the last few decades and the impact of climate change on food security of India.

**Key words:** Food; Security; climate; change; India.

## 1. Introduction

Global climate change has been the most burning issue in developing countries like India. Agriculture, the growing and harvesting of crops, raising livestock, and producing other agricultural products accounts for a high percentage of greenhouse gas emissions which contribute to global climate change. Climate change will surely influence the basic elements of life for people - access to water, food production, health and the environment. It is urgent to confront global climate change and its impact to vulnerable communities. These have led to millions of people worldwide living in a food insecure environment. The climate is also changing and global mean temperatures have increased and are projected to continue to do so. This is expected to have profound effects on food security.

Food security is a subject which closely touches upon the well being of the majority of our people. The problems which our country, India, is facing today on food front are immense. Sound evidence in dealing with the problems is not lacking. Here, we have assembled together a great deal of ideas which could provide direction as to how the nation should proceed. In spite of the fact that right to food is a basic human right, much of Asia and Africa are today beset with hunger. According to the report of UN Food & Agricultural organization almost, a billion people go hungry each day, after food prices pushed, 40 million more vulnerable people around the world into the ranks of the under nourished. Around 963 million people, which constitute 14% of the world's population, were reported to be starving in 2008, with a rise of 40 million people from last year. The facts about hunger are shocking when we pay

attention to the fact that one in seven people in this world do not get enough food to stay healthy every day. The FAO (Food and Agriculture Organization of the United Nations) estimates that 1.02 billion people are suffering from chronic hunger in the world, mostly in Africa and south Asia, meaning that almost one sixth of humanity is suffering from hunger. Despite the good economic performance, with over 200 million people who are food insecure, India is home to the largest number of hungry people in the world. International Food Policy Research Institute sheds renewed light on the acute Indian hunger situation. The Global Hunger Index 2009 ranks India at the bottom with 65th position (out of 84 countries) with a GHI of 23.90, which the index characterizes as "alarming" food security situation. The time has come to demonstrate that together we can act against the root causes of food insecurity and make a difference to the lives of the hungry people of the world. This news letter highlights some of the contemporary perspectives on food insecurity in India and attempts to in cite the readers to respond to the compounding crises. We together need to serve as a catalyst for an action to ensure "food security for all people, at all times, to have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life. Therefore, a large section of population in developing countries like India largely in backward states has limited access to food in terms of their entitlement or supply of food grains in the food deficit areas.

In this backdrop, this paper tries to analyse the food security condition of India during the last few decades and the impact of climate change on food security of India.

### 1.1. General concept of food security and food insecure people

Food is something that gives you the energy to function and keeps you alive. But food security means something more than getting two square meals. Food security means availability, accessibility and affordability of food to all people at all times. As per Rome Declaration on World Food Security at the World Food Summit, held in 1996 “*food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.*” Thus, food security is ensured in a country only if (1) enough food is available for all the persons (2) all persons have the capacity to buy food of acceptable quality and (3) there is no barrier on access to food.

Food security has following dimensions:

(a) *availability of food* means food production within the country, food imports and the previous year’s stock stored in government granaries.

(b) *accessibility* means food is within reach of every person.

(c) *affordability* implies that an individual has enough money to buy sufficient, safe and nutritious food to meet one’s dietary needs.

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Although a large section of people suffer from food and nutrition insecurity in India, the worst affected groups are landless people with little or no land to depend upon, traditional artisans, providers of traditional services, petty self-employed workers and destitutes including beggars. In the urban areas, the food insecure families are those whose working members are generally employed in ill-paid occupations and casual labour market. These workers are

largely engaged in seasonal activities and are paid very low wages that just ensure bare survival.

