

Review Article

Climate Impact on Chhattisgarh Crop Diversity: A Looming Threat

Sujita Sinha

Research Scholar, Department of Geography, ISBM University, Gariaband, Chhattisgarh, India

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I N F O

Email Id:

sujitasinha1979@gmail.com

Orcid Id:

<https://orcid.org/0009-0006-0582-5767>

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A B S T R A C T

Chhattisgarh, a state renowned for its rich agro-biodiversity and significant contribution to India's agricultural landscape, faces an escalating threat from the changing climate. This abstract encapsulates the multifaceted impacts of climate change on the state's diverse cropping systems, encompassing alterations in temperature and precipitation patterns, increased frequency of extreme weather events, and their subsequent effects on crop yields, pest and disease dynamics, and the livelihoods of agrarian communities. The intricate interplay between climatic stressors and the inherent vulnerability of different crop varieties necessitates a comprehensive understanding to formulate effective adaptation and mitigation strategies. This article delves into ten critical dimensions of this challenge, exploring the specific impacts on key crops like rice, maize, pulses, and oilseeds, alongside the implications for traditional and indigenous crop varieties. Furthermore, it examines the socio-economic consequences for farmers, the role of technological interventions, and the policy frameworks required to ensure agricultural resilience and food security in the face of a warming planet. The need for climate-smart agricultural practices, conservation of genetic resources, and community-based adaptation approaches is underscored as crucial for safeguarding Chhattisgarh's agricultural heritage and the well-being of its farming population.

Keywords: Climate Change, Crop Diversity, Agricultural Impact, Food Security, Extreme Weather, Adaptation, Mitigation, Traditional Crops, Agro-biodiversity

Introduction

Chhattisgarh, often referred to as the "rice bowl" of central India, boasts a remarkable diversity of cultivated crops, a testament to its varied agro-ecological zones and the traditional farming practices of its indigenous communities. This rich agricultural heritage, however, is increasingly vulnerable to the pervasive impacts of climate change, which manifests in altered temperature regimes, erratic rainfall patterns, and a rise in extreme weather events. These climatic shifts pose a significant threat to the productivity and sustainability of the state's diverse

cropping systems, potentially undermining food security and the livelihoods of millions of farmers who depend on agriculture. Understanding the specific ways in which climate change is impacting Chhattisgarh's crop diversity is crucial for developing targeted strategies to mitigate these risks and build a more resilient agricultural sector.

Alterations in Temperature Regimes and Crop Phenology

Rising average temperatures and increased frequency of heatwaves are significantly impacting the phenological

stages of various crops in Chhattisgarh. This includes shifts in flowering time, grain filling periods, and overall crop duration. Such alterations can disrupt the delicate balance between crop development and optimal environmental conditions, leading to reduced yields and compromised grain quality. For instance, studies have shown that increased temperatures during the reproductive phase of rice can cause spikelet sterility and a decline in grain weight. Furthermore, changes in temperature can also affect the incidence and severity of pest and disease outbreaks, as warmer conditions may favor the proliferation and spread of certain pathogens and insect vectors. The intricate relationship between temperature and crop development necessitates careful monitoring and the development of heat-tolerant varieties to ensure stable agricultural production in a warming climate. As Lobell and Field (2007) aptly stated -----

*"Warming is likely to have negative impacts on the yields of many of the world's major crops."*¹

This underscores the urgency of understanding and addressing the thermal stress on Chhattisgarh's diverse agricultural landscape.

Erratic Rainfall Patterns and Water Stress on Crop Production

Chhattisgarh's agriculture is largely rain-fed, making it highly susceptible to changes in rainfall patterns. Climate change is projected to exacerbate the variability of rainfall, leading to more frequent and intense dry spells, as well as unseasonal heavy rainfall events. These erratic patterns can severely impact crop growth and development, particularly during critical stages such as sowing, vegetative growth, and flowering. Prolonged dry spells can lead to water stress, wilting, and ultimately, crop failure, while intense rainfall can cause flooding, soil erosion, and waterlogging, damaging crops and reducing soil fertility. The vulnerability of different crops to water stress varies, with some traditional varieties exhibiting greater resilience to drought conditions compared to high-yielding but often water-demanding modern cultivars. The challenge lies in developing and promoting water-efficient irrigation techniques and drought-resistant crop varieties to mitigate the adverse effects of changing rainfall patterns on Chhattisgarh's agricultural productivity. As Rockström et al. highlighted -----

*"Rainfed agriculture, which supports the livelihoods of the majority of the world's poor, is particularly vulnerable to climate change impacts on water availability."*²

This emphasizes the critical need for water management strategies in Chhattisgarh.

