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The impact of climate change on food security: A case study of Karnataka, India

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Abstract
There has been a widespread and well-discussed issue around the world about the concept of climate change. This study paper explores what the effect of climate change is on food security in India with Karnataka as a case in point. The very first section reflects essentially around the consequences of climate change on the fundamental evaluations of food security and domestic wellbeing in India. The research employed secondary analysis of data. The key result is that states who haven't yet suffered flooding and droughts have already started to encounter such disasters and to undergo severe weather conditions, negatively impacting small and macro-level food security crises. It is proposed that the country, together with all the other stakeholders, adopt a proactive and systematic solution to the reduction and mitigation of consequences of climate change on sustainable economic growth.

Keywords: climate change, global warming, food security, living conditions, social safety

1. Introduction

Climate change refers to changes in the characteristics and concentration of the climate system that has lasted for decades or perhaps even older which can most times be for at least thirty years, AAS (2019). These climatic compositions encompasses all summations, variability and acute. The concept of climate change may be brought about by natural processes, such as the changes in the radiation of the sun, volcanic activities or climate system internal variability, or caused by man-made activities such as alterations in the composition of the land or atmosphere.

According to FANTA (2003) [15], Climate change could also be defined as the 'geographical or global alteration in historical climate patterns which can be attributed to either natural and/or artificial causes and which culminates in the periodic but increasingly frequent extreme and adverse impacts. On a global scale, climate change has emerged a very important and vital topic in recent times because of its impact on humans and the risk it poses to the future of the world. Particularly, climate change has very adverse effects on food security, human livelihoods and social welfare. The question of food safety is continually been addressed keenly by so many as the accessibility and availability of food at the global market space.

The Food and Agriculture Organization (FAO) describes the situation of food security as that of which everybody has accessibility, always, geographically, socially and economically, to enough, healthy, and nutritious food that meets the prescribed satisfactory levels of dietary requirements and food preferences for an improved lifestyle. It is necessary to remember the quality of this description. The definition encompasses four important aspects of food supply, namely: ease of access, consistency, availability and efficiency. It states that the availability of food explains the situation in which there are provisions for adequate volume of food of acceptable quality to be supplied through local imports or production.

In fact, the availability of food describes the willingness of individuals and households to gain access to adequate opportunities to obtain or buy ample and necessary food for a balanced diet. Food use explains the appropriate use of food for healthy diets. Food utilization explains the appropriate use of food for a healthy diet, clean water, sanitation and medical care in order to achieve the highest level of well-being. Food abundance thus describes the capacity of individuals to have a constant and assured exposure to food that cannot be disrupted by unexpected disruptions such as economic or climatic recession, seasonal food shortages, etc.

As per the 1996 World Food Summit (WFS) interpretation, food security can be said to mean that everyone has adequate access to, healthy and nutritious food at all times, physically, socially and economically, that meets the prescribed acceptable levels of dietary requirements and food preferences for an active and healthy life. As per this interpretation, there are three key components to the approach of food security: provision of food, food access, and absorption of food. This explains, therefore, that food production does not suffice alone as a sufficient condition or criterion for measuring the food security of a country.

Essentially, the presence of world food availability does not necessarily also mean that there is food security at the individual point. This is mainly because there are food options on the world market which are not affordable to the average individual or household, particularly those living in developing countries. According to Devereaux and Maxwell (2001) [11], however food security can be interpreted as the capability of households to access adequate and adequate food at the domestic level.

Whilst also substantial and quantifiable improvement has been achieved in fathoming the importance production of crop to yield, comparatively few models have analyzed the impact of climate change on food accessibility. Thus according conclusions of the IPCC's Fourth Assessment Report, two to six million people worldwide are expected to suffer from starvation as a direct consequence of the climate change situation by 2080 (Yohe *et al*., 2007).

Lloyd *et al* (2011), who also concludes in his research that

climate change is projected to have substantial and important implications on potential inadequate-nutrition in the country, long though the favorable and advantageous impacts of economic development are well known. Depending on different model formulations and tests, there will be a 62 per cent rise in severe growth of dwarfism in South Asia and a 55 per cent increase in the eastern and southern sections of sub-Saharan Africa by 2050.

Similar model-based studies that analyze and assess the influence of climate change on the access to food and security specifically targeting India have been very difficult to find. That being said, excellently-known specialists such as Nira Ramachandran have encouraged and spearheaded the great value of including climate change in the nutrition discourse in India. According to Ramachandran, climate change in India will significantly minimize and even devastate the food security progress that India has strived to accomplish.