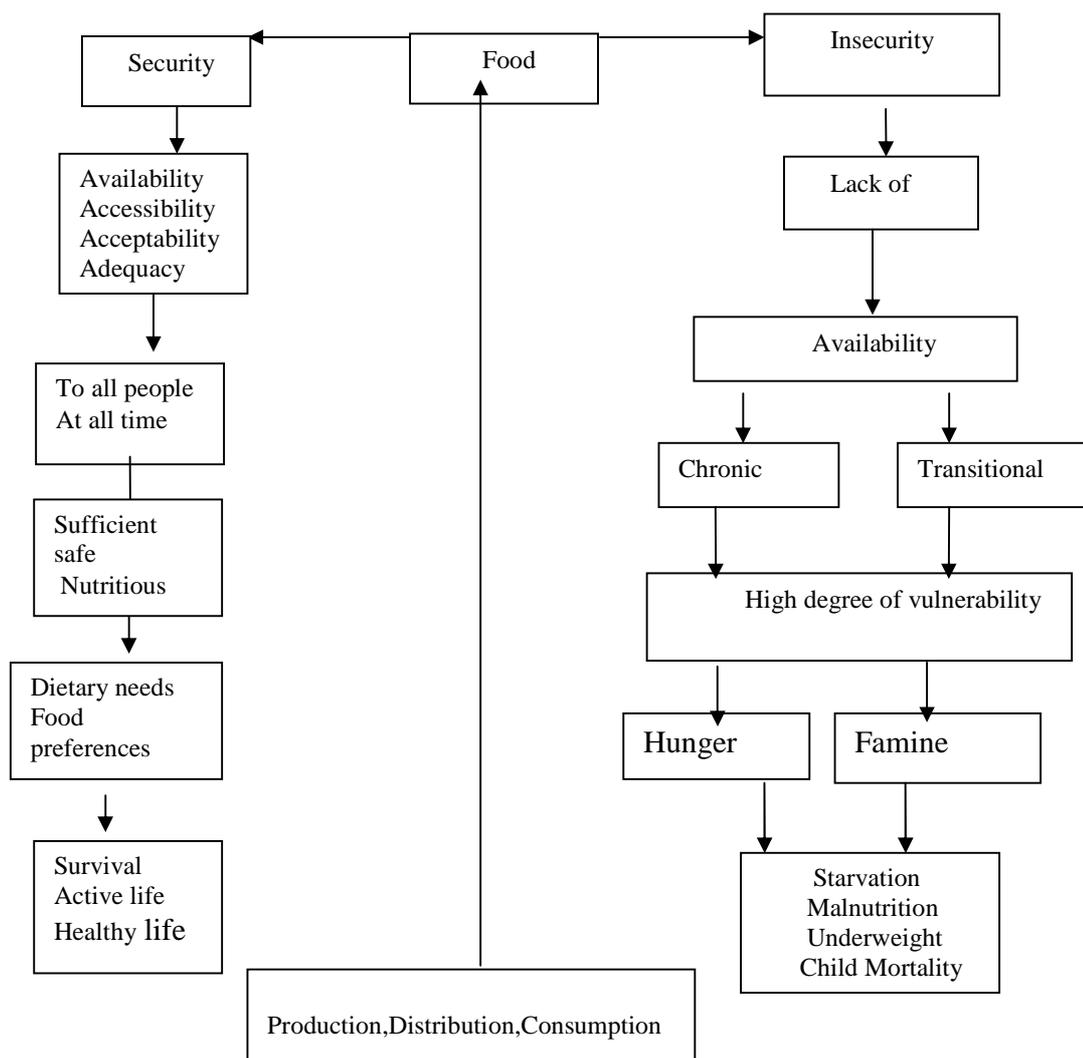
Global climate change such as shift in intensity and pattern of rainfall and variations in temperature –may lower agricultural productivity and damage infrastructure leading to slower economic growth and increasing poverty threatening food security. Projected flood and draught could cause many people to lose their livelihood, be displaced or migrate, while rising temperature could increase the incidence of vector borne diseases and lead to heat related death and water scarcity.

Climate change will affect food security. During the last century, rising atmospheric concentration carbon dioxide led to a 0.75 percent increase in average global temperature. Even if green house gas emissions stop growing, global warming is expected to continue because changes in temperature lag behind changes in emissions (World Bank, 2009).

