

Climate Change, Food and Nutritional Security: Issues and Concerns in India

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Abstract: The effect of climate change on agriculture and food system is well studied. Altered rainfall pattern or temperature significantly influences crop productivity. This results into the socioeconomic vulnerability affecting the food system and security. Even though there are numerous independent studies carried out on the aspects of climate change, food security and nutrition availability, there are few studies interlinking them, particularly in Indian context. There is a dire necessity to understand the inter-linkage among these three owing to the population growth rate in India. Present paper gives an overview on (a) what are the impacts of climate change on agriculture productivity in India; (b) how the altered productivity is going to influence food security and (c) how does the nutritional availability score in Indian context. The discussion paper also focuses on the policy steps taken by Government of India to safeguard the food security of the population.

Keywords: Climate change; Food security; Agriculture; Nutrition; India.

Introduction

Intergovernmental Panel on Climate Change has projected that the global mean temperature may increase between 1.4 and 5.8°C by 2100 (IPCC, 2001). This unprecedented increase in temperature is associated with severe impacts on global water cycle thus influencing the ecosystem dynamics, sea level, crop production and related processes. The impacts are more pronounced in the tropical areas, which mainly consist of developing countries, including India. It has been observed that mean annual air temperature has increased by 0.4–0.6°C in the last 100 years in India (Rupa Kumar et al., 2002; Ray et al., 2015). The change in climate is more pronounced in northern India where an increase of the extremes in maxima and minima in temperatures has

been observed. Rise in summer rainfall (>20%) has been projected throughout India except Punjab, Rajasthan and Tamil Nadu. A likely shift of wetter forest type towards North East region and drier forest types in North-West region of India is expected, thus exacerbating land degradation and desertification (UNCCD, 2012). As a result, the intensity and frequency of landslides and flooding are projected to increase in the North-East India. In coastal zones, the post-monsoon period is projected to increased frequency of tropical cyclones in Bay of Bengal (Hazra et al., 2002). Numerous field observation as well as modelling studies have depicted vulnerability of low-lying coastal areas (specially in Ganges delta) due to sea-level rise, resulting in inundation and salinization, loss of crop yields, land loss, migration and climate refugees (Hazra et al., 2002;

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Kay et al., 2015). It also predicted that climatic change would also induce health related risk due to deterioration of food and water quality (pathogens), lifestyle related disorders in urban areas and malnutrition/under nutrition in rural areas (Thomas et al., 2012; Gupta and Mishra, 2014).

India is an agriculture based country with two third of the population directly or indirectly involved in this sector (Figure 1). Agriculture plays a key role in overall economic and social well-being providing approximately 16% of the total GDP. Agriculture is dependent on climate and annual variations in climatic conditions (temperature and precipitation) can significantly result into the difference between bumper harvest and economic ruin. These global climate changes have increased social and economic vulnerability of the population working in agricultural sector (Aggarwal et al., 2004). A 2°C increase in mean air temperature can decrease the rice production upto 0.75 ton/hectare in the high yield areas and by 0.06 ton/hectare in the low yield areas (Sinha and Swaminathan, 1991; Aggarwal and Kalra, 1994). Under similar conditions (2°C rise), northwards shift of iso-yield lines of wheat is projected along with decrease in cultivation area (Aggarwal and Kalra, 1994). Rain fed agriculture, which constitutes 60% of total cropland area in India, will have the

more pronounced impact of climate change as farmers practicing rain-fed agriculture are the poorest and the most vulnerable (Aggarwal and Kalra, 1994).

In Indian context, the studies on impact of global climatic change on the socioeconomic structure of the country are sparse and scattered, even though the climate change issue has been widely accepted as a major challenge of sustainable development. In an agricultur-based country like India, studies related to food security (access, availability and affordability) are the need of the hour, as to make national and regional development paths more sustainable with respect to climate change. The impact of climate change on food security and nutrition availability in Indian context has been reviewed in this article.

Climate Change and Indian Agriculture

According to the IPCC's third assessment report (IPCC, 2001), agriculture is one of the systems which is most vulnerable to climate change in the South Asian region, including India. Indian agriculture traditionally is dependent upon a number of natural factors such as monsoon and water availability, soils type, and temperature. These conditions vary region to region, thus making one particular crop as the major crop of a region based on the adaptability to the growing conditions prevalent in that region. However, the productivity of a region can be increased by technological advancements such as improved crop varieties, soil fertility, land management, irrigation and plant protection measures.

