**Climate Change and Food Security: Challenges and Prospects**

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**Abstract**: Changing trends of Mother nature have perilous impact upon food security. While earth's surface temperature has increased, precipitation has decreased significantly across much of the globe in recent years. As such, unprecedented droughts and heavy floods have become common phenomena these days. Climatic crises further destabilise food security by deepening poverty among poor communities around the world.

The need for achieving food security is felt significantly in the recent years due to enormous pressure from the ever-increasing population. Owing to the change in preferences in crop production techniques over a period of time, several new challenges draw attention to food security. This paper discusses various challenges to food security. Critical analysis is made on the biggest challenge of the time i.e. climate change.

The paper discusses the multiple effects that climate change and global warming have on the four pillars i.e. availability, stability, access and utilisation as defined by the Food and Agricultural Organisation (*FAO*). The paper highlights the effects of climate change on food production and food security and further elaborates on the scenario of food security in the current climate regime and also in the scenario of changed climate. It further highlights the details of global climatic changes and challenges to different aspects of food security with special reference to India. It takes a broader view and explores the multiple effects that global warming and climate change could have on food production and food security. Dealing with climate change would require strengthening the resilience of farmers and rural people and help them adapt to the impact of climate change. The research hence looks into how adaptation can go hand-in-hand with mitigation and how these measures can be integrated into the overall development approaches and agenda. Finally it discusses the adoption and integration of the measures and policies into the overall development which would then pave towards a food secure globe in a changed climatic scenario.

**Introduction: Food Security**

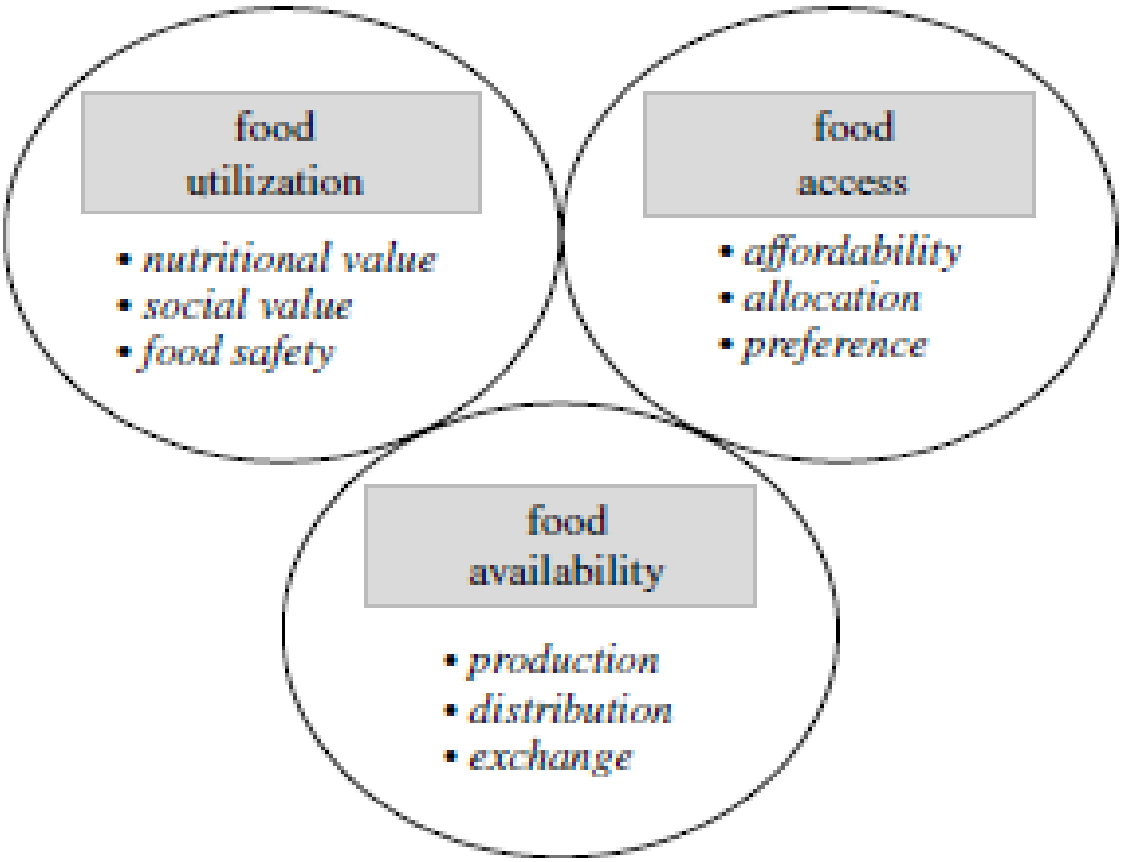
The Food and Agriculture Organisation (FAO) defines food security a "situation that exists when all people at all times have physical, social and economic access to