The suitability of the environment to provide all life support systems and the materials for fulfilling all developmental aspirations of man and animal is dependent on the stability of the climate which is undergoing constant changes. The effect of these changes is posing threat to food security in India. The world had gone through series of climatic epochs, which include the ice age, and consequently, the ice recessions among others. In the recent times, Inter-governmental Panel on Climate Change (IPCC), World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) established that the earth has become warmer over the last century. According to these agencies, the average surface temperature of the earth has increased during the twentieth century by about  $0.6 \pm 0.2^\circ\text{C}$ . It is warmer presently in many parts of the World than at any time during the past 1000 years, with possibilities of warmest years than the e previous centuries, occurring within the next few decades. This change in temperature usually lead to lower ozone levels near the earth’s surface, and significant increase of Smog problems in the cities where the release of carbon dioxide is greater .

### Chart-1

Understanding the concept of Food Security
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## 2. Present scenario of India's food security:

At present, food security in India is uncertain and may most likely fall down in future, because food is not available with the recommended quantity of nutrients and the number of malnourished/undernourished persons is increasing every year. Undernourishment is defined as having less than 9200 kJ of food energy per day. It has been reported by the Food and Agriculture Organization of the United Nations (FAO), that the proportion of undernourished people in developing countries has fallen from 57% in 1964–66 to 10% in 1997–99. However, with insufficiency in food supply, the population of hungry people in developing countries will increase by 1% for every 2–2.5% increase in prices, mainly because the purchasing power and high cost of food items do not match in the present scenario of economic growth. It means one has to purchase less food than required and ultimately this condition leads to increased hunger.

India is a home ground for more than 1000 million people, out of which 300 millions are resource surplus and connected, 400 millions are climate sensitive living on margin, 300 millions are climate refugee living in poor condition, undernourished and un-reached, mainly settled in rain fed, floodplains and forest. India, home to the largest number of poor, undernourished and food insecure, is having 700 million people dependent on agriculture, fisheries, forests. GDP growth from agriculture, being climate sensitive, declined from 42% in 1980 to 20% in 2007. In India, persons living below the poverty line (BPL) are around 25% in Maharashtra, whereas this proportion is only 5% in Punjab. In reality, we are passing through a transition from a surplus production supply to greater demand for staple food commodities. According to the estimates of the International Food Policy Research Institute, additional 38% rice should be produced by 2025 to satisfy the growing demand, without adversely affecting the resource base. In India, the agricultural land supplies nearly 90% of human food requirements, while occupying

12% of the earth's ice-free surface. During the last century, food production increased by about sevenfold. This was achieved with modern farm technologies (hybrid seeds, synthetic fertilizers, chemical pesticides, farm machineries, etc.). In India, by introducing the green revolution in the late sixties, the production of food grains could be increased fourfold, e.g. 50 mt in 1950 to 212 mt in 2006. Similarly, even though the human population grew about four-fold, the amount of food supplied by agriculture for each person on the planet was almost doubled. Therefore, adequate nourishment is possible if the food is distributed evenly across the whole world. In fact, this is not the reality, as about 10% of the population in the world is still undernourished. If this food sufficiency is to be achieved, the world food production must be about 50% greater than it was in 2000. This target seems to be difficult to achieve, as crop productivity is nearly stagnant or coming down, or if continues to increase, it would be at a much smaller rate of improvement due to several environmental changes and socio-economic situations. In fact, although human-controlled factors such as soil, seed, fertilization and plant protection can be controlled, the weather is still a key factor in agricultural productivity, and reduction in the potential yields is likely to be caused by shortening of the growing period, decrease in water availability and poor vernalization. It is estimated that humans appropriate 25–40% of the world's terrestrial biological production for their own use. This has had implications for the other species with which we share the planet. Though an increase in food production is welcome, it would be indispensable to reduce the impact of agriculture on environment. Since India is an agricultural country, farm economy should consider not only food commodities, but other agricultural productions such as textile products, medicinal plants, horticulture, forest revenues, dairy by-products and other internationally traded commodities. This is because sustainable high returns can only be generated from products that are valuable to customers. This means there is an urgent need for a transition from the present agriculture to higher value foods.