There exists two crop growing seasons based on weather. During summer it is *Kharif* (growing season: June-October) whereas *Rabi* is the winter crop (October-March). Some of the important *Kharif* crops are rice, sugarcane, maize, soybean, groundnut, pearl millet etc. whereas wheat, mustard, linseed, chickpea/gram (pulses) etc. are major 'Rabi' crops. The southwest monsoon critically influences the Kharif crops, accounting for more than 50% of the food-grain production and 65% of the oilseeds production in the country (DES, 2014).

Agriculture is the second largest source of CO₂ emissions after fossil-fuel combustion, accounting for 10 to 30% of net global CO₂ emissions. These emissions are mainly from manure and fertilizer application, soil management, livestock, rice cultivations and burning of crop residue (Tubiello et al., 2014). Even though, it is anticipated that increased CO₂ concentrations will increase the net primary productivity of plants, climate changes and the associated disturbance may lead either to increased or decreased net ecosystem

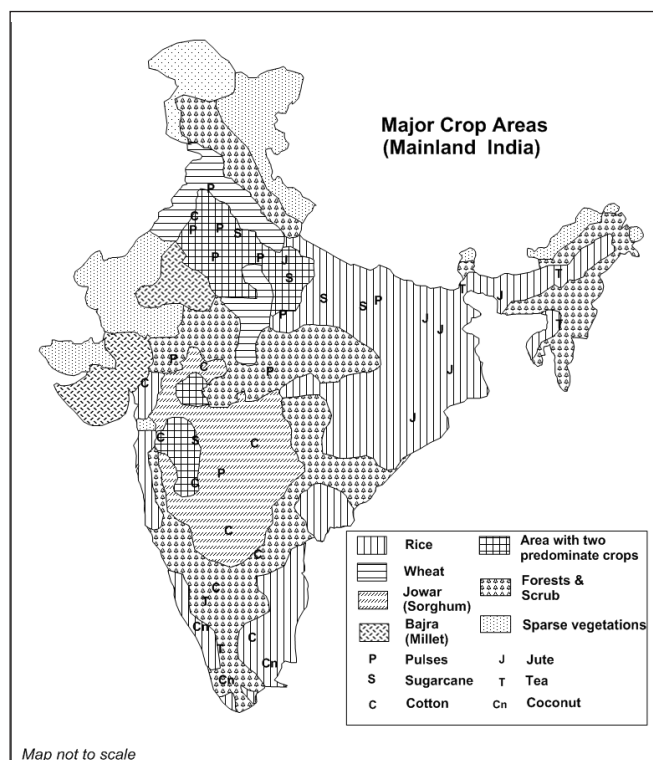


Figure 1: Major cropping regions of India (modified from map 501057, <http://www.lib.utexas.edu/>).

productivity (Fuhrer, 2003). Fuhrer (2003) concluded that the benefits of CO₂ fertilization would be largely offset by nutrient limitations, pollutants and interactions with climatic factors. As a consequence, the rice yield in Asia is expected to decline by 3.8% by the end of the 21st century under the projected climate change scenarios (Murdiyarso, 2000). If the CO₂ concentration is doubled, the resulting climate change may lead to decrease in global rice yields up to 40%, primarily due to heat-induced floret sterility (Tubiello et al., 2007).

The decrease in the potential crop yield is projected with increase in temperature in tropical countries, such as India (Tubiello et al., 2007). Substantial decline in wheat production are more likely in future climate change scenario (Aggarwal et al., 2000, 2004; Fischer et al., 2002). Even minute changes in the growing season temperature hold the key to yearly wheat yield fluctuations (Mall and Singh, 2000). The potential yields of rice and wheat in the Indo-Gangetic plains of India is predicted to decline due to increase in minimum temperature and reduction in solar radiation (Pathak et al., 2003). Furthermore, failure in monsoon or less rainfall will create stress on the irrigation water supply, resulting in decrease of the cultivable areas under irrigation for the year. Consequently, next year, potential areas under rain-fed agriculture will increase (Kumar et al., 2004).