*Chapter 11, Food Security and Food Production: Institutional Challenges in Governance Domain ed. By C. Sheela Reddy, Cambridge Scholars Publishing 2015*

sufficient ,safe and nutritious food that meets their dietary needs and food preference for an active and healthy life. The above definition spells out the four pillars of food supplies that are

- availability
- stability
- access
- utilisation

**Figure 1:** The three components of Food System with three main elements shown in italics (From Ingram *et al* 2005)




The first pillar indicates the availability of sufficient food, the overall ability to meet food demand through production, distribution and exchange with agro-climatic zones in its fold. The second pillar relates to the vulnerable individual who is at high risk of temporary or permanent loss to access in terms of affordability, allocation and preference to consume adequate food because of lack of insurance against "income shock" or lack of enough reserves to smooth consumption or both. This pillar is by and large related to climatic variability e.g. marginal or landless labourers who

actually depend on agricultural wages in region of erratic rainfall with little savings are at the highest risks of loosing access to food. The third pillar points out the entitlement, to acquire appropriate food for nutritious diet. Entitlement generally refers to all sets of command be it legal, political, economic or social elements of the community of which individual is a member. This pillar does not gives rise to purchasing power of consumers and evolution of income and food prices .The final pillar of utilization encompasses all food safety and all quality aspects of nutrition.

## Food security in the current climate regime

### *Population growth and food production*

The important consideration for food security is whether the food production would remain higher than the population growth rate. Between 1970 and 1982, the world population grew at a rate of 1.8% per annum but cereal production, which constitutes 94% of the total grain production, grew at a rate of 2.3% per annum. Thus food production outstripped population growth by 0.5% on a global scale. In 1986, 1942 million tonnes of food grains were produced for a population of 4915 million. Globally, this corresponds to about 395 kg of food grains per capita. But there were regional disparities to the extent that near-famine conditions occurred in many parts of the world. Thus, hunger existed amongst plenty and food production did not provide food security to everyone.

A United Nations study has projected the population size and growth rates for the periods between 1985 and 2000 and 2000 and 2025. The growth rate is likely to decline to 1.6 and 1.2% between 1985 and 2000 and 2000 and 2025, respectively. The projected world population is 6.1 billion in 2000 and 8.2 billion in 2025 (Table 1). Sanderson (1984) estimated per capita grain consumption in A.D. 2000 based on the expected per capita consumption in the recent past. Assuming that no significant changes in per capita grain consumption occur, the food grain requirements in various regions of the world were estimated.

**Table 1: Food requirement of Different regions of world in 2025**

| | Population ( Billions) | Average Per capita Consumption (Kg) | Food Grains Requirement MT |
|---|---|---|---|
| Africa | 1.62 | 257 | 416 |

| | | | |
|---|---|---|---|
| South America | 0.78 | 296 | 231 |
| Asia | 4.54 | 300 | 1362 |
| North America | 0.35 | 885 | 310 |
| Europe | 0.52 | 700 | 364 |
| USSR | 0.37 | 983 | 364 |
| Oceania | 0.04 | 578 | 23 |
| World | 8.22 | 373 | 3070 |

The global requirement of food grains in 2025 is about 3050 million tonnes, including food, feed and industrial use. Assuming no significant change in food consumption patterns, the projected additional demand of food grains in 2025 over that in 1986 would be 330 Mt in Africa, 130 Mt in South America, 582 Mt in Asia, 73 Mt in Europe and 16 MT in USSR. If individual regions are to be self-sufficient in food grains, the above projections lead to the following questions.

i) What changes in productivity and cultivated areas will be needed to grow the additional food grains?

ii) Will the regions requiring additional food grains be able to produce them?

