

CLIMATE CHANGE AND SUSTAINABLE AGRICULTURE IN INDIA

Priyanka Arya

Ph. D Scholar, Department of Economics
University of Allahabad

Abstract

Climate change will extensively affect the agricultural in developing countries, leading to serious consequences related to meals manufacturing and meals security, with better effects on small-holder farmers and the poor. Climate Change is the biggest threat to sustainable development in India. It has affected the Indian agriculture production. There is growing indication that climate change has negative effects on agriculture performance in India. The employment opportunities in the non-farm sectors are growing very slowly; there is a very little shift of labour force from agriculture. Agriculture sector plays a vital role in India's economy like employment, contribution to the GDP, trades, the manufacturing sector, industrial development and livelihood and food security of the people. About 55 per cent of country's population depends on agriculture for their livelihoods. There are already evidences of negative impacts on yield of wheat and paddy in parts of India due to increased temperature, increasing water stress and reduction in number of rainy days. Hence, there is a need to address the whole issue of climate change and its impacts on Indian agriculture.

So, this paper discusses climate change on agricultural production in India as a whole by examination totally different experiments at numerous regions by mistreatment different methods/ models and totally different climate situations and various factors. It will be really helpful for predicting impact of global climate change in future crop production of agriculture in Republic of India. This paper presents an outline of the state of the information of potential impact of the climate variability and change on foodstuff production in India.

Keywords: Climate Change, Agricultural Production, Food Security, Agribusiness, Population, Farming, Farmers.

Introduction

Climate affects human life on Earth. It regulates food production and water resources and influences energy use, disease transmission, and other aspects of human health and well-being (National Research Council (United States), 2010). According to the World Meteorological Organization (1992), climate change represents a significant change, that is, a change with important economic, environmental, and social

effects, in the mean values of a meteorologic element, such as temperature and amount of precipitation during a certain period, for which the means are computed across a decade or longer (World Meteorological Organization, 1992). Indian economy is undergoing a high rate of economic growth with an increase in investment and ample foreign exchange reserves. However, there are some areas of concern as well. Agriculture plays a key role in overall economic and social well-being of Republic of India. Though the share of agriculture in each Gross Domestic Product (GDP) and employment has declined over time, the pace of decline in its share working has been abundant slower than that of gross domestic product. The share of agriculture in gross domestic product is declined from thirty-nine in 1983 to twenty fourth in 2000–01 compared with abundant lower rate of decline in its share in total employment from sixty three to fifty seven throughout the identical period. Agriculture has special significance for low income, poor and vulnerable sections of rural people. Due to these reasons, agriculture has become the core of socio-economic development.

As a natural consequence of economic growth and structural changes in the economy, the share of agriculture and allied sectors in the total GDP declined from around 19 per cent in 2004-05 to 14 per cent in 2013-14 (at 2004-05 constant prices). If the share of forestry and fishing are removed, agriculture (including livestock) accounted for about 12 per cent of the national GDP. Agriculture is highly sensitive to climate variability and weather extremes viz; droughts, floods and severe storms. Agriculture production in India will be impacted by climate variability; it has estimated that greater loss is expected in *Rabi* crops as compared to *Kharif* crops. The agricultural productivity in India is climate sensitive and the fluctuations in temperatures and rainfall pattern badly affect the food-grain crops productivity and thus it may threaten food security in India (Kumar et al., 2013).

Significance of the study

Agriculture is the largest water consumer worldwide, representing about 70 per cent of total withdrawal. Agriculture is also a major source of water pollution from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental costs (Rosegrant et al., 2009). Climate change is supposed to exert crucial and negative effects on the mechanism of monsoon, which is the crux of Indian rainfall and precipitation (Sudhakaran, et al., 2011). Improving the viability of smaller holdings by providing access to technology, inputs and credit through appropriate institutions remains a big challenge for our agriculture (GOI, 2007). Our health, agriculture, livelihood, environment, everything depends on how effectively we are able to tackle this problem. The Global temperatures are rising, glaciers are melting, sea levels are rising and established climate patterns are dramatically changing, threatening of sustainable agriculture production in India.