Agricultural production (mostly rain-fed) in India has also been largely influenced by most important climatic aberration i.e. drought, caused by inadequate precipitation. Historically, there exist records of several famines due to droughts in different parts of the country. The repetitive failure of monsoon and low food production led to commissioning of a dedicated government body viz. Famine Commission. Several irrigation facilities have been developed to minimize

the impact of droughts. Ecological infrastructures (promoting water harvesting and watershed management and tree planting) are also strengthened as long-term measures in 'drought proofing' chronically drought-prone areas for minimizing the adverse impact. The drought of 1918 affected 73% of the geographical area of the country resulting in approximately 40% reduction in food-grain production. On the contrary, the drought of 1987-88 resulted in a reduction of only 9% in food-grain production over the previous best (Sinha and Swaminathan, 1992). Similarly, despite of 2002-03, 2004-05 and 2009-10 being the years of failed monsoon, no drastic decline in the yield of rice and wheat was observed (Figure 2). It is important to note that not only climate variability plays a role in governing the food production in India but the significant changes in the production pattern might be induced either by a technological trigger (e.g., hybrid varieties of wheat and rice), or a marketing trigger (e.g. assured and remunerative prices for soybean and sugarcane), or by both (Figure 3).

Impacts of climate change on agriculture vary by region depending on the availability of resources and use of technology. Technological advancements govern a farmer yield significantly, quite often far more than its climatic and agricultural endowment. Green revolution (use of high yield varieties, better agricultural practices, and subsidy) resulted in considerable positive shift in the agriculture produce. For instance, five-fold increase in rice production has been observed since 1951 with a marginal increase (1.5 folds) in the irrigated land (Figure 3). Hence, the productivity of a farmer using manual and traditional approach with a hoe and planting stick will be much lower than the one, who uses fertilizer and pesticides, hybrid plant varieties and machines. As a result, the former is more vulnerable

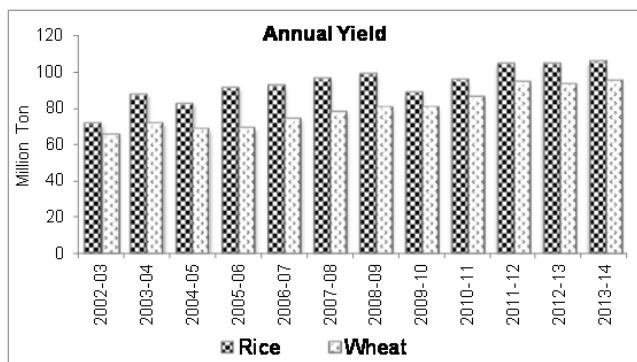


Figure 2: Decadal changes in rice and wheat production in India. Year 2002-03, 2004-05 and 2009-10 are drought (failed monsoon) year (DES, 2014).

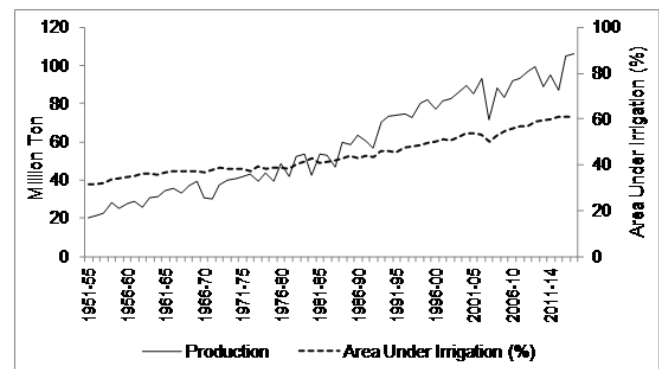


Figure 3: Decadal changes in rice production and % area under irrigation in India (DES, 2014).

to climate change than the latter. Thus, productivity is governed by not only climatic conditions, but also the economic, political, and agricultural policies at local and global scales which play an important role in the food security of the country.

