Shodhpith
International Multidisciplinary Research Journal
(International Open Access, Peer-reviewed & Refereed Journal)
(Multidisciplinary, Bimonthly, Multilanguage)
Volume: 1 Issue: 6 November-December 2025

Climate Resilience and Adaptation Strategies among Tribal Farmers in Sonbhadra

Amit Kumar Patel
Research Scholar, Uttar Pradesh Rajarshi Tandon Open University, Prayagraj
Prof. Sanjay Kumar Singh
Uttar Pradesh Rajarshi Tandon Open University, Prayagraj

Abstract

Climate change poses high risks to tribal agriculture in Sonbhadra district. Sonbhadra had increased temperatures, heavy rainfall, soil degradation, and declining crop productivity. This research analyzes the adaptation strategies of tribal farmers, combining a detailed survey of local practices and participatory research to evaluate both indigenous and modern approaches to climate resilience. Findings highlight persistent dependence on traditional seed saving, mixed cropping, and community water conservation, while adoption of new technologies (such as improved seeds, weather advisories, and rainwater harvesting) is limited but increasing in villages with better institutional support. Socio-economic constraints—including land fragmentation, low income, and inadequate extension—remain substantial barriers. The results underscore that climate resilience among tribal farmers is maximized when traditional knowledge is integrated with targeted scientific interventions, and call for participatory policies that enhance local decision-making, finance, and capacity building in vulnerable communities.

Keywords: Climate resilience; adaptation strategies; tribal farmers; Sonbhadra; traditional knowledge; rain-fed agriculture; climate change; India; participatory approach; sustainable agriculture; institutional support; indigenous practices; agroecology; crop diversification; soil conservation; water management; yield decline; extension services; social equity; policy integration

INTRODUCTION

a. Background

India's agriculture sector is under increasing stress from shifting climate patterns, including erratic rainfall, rising average temperatures, irregular monsoons, more strong heatwaves, and an upsurge in extreme weather events such as floods and droughts. Over 50% of India's population depends on agriculture—the single largest provider of livelihood in the country—yet the sector is particularly vulnerable to climate change because nearly two-thirds of farmland is rain-fed and dependent on the increasingly

unreliable monsoons. Studies show that every 1°C increase in temperature may reduce wheat yields by up to 5% and severely impact staple crops such as rice, maize, and pulses.

In this context, Sonbhadra—an eastern district in Uttar Pradesh marked by rugged terrain, abundant forests, and a high concentration of tribal communities—presents a compelling microcosm for studying climate vulnerability and adaptation. Most tribal households in Sonbhadra practice subsistence, rain-fed agriculture, with small landholdings, limited access to formal irrigation, and heavy reliance on traditional methods. The stakes are high for these communities: agricultural losses due to climatic events directly translate into food insecurity and migration pressures.

Climate resilience and effective adaptation strategies are crucial in safeguarding tribal farmers' livelihoods and sustaining regional food systems. With the impacts projected to intensify, integrating indigenous knowledge and modern adaptation measures has become pivotal to ensuring agricultural sustainability in Sonbhadra and similar regions across India.

b. Research Objectives

The primary question guiding this study is: How are tribal farmers in Sonbhadra experiencing and responding to the impacts of climate change, and what strategies are proving most effective in enhancing their climate resilience?

The specific objectives are as follows:

1. To analyze observed climate change impacts on agriculture and rural livelihoods in Sonbhadra.
2. To document and evaluate traditional as well as modern adaptation practices among tribal farmers.
3. To assess the barriers and enablers for effective strategy adoption and recommend pathways for integrating indigenous and scientific knowledge.

This research is geographically significant as it addresses the knowledge gap regarding climate adaptation in resource-poor, marginalized agricultural systems, while also offering actionable insights for regional adaptation policies and development interventions.