Objectives of the study

- To understand the role of climate change on productivity of agriculture in Uttar Pradesh
- To analyse the government policies for climate change in India
- To study the significance of agriculture sector in economic development in India
- To suggest specific measures for improving the productivity of agriculture and maintain food security

Climate change scenario in India

India is facing highly climate variability and facing many challenges of climate change. The variation in India's agricultural performance over the past half-century is due to climate change. India's climate reveals that there is an increase of 0.56 °C in the temperature for the country as a whole over the period (1901-2000) against the globally observed increase of 0.76 °C (Singh, 2013). The change in climate could lead to impacts on the availability of drinking water, oceanic acidification, food production, flooding of coastal areas and increased burden of vector-borne and water-borne disease associated with extreme weather events, etc. According to the IPCC Fourth Assessment Report (IPCC, 2007), the middle of the 20th century there is more than 90 per cent probability that global warming is due to man-made greenhouse gases (GHGs). The average global temperature is expected to rise by between 1.1°C and 2.9°C in the IPCC's lowest emissions scenario and 2.4°C and 6.4°C for the highest scenario between 2090 and 2100 compared to 1980-1999. For the sustainable agriculture, the policy aims to promote technically sound, economically viable, environmentally non-degrading and socially acceptable use of country's natural resources like land, water and genetic endowments (Chand, 2006). India has realized the threat to its precious environment due to depletion of natural resources and the growing pace of degradation of the environment status.

Agricultural Production in India

The agricultural sector represents thirty five of India's Gross National Product (GNP) and plays an important role within the country's development. Food grain production quadrupled throughout the post-independence era; this growth is projected to continue. Sustainable agriculture is a very important issue in the present scenario of climate change. Sustainable agriculture is a viable option for meeting food security needs and addressing climate change challenges. The Indian Agricultural analysis Institute (IARI) examined the vulnerability of agricultural production to temperature change, with the target of deciding variations in temperature change impacts on agriculture by region and by crop. Agriculture is highly sensitive to climate variability and weather extremes viz; droughts, floods and severe storms. Agriculture production in India will be impacted by climate variability; it has estimated that greater loss is expected in *Rabi* crops as compared to *Kharif* crops. By 2020 in the developing countries, yields from rain-fed agriculture could be reduced by up to 50 per cent. In developing countries like India, temperature change is an extra burden since

ecological and socio-economic systems already face pressures from fast population, manufacture and economic development. India's climate might become hotter below conditions of magnified atmospherically greenhouse gas.

Some studies related to climate change and its impacts on agriculture performance in India highlighted the impact of the change in temperature on the production and productivity of major agricultural crops in India. Kumar et al. (2011) examined that higher temperatures reduce the yields in spite of rainfall. Food security is directly related to climate change because any variability in climate factor can directly affect a country's ability to feed mass population (Ahmad et al., 2011).

Agricultural scenario post- economic reform in India

The post-economic reform period (the mid-1990s) has recorded a decreasing trend in the contribution of factors towards agriculture like irrigated area, public and private investment, agriculture subsidy, institutional credit, and electricity and fertilizer consumption. Indian agriculture regardless of the size of land holdings has been experiencing worst forms of crises of lower growth with decelerating agricultural productivity. Indian agriculture sector has been facing challenges of the syndrome of fatigue at the front of technology, institutions, policy and governance (Narayanamoorthy, 2007). Indian agriculture has been going through a serious distress during the post-reform (Diwakar, 2007). Not only agricultural growth has been low, the prices received for agricultural products have also failed to keep pace with the costs or the general price level and, as a consequence, profitability has declined (GOI, 2006).

Climate change on Agriculture in India

The climate change is climatic trends, climatic discontinuity, climatic fluctuations, climatic variation, climatic oscillation, climatic periodicity and climatic variability. According to Steffen and Tyson (2001), climate refers to the aggregation of components of weather precipitation, temperature and cloudiness. India is agriculture based economy mostly massive country with numerous climate wherever two third of agricultural area is rain fed. India has numerous cropping systems with varied crops at completely different seasons. Economic reform of 1991 was expected to make a significant impact on the prospect of the agriculture sector. The reform showed big optimism about the future of the agricultural sector due to the high export potential and comparative advantage in international trade of the agricultural goods that India was supposed to enjoy. Several studies showed that the high growth rate of the 1980's could not be maintained in the 1990's, i.e. the post-reform period (Bhalla, 2000). The Mid-Term Appraisal of the Tenth Five-Year Plan (Planning Commission, 2005) further established the continuation of the deceleration in the agriculture sector and particularly in the crop sector. It shows that global climate change may cut back farm incomes by 15-18%, and by 20-25% in unirrigated areas. Climate is the long-term pattern of weather in a particular area. It has been measured by assessing the patterns of variation in rainfall, temperature, humidity,

