

Climate Change Management in Rural Livelihood of India

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ABSTRACT

The livelihood of the rural people is directly dependent on climate-sensitive natural resources. It is endowed with varied climates supporting rich biodiversity and highly diverse ecology. More than 60% of its population living in rural areas, where agriculture is a major concern rural economy that is the backbone of the Indian economy. The impact of climate change on these natural resources affects agriculture, forests, water resources and human health. The consistent impact of climate change may threaten livelihood activities, which are mostly based on agriculture providing food security. Climate change and global warming pose a significant threat to agriculture. Pest populations are strongly dependent upon temperature and humidity. It has been predicted that there will be 10-40% losses in crop production in India with an increase in temperature of 3 to 5°C by the end of 21 century. The allied sectors of agriculture have also been affected adversely by climate change, e.g., lowering production in dairy cattle, poultry and fishery. The loss in net revenue at the farm level is estimated to range between 9% to 25% for a temperature rise of 2°C to 3.5°C. The National Action Plan on Climate Change (NAPCC), National Mission for Sustainable Agriculture (NMSA) and National Innovations in Climate Resilient Agriculture (NICRA) are major initiatives for climate-resilient agriculture in India. This paper attempted to review the approaches of climate change management for rural livelihood in India.

Keywords: Climate change management, Climate resilient agriculture, Rural livelihood, India.

INTRODUCTION

The livelihood of the rural people is directly dependent on climate-sensitive natural resources. It is endowed with varied climates supporting rich biodiversity and a highly diverse ecology. The impact of climate change affects natural resources like land, water and

forests. These could impact freshwater availability, oceanic acidification, food production, flooding coastal areas, and increased burden of vector-borne and water-borne diseases associated with extreme weather events.

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The consistent impact of climate change may threaten livelihood activities, which are mostly based on agriculture providing food security. Climate change has posed a significant threat to agriculture. The climate is the primary determinant of agricultural productivity. Climate change has intensified the risk of climate-dependent crop production. An increase in temperature can reduce crop duration, increase crop respiration rates, alter photosynthesis, and affect pest populations' survival and proliferation. The prominent cause of climate change is man-induced global warming due to the emission of greenhouse gases into the atmosphere. The global average surface temperature has increased by approximately 0.6°C over the past century, and further, it will be increased by 1.4–5.8°C over the end of 21 century. It has manifested in terms of events like melting glaciers, rising sea levels, extreme weather and floods. (NAPCC, 2008; Kannan, 2009; Dhaliwal et al., 2011; NATCOM, 2012; Ninan & Bedamatta, 2012; Adhinarayanan, 2013; Rattani, 2018; & IPCC, 2022).

India is a vast country occupying 2.4% world's geographical area sharing 16.2% of the global human population and 15% of the global livestock population. More than 60% of its population lives in rural India. Agriculture is the backbone of the Indian economy, which is crucial for food and livelihood security in India. It mostly depends on the onset of the monsoon and its further behaviour. The adaptability of farmers in India is severely restricted by the heavy reliance on natural factors and the lack of complementary inputs and institutional support systems. The cultivated fields are diverse, heterogenous and unorganized, and almost 60% are rainfed. The vulnerability of agricultural production to climate change depends not only on the physiological response of the affected plant but also on the ability of the affected socio-economic systems of production to cope with changes in yield, as well as with changes in the frequency of droughts or floods. This scenario is more challenging because more than 80% of Indian farmers are small and marginal, with

poor coping capacity. Food production in India is sensitive to climate changes, such as variability in monsoon rainfall and temperature changes within a season. Small changes in temperature and rainfall have significant effects on the quality of fruits, vegetables, tea, coffee, aromatic and medicinal plants, and basmati rice. Other impacts on agricultural and related sectors include lower yields from dairy cattle and a decline in fish breeding, migration, and harvests. In an increase of 1-4 °C, the grain yield is reduced on average by 10% for each degree of temperature increase, and annual wheat production could plunge by 4-5 million tons with every 1°C rise in the temperature has been predicted in India by the end of 21 century. It has also been predicted that there will be 10-40% losses in crop production in India with an increase in temperature of 3 to 5°C by the end of 21 century. The loss in net revenue at the farm level is estimated to range between 9% to 25% for a temperature rise of 2°C to 3.5°C. (Kumar & Parikh, 2001; Kumar, 2010; Ninan & Bedamatta, 2012; Ranuzzi & Srivastava, 2012; Mahato, 2014; Rao et al., 2019; & Vanaja, 2019).

