



## Climate Change and its Impact on Agriculture in the Bundelkhand Region

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### Abstract

The Bundelkhand region, located in central India across Uttar Pradesh and Madhya Pradesh, is highly vulnerable to climate change due to its semi-arid nature and dependence on monsoon-based agriculture. In recent years, significant changes in weather patterns, including irregular rainfall, increasing temperatures, frequent droughts and occasional extreme rainfall events, have adversely affected agricultural productivity. These climatic variations have led to water scarcity, declining crop yields, increased pest and disease incidence and economic instability among farmers. The situation is further aggravated by poor irrigation facilities and over-dependence on rainfed farming. Farmers in the region are increasingly facing uncertainty and risk in crop production. To address these challenges, the adoption of climate-resilient agricultural practices such as water conservation, crop diversification, use of drought-resistant varieties and improved irrigation methods is essential.

**Keywords:** Climate Change, Bundelkhand Region, Agriculture, Rainfall Variability, Drought

### 1. Introduction

Climate change has emerged as one of the most pressing global challenges, significantly affecting agricultural systems, particularly in vulnerable regions like Bundelkhand. The region's agriculture is predominantly rainfed, making it highly sensitive to fluctuations in climatic variables such as temperature, rainfall and evapotranspiration. Historically, Bundelkhand has been characterized by recurrent droughts, degraded soils and limited water resources. However, recent climatic shifts have intensified these challenges, resulting in reduced agricultural productivity and increased socio-economic instability among farming communities.

Understanding the dynamics of climate change impacts in Bundelkhand is crucial for designing targeted adaptation strategies. This includes assessing both biophysical factors (soil, water, climate) and socio-economic dimensions (farmer livelihoods, infrastructure, policy support). The present study aims to provide a comprehensive analysis of climate-induced agricultural challenges and potential mitigation

Pathways

### 2. Climate Characteristics of Bundelkhand

Bundelkhand exhibits a semi-arid tropical climate with marked seasonal variability, which strongly influences agricultural practices.

**2.1. Summer:** The summer season is typified by extreme temperatures often exceeding 40–45°C. Such conditions significantly increase potential evapotranspiration, leading to rapid depletion of soil moisture reserves. The resulting water stress adversely affects germination, root development and overall crop establishment. Moreover, prolonged exposure to high temperatures can induce heat-induced oxidative stress in plants, impairing cellular functions and reducing photosynthetic efficiency.

#### 2.2. Monsoon

The southwest monsoon constitutes the primary source of water for agricultural activities in Bundelkhand. However, the region experiences high variability in both the onset and distribution of rainfall. This variability often manifests as intra-seasonal dry spells interspersed with high-intensity rainfall events. Such patterns reduce effective rainfall utilization, as intense precipitation leads to runoff rather than infiltration, thereby

limiting groundwater recharge.

### 2.3. Winter

Winter conditions are relatively moderate, providing a conducive environment for rabi crops. However, episodic frost events and cold waves can cause significant damage to sensitive crops. The interplay between temperature and soil moisture during this season is critical for determining crop yield and quality.

## 3. Impacts of Climate Change on Agriculture

### 3.1. Increased Temperature

#### 3.1.1. Heat Stress

Rising temperatures in Bundelkhand have led to heat stress in crops, particularly during critical growth stages such as flowering and grain formation. This stress reduces yields and affects crop quality. High temperatures have been linked to reduced productivity in wheat and pulses, which are staple crops in the region.

#### 3.1.2. Water Demand

Higher temperatures increase evaporation rates and water demand, worsening existing water scarcity issues and putting additional pressure on irrigation systems and groundwater resources.

### 3.2. Erratic Monsoon Patterns

#### 3.2.1 Drought Dynamics

The increasing frequency of meteorological droughts has significant implications for agricultural drought, characterized by insufficient soil moisture to meet crop requirements. Prolonged dry spells during critical growth stages can lead to irreversible yield losses.

#### 3.2.2 Flood-Induced Stress

High-intensity rainfall events result in temporary flooding and waterlogging, which reduce oxygen availability in the root zone and inhibit nutrient uptake. Additionally, flooding accelerates soil erosion and nutrient leaching.

#### 3.2.3 Cropping System Disruptions

Unpredictable rainfall patterns disrupt traditional cropping calendars, forcing farmers to adopt sub-optimal planting times or abandon certain crops altogether. This increases production risk and reduces farm income stability.

### 3.3 Soil Degradation and Land Productivity Decline

Soil degradation in Bundelkhand is both a cause and consequence of climate change.

#### 3.3.1 Erosion Processes

Intense rainfall and surface runoff lead to **sheet and gully erosion**, resulting in the loss of fertile topsoil rich in organic matter and nutrients.

#### 3.3.2 Soil Organic Carbon Depletion

Elevated temperatures accelerate microbial decomposition of organic matter, reducing soil organic carbon levels. This adversely affects soil structure, water retention capacity and nutrient availability.

#### 3.3.3 Desertification Trends

Persistent drought conditions, coupled with unsustainable land management practices, contribute to desertification, reducing the productive capacity of agricultural land.

#### a. Pest and Disease Dynamics

Climate change significantly alters the ecological balance between crops and their associated pests and pathogens.

- Increased temperatures shorten pest life cycles, leading to more generations per season.
- Changes in humidity favors the proliferation of fungal and bacterial diseases.
- Geographic expansion of pests into previously unaffected areas has been observed.

These factors collectively increase crop vulnerability and necessitate more dynamic and adaptive pest management strategies.

## 4. Capacity Building and Knowledge Sharing

### 4.1. Farmer Training

Training farmers in climate-smart agricultural practices can improve their ability to adapt to changing climate conditions.

### 4.2. Community Engagement

Involving local communities in climate adaptation planning ensures that strategies address regional challenges effectively.

## 5. Conclusion

Climate change has significant implications for agriculture in the Bundelkhand region, including rising temperatures, erratic rainfall patterns, soil degradation and increased pest pressures. By adopting improved water management practices, cultivating climate-resilient crops and promoting soil conservation techniques, farmers can reduce the negative impacts of climate change and improve agricultural sustainability. Support from government agencies, research institutions and local communities is essential to ensure the long-term viability of agriculture in the Bundelkhand region.