Climate Change and Food Security

There exists a very few households which are self-sufficient in terms of food security, even though, the food system appears to be simple with a farmer consuming his own produce. The system has capacity to change and modify with the concurrent climatic, economic and social structure and is increasingly complex (Gregory et al., 2005). The intensification of agricultural production after green revolution resulted in the profound changes in food systems and security in distribution, marketing, affordability and preferences sectors. However, the changes are differential as the poor farmers in the warmer climate zones are more impacted, owing to fewer coping options in their agricultural system. The changing climate brings remarkable changes in land utilization pattern and water resource availability and affects food security at the global level. The food security encompasses the human environments and bio-geophysical components associated with the production, processing, distribution and consumption of food (Figure 4). The food security involves following components:

- *Availability*: Adequacy of food supplies in terms of quantity, quality and variety
- *Access*: Affordability and allocation of food as per preferences of individuals

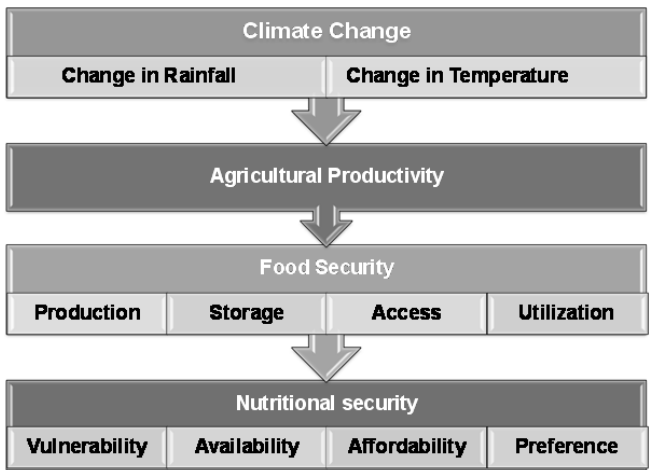


Figure 4: Components of climate change, food security and nutritional availability.

- *Utilization*: Safe and sufficient food to meet physiological requirements of the individual such as health and nutritional values
- *Stability*: The ability to consistently obtain food over time.

In India, wheat and rice are the main staple food and are the primary crops cultivated in the country (Figure 1). These are not only the primary sources of food, but also provide employment for millions. Any impact on these two crops will result in profound effects on both food crops and livelihood security as they together account for more than two-third of the total agricultural production (Brahmanand et al., 2013). Hence, an integrated approach is highly essential to address the food security concerns. However, food security and the crop production is also region and demand specific, such as potato is a major crop in hills of Nilgiri whereas millet is an important crop in the north-western India. Hence, it can be stated that specific challenges related to climate change in diversified regions need to be tackled in order to achieve food security at global level.

Food Productivity and Availability

The interrelationship between climate change and crop productivity has been well studied. It is already established that with increased carbon dioxide level, crop productivity will also increase. However, the negative influences associated with CO₂ rise such as extreme variation in temperature and rainfall as well as higher rate of natural disasters (floods and droughts) will be intensified, nullifying the positive impacts. By end of this century, it is expected that there may be substantial decrease in the cereal production potential, though the crop response will vary region to region (Parry et al., 1999). In high yield areas, a 2°C increase in mean air temperature may result in a decreased yield by 0.75 ton/hectare whereas in low yield coastal regions, the decrease will be about 0.06 ton/hectare (Ninan and Bedamatta, 2012). In case of wheat, a 0.5°C increase in winter temperature will reduce the yield by 0.45 ton/hectare by decreasing the crop duration by seven days (Lal et al., 1998; Kalra et al., 2007). Climate change is projected to reduce 6-23% wheat yield in India by 2050 and 15-25% by 2080 (Kumar et al., 2014). Overall, a temperature increase of >2.5°C would result in net revenue loss upto 25% (Lal, 2007).

An increase of 50% yield for soybean in a double carbon dioxide world is predicted, however accompanying 3°C rise in temperature will nullify

the positive effects of doubling of carbon dioxide by reducing the total duration of the crop (by inducing early flowering and shortening the grain fill period) thus reducing net productivity (Lal et al., 1998). Similarly, for 0.5-1.5°C temperature rise the yield of maize is predicted to decrease by 2-5% in India (Aggarwal, 2003); however the predictions vary regionally. A model simulated by Byjesh et al. (2010) suggested that high temperature will lead to reduction in monsoon yield of maize in Southern Plateau (up to 35%) and winter yield in Mid Gangetic Plain (up to 55%). The impact of climate change on oilseed crops is less studied as compared to cereals. Boomiraj et al. (2010) reported that Indian mustard (*Brassica juncea*) was sensitive to changes in carbon dioxide (CO₂) and temperature. Future climate change scenario analysis showed that the reduction in yield would be higher in eastern India (67 and 57%) as compared to Central India (48 and 14%) and northern India (40.3 and 21.4%) for irrigated and rainfed conditions, respectively. This decline in yield is attributed to maximum temperature rise projected for 2080.