#### *Production trends:*

It is evident that India's total food production has been witnessing unpredictable trend. Output has been fluctuating sharply keeping pressure on supply side. India stands at a tipping point, particularly as food grains output is stagnant. Wheat production was stood at 72.8 million MT in 2002. In the year 2007-2008 the figure is 74.0 million MT. Rice productions was 93.3 million MT during 2002 and in the year (2007-2008) it stood at 90 million MT. Meanwhile, population has increased by nearly 88 million during the said period. So there is a need for imports. This in turn would lead to increase in global prices. As soon as India bought 795,000 MT of wheat in August 2008, at a record price of US \$ 389.5, wheat futures in Europe would go up by 70% on expectations of more orders (Woolverton, 2009).

#### *Per capita Availability:*

In 1979, at the height of the Green Revolution euphoria, per capita availability of cereals and pulses had gone up to 476.5 g/day. In 2006 it was still lower at 444.5 grams. The reason for this fall in the availability of food is that Indian farm output is just not growing. Since the mid 1990s the output has hovered nearly 415 million tonne. In the eight years i.e. between 1996 and 2004 when agriculture was growing at a low rate of 2%, there was in fact zero growth in food (Sen, 2008). The stagnation is hitting the agriculture situation in the country.

### **3. Impact of climate change on Indian Agriculture**

In general, climate change in India is accompanied by high average temperature, changed rainfall patterns, increased severity and frequency of floods, droughts and cyclones, oceanic acidification, climate changes due to GHGs, transport, industries, agricultural waste decay, high yielding techniques of agriculture, arbitrary use of natural resources, deforestation, reduction in pastures, fertility of land reduction, forests, flora and fauna disappearance. It has the effect on livelihoods of poor in developing countries like India, availability of water, food production / food security, flooding of coastal areas, increased burden of vector borne and water borne diseases, slows down the pace of development.

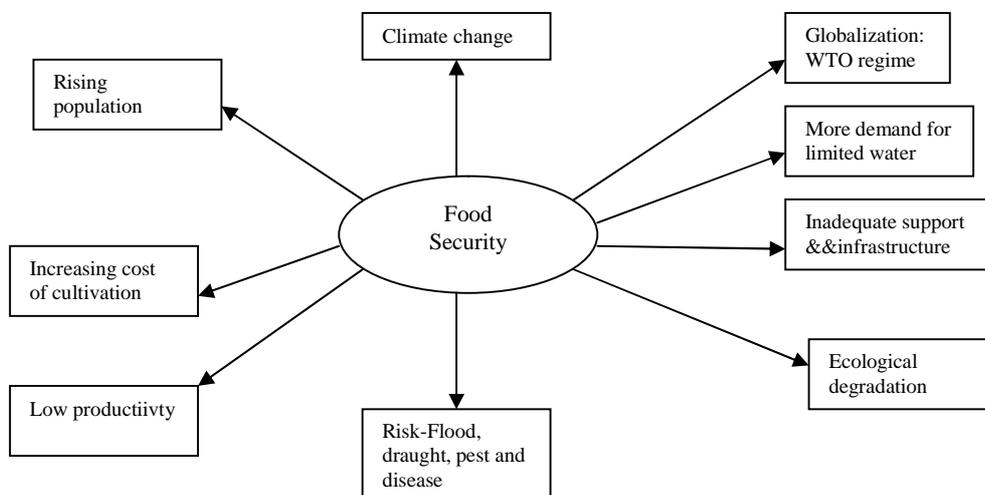
Sinha and Swaminathan (1991) observed and proved that an increase of 2<sup>0</sup> C in temperature could decrease the rice yield by about 0.75 ton/ ha in the high yield areas and a 0.5<sup>0</sup> C in winter temperature would reduce wheat yield by about 0.45 ton /ha. Rao and Sinha (1994) showed that wheat yield could decrease between 28 to 68% without considering the CO<sub>2</sub> fertilization effects and would range between +4 to -34% after considering CO<sub>2</sub> fertilization effects. at et.al (1996) concluded that carbon fertilization would not be able to offset the negative impacts of high temperature on rice yields. Soseendran et.al(2000) showed that for every one degree rise in temperature, decline in rice yield would be about 6%. Climate change would considerably affect food availability and supply systems by direct and indirect effects on crops, livestock and fisheries, and on their inter relationships. With India's dependence on monsoon rains, Himalayan glacier-fed rivers and its long coastline, climate change would have a serious impact. Recent studies indicate a probability of 10-40% loss in crop production by 2080-2100 in India and other South Asian countries due to increases in temperature, rainfall variability, and decreases in irrigation water. The Indian Agricultural Research System accords high priority to understanding impacts of climate change, and developing adaptation and mitigation strategies, and launched a nationwide climate change network involving 25 institutions.