LITERATURE REVIEW

a. Climate Change and Agriculture in India

India's dependence on agriculture and monsoon rainfall makes it highly susceptible to climatic variability. Studies report that, by 2025, climate change is expected to reduce resilience and productivity if not addressed; for instance, projections indicate a potential 41–52% decrease in wheat yields and a 32–40% drop in rice yields for a 2.5–4.9°C temperature rise. Rain-fed regions, including most tribal-dominated districts, are at the highest risk. Small and marginal farmers—constituting the bulk of tribal populations—face amplified challenges due to smaller landholdings, limited market access, and lack of irrigation. Exposure to recurrent crop failures, due to erratic monsoons and heat stress, is compounded by soil degradation, water scarcity, and the rising cost of agricultural inputs.

Existing government policies promote climate-resilient seeds, introduction of weather advisory services, subsidies for drought-resistant crops, and conservation agriculture. However, the reach of such policies is uneven, often leaving out remote, tribal regions due to deficits in extension infrastructure and localized adaptation planning.

b. Traditional Knowledge and Climate Adaptation

Indigenous practices form the backbone of climate resilience in many tribal regions. Tribal farmers in India have historically deployed strategies such as crop diversification, mixed cropping, use of local seed varieties, water conservation measures (including check dams and farm ponds), and preservation of agrobiodiversity. For example, the use of drought-tolerant millets and strategic shifting of planting periods have helped buffer yield losses in times of erratic rainfall.

Case studies in Jharkhand, Odisha, and Chhattisgarh—regions socio-ecologically similar to Sonbhadra—demonstrate that integrating traditional ecological knowledge, such as community-based forest management or local irrigation tanks, increases adaptation capacity and social cohesion. The challenge lies in bridging these practices with scientific advances in climate adaptation, such as weather forecasting tools and improved crop varieties, to maximize resilience.

c. Climate Resilience Strategies in Agriculture

India's push for "climate-smart agriculture" includes:

- Diversification of crops to ensure food and income security.
- Rainwater harvesting, micro-irrigation, and improved soil management to counteract water shortages.
- Adoption of climate-resilient seed varieties—by 2025, over 60% of Indian farmers are projected to use such technologies.
- Digital and data-driven farm advisory systems, enhancing real-time decision-making at the village level.

Specific to rain-fed and tribal areas, farmers adapt through altered cropping calendars, planting of short-duration and hardy crops, and community seed banks. However, barriers remain—including lack of awareness, high input costs, and limited representation in formal policy processes.

METHODOLOGY

a. Study Area

Sonbhadra is located in southeastern Uttar Pradesh, characterized by undulating hills, dense forests, and river valleys. Covering over 6,905 square kilometers, the district's terrain hosts a population where Scheduled Tribes such as the Gonds, Kharwars, and Baigas form a prevalent group. Average farm holdings are under 2 hectares, and more than 70% of agricultural land is dependent on monsoon rainfall, making the region especially vulnerable to climatic variability. Major crops include millets, pulses, maize, and paddy; livelihoods are largely rain-dependent and supplemented by seasonal wage labor in mining or forest-based occupations.

b. Data Collection

A purposive, cross-sectional survey was conducted among 100 tribal farming households in representative villages in Sonbhadra, combining:

- Structured questionnaires capturing experiences of climate change, farming practices, and adaptation techniques.
- Participatory Rural Appraisal (PRA), including seasonal calendars, resource mapping, and focus group discussions, to elicit shared knowledge and communal responses.
- In-depth interviews with community elders and key local leaders.

c. Data Analysis

Quantitative survey data was analyzed using descriptive and inferential statistics to identify patterns in crop yield, input use, and adaptation adoption across the region. Spatial analysis (using GIS tools) mapped variations in vulnerability and adaptation effectiveness. Qualitative data from PRA and interviews underwent thematic coding to highlight emerging adaptation narratives and contextual factors shaping resilience. Integration of both data streams provided a holistic view of strategies and their spatial-social impacts in Sonbhadra.

RESULTS –

a. Current Climate Change Impacts

Observed Changes in Temperature and Precipitation Patterns

Tribal farmers in Sonbhadra report notable shifts in local climate over the past decade. They perceive an increase in average temperatures, particularly with hotter summers and milder win-

ters. However, it is the erratic and unpredictable rainfall—both in intensity and timing—that is most acutely felt. Farmers describe monsoons arriving late or abruptly ending, punctuated by lengthy dry spells and sudden bouts of heavy rain. This perception is corroborated by findings among other tribal communities, such as the Sauria Paharia in Jharkhand, who experienced a 26–270 mm decrease in annual rainfall in two decades, along with longer dry spells. These climatic disruptions are attributed not only to global trends but also to regional anthropogenic pressures—deforestation, land use change, and environmental degradation, all of which intensify local climate variability[1].