Climate change accelerates the economic causes of food scarcity in very clear ways, which can be reflected in a variety of forms, such as shifts in the duration of the growing season and the increased occurrence of disastrous events related to climate change, as well as the consequent negative production growth that adversely affects farmers' net incomes. In particular, India is prone and susceptible because its rural areas contain a large number of meagre and small-scale farmers who depend on rain-fed monocropping, hardly having a short period of food security in a typical year. In his thesis, Ramachandran (2014) states that food rations begin to run out as rapidly as three to four months after harvesting, farm work is impossible, and by the next planting cycle, food unavailability goes beyond the starvation. The effects of climate change would also have a huge effect on the livelihoods of fishermen and forest resources dependent communities. Landless farm workers who are entirely reliant on farm salaries are often at the greatest risk of losing their exposure to food and employment.

For regions with elevated levels of food scarcity and inequalities, high rates of flooding and droughts, children and women would be the most negatively impacted or influenced, despite their vulnerability. According to a survey undertaken by Vedeld *et al* (2014) of nine villages in the Jalna district of Maharashtra, local yields from crops and farmers' incomes were found to have decreased by around 60 per cent between 2012 and 2013 owing to the drought faced by the region. Such a large and substantial decrease in income is expected to have a major effect on infant welfare, since poor families expend the majority of their income on food.

More specifically, as the emphasis of the connection between climate change and food security has been expressed in rural areas, it is worthwhile to consider the relationship and effect of climate change on food access not only in rural areas but also in urban areas. Urban food scarcity is also a serious problem, as remote and coastal regions inhabiting households continue to migrate to urban areas for alternate livelihoods. According to the Ramachandran report, it is observed that poverty typically causes a major wave of rural-urban migration, relocating households to urban slums. This major rural-urban migration mainly strengthens the ranks of already badly paying employees in the informal sector, where it is marked by little guarantee of tenure and salaries dropping below the appropriate national minimum wage limit. Urban food insecurity indicators in India are showing a disturbing picture. An example of this troubling situation shows that over 30 per cent of children under the age of five are underweight in the urban areas of Bihar, Madhya Pradesh and Karnataka (see Table 1).

The proportion of children in urban areas who are stunted and undernourished is high, also in states such as Karnataka and Maharashtra, which are wealthy states.

The Chart below shows this clearly

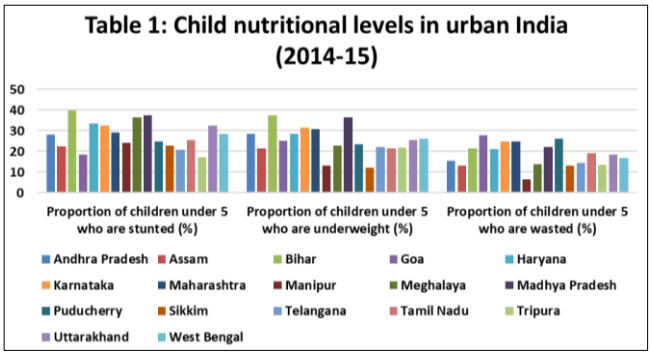

Fig 1

Climate change would exacerbate and worsen India's still present urban food shortage problems. The biggest threats associated with climate change are projected to be distributed in low-income populations living in communities in areas prone to flooding and landslides and where infrastructure is especially susceptible to severe weather conditions such as water hazards and storms. Chennai and Mumbai are especially vulnerable to bear the brunt of climate change. According to a report by Dasgupta *et al* (2012), Kolkata has been added to the list of cities that are increasingly susceptible to climate threats, as shifts in atmospheric patterns and structure are projected to increase mainly the frequency of flooding in the Hooghly River during the monsoon. Low-income households in Kolkata are most impacted as their dwellings are located in low-lying areas that are mainly susceptible to coastal and storm surges.

Food being the single highest expense for urban poor homes, migration, and lack of life or disruption to properties related to any such adverse weather occurrence would undoubtedly have a significant and detrimental effect on household food welfare. Poor urban households have already been listed as the most susceptible to rising food prices as a consequence of food supply shocks and expected reductions in the light of potential climate change.