The UN Intergovernmental Panel on Climate Change (IPCC) estimated that GDP in the developing and less developed countries would decline by 1.4–3.0% due to

climatic change. In India, the effects of global warming are likely to be more severe. For every 2°C rise in temperature, the reduction in GDP is 5% and for the next 6°C it would be 15–16%. Likewise, FAO has estimated that India would lose up to 125 mt of cereals. In Haryana, wheat production has declined from 4106 kg/ha in 2000–01 to 3937 kg/ha in 2003–04, with maximum temperature rising by about 3 °C during February–March in the last seven years. Thus, the direct impact of climate change on agriculture and food supply includes shortage in grain production resulting in less availability of food items, especially to the economically poor people, changes in agricultural inputs such as fertilizers and pesticides, shift in planting dates of agricultural crops, preference of crop genotypes due to adaptation to changing climate, soil erosion, soil drainage and lower fertility level. Additionally, the incidence of pests, weeds and diseases in food crops will be more pronounced. The IPCC has predicted that the greenhouse gases (GHGs) will cause temperature to increase from 1.5 to 5.8°C and precipitation patterns to shift resulting in the increase of sea water level by 15–95 cm by 2100. There would be floods on coastlines and no agricultural activities would be possible in these areas. Ultimately, people would strive for their livelihood or may move to urban areas.

Moreover, the proliferation of heavy and medium industrial units and the growing urban population in India has put enormous pressure on air, water and land resources. Concentration of GHGs such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbon, etc. has been rising at a fairly rapid rate. Agriculture is the main contributor to increasing methane and nitrous oxide concentration in the earth's atmosphere. These gases prevent and absorb radiation from the earth, which increases the temperature of earth's surface as well as the lower layers of the atmosphere. The IPCC report indicated that an overall increase of 2°C in temperature and 7% in rainfall would lead to an almost 8% loss in farm level net revenue. High probability of crop losses with increase in temperature in the tropical regions is also foreseen. Water supply will suffer because of scanty rainfall in the Himalayas. According to the National Climate Centre in Pune, rainfall has decreased in July and greater rainfall has been recorded in August in key crop growing areas of the country. Another major change in the monsoon pattern is that there has been a shift westwards, with the rainfall getting confined to certain pockets which may result in floods, resulting in the lack of food for people.

### Chart: 2



Therefore, India is confronting high degree of climate variability, GDP growth is attributable to yearly variations in rainfall. Himalayan eco-system is now highly vulnerable and an increase in mean sea levels is going to affect large populations in peninsular and coastal India. *Gangotri* Glacier - one of the largest is retreating gradually and rainfall in India may increase by 15 to 40% and annual mean temperature by 3 to 6 degree and more particularly, agriculture sector would be most affected. High

anthropogenic production of greenhouse gases and associated changes in climate is being looked upon as a great challenge to food and livelihood security in India. Frequency and intensity of chaotic weather events like late/early onset of rains, late or early withdrawal, long dry spells, droughts, floods, cold/heat waves, cyclones, hailstorms, etc., have increased due to global warming. Himalayan glaciers are retreating at rates of 12-24 m per

annum. About 28% of the geographical area of India is vulnerable to droughts, 12% to floods and 8% to cyclones.

Climate change will make monsoons unpredictable. As a result, rain-fed wheat cultivation in South Asia as well as in India will suffer in a big way. Total cereal production will go down. The crop yield per hectare will be hit badly, causing food insecurity and loss of livelihood.

The rising levels of the sea in the coastal areas will damage nursery areas for fisheries, causing coastal erosion and flooding.

The Arctic regions, Sub-Saharan Africa, small islands and Asian mega deltas, including the Ganga and Brahmaputra, will be affected most.