Studies indicated that warming has occurred at faster rates in Himalayan region as compared to most places in the world. An increase in mean surface temperature by 1.5°C from 1982 to 2006 has been observed in the region. Studies in the Kumaon Himalaya region revealed during the last 30 years that annual agricultural productivity has declined by 25% (nearly 125 Kg per ha), causing a massive decline in per capita food productions (Tiwari and Joshi, 2012). Himachal valley has witnessed a steady decline in apple production, owing mainly to a fall in productivity. The winter temperature and snow fall governs the induction of dormancy, and bud break ensuring proper flowering in apples. Apple-growing areas in low altitudes like Solan in Himachal have been reduced by as much as 77% between 1981 and 2007. As a result, the cultivation shifted to higher altitudes. Recent studies have predicted a 4% reduction in apple productivity in higher altitude also (Gautam et al., 2014).

The Ganga plain, largest river flood plain system of India, is a major source of agricultural production in the country. Any changes in monsoon rains and Himalayan climate and tectonics are liable to adversely affect the hydrology, soil fertility, food production and settlement pattern of Indo Gangetic Plain. Further, varying conditions of temperature and rainfall can change the processes of sand movement and can force undesirable modifications in the landscape in its proximity of Thar

desert (Saini, 2008). Siderius et al. (2014) estimated that 25% (Kharif cropping season) to 18% (Rabi cropping season) of the land area is significantly affected in the Ganges basin by rainfall variability. This suggests larger dependency on groundwater sources for irrigation resulting in larger utilization rates than naturally replenished within the Ganges river basin, especially in Haryana and some parts of Rajasthan (Rodell et al., 2009). As a result, the food production and availability become more sensitive to rainfall variability.

The food grain production in 2013-2014 was distinctively five times the production in 1950-1951 (Figure 3). However, due to ever growing population which is likely to reach 1.30 billion by the year 2020, there is a major challenge before the country to increase its food production to >300 million ton by 2020 (Figure 5). Henceforth, the yield needs to be increased by 50% more by 2020 in order to achieve the food security for this increased population (Paroda and Kumar, 2000; DES, 2014). So, it clearly indicates that in order to fulfill the food grain demand for the growing population, increased pressure on land will be the most likely means for intensification of agriculture (Figure 6). Due to increasing economic development, the vast agricultural lands are often used up to support industrialization and urbanization. This may further aggravate the situation, since land will become limited and need for the food security could likely be met by increasing yields per unit of land, water, energy and time. Additionally, this cannot be denied that the clearing of forests zones for agriculture will result in the loss of sequestration capacity or capability of soil, further exacerbating the problem (Figure 6). In a nut-shell, the climate change will further increase pressure on environment by degradation of riparian areas, intensification of the land and water use, increased pollution load and species invasions in absence of sustainable utilization of resources.

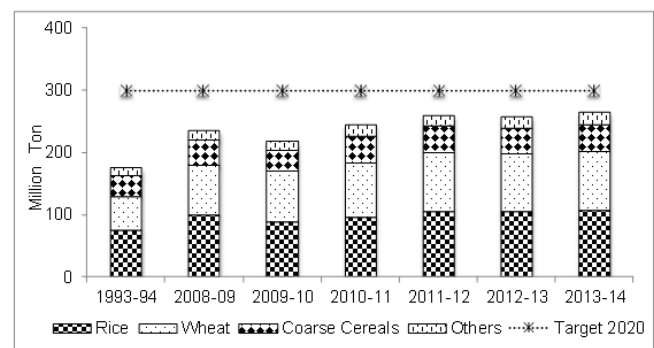


Figure 5: Decadal trends in food grain production in India (DES, 2014).