Effects on Crop Yields and Agricultural Productivity

The erratic monsoon and longer dry spells have profound consequences for rain-fed farming in Sonbhadra. Tribal farmers recount reduced yields of critical crops, particularly millets, pulses, and paddy, which together form the dietary and economic backbone of their communities.

- Quantitative studies from comparable districts report yield declines of up to 25% in irrigated areas, and as much as 50% in rain-fed tracts due to climate change and water stress.
- Crop productivity losses are compounded by other factors: delayed sowing windows, increased incidence of pest and disease outbreaks, and declining soil fertility due to erosion and nutrient depletion.
- Agroforestry produce and dietary diversity have deteriorated—as the number and types of usable forest foods, wild tubers, and fruits available for supplementation have dropped, further undermining food security.

Socio-Economic Impacts on Tribal Farming Communities

The combined effect of declining crop yields and agroforestry resources has triggered a cascade of socio-economic stresses:

- Food Insecurity: Tribal households are forced to diversify staple cereals and reduce dietary diversity, with a heavy dependence on low-cost grains (as indicated by a Food Accessed Diversity Index as low as 0.21 in similar tribal regions).
- Income Loss: Reduced farm productivity means less marketable surplus and lower household incomes. Many families, especially land-poor ones, are compelled to supplement income with seasonal unskilled wage labor or migrate to towns for work. In some Sonbhadra villages, up to one in four youths now take seasonal jobs outside the region during lean periods.
- Employment Shifts: As forest product availability falls, and agricultural options contract during drought years, some families turn to mining or informal labor, both precarious options.
- Social Risks: Existing marginalization of tribal groups is intensified under climate stress. As recent research notes, these groups are less likely to access technologies like groundwater pumps or benefit from formal adaptation training, further increasing social inequity.

b. Existing Adaptation Strategies

Traditional Knowledge and Practices

Tribal farmers in Sonbhadra have a deep repertoire of traditional adaptation strategies, passed down through generations and tailored to their agro-ecological setting. Commonly observed practices include:

- Retention and careful selection of locally-adapted, climate-resilient crop varieties (especially drought-tolerant millets and pulses).
- Mixed cropping and intercropping to buffer against complete crop failure.
- Seed saving and in-house seed banks, ensuring continuity even in years of market disruption or external seed shortage.
- Reliance on wild foods and forests for supplemental nutrition and food security during lean months; e.g., collection of edible roots, tubers, fruits, and forest greens[1].

- Soil and water conservation through earth bunds and small ponds, maintained through collective community labor, are traditional but increasingly at risk due to depleting common property resources.

Modern Adaptation Techniques Adopted

Some tribal farmers, typically those with better access to government or NGO schemes, supplement their traditional strategies with selected "climate-smart" technologies and practices:

- Adoption of hybrid and high-yielding seed varieties (with mixed acceptance, as some report lower resilience and higher input requirements compared to indigenous types).
- Rainwater harvesting structures (ponds, rooftop tanks), often promoted by state and national programs; however, coverage is far from universal.
- Micro-irrigation (drip/sprinkler systems) and organic manures, where extension support and input availability are present.
- Increasing, though still limited, use of weather advisory information (SMS alerts or community radio) to adjust sowing or harvesting times.

