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Impact of climate change on sustainable agriculture and food security in India

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Abstract
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. Agriculture sector contributes about one-third of the greenhouse gas emissions; it contributes significantly to climate change mitigation. The agriculture sector is the largest water absorption about 70 per cent of total withdrawal globally. The agriculture sector is also a major source of water pollution that emerges from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental degradation. The majority of the rural population depends on climate-sensitive sectors like agriculture and its allied sector for their livelihood in the country. The adverse impact of climate-changing the form of change in rainfall patterns, rising temperatures increased the severity of the droughts and floods threaten food security and livelihood in the country. The success of the Green Revolution has become created a new set of agriculture crisis in the country. It has led to high consumption of tube well irrigation, high subsidy on fertilizers and pesticides consumption of high level of chemical pesticides and fertilizers. India has the largest area in terms of irrigated land (61.71 million hectares) of which about one-third land is already degraded and 7 million hectares has been abandoned. In such a situation sustainable agriculture is the only solution for successful agricultural revolution. The agriculture sector is also a major source of water pollution that emerges from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental degradation. The majority of the rural population depends on climate-sensitive sectors like agriculture and its allied sector for their livelihood in the country.

Keywords: impact of climate change, sustainable agriculture, and food security, etc

1. Introduction
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. Agriculture sector contributes about one-third of the greenhouse gas emissions; it contributes significantly to climate change mitigation. The agriculture sector is the largest water absorption about 70 per cent of total withdrawal globally. The agriculture sector is also a major source of water pollution that emerges from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental degradation. The majority of the rural population depends on climate-sensitive sectors like agriculture and its allied sector for their livelihood in the country. The adverse impact of climate-changing the form of change in rainfall patterns, rising temperatures increased the severity of the droughts and floods threaten food security and livelihood in the country. The success of the Green Revolution has become created a new set of agriculture crisis in the country. It has led to high consumption of tube well irrigation, high subsidy on fertilizers and pesticides consumption of high level of chemical pesticides and fertilizers. The excessive usage of water results in water logging and salinization whereas an excess consumption of fertilizers and pesticide causes pollution of water bodies and contamination of ground-water. India has the largest area in terms of irrigated land (61.71 million hectares) of which about one-third land is already degraded and 7 million hectares has been abandoned. In such a situation sustainable agriculture is the only solution for successful agricultural revolution.

Sustainable agricultural development and food security are the key challenges for India in the 21st century. About 69 per cent of India's population lives in the rural area with agriculture sector as their main source of livelihood. The majority of Indian farmers are small and marginal land holdings. About 80 per cent of agricultural land holders in India are less than two hectares and approximately 60 per cent of farmers operate less than one hectare each. The employment opportunities in the non-farm sectors are growing very slowly; there is a very little shift of labour force from agriculture. However, the agriculture sector has witnessed decreasing performance after the economic reform in 1991. It had failed to maintain the growth rate of pre reform in the post-reform period, especially in the non-agricultural sector. The decline in agricultural growth was mainly due to serious drought in 2002-03 and with a decline in agriculture production and the area sown under major crops; agriculture sector needs a transformation to ensure sustainable livelihoods for the farmers and food security in the country. The post-economic reform period (the mid-1990s) tends to have a downward trend in the growth of all the major factors that affect agriculture like area expansion, irrigation, subsidy, credit, electricity, and fertilizer consumption. The downtrend is closely linked to the sharp decline in public and private investment in agriculture coupled with a policy reduction in subsidy and declining support to the public procurement system. Price incentives, which were viewed as the main instrument for increasing

investment in agriculture and pushing its growth rate, have proved to be ineffective in the absence of adequate support in terms of rural infrastructure, modern mtechnology, and institutional reforms. The agriculture policy support by the government of India, adoption of improved production technologies and public investment in rural infrastructure, research and extension contributed to growth in the agricultural sector.