**Changed Climate and food security**

Food production in any given year is affected most directly by the values of the critical climate elements (temperature, radiation, precipitation, etc.) during the year. The stability of available food supplies is governed by the inter annual variability of these elements. Access to food supplies in different regions of the world is determined by their share of the food production, the role of cereals in the diet of the people, and the various political and market forces that act upon the global food security system. The climate anomalies that occurred during the 1970s caused fairly small fluctuations in the world cereal supply. But they occurred at a time of an increasing use of cereal as livestock feed. The food shortages were particularly severe in the Soviet Union and its large grain purchases led to dramatic fluctuations in world

cereal prices. The disastrous effects these had on the world food security system are now well documented (Garcia, 1981).Climate fluctuations of the kind witnessed in the 1970s lie within the variability of the present climate. They could have been anticipated by prudent societies if an eye had been kept on the climatic record. In addition to the normal variability of the climate, there is increasing evidence for a change in atmospheric optical properties as a result of the build up of $CO_2$ and other "greenhouse gases". It is also clear that their build up will continue. It is expected that in the long term this will result in "climate change".

Mathematical models of the potential climatic impact of such a change have been developed by various groups. Such models attempt to predict the changes in critical climate elements for a doubling of the $CO_2$ concentration. Although there is little agreement between various models about the specific magnitudes of the regional changes during the next 50 to 100 years, and details needed for regional planning, there is considerable agreement on the global changes, which may be summarized as follows:

- The lower atmosphere will warm and the stratosphere will cool.
- The annual average global warming will be 1.5 to 4deg.C. This is much greater than any natural climate change. The rise in temperature is, in general, greater in the Northern Hemisphere than in the Southern Hemisphere and increases (by a factor of 2 to 3) pole wards.
- The temperature rise will be greater (by about 50%) in winter than in summer. Consequently, we may expect the production of winter season crops to be more affected than that of summer crops.
- Freeze-free periods will lengthen in higher latitudes so that larger areas may be brought under cultivation, if soil conditions are suitable. The increase in the freeze-free period will depend on the current length of this period, e.g., a 1deg.C rise in temperature will lengthen an 80-day freeze-free period by about 20 days but a 120- to 130-day period by only 6 days.
- General warming will be accompanied by a weakening of temperature differences between the equator and the poles, which will affect the atmosphere's general circulation. This could lead to longer dry periods.

- The global average annual precipitation will increase by about 7 to 11%, but its regional and temporal variations are uncertain.
- Relationship between precipitation and evaporation is not likely to change in the lower latitudes. Evaporation will increase more than precipitation in the mid- to higher latitudes.
- Soil moisture conditions will be "wetter" in some regions of the world (35deg.N-35deg.S), but "drier" in others, compared with present conditions.
- A sea-level rise is foreseen but its magnitude and time-scale are uncertain. The effects on agriculture in coastal regions could be disastrous.
- Agro climatic zones will shift pole ward (about 100 km per degree of warming).
- The variability of temperature and precipitation may decrease because of the weaker circulation. The regional variations are uncertain.
- Only changes in mean climate conditions are specified by the models. Sizeable uncertainties remain about the timing, intensity and direction of specific effects.

**Challenges with respect to climate change**

Food security is severely influenced by climate change. The changing climate will influence the food grain production in different ways. For example, the temporal and spatial variations in precipitation including rainfall may result in deficit moisture stress, i.e. drought or excess moisture stress condition, i.e. flooding. Similarly, extreme high or low temperatures result in variations in the length of crop growing season. These factors would also affect the crop productivity and farm net income and hence climate resilient agricultural practices have to be promoted. This is applicable to all the nations, including India. Understanding the impact of climate change on Indian agriculture is quite complex as several factors are involved in this phenomenon. For example, the negative effect of global warming on crop productivity in India may be compensated by carbon fertilization to some extent. Several researchers conducted studies on the interrelationship between climate change and food security in relation to impacts of climate change on crop productivity, food production and socio-economic aspects. Gregory *et al.* based on their experiments conducted on wheat and rice reported that global warming would result in decreased crop duration. It is already established that some factors of climate such as increased