Changes in climate around the globe are expected to trigger a steep fall in the production of cereals, says R K Pachauri, chairman of the IPCC. He estimated that a rise of 0.5 degree Celsius in winter temperatures could cause a 0.45 tonne per hectare fall in India's wheat production. The average per hectare production in India is 2.6 tonnes.

Worse still, Pachauri said, total agricultural land will shrink and the available land may not remain suitable for the present crops for too long. Farmers have to explore options of changing crops suitable to weather. He also pointed out that climatic changes could lead to major food security issues for a country like India.

The report also predicts huge coastal erosion due to a rise in sea levels of about 40 cm resulting from faster melting of glaciers in the Himalayan and Hindukush ranges. It can affect half-a-million people in India because of excessive flooding in coastal areas and also can increase the salinity of ground water in the Sunderbans and surface water in coastal areas.

India needs to sustain an 8 to 10 per cent economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals, according to a 2006 report on an integrated energy policy prepared by an expert committee of the Planning Commission. Consequently, the country needed at the very least to increase its primary energy supply three or four-fold over the 2003-04 level. India's economic growth would "necessarily involve increase in (greenhouse gas) emissions from the current extremely low levels." Any constraints on such emissions by India, whether direct, by way of emission targets, or indirect would reduce growth rates, the report stated. However, the report also added, "India should be willing to contain her (greenhouse gas) emissions as long as she is compensated for the additional cost involved."

In his Budget speech this year, 2011-12, Union Finance Minister of India, Pranab Mukherjee had promised the appointment of an expert committee 'to study the impact of climate change on India and identify the measures that we may have to take in the future'. The Union government has recently constituted the committee, headed by R Chidambaram, Principal Scientific Adviser to the government.

#### **4. Steps to be adopted to prevent climate change and ensure food security**

India has been arguing at all climate negotiations that though it is among the top 10 emitters of carbon dioxide, the per capita emission is still one-sixth of the global average. Further, it has managed an 8 per cent growth with only a 3.7 per cent growth in energy consumption.

**Table: 1: Total Carbon Emission worldwide**

USA	19.8
China	17.7
Russia	5.2
<b>India</b>	<b>4.7</b>
Japan	4.1
Germany	2.6
Canada	2.1
U.K.	2.0
South Korea	1.6
Mexico	1.5

All other Countries	38.8
Total	100

### India's total Co<sub>2</sub> emissions are about 5% of global emission

India may oppose any move to seek its commitment to reduce greenhouse gas emissions and will ask the developed world to transfer Intellectual Property Rights with the clean technologies.

The Indian Constitution on a sensitive provision in Article 48-A states, "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country." This is a fundamental obligation of the state since its violation has fatal implications. Article 51A (g) creates a fundamental duty on every individual to obey the mandate of environment and ecology.

India needs to chart out a roadmap for itself in the light of the report on climate change. Climate change can be mitigated in many ways, such as improving the efficiency of energy - intensive devices, vehicles and buildings, all of which involve direct and indirect gas emissions. Developing countries like India must adopt new energy - efficient technologies.

Fuel - efficient vehicles, hybrid vehicles, and affordable and safe public transport need policy support in the form of lower taxes and promotion of usage. The government can mandate that buildings integrate green technologies such as solar photovoltaic systems, which are particularly relevant in a country with plentiful sunlight.

The energy efficiency of end user equipment can be ensured through appropriate tax brakes and certification systems. The improved cooking stoves and high efficiency lighting, heating and cooling devices are available even today.

Ministries of Agriculture and Environment have taken many steps. Organic farming and green agriculture are environment friendly which is being done in India. Green agriculture is based on integrated pest and nutrient management crop livestock integration, use of most appropriate and productive genetic strains and adoption of more crop and income per drop of water technologies. A bio-diversity valley in Orissa is established already. Generation of electricity and bio-manure through Waste Management, Bio-fertilizer, compost vermiculture should be ensured. Bio-mass briquettes -Gassifier based grid power programme, conversion of solid bio-mass (wood, agriculture residue) into combustible gas has to be adopted. India has evolved appropriate policies and institutions, enacted/amended laws, set up authorities, and committed financial resources for immediate relief, adaptations, mitigation (resilience) and reducing vulnerability to climatic changes. As a case study, crop contingency plans, compensatory production systems and safety nets to manage chaotic climatic changes have been illustrated for the droughts in 2009. Medium and long term measures are in place for the *in situ* conservation of rainwater, variety/