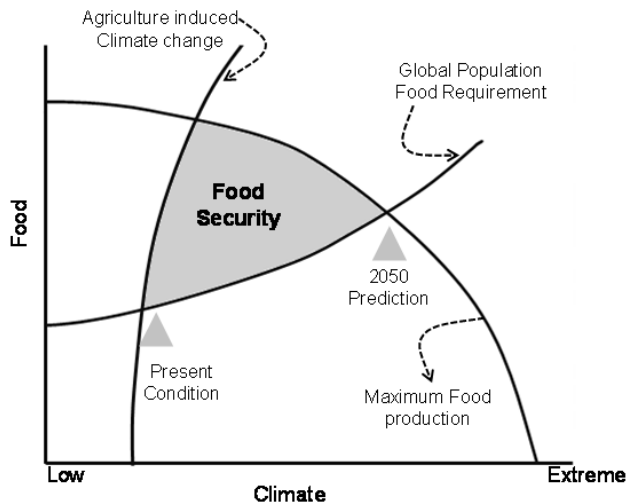


Figure 6: Food security and climate change in a changing world (redrawn from Beddington et al., 2012).

Food Access and Utilization

In recent decades rising unemployment and agricultural depression has been observed in country with sharp decline in per capita grain output as well as grain consumption. There has been a constant shift in income from the majority group of population towards the wealthy minority group and substantial segments of the population obtain less food (Pataniak, 2009). High population growth rate alongwith high urbanization rates will enhance the food demand and reduce supply in India as cropland area is limited (Murdiyarso, 2000; Brahmanand et al., 2013). Further, the decline in the crop productivity may hike global cereal prices by three-fold by 2050 (Parry et al., 2004). Since agriculture makes up roughly 16 percent of India's GDP, a 4.5-9% less production implies approximate cost of climate change to be 1.5% of GDP per year. The local perception of climate change is reflected by the utilitarian aspects. Income of person and price of the produce governs the food supply to a household. According to Aggarwal et al. (2004), rise in temperature by 2°C will result in loss of net income in the range of 15-20% in India which may account for increased migration rates from rural-agricultural-marginal sector to urban-unorganized working class. Non-availability of work throughout year to the marginal farmers and farm-labourers (in regions with monoculture) force them to opt for seasonal and permanent migration (Murali and Afifi, 2014). Additionally, massive decline in per capita food production would affect off-farm employment opportunities in different traditional rural sectors

(Tiwari and Joshi, 2012), thus posing a serious threat to food security. The situation can worsen if there are incidences of economic recession or slow down (Tiwari and Joshi, 2012). The most vulnerable communities include marginal and small-holder farmers and landless households, mainly including socially backward communities and families with very low incomes. In addition, this sector of the population is more likely exposed to risks associated with floods and other climate-related hazards in areas where they are forced to stay in (Adger, 2003). A similar study conducted in China suggested that poorer households would be the most vulnerable and sensitive to climate change because weakness and diseases occur increasingly with lower income households, while households in the richest strata would benefit from the climate change (Zhou and Turvey, 2015). They suggested that moderate climate change may rather have a long-term impact on health aspect (such as a serious malnutrition problem) than extreme events. However, in the long term, all households in rural China face equal vulnerability, though they appeared to adapt to the changing climatic conditions.

Average food consumption in India is low (200 kg per capita per year) as compared to other countries such as China (358 kg per capita per year) and USA (1040 kg per capita per year). There is wide gender disparity in food consumption pattern with males being higher than the female (Venkiah et al., 2002; Maharana and Ladusingh, 2014) (Figure 7). The current annual consumption is compensated by annual production which is around 250 million ton (Siry, 2013). However, the self-reliance on the food is achieved throughout by only a margin of the population of India and usually there is exchange, bartering or the cash economy to bring food into the household. With present rate of increase in population and agricultural yield, it is expected to have acute food shortage by year 2020,

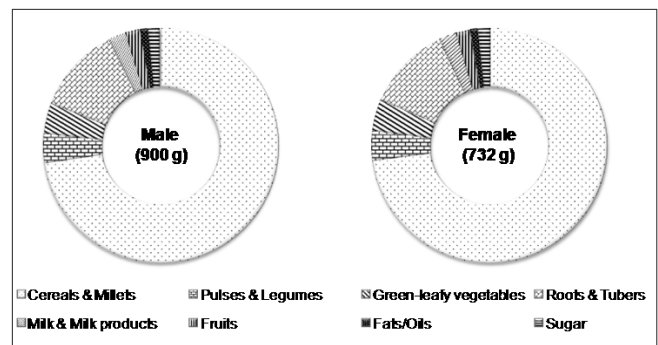


Figure 7: Daily food intakes (average) by Indian population (modified from Vecchio et al., 2014).

making a marginal sector vulnerable with respect to food security.