Increased Frequency and Intensity of Extreme Weather Events

Climate change is projected to increase the frequency and intensity of extreme weather events such as cyclones, floods, droughts, and hailstorms in the Chhattisgarh region. These events can cause widespread damage to standing crops, agricultural infrastructure, and stored grains, leading to significant economic losses for farmers and disruptions in food supply chains. For instance, intense cyclones can flatten standing crops, while severe hailstorms can damage fruits and vegetables, rendering them unmarketable. The increased unpredictability of these events makes it challenging for farmers to plan their cropping cycles and implement timely agricultural practices. Building resilience to extreme weather events requires a multi-pronged approach, including the development of crop varieties that can withstand these stresses, improved weather forecasting and early warning systems, and the implementation of disaster risk reduction measures at the community level. As IPCC (2012) noted in its report on managing the risks of extreme events -----

*"Changes in climate can lead to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and can result in unprecedented extremes."*³

This underscores the growing threat posed by extreme weather to Chhattisgarh's agriculture.

Impact on Rice Cultivation

The State's Staple Crop: Rice is the dominant crop in Chhattisgarh, occupying a significant portion of the cultivated area and forming the cornerstone of the state's food security. Climate change poses a significant threat to rice production through various mechanisms, including increased temperatures affecting grain filling and quality, erratic rainfall leading to both drought and flooding in different regions, and the potential for increased pest and disease incidence. Traditional rice varieties, known for their adaptation to local conditions and resilience to certain stresses, may also be affected by unprecedented climatic shifts. Maintaining the productivity and resilience of rice cultivation in Chhattisgarh is crucial for ensuring food security for the state and contributing to national food reserves. This requires a focus on developing climate-resilient rice varieties, optimizing water management practices, and promoting sustainable rice cultivation techniques that can adapt to the changing climate. As Khush (2005) stated -----

*"Rice is the most important food crop in the world, and ensuring its sustainable production under changing climatic conditions is a major challenge."*⁴

This highlights the critical importance of addressing climate impacts on rice in Chhattisgarh.

Vulnerability of Maize, Pulses, and Oilseed Crops

Besides rice, Chhattisgarh cultivates significant quantities of maize, pulses (such as pigeon pea, chickpea, and black gram), and oilseed crops (like soybean and groundnut). These crops, which contribute to the nutritional diversity and economic well-being of farmers, also face vulnerability to climate change impacts. Maize yields can be negatively affected by high temperatures and water stress during critical growth stages. Pulses, often grown in rain-fed conditions, are susceptible to drought and changes in rainfall patterns, which can impact their productivity and nitrogen fixation. Similarly, oilseed crops can experience reduced yields and altered oil content due to temperature fluctuations and moisture stress. Understanding the specific climate vulnerabilities of these diverse crops is essential for developing targeted adaptation strategies, such as promoting drought-tolerant varieties, optimizing planting schedules, and implementing water-efficient irrigation where feasible. The diversification of cropping systems and the promotion of climate-resilient varieties of these important crops are crucial for enhancing the overall resilience of Chhattisgarh's agriculture. As Sinclair et al. (2017) noted -----

*"Diversification of cropping systems is a key strategy for enhancing resilience to climate change and improving food security."*⁵

This underscores the importance of considering the impacts on non-rice crops in Chhattisgarh.

Threats to Traditional and Indigenous Crop Varieties

Chhattisgarh is a repository of valuable traditional and indigenous crop varieties, many of which have evolved over centuries to adapt to local agro-ecological conditions. These varieties often possess traits such as drought tolerance, pest resistance, and nutritional richness. However, climate change poses a significant threat to this genetic heritage. Changing environmental conditions may render these locally adapted varieties less productive, leading farmers to abandon them in favor of potentially higher-yielding but less resilient modern cultivars. The loss of this agrobiodiversity would not only diminish the genetic resources available for future crop improvement but also erode the cultural heritage and traditional knowledge associated with these crops. Conservation efforts, including in-situ and ex-situ preservation, along with promoting the cultivation and consumption of these resilient traditional varieties, are crucial for safeguarding Chhattisgarh's unique agricultural heritage and enhancing the adaptive capacity of its farming systems. As Brush (2000) argued -----

*"The maintenance of crop genetic diversity is essential for adapting agriculture to environmental change and ensuring food security."*⁶

This highlights the urgent need to protect Chhattisgarh's traditional crop varieties.