CLIMATE CHANGE MANAGEMENT

Climate change is a global problem. Adaptation, mitigation and natural resource management are basic components of remedial measures taken to combat the adverse impact of climate change. To minimize the adverse impact of climate change, adaptation comprises shifting the population living close to the seaside to escape the rising sea level or promote crops that can tolerate higher temperatures, and mitigation comprises measures to reduce the emissions of greenhouse gases by switching to renewable sources of energy. Natural resource management is a holistic approach to minimizing the adverse impact of climate change by application of a sustainable approach in livelihood practices. To combat the adverse impact of climate change on agriculture, it's an urgent need to adopt climate-resilient strategies and initiatives for agriculture in India. The strategies for climate

resilient agriculture are practitioner approach, and initiatives for climate resilient agriculture are government approach.

STRATEGIES FOR CLIMATE-RESILIENT AGRICULTURE

Potential adaptation, mitigation and natural resource management are the prominent strategies for climate-resilient agriculture. These strategies should be mostly deal with conservation agriculture, production augmentation, crop diversification, varietal improvement, soil and water management, sustainable pest management, weather forecasting application and harnessing indigenous technical knowledge in agriculture. The strategies for climate-resilient agriculture are the practices conducted by farmers for their farm production to minimize the adverse effects of changing climatic conditions. These prominent strategies in the Indian context are discussed below-

1. Conservation Agriculture

The adverse impact of climate change on rural livelihood agriculture could be compensated with conservation agriculture. Conservation agriculture helps to minimize the adverse effect of climate change on the cost of production, the risk of fluctuating monsoonal patterns, water and nutrient management and pest management by supplementing the cost-effective farm production and livelihood improvement. Conservation agriculture is the holistic approach to natural resource management by minimizing the exploitation of natural resources. The conservation agriculture practices and their associated cultivation practices modification like crop establishment, water and nutrient management, pest management and harvest practices will affect yield potential, soil fertility and livelihood status. Zero-tillage with less demand for water, fertilizers and labourers seems to be a good option for upland and drought regions. The early showing crops mature before peak heat phase counter yield loss due to heat-induced reduction during the growing period can be brought under conservation agriculture with wheat, pulse and oilseed crops. The largest agroecosystem of India, the Indo-Gangetic

Plains, follows commonly rice-based crop rotation; late sown as a result of delayed onset of monsoon can be compensated with the higher application of nitrogen fertilizers without exploitation of water resources for early sowing. Optimizing tillage, proper water and nutrient management, and growing suitable crop cultivars are some of the potential technologies to reduce nitrous oxide (N₂O) emissions for mitigating greenhouse gases (GHGs) emissions. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

2. Production Augmentation

The adverse impact of climate change on farm production could be compensated with production augmentation. The production augmentation helps to minimize the adverse effect of climate change on the production potential of crops and livestock by supplementing the technology-induced increasing farm production and livelihood improvement. Production augmentation is the enhancement of farm production with cost-effective higher yield potential by strengthening technology-induced farming systems. The production augmentation practices and their associated cultivation practice modifications like technology establishment and diversified farming will affect higher yield potential and livelihood status. Technology-induced farm production with higher yield potential seems to be a good option for enhancing crop production to minimize the scope of climate change. Integrated farming, agroforestry and fisheries are cost-effective higher farm production systems that can be brought under production augmentation with small and marginal farmers. The small and marginal farmers are the most important components of the Indian rural economy. Subsistence farming needs assistance to make their agriculture profitable, improve their livelihoods, and minimize climate change. Optimizing new technologies for farm production, increasing net profit, and sustainable farming will be explored to introduce farming systems to complement and synergize productivity and income under

changing climatic conditions. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

2. Crop Diversification

The adverse impact of climate change on crop production could be compensated with crop diversification. Crop diversification helps to minimize the adverse effects of seasonality on the cost of production, risk of fluctuating monsoonal patterns, water and nutrient management and pest management by supplementing the increasing farm income. Crop diversification is the alteration of various crop production with the relevant ecosystems in the same region by minimizing the exploitation of natural resources. The diversified crops and their associated cultivation practice modifications like crop establishment, water and nutrient management, pest management and harvest practices will affect yield potential and soil fertility status. Pulse and oilseed crops and intercrops with less demand for water and nitrogen seem to be a good option for upland and drought regions. The largest agroecosystem of India, the Indo-Gangetic Plains, commonly follows rice-fallow crop rotation. Having adequate soil moisture can be brought under crop diversification and intensification with pulse, oilseed and fibre crops. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