atmospheric pressure, the wind, atmospheric perspective and other meteorological variables in a particular region over long periods of time (Mc Michael, 2013). The changing in natural phenomenon may culminate as an adverse impact on the agriculture production in India. Indian agriculture is highly sensitive to climate variability and weather extremes, such as droughts, floods and several other climatic storms. The relationship between climate change and sustainable agriculture production pertaining to disastrous event such as floods and droughts which are projected to multiply as a consequences of climate change leading to huge amount of crop loss and leaving large part arable land unfit for cultivation and hence threatening for Food Security in the country (Chaudhary and Aggarwal, 2007). Climate change is directly related to agriculture production. The main climatic parameters such as temperature and rainfall which govern crops growth will have a direct impact on the food production.

Performance of Agriculture sector

The major agriculture policy reforms during the 1960s, like setting up of the Commission for Agricultural Costs and Prices (CACP); ensure minimum support prices to producers, new agricultural strategy, investment in research and development, public investment and provision of institutional credit facilities helped in promoting agricultural growth. The Green Revolution was adopted in 1966, due to the severe food crisis in the country that raised during the mid-1960s. There was a shortage of food-grains supply because of severe drought situation in the year 1964-65. During the period 1965 to 2015, the food-grains production multiplied by 3.7 times while the population growth increased by 2.55 times in the same period. This performance led to 45 per cent increase in per person's food production in the country thus making India self-reliance country in food-grains (Chand, 2017).

Food-grains production in India increased outstandingly due to the Green Revolution from 50 Million tonnes in 1951-52 to 252 Million tonnes in 2015-16 and the total food-grains productivity has increased from 552 kg/ ha in the year 1950-51 to about 2125 kg/ ha in the year 2012-13 (GOI, 2014). The productivity of rice, wheat and pulses increased from 668 kg/ha, 655 kg/ha and 441 kg/ha in 1950-51 to 2462 kg/ha, wheat 3118 kg/ha and pulses 786 kg/ha respectively in the year 2012-13.

Agriculture performance: A state-level analysis

Agriculture growth in the states has experienced a slowdown in the mid-1990s. The deceleration has been recorded in productivity and growth of almost all crops in the post-reform period. Most of the states recorded decline in agriculture growth rate. Some states like Bihar, Orissa, Madhya Pradesh and West Bengal which are also among the poor states of India registered negative growth rates in agriculture production in the post-reforms period.

Share of agriculture and allied sector in GSDP	States
More than 30% Arunachal Pradesh	More than 30% Arunachal Pradesh
Between 20-29%	Andhra Pradesh, Assam, Bihar, Chhattisgarh, Jammu and Kashmir, Madhya Pradesh, Manipur, Nagaland, Punjab, Rajasthan, Tripura and Uttar Pradesh
Between 15-19% Haryana, Himachal Pradesh, Jharkhand, Karnataka, Meghala	Haryana, Himachal Pradesh, Jharkhand, Karnataka, Meghala ya, Mizoram, Odisha, Telangana and West Bengal
Less than 15%	Goa, Gujarat, Kerala, Maharashtra, Sikkim, Uttarakhand and Tamil Nadu

Table shows that the all-India level share of agriculture has a declining rate of change of about 25 per cent in 1990-91 which further declined to about 12 per cent 2013-14. There has been a continuous decline in the share of agriculture and allied sector in the states. The contribution of agriculture to the total GDP was more than 20 per cent in the states like Andhra Pradesh, Assam, Bihar, Chhattisgarh, Jammu and Kashmir, Madhya Pradesh, Manipur, Nagaland, Punjab, Rajasthan, Tripura and Uttar Pradesh. The agriculture in states like Gujarat, Kerala, Maharashtra, Uttarakhand and Tamil Nadu are less than 15 per cent.