There are various ways of food security. FAO (2008) has clarified that the definition of food protection can be seen from four central and important dimensions, namely: the supply of food; the quality of food; the sound utilization of food; and the integrity of the food system and the sustainability of food. Climate changes impacts all four facets of food sustainability. It means that the abundance of food on its own may not equate into food security since, although food can be abundant, that may not imply that it is open and affordable to all households at all times. It calls for a systematic approach to tackling the problem of food security. Hence, the formulation of policies, projects and programs to address the adverse impacts of climate change

on food security components are therefore crucial (Vogel and Smith, 2002; Clover, 2003) [3, 6].

Agriculture does not only just represent a source of food, but also a significant stream of earnings. In a society in which trading is feasible at relatively low costs, the main question for food security is not of the issue of whether food is "accessible',' but whether the money as well as non-monetary funds at the hands of the population are adequate to give anyone access to sufficient food supplies. The significant implication of this is that national food self-sufficiency is neither necessary nor adequate to guarantee food protection at the individual level. Notice that Hong Kong and Singapore who are not agriculturally self-sufficient (agriculture is unavailable), yet their populations are regarded as food-secure, while India howbeit self-sufficient, still a substantial portion of its population is regarded as not food-secure. This indicates, however, that there is an indirect link between the availability of food and the reality of food security, where it may confidently be stated that the achievement of national food self-sufficiency does or does not automatically result in the lack of food security for the average household.

Individuals and families are predominantly involved in a variety of tasks and projects in order to make ends meet. Agriculture, which is often the most influenced by climate change, is the main occupation for making a livelihood in rural areas. As per the Intergovernmental Panel on Climate Change (IPCC, 2007) report, agriculture has been found to be the most prone to the enhanced severity, extremity and incidence of significant weather disasters triggered by climate change, such as flooding, droughts and increasing ocean levels, as well as others. In fact, the IPCC has demonstrated that on an international scale, many projections expect considerable levels climate change trend over the next 20 years, predicting that all areas should undergo rising temperatures and shifts in weather trends that would impact all agricultural output rates and food stability inevitably.

While early forecasts forecasting global food demand and supply in the twenty-first century have indicated, in turn, that world food stocks would match or surpass the minimum food needs of the planet in the next twenty to thirty years (Devereux and Edwards, 2004), the fact shows otherwise. One drawback in both these models is that the parameters of the models are quite rough and do not always expose the divisional inequalities that are of significant concern to food-insecurity regions (Stephen and Downing, 2001) [13]. Worthy of note is another significant shortcoming in that such projections do not pay adequate focus to climate change, which is proven to be a primary challenge to food protection in many areas of developing countries, primarily based on rainfed, labour-intensive and subsistence agricultural growth (Parry *et al*., 1999, 2004; Döös and Shaw, 1999; IPCC, 2001a) [4, 12]. For fact, the Intergovernmental Panel on Climate Change (IPCC) studies (e.g. IPCC, 2007) and also the Food and Agriculture Organization (FAO) research on climate change and food protection (FAO, 2008a) have suggested that the tropical regions would be extremely and adversely affected by climate change. The FAO and IPCC reports, separately, projected these effects by increasing temperature rates and evolving weather trends, contributing to higher rainfall amounts. Climate change impacts agriculture and food output in a large, comprehensive and dynamic way. It explicitly influences food output by modifying agro-ecological factors and indirectly by influencing the development and distribution of income and hence the market for agricultural products. Numerous attempts have been made in the past to measure implications in a variety of experiments under diverse sets of assumptions.

Underground water rates are steadily decreasing in India. For most of the more than 4,000 wells recorded in Inland Water Transport (IWT 2.0) exhibiting major statistical patterns, there's been a 54 per cent decline over the last seven years, and up to 16 per cent falling by greater than 1 meter (3.2 feet) each year.

Local farmers in regions with erratic rainfall are highly reliant on groundwater for irrigation. The Government of India has worked to subsidize farmers' electrical pumps and has eliminated all restrictions on the amount of groundwater they can draw, generating a pervasive trend of unsustainable water consumption and stressed electricity grids.

As according to results of the FAO and IPCC, rising ocean levels would inevitably impact the livelihoods of a significant proportion of the people residing in coastal regions. As a consequence of climate change, all elements of food stability as well as livelihoods will be at significant risk in both temperate and tropical areas. By the end of the day, the impact of climate change on all four elements of food supply, consumption, sustainability and resilience would be felt differently based on region and location.

Low profitability is one of the major problems confronting the Indian agriculture market. Cereal yields have fallen significantly relative to those in industrialized areas such as North America, which is 6671 kg per hectare, East Asia and the Pacific, which is 5.184 kg per hectare, and the Euro area is 5855.4 kg per hectare (see Table 2) presented in the chart below.

