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Climate Change Through Farmers' Eyes: Insights from Villages in Gwalior District, Madhya Pradesh

Niranjan Dev Bharadwaj[1], Ravi Yadav[2], Prof. Ashok Kumar[3]

[1]*Researcher and Advisor, Global Foundation for Advancement of Environment and Human Wellness, Gwalior (Madhya Pradesh, India)*

[2]*Communications Head, Global Foundation for Advancement of Environment and Human Wellness, Gwalior (Madhya Pradesh, India)*

[3]*Founder and Chairman, Global Foundation for Advancement of Environment and Human Wellness, Gwalior (Madhya Pradesh, India)*

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Abstract:

Climate change is increasingly influencing rural life and agricultural stability across India, and Gwalior district in Madhya Pradesh is no exception. Farmers here depend heavily on climate-sensitive resources, making even small environmental shifts noticeable in their day-to-day work. This study focuses on ten villages in the district and explores how farmers interpret the ongoing changes in weather, how these shifts are affecting their crops, and what practical measures they are adopting to cope. A purposive sample of 100 farmers was selected to capture a mix of age groups, landholding patterns, and socio-economic backgrounds, giving a clearer picture of the diversity within the community.

The analysis is supported by established research on climate science and adaptation (United Nations, 2023; Alley et al., 1999; Stern et al., 2013; IPCC, 2023; Kurukulasuriya & Rosenthal, 2003; Stocker et al., 2013; Habtemariam et al., 2017; Antronico et al., 2020; Masud et al., 2015; Funatsu et al., 2019), helping position local experiences within broader climate debates. Farmers across the surveyed villages reported noticeable irregularities in rainfall, more intense dry periods, shifting temperature patterns, and declining crop performance. Although they recognise these trends, their coping strategies tend to rely on traditional knowledge and are often constrained by financial conditions, limited irrigation options, and uneven institutional support.

The findings offer a grounded understanding of how rural communities in Gwalior district perceive and navigate climate-related challenges. The study highlights the need for targeted awareness efforts, improved local planning, and stronger policy support to enhance resilience. The recommendations, aligned with the vision of the Global Foundation for Advancement of Environment and Human Wellness, emphasise community-led and environmentally responsible pathways for strengthening long-term sustainability in rural Madhya Pradesh.

Keywords: *Climate Change; Farmers' Perception; Gwalior; Climate Adaptation; Agriculture; Livelihood Vulnerability; Environmental Awareness; Community Resilience.*

1. Introduction:

Scientific evidence over the past several decades shows that climate systems do not behave in a fixed or predictable manner. Research by Alley et al. (1999) demonstrates that the Earth has undergone abrupt shifts between different climate modes in the past, and many of these transitions may now be influenced or accelerated by human activity. These rapid changes, combined with the long-term warming trend documented by the United Nations (2023), have brought agriculture-dependent regions to the forefront of climate vulnerability.

The IPCC (Climate Change 2023 Synthesis Report, n.d.) warns that climate change is already causing wide-ranging social and economic losses, particularly in sectors like agriculture, forestry, energy, and food security. These impacts are unevenly distributed, and rural populations—especially women and smallholder farmers—face disproportionate risks. With agriculture being extremely sensitive to rainfall, temperature, and seasonal balance, any shift in climatic behaviour directly affects production cycles and household livelihoods.

Understanding the nature of these shifts requires attention to multiple climate dimensions. While rising temperatures are often the most visible marker of climate change, Stocker et al. (2013) emphasize that rainfall variability, atmospheric changes, and extreme events are equally significant indicators. These factors collectively shape how farmers interpret climatic changes and decide their next steps. Insights by Funatsu et al. (2019) show that references to unusual climate behaviour are becoming more common among the general public, signifying a slow rise in climate awareness.

In rural agricultural regions like Gwalior district, Madhya Pradesh, farmers depend heavily on monsoon patterns and local water availability. As noted by Kurukulasuriya and Rosenthal (2003), long-term changes in precipitation and the increased frequency of extreme events place additional stress on agricultural productivity. Climate-related disruptions—such as delayed monsoons, shorter growing seasons, or unexpected temperature extremes—are already visible in many farming communities across central India.