Determinants of Agricultural performance in India

A number of studies have been undertaken to examine the factors which have contributed to the growth of agriculture in India. Bhatia (1999) had highlighted the significant positive relationship between rural infrastructural development and level of the yield of food-grains. (Bhattarai and Narayanamoorthy, 2003) have empirical analysis showed that improvement in irrigation and rural literacy are the two most important factors for agricultural growth in India. (Dev, 2002) advocated that for a greater need for public investment in irrigation, credit availability, better marketing of agricultural products, research and development. Public investment in agriculture including irrigation, marketing, food processing and storage has a positive impact on agricultural production (Mathur et al., 2006). (Chand et al., 2007) have analysed that the south-west monsoon rainfall is one of the most important factors for agriculture production. Bhalla and Hazell (2003) have observed that there is a secular decline in the employment elasticity in agriculture over time. For instance, the FCI procures approximately 95 per cent of wheat from three states: Punjab, Haryana and Uttar Pradesh and 85 per cent to 90 per cent of rice from mainly five states viz. Punjab, A.P., Haryana, U.P., and Tamil Nadu. In these MSP beneficiary states, income transfer to the large farmers is approximately 10 times that received by marginal farmers (World Bank, 2004).

Impacts of Temperature on Agriculture Performance

Climate change and agriculture are inter-related. Agriculture contributes, to the global warming by discharge greenhouse gas and in turn, gets affected by its consequences. Global climate change features a direct impact on crop evapotranspiration (ET). Higher temperatures and dynamical precipitation patterns can severely have an effect on the assembly patterns of various crops. The Indian Agricultural Research Institute (IARI) indicates that the possibility of loss 4 to 5 million tonnes in wheat production for every 1°C rise in temperature throughout the growing period. Losses for other crops are uncertain but are expected to be smaller for the *Kharif* crops. In such a situation, agriculture can would like higher management of natural resources like land, water and genetic resources to form it additional resilient. Gangadhar Rao and Sinha (1994) studied the impact of global climate change on wheat performance of Asian nation and showed that wheat yields decreased thanks to the adverse effects of temperature throughout grain filling and maturity stages of the expansion. The results of this study indicate that crop characteristics like sensitivity of grain filling length to temperature, play a serious role in determinative the results of climate change on crop productivity. Climate change leads to an increase of temperature from 1°C to 4°C can reduce grain yield of rice by 0 to 49 per cent, potato by 5 per cent to 40 per cent, green gram by 13 per cent to 30 per cent and soyabean by 11 per cent to 36 per cent. The major impacts of climate change will be on rain-fed crops (other than rice and wheat), which account for nearly 60 per cent of cropland area. Indian climate is too warm; therefore crop diseases for major cereals (rice and wheat) could become more widespread. According to (Lal, 2007), at the end of the 20th century, 4 per cent to 10 per cent net cereal production in South Asian countries is projected to decline. With temperature rise of 0.5oC to 1.5oC in India 2 per cent to 5 per cent yield reduction for wheat and maize was also projected by (Aggarwal, 2003). A change in climate is expected to bring changes in almost all spheres of agricultural practices. Sustainability of agriculture can be attained by improved land and water management, adopting eco-friendly technologies and initiating good agricultural practices in different agro ecosystems.

Factors responsible for Agricultural declining

The poor performance of agriculture could be attributed to a large number of factors such as natural disasters (like droughts, floods, hailstorm and cyclones), obsolete technology, poor rural infrastructure (including irrigation, storage facility, marketing facility and lack of institutional credit) and the economic environment comprising minimum price signals and institutions. Increasing fragmentation of land holdings has been the continuous cause of concern for sustainable agriculture development in India. Around 86 per cent of the operational holdings in the country are small and marginal, i.e., holdings of less than 2 hectares each. Between 2000-01 and 2010-11, the number of marginal holdings increased from 75.41 million to 92.83 million, a rise of 23 per cent and the number of small holdings increased from 22.70 million to 24.78 million (9 per cent rise). The Expert Group on Agriculture Indebtedness (EGAI) in its report published in

July 2007 observes that the root cause of the current crisis is not indebtedness alone it is just a symptom. The main reasons are stagnation in agriculture growth, increasing production and marketing risks, institutional vacuum and lack of alternative livelihood options. The declining trend had been mainly since the post-economic reform. It implies that there has been a lesser investment in agriculture as compared to the non-agriculture sector (Roy, 2017).

Thus, the main factors which led to a slowdown in agriculture at national level mainly after 1995-96 are: the decline in the area under cultivation, which seems to be a result of expanding urbanization and industrialization in the country, stagnant cropping intensity, slow progress of irrigation and the consumption of fertiliser and decline in supply of electricity to agriculture.