Nutritional Availability and Malnutrition

Due to reduction in food production caused by climate change while populations increase, the world is likely to face the sweeping hunger outbreak resulting in localized increase in food prices. It is projected the risk of hunger will remain very high in several developing countries like India under A2 scenario of IPCC, with regular increase in population at risk of hunger. It is expected that by 2020, additional 49 million people will be on risk; this count may increase to 132 million and 266 million by 2050 and 2080 respectively (Parry et al., 2004). Coastal erosion and inundation may also aggravate the problem by loss of cultivated land in low-lying areas of India further exacerbating the food insecurity and loss of livelihood. In this case, the pressures arising from climate change could be reduced by few management options, such as better stock management and more integrated agro-ecosystems and improve land conditions as well. It is, therefore, critical to understand the complex substitutability across nutrient groups in food demand faced by farm households under adverse climate conditions by food policy makers, agricultural economists, development economists and climate scientists.

A range of health issues including under nutrition, chronic diseases, infectious diseases, food safety, and environmental and occupational health could be affected by agriculture and climate change. There are numerous scientific evidences convincing that climate change will have negative effects on hunger and nutrition which would threaten the current agriculture and food systems (Rosenzweig and Parry, 1994; Parry et al., 2007; Nelson et al., 2009) along with reduced caloric intake through income and non-income effects. Also, poverty nutrition trap (PNT) is a serious concern which means climate shocks may reduce agricultural productivity and income, causing adverse nutrition and health consequences (Brown and Funk, 2008). According to the 2013 Global Hunger Index, over 17% of India's population is undernourished. It has been estimated that over 15% of the global disease burden is due to under nutrition, being a major global public health problem, despite increased global food production over recent decades. Thus, ill health in the farming community can reduce its ability to develop and deploy appropriate measures for food productivity (Greenfacts, 2008). One of the serious concerns is

about the prevalence of malnutrition among poorer and marginal groups, particularly rural children, and also about the large number of people below the poverty line in many countries limiting their ability to purchase the food. High variability of existence of protein energy and micronutrient malnutrition, between and within countries, remains a challenge (Greenfacts, 2008). As reviewed by Easterling et al. (2007), the studies suggest that with the rise in global temperatures by 3°C, prices will start to rise as production falls, which in turn, may have health consequences as individuals may shift to lower cost food items. There may be increased risk to vulnerable groups where dietary intakes are already suboptimal (e.g., persons with low incomes, migrant workers) and nutrient density requirements are elevated (e.g., pregnancy, childhood, old age).

It is well established that the poor diet throughout the life course is a major risk factor for chronic diseases, a major issue in third world countries (Greenfacts, 2008). Additionally, reduced quality of diet and associated low nutritional density has been a major cause of worldwide obesity and chronic diseases such as heart disease, hypertension, stroke and diabetes. The most striking example of new nutritional stresses has been the recent "nutrition transition," i.e., the process by which globalization, urbanization, and changes in lifestyle that are linked to excess caloric intake, poor-quality diets, and low physical activity. A shift towards a high-fat and energy-dense diet has been observed among the people in developing countries (Gupta and Mishra, 2014; NCAER, 2014). However, these effects of climate change on food security may be highly localized, with the foods most at risk being those produced in areas undergoing rapid environmental change, agricultural adaptation, or mitigation (Figure 8). For instance Vitamin-D deficiency was well correlated with environmental/ecosystem degradation (Wahlqvist, 2013). Introduction of policies and programmes

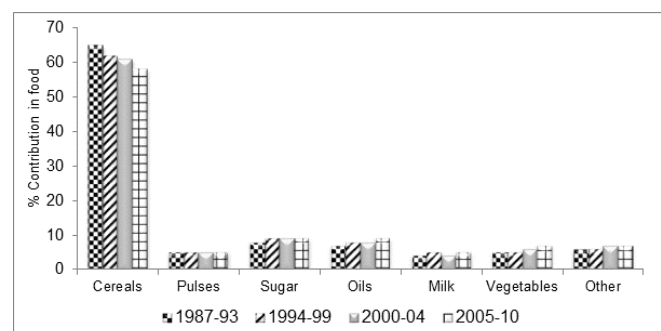


Figure 8: Decadal changes in the average food composition in India (Gupta and Mishra, 2014; NCAER, 2014).