These climatic pressures have wider socio-economic consequences. Studies by FAO (2015) highlight that climate change restricts access to food, reduces incomes for small-scale food producers, and can push rural families deeper into poverty. In the Indian context, Pailler and Tsaneva (2018) note that the negative impacts on rural livelihoods are expected to intensify further, particularly for small and marginal farmers who have limited financial buffers or irrigation facilities. The consequences are not only economic. Mestre-Sanchís et al. (2009) point out that climate variability reduces land suitability for cultivation and affects employment in the agricultural sector, thereby weakening the social fabric of rural communities. The severity of these impacts, however, differs across regions. According to Habtemariam et al. (2017), the effects of climate change toward 2030 will be uneven, shaped by agro-ecological conditions and existing socio-economic disparities.

Since perception strongly influences adaptation, understanding how communities interpret climate change is essential. Masud et al. (2015) found that higher awareness and knowledge levels positively shape attitudes towards adaptation. At the same time, Antronico et al. (2020) highlight that people's understanding of climate risks is influenced by factors such as education, local experiences, institutional support, and socio-cultural context.

Against this larger backdrop of climatic and socio-economic stress, the present study investigates how farmers in five villages of Gwalior district—Antri, Bahadurpur, Panihar, Ghatigaon and Utilaperceive climate change and respond to its impacts. These villages represent a mix of semi-arid landscapes, rain-fed farming systems, and diverse agricultural practices, making them an important micro-region for understanding climate vulnerability in central India.

The research, carried out by theGlobal Foundation for Advancement of Environment and Human Wellness, adopted a purposive sampling strategy to select 100 farmers from across the five villages. The sample includes farmers of different ages, gender groups, landholding categories, and socio-economic backgrounds. This diversity allows the study to capture variations in climate perception, adaptive capacity, and lived experiences across different community segments in Gwalior district.

By examining farmers' observations, their interpretation of climate signals, and their practical adaptation choices, the study aims to contribute new insights to the broader conversation on rural climate resilience in India. In doing so, it highlights that climate action must be grounded not only in scientific models and national policies but also in the everyday realities and strategies of communities who directly experience the consequences of changing weather patterns.

2. Methodology:

This study followed a field-based, cross-sectional design to understand how farmers in Gwalior district perceive climate change and respond to its impacts. Data were collected during February 2025 across five selected villages: Antri, Bahadurpur, Panihar, Ghatigaon and Utila. These villages were chosen because they represent different agricultural conditions, levels of water availability, and socio-economic settings within the district.

A mixed-methods approach was used to capture both measurable patterns and lived experiences. The quantitative component consisted of a structured survey designed to document farmers' demographic profiles, landholding characteristics, farming practices, and observations of rainfall, temperature, and seasonal changes. Alongside this, qualitative insights were gathered through informal discussions and open-ended questions that allowed farmers to describe changes they had noticed in their environment and the strategies they used to cope.

A purposive sample of 100 farmers (20 from each village) was selected to ensure variation across age groups, gender, land sizes, education levels, and income categories. This sampling

strategy enabled the study to reflect the diversity of agricultural households in the area and understand how different experiences shape climate perception.

All data were collected directly from the field through household visits. Responses were manually recorded, checked for consistency, and then classified into thematic categories such as awareness, perception of climate events, adaptation practices, and barriers to adaptation. This combination of quantitative and qualitative data provided a broader picture of how climate change is understood and managed at the community level in rural Gwalior.

2.1. Study Area and Sampling:

The study was conducted across five villages in Gwalior district: Antri, Bahadurpur, Panihar, Ghatigaon and Utila. These villages lie within the semi-arid landscape of northern Madhya Pradesh, a region known for its high vulnerability to climatic stress. Irregular rainfall, rising temperatures, declining groundwater availability, and frequent dry spells have made agriculture increasingly uncertain for small and marginal farmers.

The geographic coordinates of the selected villages are as follows:

- Antri: 26.06° N, 78.21° W
- Bahadurpur: 26.34° N, 78.33° W
- Panihar: 26.10° N, 78.03° W
- Ghatigaon: 26.07° N, 77.96° W
- Utila: 26.16° N, 78.33° W

These locations were selected because they reflect a range of agricultural and environmental conditions—varying groundwater levels, soil types, access to irrigation, and socio-economic characteristics—which together offer a comprehensive picture of climate sensitivity in rural Gwalior. From each village, 20 farmers were purposively selected, resulting in a total sample of 100 respondents. The sampling aimed to include farmers with different landholding sizes, age groups, educational backgrounds, and economic conditions. This heterogeneity allowed the study to capture diverse experiences and understand how local factors shape climate change awareness, perceived risks, and adaptive responses.