Climate change and Agricultural Food production

Climate change offers an additional stress on India's long-term food security challenges as it influences food manufacturing in many ways. For one, it can also motivate vast increases in inter-annual and intra-seasonal variability of monsoon rainfall. The World Bank (2013) also predicts that droughts will pose an increasing threat in the north-western section of India. The have an impact on of local weather exchange on water availability will be particularly severe for India due to the fact large components of the use already suffer from water scarcity, to start with, and largely depend on groundwater for irrigation. According to Cruz et al. (2007), the decline in precipitation and droughts in India has led to the drying up of wetlands and severe degradation of ecosystems. According to the World Bank projections, with a global mean warming of 2°C above pre-industrial levels, food water requirements in India will exceed green water availability. The mismatch between demand and supply of water is likely to have far-reaching implications on food-grain production and India's food security. Wheat and rice, two crops central to nutrition in India, have been found to be particularly sensitive to climate change. Lobell et al (2012) found that wheat growth in northern India is highly sensitive to temperatures greater than 34°C. Climate exchange will also have a negative impact on the livelihoods of fishers and forest-dependent people. Landless agricultural labourers completely structured on agricultural wages are at the highest chance of dropping their get right of entry to food.

Climate Change on Food Security and Livelihoods

The World Food Conference was held in Rome in 1974 by the United Nations under the support of the UN Food and Agriculture Organization (UN-FAO), in the wake of the devastating famine in Bangladesh in the preceding two years. This Conference emphasised on "every man, woman and child have the inalienable right to be free from hunger and malnutrition in order to develop their physical and mental faculties." This concept of food security is further elaborated by the World Bank (1986) "access to all people at all times to enough food for an active, healthy life". The Food and Agriculture Organisation (FAO, 2010) has estimated that unless progress was accelerated, there could still be some 680 million hungry people in the world by the

year 2010, more than 250 million of whom would be in sub-Saharan Africa. Some regions of the world have shown rapid improvement in poverty reduction and food insecurity in absolute terms and in terms of prevalence (Goshu, 2016). At present, there has been a significant improvement in the way food-grains is produced, consumed, distributed, net-export, purchasing and storage. The predominance of selective cropping and cash cropping has serious implications on the magnitude and the diversity of the food-grains production. As a signatory to the UN's Millennium Development Goals (MDGs), the Government of India and all state governments have an obligation to reduce by half the proportion of people suffering from hunger by 2015 (IDD and UN-WFP, 2009). The food security has become increasingly important globally as well as at domestic front as the global foodgrains production is not keeping pace with increasing population (Singh and Mishra, 2008). In 2010, the National Advisory Council (NAC) drafted a National Food Security Bill, proposing legal entitlements for about 75 per cent of the rural population in the country. The Expert Committee set up by the Former PM Dr. Manmohan Singh under the Supervision of Chief economic adviser chairmanship of Dr. C. Rangarajan examined the Bill and made several recommendations, including reducing the proportion of the population entitled to benefits of the PDS. The present study shows that India is moving from traditional subsistence agriculture to high-value agricultural commodities. The sustainable agriculture production in India is playing a vital role in achieving food security, generate employment opportunities in the rural area, enhancing the income of the small farmer and create a surplus for export of processed products. The consumption patterns are changing towards high-value agricultural commodities and this is driving the process of agricultural development in India.

Conclusion

The agriculture faces various challenges: low growth rate, sustainability, efficiency and equity. There are also other important concerns like climate change, food security, livelihood, employment and improvement in the standard of living of agriculture dependent population in the country. Change in temperature, radiation, precipitation and dioxide levels will affect the yields of agricultural production through their direct impact as well as indirect effects. To ensure that growing agriculture sector will contribute vastly in reducing rural poverty, improving food security and overall economic growth in India. There is a need for strategic research to decorate the resilience of Indian agriculture, which includes crops, herbal useful resource management, horticulture, livestock, and fisheries, for the development and utility of improved production and threat management technologies. Land degradation and climate change, are the biggest threat to sustainable livelihood security of the farming communities across the country. All these factors contributed toward a decline in agricultural productivity and thus leading to food insecurity in India. The degradation and scarcity of natural resources, pollution resulting from agricultural production, food loss through wastage of food and food safety, both in terms of production and post-harvest handling are critical issues that must be addressed in order to achieve food security in India

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