2. Review of Literature

- Sanghi *et al*. (1998): have attempted to incorporate adaptation options while estimating agricultural impacts. They calculate that a 2 °C rise in mean temperature and a 7 per cent increase in mean precipitation would reduce net revenues by 12.3 per cent in the country. Agriculture in the coastal regions of Gujarat, Maharashtra, and Karnataka has found to be the most negatively affected. Small losses have been recorded for the major foodgrains producing regions of Punjab, Haryana and western Uttar Pradesh. On the other hand, West Bengal, Orissa and Andhra Pradesh have predicted to benefit to a small extent from warming.
- Gadgil and Gadgil (2006): has examined that the Indian rainfall depends on the south-west monsoon which helps in the production of crops. They have taken the data from 1951-2003. They discussed that until 1990, the growth rate of annual crop production was 2.7 per cent and later it decreased to less than 1 per cent. Finally, they said that irregular rainfall (Monsoon Variations). Due to climate, change over the five decades is mainly responsible for the low production of crops and ultimately lead to declining agriculture GDP.
- Khan and Bano (2012): in their study observed that the structure of agricultural protectionism was mainly in developed countries. The World trade is expanding within a changing institutional framework of WTO. The time is ripe to review the current changing patterns of world trade in agriculture and its impact on developing the international institutional framework. They observe that India must have greater participation at the negotiating table and must have own explicit agenda about tariff reductions; market access; and substantial reduction of domestic and export subsidies.
- Dreze and Khera (2013): have examined that the impact of India's Public Distribution System on rural poverty, using National Sample Survey data for 2009-10 and official poverty lines. The all-India level, the PDS has estimated to reduce the poverty-gap index of rural poverty by 18 to 22 per cent. The corresponding figures are much larger for states with a well-functioning PDS from 61 per cent to 83 per cent in Tamil Nadu and from 39 to 57 per cent in Chhattisgarh. There are both good news and bad news in their findings. It is evident that the PDS system has a significant impact on rural poverty. The impact of PDS System is particularly large in states with a well-functioning PDS. PDS is now an important source of economic security for poor people in the country. The bad news is that the PDS still has very little impact on rural poverty in a number of large states such as Bihar, Jharkhand, Uttar Pradesh and West Bengal where PDS reforms are long overdue.

3. Objectives

1. To study the impacts of climate change on Sustainable Agriculture
2. To suggest specific measures for improving the productivity of agriculture and maintain food security.

4. Methodology

The study is based on only secondary data which were collected from books, article, journals, government reports, and websites.

5. Climate Scenario and Sustainable Agriculture: An India

Agriculture is most sensitive to the climate change in India. The performance of agriculture is one of the most determined by the climatic conditions. The growth of the crops and their health also depends on the quality and texture of the soil which is the primary determinant. In fact that agriculture today accounts for about 12 percent share of our total National Income while it continues to provide livelihood to about 55 per cent of our population is a matter of challenge which can only be addressed through the sustainable agriculture production. The Intergovernmental Panel on Climate Change (IPCC) has recognized that India is one of the most vulnerable countries in the world because of negative impacts of climate change on agriculture production. The United Nations Development Programme (UNDP) has identified India to be the most vulnerable country in the world for tropical cyclones and the sixth most vulnerable country for floods (UNDP, 2004). The threats to sustainable agriculture production have the impacts of climate change to achieve the food security and livelihood problem in India. The climate change phenomenon is at present a widespread reality. 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. Moreover, increase in mean sea levels will affect large populations, communities in the peninsular and coastal areas. Total frequency of cyclonic storms forming over the Bay of Bengal remained almost stable during 1887-1997. By the end of 21st century, rainfall in India may increase by 15 per cent to 40 per cent with high regional variability. 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. Moreover, increase in mean sea levels will affect large populations, communities in the peninsular and coastal areas. Total frequency of cyclonic storms forming over the Bay of Bengal remained almost stable during 18871997. By the end of 21st century, rainfall in India may increase by 15 per cent to 40 per cent with high regional variability. Warming may be more pronounced over 143 land areas with northern India experiencing maximum increase.

6. Agricultural Growth in India: An Analysis

The performance of Indian agriculture especially in the post-economic reform period. The most important feature of this period was that agricultural growth started to decelerate sharply at all India level as well as at the state-level. In this Chapter have dealt with the background of Indian Agriculture and some aspect of sustainability.