2.2 Data Collection:

Data were collected during field visits in February 2025 using two complementary tools: a structured questionnaire and informal conversations with farmers. The questionnaire generated quantitative information, while the discussions helped capture individual experiences and locally rooted knowledge.

The key areas covered in the data collection included:

- Awareness and understanding of climate variability, especially changes in rainfall, temperature, and seasonal patterns.

- Educational background, including literacy, years of schooling, and any exposure to agricultural extension services or climate-related training.
- Demographic characteristics, such as age and gender of respondents.
- Socio-economic features, including size of landholdings, main and secondary income sources, access to irrigation, and dependence on rainfed farming.
- Observed environmental changes, such as shifts in monsoon timing, prolonged dry spells, increased pest attacks, and changes in crop productivity.
- Adaptive responses, ranging from adjustments in crop choices and sowing time to water management practices and traditional coping mechanisms.

Participation was voluntary, and farmers were clearly informed about the purpose of the study before any data were collected. Ethical guidelines were followed throughout the fieldwork. Due to prevailing social norms in rural Gwalior, women's participation remained limited, and they accounted for roughly 12% of the total respondents. Efforts were made to create a respectful and comfortable atmosphere, especially during interactions with female participants.

2.3 Data Analysis:

The collected quantitative data were organized and examined using basic descriptive tools such as percentages, frequency distributions, and village-wise comparisons. These measures helped identify patterns in awareness, education, socio-economic status, and the range of adaptation practices adopted by farmers across the five villages.

Qualitative insights from informal discussions were reviewed to understand farmers' reasoning, perceptions of risk, and the challenges they face in adjusting to changing climatic conditions. These narratives helped explain why certain adaptations were preferred while others were avoided, and how local experience shaped climate-related decision-making.

Cross-sectional comparisons were conducted to explore how variables such as literacy, age, gender, land size, and income relate to climate awareness and adaptive behavior. This combination of numerical data and descriptive insights allowed for a more balanced interpretation of farmers' responses.

By using a mixed-methods approach grounded in field realities, the study provides a clear and comprehensive understanding of the factors influencing climate perception and adaptation among farming communities in Gwalior district, Madhya Pradesh.

3. Education, Demography, and Climate Change Perception:

Education, age, and gender remain central in shaping how farmers understand climate change and respond to its impacts. In the five surveyed villages of Gwalior district—Antri, Bahadurpur, Panihar, Ghatigaon, and Utila—these factors interacted with farmers' lived experiences, access to information, and socio-economic conditions. Together, they produced clear differences in awareness

levels, understanding of climate-related risks, and the ability to adopt adaptive measures.

3.1 Village-wise Summary:

The table below summarises key demographic and perception-based indicators from the 100 surveyed farmers (20 from each village).

Table 1: Education, Demography, and Perception Indicators Across Five Villages

Indicator	Antri	Bahadurpur	Panihar	Ghatigaon	Utila	Overall Trend
Male farmers	18	17	18	18	17	88%
Female farmers	2	3	2	2	3	12%
Literate farmers (all genders)	5	4	6	5	5	25%
Illiterate farmers	15	16	14	15	15	75%
Avg. years of schooling (literate only)	5	6	7	6	5	5–7 years
Young adults (<30 yrs)	4	5	4	5	4	22%
Middle-aged (30–60 yrs)	10	9	11	9	10	49%
Older adults (>60 yrs)	6	6	5	6	6	29%
Heard of climate change	4	5	5	4	5	23%
Understand climate change	3	3	4	3	3	16%
Observed changes in rainfall/temp/pests	17	18	17	18	18	88%
Livelihood affected by these changes	18	17	18	17	18	88%
Taking adaptive measures	5	4	6	4	5	24%
Source of information (TV, radio, peers, training)	4	3	4	3	4	18%

3.2 Analysis: Intersections and Cross-Sectional Insights:

The patterns emerging from the five surveyed villages—Antri, Bahadurpur, Panihar, Ghatigaon, and Utila—show that education, age, gender, and socio-economic conditions strongly influence how farmers understand and respond to climate change. Although all households depend directly on agriculture, their awareness and adaptive choices differ based on their background and access to information.

A consistent trend across villages is the low female participation in climate-related discussions. With only 12% of the respondents being women, the study highlights the continuing influence of patriarchal norms in rural Gwalior. Women engage actively in agricultural labour, yet their exclusion from decision-making limits their role in climate-responsive practices.