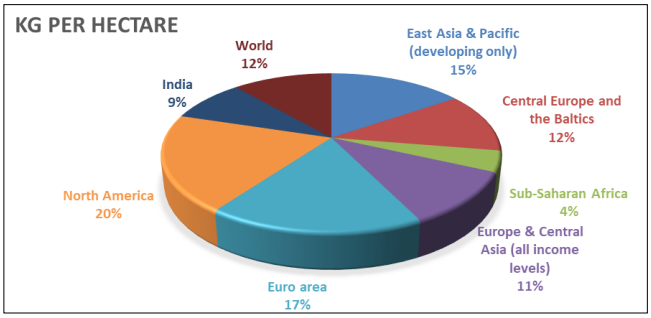

Fig 2

The graph below explains that the foodgrains yield per hectare growth has remained stunted in India since the 1980s (see Table 3)

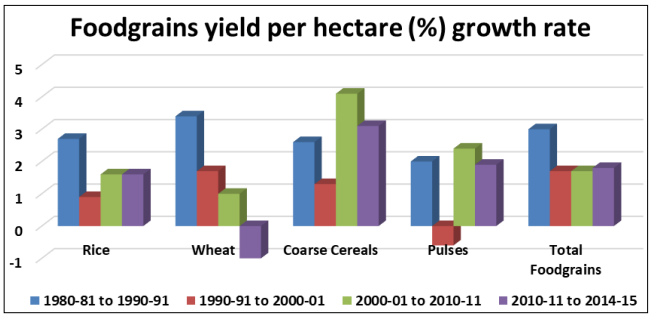

Fig 3

The goal of this research is aimed at exploring the effect of climate change on food security in India with Karnataka as a case in point. The preference of Karnataka is focused on the reality that it is a very susceptible area of the country. However, the evaluation of mechanisms such as global warming and climate change, which are forecasted to raise the amount of significant incidents in temperature and rainfall, must be taken seriously (IPCC SREX 2012 Report). In this sense, it is crucial to consider historical patterns in climate change in Karnataka in order to establish effective adaptation strategies in vulnerable areas. The remaining portion of the paper is divided into four major parts. The literature review is discussed in the next part. The methodology for the research paper is shown in section 3. The findings and summary of the paper are discussed in Section 4. Section 5 points out the conclusions and policy effect ramifications of climate change for food protection in the state of Karnataka.

2. Literature Review

As per the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2001b), dry areas are predicted to suffer normal and enhanced dryness as a consequence of global warming. While the problem of food security is explicitly related to climate change (Winters *et al*., 1999; Reilly, 1995) [21], it is important to keep in mind that climate is not the only factor in terms of yield, but also the physical environment, which also is a crucial factor in understanding food protection (Parry *et al*., 2004) [10].

Devereux and Maxwell (2001) [11] claimed that scarcity in food and nutrition is no longer regarded as an inadequate agriculture to deliver adequate food on its own, but also a lack of guarantees in domestic terms for access to adequate food. This clearly shows that the problems of food shortages relate directly to the broader question of livelihoods. The state of Karnataka has three cultivation periods, including the Kharif season, which makes up 70 percent of annual production of food grain and oil seeds. The state's production and diversification in agriculture contributes 28.6 percent to GSDP.

70% of the geographic area of Karnataka can be classified as arid or semi-arid (KSPCB Survey, 2015). When 54 percent of the state is afflicted by drought, Karnataka has considerable vulnerability to climate change. Drought has a considerable effect on the state's agricultural production, which is especially vulnerable to Kharif plants.

Given the effects of climate change on crop and food supply, endeavors to improve food autonomy and protection are a focus area of policymakers around the world (Bryant *et al*., 2000; Smith *et al*., 2000) [3].

(Parry *et al*., 1999) [4] This is significant, in large part, since climate change affects both the level of agricultural production and the availability of food in a direct and significant way. This is mainly because agriculture is highly susceptible to weather factors and as such one of the most susceptible industries to global climate change impacts.

Rising population growth is placing immense strain on agriculture, combined with the interconnected powers of diminishing rainfall, and decreased grazing has eventually already begun to negatively affect the livestock sector and the supply of food.

The state of pasture land is greatly affected by the environment and, in effect, it directly affects the amount and quality of small and large stocks and the related livelihoods.

As per the concept (USAID, 1992), household food access can be characterized by the ability of homes to obtain nutritious, healthy and adequate food to me*et al*l household dietary requirements. Individuals would have enough access to food whether they have ample income or other wealth to buy the necessary food quantities required to ensure an acceptable nutritious standard of eating.