to increase dietary diversity and development and deployment of existing and new technologies for production, processing, preservation, and distribution of food could play a significant role in improving and ensuring food security. Indeed, sufficient, safe and varied food supplies would be helpful in the prevention of malnutrition.

Policy and Measures

Social well-being, economic development and national and global stability are significantly enhanced by food security along with health and productivity. Since the frequency and intensity of climate extremes are predicted to increase in future, it is important to understand and learn from relevant past adaptations and indigenous knowledge (Gregory et al., 2005). Crop yield could be increased by making investments in improved seeds and varieties and an augmented use of inorganic fertilizer. Early warning systems (extensive climate monitoring and prediction) could be used to design region specific agricultural programmes. New research for different agro-climatic settings could help in developing adaptation and mitigation strategies to address the impact of climate change on agriculture. Adverse effects might be reduced by the use of alternative crops/cultivars adapted to the likely changes, alteration in the planting date, management of plant spacing and input supply. Conservation agriculture management technologies are suggested across the Ganges River basin by maintaining soil fertility and water-holding capacity in conditions of unpredictable monsoons (Erenstein et al., 2008; Gathala et al., 2011; Jat et al., 2009). Policy formulation with proper scientific inputs will result in better coping capacity e.g. application of remote sensing in Crop Insurance Programs (Leeuw et al., 2014). Since the implementation of neoliberal economic reforms in 1991, India has observed a growing issue of food production and availability for population (Pataniak, 2009).

In India, traditional approach to meet food security has been in proactive through ancient ages as food-for-work schemes. In drought years, the wages were paid in the form of grains from public stocks and the state provided employment in public works. However in early 2000s, a sharp rise in unemployment and fall in purchasing power led to 64 million tons of unsold grain stocks leading to a decrease in popularity of food-for-work programme. In 2006, Government of India

reframed a National Rural Employment Guarantee Act (NREGA) which guarantees 100 days of employment per worker to every rural family seeking work (Pataniak, 2009). The NREGA became widely popular and one of the most successful schemes providing livelihood assurance to marginal and poor. The programme also supported various climate change adaptation and mitigation initiatives such as watershed development and other land development programmes for arresting land degradation and establishment of vegetation in degraded and community lands (Venkateswarlu and Prasad, 2012). Government of India in 2008 formulated National Action Plan on Climate Change (NAPCC) that triggered the need for a structured approach on climate change vulnerability assessments in India. The state governments focused on State Action Plans on Climate Change (SAPCC) to mainstream the adaptation and solutions. As about 16% of India's GDP is generated from agriculture, Government of India has accorded high priority on research and development to cope with climate change in agriculture sector. A major long-term project has been launched with Indian Council for Agricultural Research (ICAR) entitled, National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with following objectives:

- Development of climate resilient agriculture (crops, livestock and fisheries) covering climatic variability as well as development and application of improved production and risk management technologies.
- Climate change adaptation strategy by application of site specific technology packages on farmers' fields.

Rapid improvements in food access and availability could be made through improved local governance, reduced developed-world agricultural subsidies, together with more nuanced food aid policies that protect local markets, thereby, reducing hunger while providing food for more people. In order to provide the food security to around two-thirds of the country's population, the Government has enacted National Food Security Act 2013 providing subsidized food grains to the most vulnerable households and address food security. However, it has also to be viewed that in the long run, people should be made less dependent on the subsidies of the PDS and better able to ensure the needed food diversity for optimum nutrition. This can be possible if Indian government prioritize to create a system of income support and economic security to all.

Conclusion

The discussion paper concludes that despite various measures taken by Indian Government, the stress of rapidly growing population is very high on the food security. The poor is not only vulnerable against the availability of the food but also nutritional value. The sustainability can be achieved not only by mitigation of climate change, but also by population controls, integrated water management, development of climate resilient agriculture and implementation of proper policies.

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