In order to study the year-wise and plan-wise growth in the variables, Percentage growth rates and compound annual growth rates (CAGR) were calculated. The Coefficient of Variation (CV) was also used. For measuring the relationship between agricultural production and factors of agriculture production ordinary least squares (OLS) regression model was used. The chapter analyses the performance of agriculture in India. The agriculture sector is an important part of the Indian economy that provides food and livelihood to the mass population of the country. The share of agriculture sector in Nation's total GDP is about 12 per cent in 2013-14 (prices, 2004-05). The agriculture sector plays an important role in the country's development. 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.

7. Agricultural and Food Security Production in India

Agriculture is the primary sector that provides livelihoods to a significant proportion of the population in India, especially in rural areas. The agriculture and allied sector contribute immensely to the overall growth, poverty reduction and therefore it is an important sector for spurring economic growth, reducing poverty, and enhancing food security. The total GDP growth from agriculture is two times more effective in reducing poverty as compared to total GDP growth of the other sector (Ligon and Sadoulet, 2007). The second Sustainable Development Goals (SDG) has targeted at the end of 2030 to, "End hunger, achieve food security and improved nutrition and promotes sustainable agriculture efforts to combat hunger and malnutrition have advanced significantly since 2000. Ending hunger, food insecurity and malnutrition for all, however, will require continued and focused efforts, especially in Asia and Africa. More investments in agriculture, including government spending and aid, are needed to increase capacity for agricultural productivity" (UN, 2015). In the 21st century, agriculture continues to be themost important instrument for the sustainable development and poverty alleviation in India. Agriculture is the predominant sector and majority of the population in the country lives in rural areas and depends on agriculture for livelihood and sustenance. Despite the rapid growth of some of the sectors, the dependence on agriculture as the main livelihood has seen a very small decline. It is clear that future growth of agricultural sector holds the key to livelihood security, eradication of poverty, reduction in hunger, inclusive growth and sustainable progress of the country.

8. Climate Change Policy Implications

India should promote win-win- strategies in relation to climate change that involves investment and policies that promote climate change adaptation and mitigation. The improvement in land management and energy efficiency has led to an increase in productivity. The agriculture production since 1995-96 is concerned the growth slowdown heavily. Thus underscoring the urgency of addressing critical policy issues for anticipating the highly uncertain outcomes of climate change:

- To improve water management and efficient use of water resources while promoting public and private investments in sustainable irrigation for weatherproof agriculture.
- For promoting public and private investment, in introducing suitable and modern technology to mitigate and potentially adapt to climate variability.
- Address the problems of small and marginal farmers more effectively.
- Development of low-cost, appropriate technologies for yield improvement and cost reduction in farming systems.
- Using a suitable institutional mechanism to exploit irrigation potential that exists in most of the states.
- Strengthening rural infrastructure and institutions such as road connectivity, electricity, markets, cold storage, godowns, banks, cooperatives, self-help groups, veterinary services, education, etc. It would help in promoting agricultural diversification as well as value addition

9. Conclusion

Among all sectors, Indian agriculture is termed as most sensitive to the climate change. The production of agricultural commodities is primarily determined by the climatic situation. A change in climate is expected to bring changes in almost all spheres of agricultural practices. This adversely affects the future productivity of natural resources and has serious implications for sustainable development. Sustainable agricultural development and food security will be one of the key challenges for India in this century. Around 69 per cent of India's population is living in rural area with agriculture as their livelihood support system. The vast majority of Indian farmers are small and marginal. Their farm size is decreasing further due to population growth. And the quality of the land is deteriorating due to heightened nutrient mining, soil erosion, increasing water scarcity, adverse impacts of climate change and accumulation of toxic elements in soil and water. Land degradation, like climate change, is an anthropogenic induced process and poses the biggest threat to sustainable livelihood security of the farming communities across the country. All of these factors combined with the increased rate of land degradation are contributing towards a decline in agricultural productivity leading to food insecurity. Since land resources are finite, requisite measures are required to reclaim degraded and wastelands, so that areas going out of cultivation due to social and economic reasons are replenished by reclaiming these lands and by arresting the further loss of production potential. Sustainable agriculture development is affected by persistent land degradation, land fragmentation, labour problem and over-exploitation of natural resources. The government should need to focus mainly on the sustainable production systems by \ strengthening the ecological foundations. This requires a holistic approach by considering technological, biophysical, socio-economic, political and environmental factors. 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. Further, strategic research and technology in agriculture and adoption of sustainable practices are necessary to meet current and future threats to food security in India.

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