3. Varietal Improvement

The adverse impact of climate change on crop production could be minimized with varietal improvement. The varietal improvement helps minimize seasonality's adverse effects on yield potential and stress resistance of crops by increasing farm income. Varietal improvement is the development of new crop varieties with higher yield potential and multiple stress resistance by strengthening germplasm improvement programmes. The improvised germplasm with multiple abiotic stress resistance, like oxidative stress tolerance and frostbite and heatstroke tolerance, will affect yield and potential varietal status. Pulse and oilseed crops with oxidative stress-tolerant varieties seem to be a good option for upland and drought regions. In the most diversified ecosystem of India, the short-duration crop

varieties mature before the peak heat phase, and varieties of higher per day yield potential counter yield loss due to heat-induced reduction during the growing period can be brought under crop improvement and establishment with pulse, oilseed and fibre crops. (NAAS, 2013; NMSA, 2014; SLCC, 2019; Vanaja, & 2019).

5. Soil and Water Management

The adverse impact of climate change on crop production could be minimized with soil and water management. Soil and water management helps to minimize the adverse effects of seasonality on the soil and water resources of crops by increasing farm income. Soil and water management efficiently uses soil and water resources with higher yield potential and cost-effective crop production by strengthening soil and water conservation practices. The improved soil and water conservation practices with efficient soil and water use efficiency will affect yield potential and the cost-effective status of crop production. Soil and water conservation with soil aggregation and water harvesting seems to be a good option for upland and drought regions. In the rich ecosystem of India, the soil and water conservation structures like contours, ridges, vegetative hedges and crop residue mulches, and micro-irrigation practices at critical stages of crop growing period can be brought under soil and water management and improvement with upland and drought regions. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

6. Sustainable Pest Management

The adverse impact of climate change on crop production could be minimized with sustainable pest management. Sustainable pest management helps minimize seasonality's adverse effects on increasing crop pests incidence by increasing farm income and quality yield. Sustainable pest management is eco-friendly pest management with higher yield potential and cost-effective crop production by minimizing adverse impacts on natural resources of pest management. The improved pest management practices with an efficient, eco-friendly approach will affect the

quality yield potential and cost-effective status of pest management. Eco-friendly pest management with approaching natural resources of pest management seems to be a good option for changing climatic conditions. In the rich ecosystem of India, integrated pest management, bio-intensive pest management, eco-friendly insecticide technology and ecologically engineered pest management can be brought under sustainable pest management by minimizing the cope of climate change on natural resources of pest management. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

7. Weather Forecasting Application

The adverse impact of climate change on farm production could be minimized with the application of weather forecasting. Weather forecasting helps minimize the adverse effects of seasonality and climate change on farm production potential and livelihood improvement. Application of weather forecasting is the early warning systems of weather and climate for minimizing risks of climatic vagaries. The early warning systems of weather with monitor changes in farm production seasonality will be affecting higher yield potential and livelihood status. Seasonal weather forecasts and agreement advisory services seem to be a good option for minimizing the cope of climatic vagaries and change. In the rich ecosystem of India, the monitoring of changes in biotic and abiotic stresses of farm production can be brought under weather forecasting by minimizing the cope of changing climatic conditions. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

8. Indigenous Technical Knowledge in Agriculture

The adverse impact of climate change on farm production could be minimized with the application of indigenous technical knowledge in agriculture. Applying indigenous technical knowledge in agriculture helps minimize the adverse effects of seasonality and climate change on farm production potential and livelihood improvement. Indigenous technical knowledge in agriculture is the revival of

traditional agriculture knowledge of the scientific rationale for sustainable agriculture production. The traditional agriculture knowledge of scientific rationale will be affecting sustainable yield potential and livelihood status. The application of traditional agriculture knowledge of scientific rationale seems to be a good option for changing climatic conditions. In the rich ecosystem of India, the traditional agriculture knowledge of scientific rationales like farmyard manuring, indigenous wells, field mulching, and livestock littering in farm production can be brought under indigenous technical knowledge in agriculture by minimizing the cope of changing climatic conditions. (NAAS, 2013; NMSA, 2014; SLCC, 2019; & Vanaja, 2019).