This description describes that access to food is primarily based on physical and financial capital, as well as on other variables such as socioeconomic, cultural and political influences. It may also be argued that access to food depends on the willingness of households and individuals to procure food through sales, output, supplies, or by food transfers through community leaders, families, government, or other contributors. Access to food is also affected by the increased availability of food on the market, productive inputs, market prices and credit (FAO, 2000).

Another important element influencing food supply is transport so that, after food has been generated, it has to be transported from the point of processing to the point of consumption.

For most developed countries, access to food is troubled and exacerbated by inadequate and unreliable transport networks, which obstruct the timely supply of food goods from suppliers to final consumers. This scenario thus causes false food insecurity and poverty, causing food prices to increase and rendering food scarce and unavailable to the weak and disadvantaged.

It follows Perry and Symons (1994) that rising heat rates would result in a decline in road life as a result of climate change. The results also showed that the atmosphere might raise the intensity and frequency of wind storms which would have a negative effect on air and maritime port traffic, and could lead to destruction of infrastructure that could result in food transport interruptions, which could theoretically lead to food accessibility problems.

Food sustainability relies on production systems, whether commercial or non-market, and therefore risks causing climate change.

The willingness of households to purchase food may be greatly and badly affected, because revenue for farmers in developed countries relies primarily on the ability to sell surplus produce from subsistence farming.

Incredibly low commodity rates would also contribute to poor earnings for farmers; the same is true with high market prices, because farmers will not be willing to sell their farm goods either because there would be no buyers or because they themselves may not be able to purchase other food to hold surpluses for their own use, all of which have an effect on their own use. Adequate food consumption is accomplished where adequate food production, storage and usage techniques are available. It has also been identified that climate change has an indirect effect on the production of food.

Climate change fundamentally impacts household food protection and the basis of livelihoods from different studies. This influences the supply of food, the quality of food, its utilization and security, as well as livelihoods in general. Low household income as a function of climate change would have an effect on production, which would consequence in households' failure to provide healthy and nutritious diets, contributing to malnutrition. Increased temperatures and shortage of cooling facilities would also

contribute to loss in food safety and water shortages.

3. Objectives

1. To know the variations in food production in Karnataka.
2. To assess the extent of the impact of climate change on food production.

4. The Methodology

The study only collected quantitative data using a secondary data collection method. Data collected from multiple institutional and government websites have provided an opportunity for researchers to use their experience of climate change in the study. Data were collected by the researcher on particular parameters, such as rainfall rates, temperature levels, crop yield yields and trends of livelihoods, which were a valuable source of knowledge for the analysis. The value of this data collection strategy is that it provides the researcher the opportunity to have in-depth information from a broad variety of outlets, including policy and association study. This research provides detailed details on the many diverse aspects in which climate change impacts food protection and subsistence results in the studied populations, such as Karnataka.

5. The Results and Discussion

The analysis has shown that climate change and its many consequences are widespread in Karnataka. The research reveals that neighborhoods that have never experienced the dual chaos of floods and droughts between and in seasons have now begun to experience the same. The adverse and extreme effect of climate change on agriculture has begun to render most households, who were historically solely dependent on it for their livelihoods, food unhealthy. This is because agriculture is susceptible to external impacts, including economic crises and food price increases, and to other factors such as droughts, floods and incidents. As a consequence, maintaining the quality, sustainability and security of food sources is influenced by the evolving and varying trends of crop cycles that are impacted by climate change.

The study indicates that household food scarcity, caused by climate change, has a detrimental effect on general livelihoods and therefore has the ability to place households in a persistent poverty pit. This is essentially due to the fact that climate change causes crop yields to decline as a result of erratic rainfall patterns, as observed in the study region. As farmers produce less harvest, the availability of food is severely affected, not only for consumers, but also for farmers, because they have little or nothing to sell. As a consequence, customers often have to purchase or waste food at exorbitant costs and this adds to food poverty.

Regarding much of the knowledge gathered in the study, food scarcity is counterproductive, because it affects resilience in livelihood growth as farmers direct their funds to consumption and not to investment in development projects. Sources would be the re-allocation of funding used for healthcare, alternative income production and jobs to ensure that basic household nutrition needs are met, among other things.