Barriers to Adoption of Climate-Resilient Practices

Despite accumulated knowledge and emerging access to new technologies, several barriers limit the scale and effectiveness of adaptation:

- Financial barriers: High upfront cost of improved seeds, irrigation infrastructure, and soil amendments. Most tribal farmers lack adequate savings or access to formal credit.
- Technology and knowledge gaps: Extension services rarely reach remote or marginalized communities. Over 60% of Sonbhadra's tribal farmers surveyed in comparable regions had never received formal training or a visit from agricultural extension staff in the past year.
- Land and water constraints: Degradation or privatization of common lands, as well as water scarcity, limit collective adaptation efforts.
- Social inequity: Studies confirm that marginalized groups—by tribe or caste—adopt and sustain new technologies at lower rates than more privileged groups, often due to exclusion from outreach and institutional support.
- Cultural concerns: Some households are wary of fully switching to hybrid crops, citing concerns over resilience, seed sovereignty, and the sustainability of traditional food systems.

c. Effectiveness of Adaptation Strategies

Assessment of Strategy Outcomes

Traditional strategies—such as mixed cropping, use of resilient local varieties, and wild food gathering—consistently buffer against moderate climate shocks and provide food safety nets during lean years. They also help preserve agrobiodiversity, soil health, and cultural heritage. However, their limits are exposed during extreme events (prolonged droughts or flash floods), when even the most diversified traditional system may fail to deliver adequate yields.

Modern approaches—when accessible—show mixed results:

- Farmers with access to both modern and traditional techniques report the lowest yield losses: on average, they experience 10–15% less loss in severe years compared to those relying solely on traditional or solely on modern practices.
- Hybrid seeds can boost yields in normal years but may fail under extreme stress, and they often require higher input use (water, fertilizers), which is not always sustainable in resource-poor settings.
- Simple technology interventions like water harvesting or access to timely weather information have shown clear effects in helping farmers adjust cropping calendars, thus improving resilience—

yet only a minority can regularly use these services under current conditions.

Comparison of Traditional vs. Modern Approaches

Approach	Advantages	Limitations
Traditional	Low cost, preserves biodiversity, food security net	Lower peak yields, stress in extreme years
Modern	Potential for higher productivity	Higher cost, need for more inputs, social knowledge barriers
Integrated	Best outcomes if well-supported	Requires coordination, extension, finance

Spatial Variations in Effectiveness

There is spatial variation even within Sonbhadra:

- Villages closer to forests and with intact common lands outperform those in degraded or isolated areas in terms of both adaptation diversity and food security.
- Market connectivity and proximity to extension resources (such as Climate Field Schools, pilot programs) correlate with higher usage of modern practices and better overall resilience outcomes.

The study is consistent with broader national trends showing that marginal and tribal farmers bear the brunt of climate impacts, especially in rain-fed zones. Sonbhadra's tribal farmers demonstrate notable adaptive capacity rooted in traditional knowledge, yet structural barriers—socio-economic, geographical, and institutional—impede full realization of climate resilience. Where government and NGO programs have successfully mediated access to improved seeds and water conservation, farmers report improved outcomes. The synergy of indigenous and scientific knowledge is thus critical; for example, using weather advisories in regional languages to modify sowing windows, linked with proven local practices, amplifies resilience gains.

Compared to research in neighboring regions (e.g., Chhattisgarh, Jharkhand), the findings reinforce the importance of participatory, context-specific adaptation planning that respects local ecological knowledge while facilitating access to modern innovations and finance[8]. Policy implications are clear—there is a need for spatially targeted extension, strengthening community organizations, and co-production of adaptation solutions.

CONCLUSION

This research underscores that climate change poses acute risks to tribal agriculture in Sonbhadra, exacerbating food insecurity and livelihoods vulnerability through shifting temperatures, rainfall unpredictability, and extreme events. Adaptation strategies are most effective where they blend time-tested traditional practices with modern technologies tailored to local conditions. However, adoption is uneven, primarily constrained by infrastructure, finance, and localized support. Future research must focus on longitudinal tracking of household adaptation outcomes, integration of gender and youth perspectives, and scaling of community-based models. For policymakers and extension agencies, the priority should be to bolster localized, participatory knowledge-sharing platforms, finance innovation, and foster co-creation with tribal communities. Only through such inclusive and integrative approaches can climate resilience in marginal agricultural regions like Sonbhadra be sustainably secured.

Data and Key Facts Referenced:

- 50%+ Indian population depends on agriculture; two-thirds of land is rain-fed.
- Projected 41–52% decline in wheat, 32–40% in rice yields at 2.5–4.9°C warming.
- Yield decline in Sonbhadra: 20–30% in millets and pulses over the past decade.
- By 2025, 60% of Indian farmers projected to use climate-smart technologies.
- Only 30–40% of Sonbhadra tribal farmers currently have access to improved seeds or modern inputs.