carbon dioxide level would play a positive role in enhancing crop productivity. However, the crop productivity would be negatively influenced by changes caused by extreme variation in temperature and nutrient interactions and higher rate of natural disasters such as floods and droughts. (Frenck et al) The fourth assessment report (AR4) of The International Panel on Climate Change predicted an increase in global temperature by 2–6°C by the year 2100 which is alarming.(IPCC, Fourth Assessment Report) The changing climate affects food security at the global level as it brings remarkable changes in land utilization pattern and water resource availability.(Nema *et al*. At the same time, increased human interference may fasten the changes. It was reported that ever increasing human population coupled with their changing dietary preferences significantly increased global demand for food and thereby generating tremendous pressure on native vegetation and ecosystems. (Tilman *et al*) India also faces a similar grim situation in tackling the issues related to food security and policies related to globalization further affected the environmental health stressing the need for regulation of the same. Though climate change related agricultural research has been focused on assessing the response of various growth parameters of crops due to specific changes in climate, accurate analysis of food security indicators could not be achieved which reflects the vulnerability of food systems to global climate change (Figure 2). This is due to the fact that the individual assessments in general study climate variability without any integrated approach as they mainly focus on bio-physical aspects of production only. As a result, the food accessibility and food consumption elements of food security get little attention. There is an urgent need to address the food security concerns that are central to economic and sustainable development issues in both India and the other nations which is possible by integrating bio-physical and socio-economic aspects of food systems Climate change in the recent years has resulted in higher frequency of floods and droughts, making the objective of attaining food security very complex. Hence, the future research efforts related to management aspects of tackling vulnerability caused by natural hazards must consider the social, economic and geo-political constraints .Enhancing the resilience of human systems to cope with extreme climatic stresses should become the main objective. There is a strong need to address changes in institutions and resource accessibility to tackle the climate induced natural hazards. Overall, the agricultural practices have to be reoriented which would provide better climate resilience and enhanced net farm income. The capacity of people to cope with climate

change and its related edaphic changes varies from one region to another in India. The study also suggested that an integrated approach is highly essential to address the food insecurity concerns.

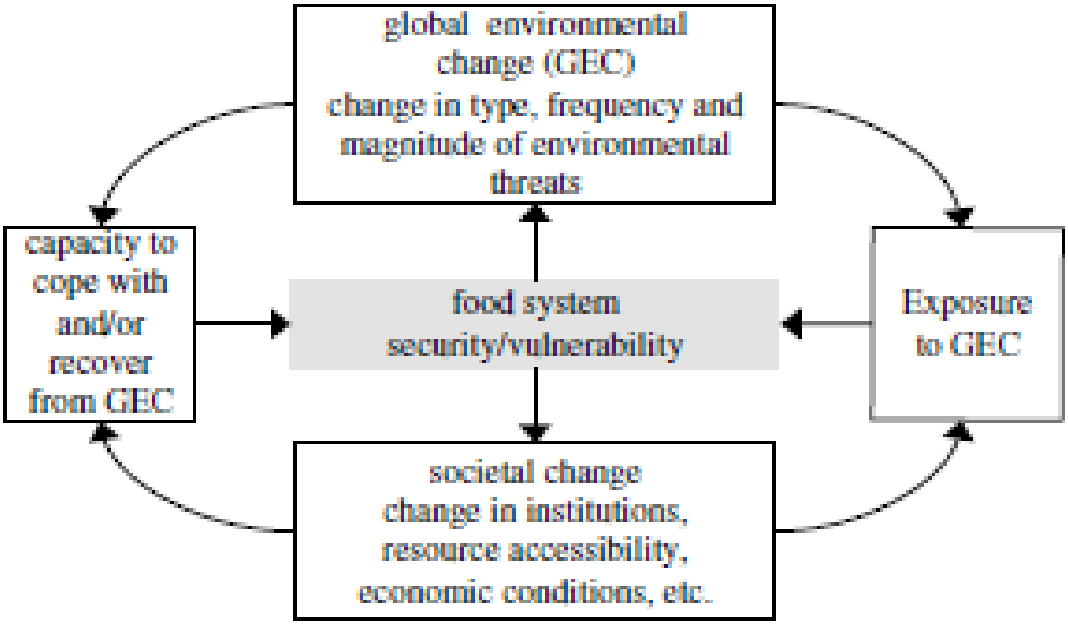



**Figure 2:** Factors determining the vulnerability of food systems to global environmental change (from Gregory *et al* and Ingram *et al*)

**Policy measures**

The transition to a global food system that satisfies human needs, reduces its carbon footprint, adapts to climate change and is in balance with planetary resources requires concrete and coordinated actions, implemented at scale, simultaneously and with urgency.The following evidence-based actions to achieve food security in the face of climate change must be taken.

**Integration of food security and sustainable agriculture into national policies**

The Integration of food security and sustainable agriculture into national policies must establish a work programme on mitigation and adaptation in agriculture in accordance with the principles of UNFCCC, to include climate change in agricultural policy. Climate friendly agriculture with green growth as the central idea must be developed. There must be a proposition of "early action" to drive change in agricultural production systems towards increasing

resilience to weather variability and shocks, while contributing significantly to mitigating climate change.