Literacy levels remain low, with only 25% of respondents having any formal education. This limited educational exposure directly affects their ability to understand climate variability in scientific terms. Farmers who had completed basic schooling—mainly in Panihar and Antri—showed relatively higher awareness of climate change and were also more likely to adopt small adaptive measures. This indicates that even minimal education can improve climate understanding and action.

Age also played a clear role. Middle-aged farmers (30–60 years) formed the largest group (49%), and they displayed the strongest experiential knowledge of changing weather patterns. Older farmers recognised long-term shifts in rainfall and temperature but were less inclined toward adopting new practices. Younger farmers, although more open to adaptation, often lacked land ownership and decision-making power.

The data further show that while almost 88% of farmers observed changes in rainfall, heat, and pests, only 16% truly understood the concept of climate change. This gap between observation and understanding is shaped by limited access to reliable information. When asked about sources of knowledge, only 18% mentioned TV, radio, peers, or past agricultural training. Most farmers rely on personal experience rather than scientific or institutional guidance.

Adaptive measures—such as adjusting sowing dates, changing crop varieties, and increasing irrigation use—were adopted by only 24% of respondents. The reasons commonly reported during field visits included lack of water, inadequate financial resources, and uncertainty about which practices would genuinely help. Villages like Panihar, which had more literate farmers, showed slightly better adoption rates, reinforcing the link between education and adaptive capacity.

Overall, the cross-sectional insights highlight a clear pattern: farmers are aware of environmental changes, but limited education, restricted access to information, and socio-economic constraints weaken their ability to interpret these changes as "climate change" and respond effectively. Strengthening awareness programmes, expanding agricultural extension services, and improving communication channels in rural Gwalior can significantly enhance the region's climate resilience.

4. Socio-Economic Factors:

Socio-economic conditions strongly influence how farmers experience climate stress and shape the options available for adaptation. In rural Gwalior, livelihood security depends heavily on household income, size of landholdings, availability of irrigation, and access to secondary income sources. These variables determine the extent to which a household can absorb climatic shocks or invest in new farming strategies. Understanding this socio-economic background helps explain the differences in climate awareness and adaptation seen across the five surveyed villages.

4.1 Indicators Used:

To assess the socio-economic status of farmers, the study examined four key indicators:

- Household income levels: Categorised as low, medium, and high based on monthly agricultural and non-agricultural earnings.
- Landholding size: Categorised into marginal (<1 ha), small (1–2 ha), medium (2–4 ha), and large (>4 ha).
- Access to irrigation: Whether the farmer had reliable access to canal water, tube wells, ponds, or other sources.
- Occupational diversity: Presence of secondary income sources such as labour work, dairy, small trade, or seasonal migration.

These indicators were chosen because they directly influence a household's adaptive capacity, investment decisions, and overall resilience to climate variability.

4.2 Village-wise Observations:

Socio-Economic Conditions Across the Five Villages (Sample: 20 Farmers per Village)

Socio-Economic Variable	Antri	Bahadurpur	Panihar	Ghatigaon	Utila	Overall Trend
Low-income households	7/20	8/20	9/20	8/20	7/20	39%
Medium-income households	10/20	10/20	9/20	10/20	11/20	50%
High-income households	3/20	2/20	2/20	2/20	2/20	11%
Marginal landholders	10/20	9/20	11/20	10/20	9/20	49%
Small landholders	5/20	5/20	4/20	5/20	6/20	25%
Medium landholders	4/20	4/20	3/20	4/20	4/20	19%
Large landholders	1/20	2/20	2/20	1/20	1/20	5%
Access to irrigation	12/20	11/20	10/20	11/20	12/20	56%
Secondary income sources	6/20	5/20	4/20	5/20	6/20	26%

4.3 Interpretation of Socio-Economic Patterns:

The distribution of income and landholding sizes shows that most households fall into low or medium income categories, with very few high-income families. This limits their capacity to invest in irrigation, new seeds, or machinery—factors essential for climate adaptation.

A significant share of the sample (49%) are marginal landholders, which reflects the fragmented land ownership pattern common in the region. These farmers are particularly vulnerable because small plots offer fewer opportunities for crop diversification and generate lower returns.

About 56% of respondents reported access to irrigation, though the reliability and continuity of water supply varied. Villages closer to canal networks, such as Antri and Utila, had slightly better

access compared to Panihar.