crop diversification, developing and recharging ground water, enhancing efficiency of surface water resources, breeding tolerant crops, varieties, trees and animal breeds to offset vulnerability. Safety nets like insurance, credit, employment, buffer food stocks, public distribution of food grains, fodder, feed and seed banks are described. Deployment of energy to extract ground water by farmers was the latest unique feature of managing droughts in India. To expedite research and development activities and an action plan for its implementation, India organized a National Conference on Climate Change in October 2007, which highlights additional strategies for increasing adaptive capacity, including bridging yield gaps, developing adverse climate tolerant genotypes and land use systems, assisting farmers in coping with current climatic risks by providing weather-linked value-added advisory services and crop/weather insurance, and improved land, fertilizer and water use management and policies. Agriculture will have to be insulated and be made more competitive, efficient, profitable, and develop inbuilt mechanisms to reduce its vulnerability. Evolving scientific, technological, economic and political solutions to address these challenges is in the interest of agriculture as well as the global environment. There is an appreciation of the urgent need to strengthen locally relevant research efforts in the vulnerable regions, to understand the probable biophysical and economic impacts of, and adaptation to, increasing climatic risks, especially in relation to subsistence agriculture and native foods such as millets, legumes, oilseeds, and local species of fish and livestock. Efforts are on to evolve new and innovative models of cooperation and partnerships for adaptation research and development, including input intensive research with long gestation periods needing highly specialized human resources with innovative institutional setups and partnership mechanisms, requiring action and added investment in agriculture, human resource development and extension. It is believed that transgenic culture in agriculture would be a major savior, hence, ongoing efforts in gene discovery, allele mining and contemplated efforts of their effective deployment in appropriate genetic backgrounds are considered vital. After a series of discussions, region by region, season by season, situation by situation and system by system, research initiatives are being taken. High anthropogenic production of greenhouse gases and associated changes in climate is being looked upon as a great challenge to food and livelihood security in India. Frequency and intensity of chaotic weather events like late/ early onset of rains, late or early withdrawal, long dry spells, droughts, floods, cold/heat waves, cyclones, hailstorms, etc., have increased due to global warming.

Himalayan glaciers are retreating at rates of 12-24 m per annum. Regarding disaster vulnerability, about 28% of the geographical area of India is vulnerable to droughts (116 districts in 14 States), 12% to floods (40 Mha in 8 river valley areas) and 8% to cyclones, annual soil loss 5334 mt (64% as river deposit), annual nutrient loss 5.4 to 8.4 mt, crop pest being 5-10 times more susceptible, compared to temperate countries.

Specific areas of concern include agriculture, water resources, health and sanitation. Most effective response strategy to climate vulnerability is imbedded into the multi-sectoral programmes, viz. food security, poverty alleviation, disaster risk reduction and sustainable development. High anthropogenic production of greenhouse gases and associated changes in climate is being looked upon as a great challenge to food and livelihood security in India. Frequency and intensity of chaotic weather events like late/early onset of rains, late or early withdrawal, long dry spells, droughts, floods, cold/heat waves, cyclones, hailstorms, etc., have increased due to global warming. Himalayan glaciers are retreating at rates of 12-24 m per annum.

## 5. Conclusion

This paper demonstrates that climate change is only one of several changes affecting food systems. The changing temperature and rainfall patterns and increasing carbon dioxide level will undoubtedly have important effects on agriculture and thus on food security of India. In the likely

event of enhanced adverse impacts of climate change on agriculture in arid and semi-arid regions of the world 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. Frequent climatic extremes result in droughts, floods, migration and famines if food security is not at the centre stage of all-out actions on a long term sustainable basis. Continued high demographic pressure, unbalanced use of nutrients, low water use efficiency, soil erosion, degradation and poor health, changes in pest/disease patterns, etc. would further aggravate the situation.

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