**Increased level of investment in sustainable agriculture and food system**

The national research and development budgets must be designed to accommodate the build –up of integrated scientific capacity. The reflections of sustainable agriculture in changed climatic scenarios must be seen through the indicators such as poverty reduction, food security and environmental sustainability. The knowledge base of the best practices nd access to innovations must be revitalised by extension services, technology transfer and communities of practice), with emphasis on low to high-income countries and on women farmers.

**Sustainably intensify agricultural production while reducing greenhouse gas emissions and other negative environmental impacts of agriculture**

The idea is to develop, facilitate and reward multi-benefit farming systems that enable more productive and resilient livelihoods and ecosystems, with emphasis on closing yield gaps and improving nutrition. The strategies which minimize ecosystem degradation and rehabilitate degraded environments, with emphasis on community-designed programmes must be introduced. Special empowerment must be facilitated to the marginalized food producers (particularly women) to increase productivity of a range of appropriate crops by strengthening land and water rights, increasing access to markets, finance and insurance, and enhancing local capacity (for example through farmer and community-based organizations).The subsidies (such as for water and electricity) that provide incentives for farmers to continue agricultural practices that deplete water supplies or destroy native ecosystems must be identified and modified accordingly

**Development of Policy Specific Programmes for the most vulnerable**

The funds responding to the climate shocks such as 'index-linked funds ' that provide rapid relief when extreme weather events affect communities, through public-private partnerships based on agreed. Safeguards related to import surges and trade distortions in trade agreements. The country information on production forecast and stocks must be used to moderate excessive price fluctuation. Special allowances such as tax free export and

import for humanitarian assistance must be made available There must be a creation and support of safety nets and other programmes to help vulnerable populations in all countries become food secure (for example, cash and in-kind transfers employment guarantee schemes, programmes to build resilience, health and nutrition, delivery of education and seeds of quick growing foods in times of famine). Support platforms must be developed and nurtured to harmonise and coordinate global donor programmes, policies and activities, paying particular attention to systematically integrating climate change risk management, adaptation and mitigation co-benefits, and improved local nutritional outcomes.

**Remodel food access and consumption pattern for sustainable eating pattern**

The chronic under nutrition and hunger must be addressed by developing sound policy that coordinates regional programmes and strengthens livelihoods and establishes access among food insecure rural and urban communities. Innovative education campaign targeting young consumers must be organised to promote positive changes in variety and quantity of diets, keeping the public health and environmental goals in mind. A sustainability metrics and standards must be promoted to monitor and evaluate food security, nutrition and health, practices and technologies across supply chains, agricultural productivity and efficiency, resource use and environmental impacts, and food system costs and benefits

**Creation of comprehensive, information systems embedding human and ecological dimensions**

Comprehensive, shared and integrated information encompassing human and ecological system must be developed, which may regularly monitor, on the ground and by public domain remote sensing networks, to track changes in land use, food production, climate, the environment, human health and well-being worldwide. Develop, validate and implement spatially explicit data and decision-support systems that integrate biophysical and socioeconomic information and that enable policy makers to navigate trade-offs among agricultural intensification, nutritional security and environmental consequences.

## Future Ahead

The interventions can be in the following areas:

- Poverty and food insecurity is greater in rain fed and dry land areas. Small farms can be helped in increasing productivity by having access to extension services and better water management. Sustainable agriculture should be the focus of interventions.
- Local knowledge and local seeds can be used for biodiversity. Organic farming can also be encouraged to protect the environment and generate higher incomes for small farmers.
- Urban agriculture can improve food security in urban areas. Home grown food can also be encouraged as it would contribute to food security and nutrition as well as freeing incomes for non-food expenses such as health and education.
- New and innovative solutions for water management and improving soil fertility.
- Focus on tribal areas for sustainable agriculture.
- Focus on areas likely to be affected by climate change.
- Using information technology for agricultural production and marketing. For example, providing mobile phones to the poor and marginal farmers can help in marketing.
- Purchasing locally grown food from low income and small holder farmers to benefit their families and communities.
- In order to improve delivery systems in food based programmes there is a need to strengthen programmes like ICDS with the convergence of several departments. International agencies can help in this convergence as a pilot project to improve the delivery systems.

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