Researchers have now argued that agricultural households have serious threats to their ability to guarantee food protection because climate change is affecting their producers and consumers' decision-making. This finding is in congruence with the findings from McConnell and Moran (2000), whereby the acquirement of food for marginal groups frequently involves expensive and delicate trade between food production in stressful conditions and developing social and economic resources for access to scarce food.

The researcher is of the opinion that food scarcity has already become a widespread problem in Karnataka due to climate change activities. This is said to have been the result of the frequent occurrence of the starvation period, usually from around April to June / July, which also recently started in March and ended in August, due to the new normal climate change. Knowing the significance of the role of climate change in food development, climate change would have immense benefits. For households in Karnataka and elsewhere, the issue of climate change should not be limited to academic discussions; they should be dealt with in practical terms as well as urgently needed. The achievement of food security has become a pipe dream for the majority of households in Karnataka, and climate change has complicated the circumstance.

There was also a common agreement that climate change is real and it adversely affects the ability of urban families, most of whom are not engaged in agricultural production. Over the years, the research region has and continues to undergo rising dry seasons, both in duration and extremity.

As temperature levels are rising, and everyone, including farmers and rural dwellers, is aware of this fact, it has also been observed that there has now been an increased rise in the number of hot days and nights in the area. These events are often linked with an exponential rise in the incidence of pests as well as diseases. So another conclusion on the effect of climate change on food security will be that climate change has an induced effect on food security in the form of increased pests and diseases attack on food crops and animals which will culminate in reduced food availability.

The analysis also showed that climate change throughout time affected the capacity of agricultural households to gain adequate income by their failure to grow cash crops. At the end of the day, this event has greatly decreased the capacity of these farming households to carry out food marketing operations as a consequence of minimal to no surplus sales. Throughout, as an adverse output of climate change as well as the reduction of agricultural productivity, costs of both products and services have risen. It further exacerbates the rise in food insecurity, particularly for poor households, which includes and reflects the majority of rural dwellers in Karnataka.

Another important effect of climate change in this study is that climate change also has a tremendous impact on water supplies in Karnataka. Rivers, dams, streams and groundwater sources, for example, have now been put under pressure. The consequence of global change has culminated in the drying up of too many dams and streams. The impact of these circumstances on food security in Karnataka has been unfavorable, which can better be clarified by the problem of many farmers who are practically unemployed in the prolonged dry season.

From the findings of this research, it is needless to argue that the manifestation of climate change in Karnataka is real and that its impact is felt across the state. It has had a major impact on food availability, accessibility, utilization and stability. It has been concluded that the poorest households in rural areas, which rely essentially on agriculture for their

daily livelihoods, are, sadly, the hardest affected.

6. Recommendations and Conclusion

It is evident from the study that climate change is a global trend experienced in almost every part of India, and especially in Karnataka, where there is a large majority of individuals and households who are utterly reliant on the environment and other natural resources for their existence and prosperity, as it directly and significantly affects their food security. Climate change is indeed a major source of worry and, as such, there is a pressing need to do something dramatic to offset its detrimental impact. This is crucial because the greater the effect of climate change on households' prospects of survival, the more effort will be given to rely on certain accessible natural resources, such as trees, which could only intensify conditions which may contribute to a reliance on more inefficient which damaging structures. Obviously, a situation as such will lead to greater climatic uncertainties and chaos, which will only continue to worsen. It is therefore important to educate people to understand the origin, manifestations and likely alternatives to the climate change problem. There is a need for enhanced and more serious discussions on climate change, which must take place in more forums and public discussions, if there is hope that we will begin exploring ways to solve this problem. More important, however, is that those who lead such discussions must be well informed of the facts and not misguide people any further.

Particularly, the following are very essential and important for policy

- Disadvantaged and deprived individuals and households, particularly those in rural Karnataka, are heterogeneous in nature of their many financial, social, natural, and human resource assets. This means, in essence, that these different households are affected by climate change at varying levels and in different ways and, as such, it is necessary to identify first of all the different categories of poorest and most vulnerable in other to develop concise and appropriate climate change research and improvement targets.
- Food security depends essentially on the four cardinal key components of availability of food, food accessibility, food utilization and stability, of which are all straightforwardly impacted by climate change. Consequently, strategies, policies and actions to overcome the repercussions of climate change on food security must also be based on and focused on these aspects.
- Farmers should be motivated to explore and take advantage of the latest agricultural production technologies and productivity-enhancing process and systems. In order to efficiently do this, the State and its partnering development agencies will also aggressively engage in agricultural modernization, including the modernization, mechanization and installation of adequate irrigation facilities.

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