INITIATIVES FOR CLIMATE-RESILIENT AGRICULTURE

The potential efforts by government functionaries for minimizing the cope of changing climatic conditions are the prominent initiatives for climate resilient agriculture. These initiatives should mostly deal with conservation agriculture, production augmentation, crop diversification, varietal improvement, soil and water management, sustainable pest management, weather forecasting application and harnessing indigenous technical knowledge in agriculture. The National Action Plan on Climate Change (NAPCC) of India and the National Innovations in Climate Resilient Agriculture (NICRA) project of the Indian Council of Agricultural Research (ICAR) has made excellent initiatives towards rendering Indian agriculture more resilient to climate change. These prominent initiatives are discussed below-

1. National Action Plan on Climate Change (NAPCC)

To enable the country to adapt to climate change and enhance ecological sustainability, the government of India launched a national strategic plan, as National Action Plan on Climate Change (NAPCC), in the year 2008. The National Action Plan on Climate Change is an integration of many statutory plans. It is an amalgamation of eight missions, each of

which caters to the improvement of national prospects on the threats posed by climate change and the measures proposed by India to counter them. They focus on promoting an understanding of climate change, adaptation, mitigation, energy efficiency and natural resource management. The eight missions are 1.National Solar Mission, 2.National Water Mission, 3.National Mission for a Green India, 4.National Mission on Sustainable Habitat, 5.National Mission for Sustainable Agriculture, 6.National Mission for Enhanced Energy Efficiency, 7.National Mission for Sustaining the Himalayan Ecosystem, and 8.National Mission on Strategic Knowledge for Climate Change. The National Mission for Sustainable Agriculture (NMSA) aim is to make Indian agriculture more resilient to climate change by identifying conservation agriculture, production augmentation, crop diversification, varietal improvement, soil and water management, sustainable pest management, weather forecasting application and harnessing indigenous technical knowledge in agriculture., as well as finance and insurance mechanisms. (NAPCC, 2008, NMSA, 2014; & Rattani, 2018).

2. National Innovations in Climate Resilient Agriculture (NICRA)

The aims to enhance the resilience of Indian agriculture to climate change and its variability, the Indian Council of Agricultural Research (ICAR), New Delhi, has launched a national strategic research and technology demonstration network project as National Innovations in Climate Resilient Agriculture (NICRA) in the year 2011. It was formerly known as National Initiative on Climate Resilient Agriculture (NICRA). The National Innovations in Climate Resilient Agriculture is a flagship program of the Indian Council of Agricultural Research to undertake systematic long-term research on the impacts and adaptation of Indian agriculture and frontline demonstration of best practices to minimize the scope of climate change. This has been carried out in 151 vulnerable districts of the country. The National Innovations on Climate Resilient Agriculture is an integration of many

village-level intervention strategies. It is an amalgamation of ten intervention strategies, each of which caters to the improvement of national prospects on location-specific interventions in vulnerable districts of India to enable farmers to cope with current climatic variability. ten intervention strategies. The ten village-level intervention strategies are 1.Building Resilience in Soil, 2.Adapted Cultivars and Cropping Systems, 3.Rainwater Harvesting and Recycling, 4.Water Saving Technologies, 5.Farm Machinery (Custom Hiring) Centres, 6.Crop Contingency Plans, 7.Livestock and Fishery Interventions, 8. Weather-Based Agro Advisories, 9.Institutional Interventions, 10.Village Climate Risk Management Committee. (CRIDA, 2016; Prabhakar, 2019; & Vanaja, 2019).

CONCLUSION

The impact of climate change on these natural resources affects agriculture, forests, water resources and human health. The consistent impact of climate change may threaten livelihood activities, which are mostly based on agriculture providing food security. Climate change and global warming pose a significant threat to agriculture. Adaptation, mitigation and natural resource management are basic components of remedial measures taken to combat the adverse impact of climate change. To combat the adverse impact of climate change on agriculture, it's urgent to adopt climate-resilient strategies and initiatives for agriculture in India. The strategies and initiatives should be mostly deal with conservation agriculture, production augmentation, crop diversification, varietal improvement, soil and water management, sustainable pest management, weather forecasting application and harnessing indigenous technical knowledge in agriculture. The National Action Plan on Climate Change (NAPCC), National Mission for Sustainable Agriculture (NMSA) and National Innovations in Climate Resilient Agriculture (NICRA) are major initiatives for climate-resilient agriculture in India.

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Author Contribution

Both authors have participated in critically revising the entire manuscript and approving the final manuscript.

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