Secondary income sources were present in one-fourth of households, mostly through wage labour, dairy activities, or seasonal migration. These additional income streams served as important buffers during years of poor rainfall, but they were irregular and not enough to offset major agricultural losses.

Overall, the socio-economic profile of the surveyed villages reveals a largely resource-constrained farming population. These constraints significantly shape how farmers perceive climate risks and determine the types of adaptive responses they can realistically adopt.

5. Conclusion:

The findings from the five villages of Gwalior district—Antri, Bahadurpur, Panihar, Ghatigaon, and Utila—reveal that climate change perception among farmers is shaped through a deep interplay of educational levels, demographic realities, and socio-economic conditions. Together, these factors create a layered understanding of how communities interpret environmental changes and respond to them.

From the education and demographic analysis, a consistent pattern emerges: low levels of formal schooling, a predominantly male farming population, and the dominance of middle-aged and elderly farmers influence how climate-related knowledge is interpreted. While most farmers physically observe shifts in rainfall, temperature, and pest patterns, only a fraction recognize these as elements of broader climate change. Limited conceptual understanding—but high experiential awareness—indicates that farmers rely more on observation-based knowledge than on scientific or institutional inputs.

Socio-economic findings further illuminate these patterns. Most surveyed farmers fall into low- or medium-income households, hold marginal or small landholdings, and depend on irregular irrigation access. These constraints reduce their adaptive flexibility, even when they are fully aware of climatic shifts affecting their crops. Moreover, households with limited land and income are less able to invest in adaptation strategies such as improved irrigation, heat-tolerant seeds, diversified livelihoods, or soil-management practices.

When viewed together, these dimensions highlight a powerful insight of this research: Climate change perception is not merely a function of knowledge—it is the product of lived experience interacting with structural socio-economic realities. Even when farmers understand environmental changes, their adaptive responses are restricted by economic capability, land resources, and access to reliable information systems.

This integrated perspective distinguishes the present study. By merging educational-demographic analysis with socio-economic profiling, the research demonstrates that effective climate adaptation policies must address knowledge gaps and resource limitations simultaneously.

Strengthening agricultural extension networks, improving accessibility to climate-resilient technologies, and enhancing rural education—formal and informal—are crucial steps.

Ultimately, the study underscores that farmers in Gwalior have the observational insight and willingness to adapt, but their efforts can only be successful when supported by targeted, context-specific interventions that bridge both informational and socio-economic divides.

6. Recommendations:

Based on the combined insights from educational, demographic, and socio-economic patterns observed across the five surveyed villages in Gwalior district, a set of targeted recommendations is proposed by theGlobal Foundation for Advancement of Environment and Human Wellness. Strengthening climate literacy must be a priority, and this can be achieved by establishing community-based learning platforms such as Village Climate Schools, where farmers receive simple, practical, and locally relevant knowledge on rainfall patterns, soil health, cropping strategies, and adaptation techniques. These efforts should be supported by localized climate information networks, including Climate Information Corners in panchayat offices and village-level WhatsApp groups for real-time weather alerts and advisory dissemination. Given the economic vulnerability of many households, the Foundation recommends expanding low-cost adaptation tools such as community-managed drip irrigation, rainwater harvesting structures, mulching practices, and the introduction of drought-tolerant crop varieties suited to the semi-arid conditions of Gwalior. Parallel to these efforts, livelihood diversification must be encouraged through eco-livelihood initiatives such as beekeeping, nursery raising, agroforestry, and climate-linked microenterprises, especially for women's self-help groups, to enhance resilience and reduce dependence on climate-sensitive agriculture.

Institutional support is equally critical, and the Global Foundation advocates for climate-resilient village action plans designed jointly by panchayats, youth groups, and local organizations, alongside the strengthening of rural infrastructure such as farm ponds, check dams, and green buffer zones. In line with the Foundation's core philosophy, there is also a need to promote an ecological mindset rooted in collective responsibility, encouraging village-wide efforts such as water conservation campaigns, plastic-free initiatives, and tree-planting drives that reinforce the principle of "living lightly with nature." Finally, the Global Foundation for Advancement of Environment and Human Wellnessproposes the development of a Model Village within Gwalior district. This pilot site would integrate climate literacy, soil regeneration, green livelihoods, women's leadership, clean energy initiatives, and biodiversity conservation, becoming a replicable example for surrounding villages and enabling a broader, sustainable transformation across the region.

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