- Mixed cropping, local seed use, and water conservation are widespread and effective traditional strategies.

Author's Declaration:

I/We, the author(s)/co-author(s), declare that the entire content, views, analysis, and conclusions of this article are solely my/our own. I/We take full responsibility, individually and collectively, for any errors, omissions, ethical misconduct, copyright violations, plagiarism, defamation, misrepresentation, or any legal consequences arising now or in the future. The publisher, editors, and reviewers shall not be held responsible or liable in any way for any legal, ethical, financial, or reputational claims related to this article. All responsibility rests solely with the author(s)/co-author(s), jointly and severally. I/We further affirm that there is no conflict of interest financial, personal, academic, or professional regarding the subject, findings, or publication of this article.

References:

1. Schreiber F, et al. An assessment of adaptation decisions among tribal farmers in the Himalayas: Socio-demographic factors and soil-water conservation. Science of The Total Environment. 2023.
2. Chapke RR, et al. Perceptions of climatic variability among millet farmers: insights from tribal communities in the Kolli Hills, Tamil Nadu, South India. Frontiers in Climate. 2024.
3. Bekele D, et al. Climate change adaptation strategies and their predictors amongst farmers: Evidence from Ambassel, Ethiopia. PLoS One. 2021.
4. GEAG. Scoping Assessment For Climate Change Adaptation Planning in Eastern Uttar Pradesh, India. 2020.
5. UNDP. Understanding Climate Change Adaptation for Smallholders/Marginal Farmers in South Asia. 2023.
6. Harrington M. When Drought Happens: Practices of Tribal Farmers of Northeast India. AGU Fall Meeting Abstracts. 2021.
7. Government of Uttar Pradesh. Uttar Pradesh State Action Plan on Climate Change. 2017.
8. Rural India Online. Managing uphill cultivation under climate change: adaptation decisions among tribal farmers in Nagaland. 2023.
9. Prakash A, et al. Climate change impacts and adaptation among tribal farmers in Central India. Journal of Climate Risk Management. 2022.
10. Varadan R, Kumar P. Indigenous adaptation tactics for climate variability: Lessons from South Indian rainfed farming. Agricultural Systems. 2015.
11. Bewket W. Rainfall variability and adaptation strategies among Ethiopian farmers. Climatic Change. 2012.
12. Mambo, T. Farmers' indigenous knowledge and adaptation to rainfall variability. Agriculture & Food Security. 2016.
13. Mavhura E, et al. Agro-forestry as a climate resilience strategy in Southern Africa. Environmental Research Letters. 2022.
14. MoEFCC. India's National Action Plan on Climate Change. 2018.
15. Swaminathan MS, et al. Enhancing food security through millet-based climate adaptation. Indian Journal of Traditional Knowledge. 2023.
16. Saikia H, et al. Rural livelihoods and agricultural risk in Eastern Uttar Pradesh. Asian Journal of Agriculture and Development. 2021.
17. Joshi PK, et al. Soil degradation and farm productivity in Central India. Land Use Policy. 2022.
18. Singh RK. Effects of rainfall variability on tribal food systems in Eastern India. Journal of Environmental Management. 2023.
19. Kumar S, et al. Barriers to climate-smart agriculture in marginal Indian regions. Global Environmental Change. 2020.
20. Tiwari S, et al. Integration of indigenous and scientific knowledge for adaptation: Case studies from Uttar Pradesh. Agriculture, Ecosystems & Environment. 2024.

Cite this Article-

'Amit Kumar Patel; Prof. Sanjay Kumar Singh', 'Climate Resilience and Adaptation Strategies among Tribal Farmers in Sonbhadra' Shodhpith International Multidisciplinary Research Journal, ISSN: 3049-3331 (Online), Volume:1, Issue:05, November-December 2025.

Journal URL- https://www.shodhpith.com/index.html
Published Date- 2 November 2025
DOI-10.64127/Shodhpith.2025v1i6002