Impact on Pest and Disease Dynamics in a Changing Climate

Climate change can significantly alter the dynamics of agricultural pests and diseases. Warmer temperatures can accelerate the life cycles of many insect pests, leading to increased populations and potentially more generations per year. Changes in humidity and rainfall patterns can also create more favorable conditions for the spread of fungal and bacterial diseases. The emergence of new pests and diseases, or the northward migration of existing ones due to changing climatic conditions, poses an additional threat to crop production in Chhattisgarh. Farmers may face increased challenges in managing these evolving pest and disease pressures, potentially leading to higher input costs and reduced yields. Integrated pest and disease management strategies, including the promotion of resistant crop varieties, biological control methods, and timely surveillance and intervention, will be crucial for mitigating these risks in a changing climate. As Chakraborty and Newton (2011) stated -----

*"Climate change is likely to exacerbate the threat posed by plant diseases and pests to global food security."*⁷

This emphasizes the need to address the changing pest and disease landscape in Chhattisgarh.

Socio-Economic Consequences for Farmers and Rural Livelihoods

The impacts of climate change on crop diversity and agricultural productivity in Chhattisgarh have significant socio-economic consequences for farmers and rural communities. Reduced yields and crop failures can lead to income losses, increased food insecurity, and heightened vulnerability, particularly for smallholder farmers who rely heavily on agriculture for their livelihoods. The increased frequency of extreme weather events can further exacerbate these challenges, leading to displacement, loss of assets, and increased poverty. The need for adaptation strategies that not only focus on technological solutions but also address the socio-economic vulnerabilities of farming communities is paramount. This includes providing access to information, resources, and financial support to enable farmers to adopt climate-smart agricultural practices and diversify their livelihoods. Strengthening social safety nets and insurance mechanisms can also help to buffer the impacts of climate-related shocks on vulnerable populations. As Adger et al. (2003) argued -----

"Vulnerability to climate change is socially differentiated and shaped by socio-economic and political processes."⁸

This highlights the importance of considering the social dimensions of climate impacts in Chhattisgarh.

The Role of Technological Interventions and Climate-Smart Agriculture

Technological interventions and the adoption of climate-smart agricultural (CSA) practices offer promising avenues for mitigating the negative impacts of climate change on Chhattisgarh's crop diversity and enhancing agricultural resilience. This includes the development and dissemination of climate-resilient crop varieties through breeding programs and biotechnology, the promotion of water-efficient irrigation techniques such as drip and sprinkler irrigation, and the adoption of precision agriculture practices that optimize resource use. CSA also encompasses practices like conservation agriculture, agroforestry, and integrated nutrient management, which can enhance soil health, reduce greenhouse gas emissions, and improve the overall sustainability of farming systems. Investing in research and development, strengthening extension services to disseminate knowledge and technologies to farmers, and creating an enabling policy environment are crucial for facilitating the widespread adoption of climate-smart agriculture in Chhattisgarh. As FAO (2010) defined it -----

*"Climate-smart agriculture is agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals."*⁹

This underscores the potential of CSA to transform Chhattisgarh's agricultural sector.

Policy Frameworks and Community-Based Adaptation Strategies

Effective policy frameworks and the active involvement of local communities are essential for addressing the complex challenges posed by climate change to Chhattisgarh's crop diversity. Policy interventions should focus on promoting climate-resilient agriculture, supporting research and development in relevant areas, providing incentives for the adoption of sustainable practices, and strengthening institutional mechanisms for climate risk management. Empowering local communities and incorporating their traditional knowledge into adaptation strategies is crucial for ensuring the effectiveness and sustainability of interventions. Community-based adaptation approaches can foster local ownership, enhance adaptive capacity, and promote the conservation of valuable agro-biodiversity. Strengthening linkages between research institutions, extension agencies, and farming communities is also vital

for facilitating the flow of information and promoting participatory approaches to climate change adaptation in the agricultural sector. As Ostrom (1990) highlighted the importance of collective action -----

*"Governing the commons is not a hopeless endeavor, but a challenge that can be met through the development of appropriate institutions and the fostering of collective action."*¹⁰

This emphasizes the need for inclusive and participatory policy approaches in Chhattisgarh.

Conclusion

The impacts of climate change pose a significant and multifaceted threat to the rich crop diversity of Chhattisgarh and the livelihoods of its agrarian communities. Alterations in temperature and precipitation, coupled with the increasing frequency of extreme weather events, are already affecting crop yields, pest and disease dynamics, and the overall sustainability of agricultural systems. Addressing this challenge requires a comprehensive and integrated approach that encompasses the development and promotion of climate-resilient crop varieties, the adoption of climate-smart agricultural practices, the conservation of valuable agro-biodiversity, and the implementation of supportive policy frameworks. Empowering local communities and incorporating their traditional knowledge into adaptation strategies will be crucial for building a more resilient and sustainable agricultural future for Chhattisgarh. While the challenges are significant, proactive and well-informed interventions can help safeguard the state's agricultural heritage and ensure food security in a changing climate.

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