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Spatial Variation of Gender-Sensitive Adaptation Strategies to Climate Change in Western Uttar Pradesh & Western Bihar- A Household-Level Analysis

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Abstract

In recent years, climate change has posed a serious threat to us. Women experience climate variability differently and have varying adaptive capacities to the risks it poses. Therefore, this study examines different gender-sensitive adaptation strategies to tackle the severe effects of climate change in two agrarian regions of North India: Western Uttar Pradesh and Western Bihar. Drawing on primary data collected from 1,600 households across 64 villages, the findings reveal that women's participation in adaptation initiatives remains limited despite policy interventions such as the Mahila Kisan Sashaktikaran Yojana and Self-Help Group-linked credit schemes. Despite some progress in adaptation strategies in terms of access to credits, cooperatives, and Community-Based Resource Management (CBRM), the majority of respondents viewed these strategies as ineffective, citing insufficient training, weak institutional coordination, and limited community engagement. The study concludes that current strategies suffer from a disconnect between policy intentions and lived realities, necessitating a shift toward more inclusive, context-specific execution to ensure equitable climate resilience.

Keywords: Gender-Sensitive Adaptation; Climate Change; Rural India; Women Empowerment; Adaptation Strategies

1. Introduction

In recent years, climate change has posed a serious threat to us by creating numerous challenges that affect agricultural productivity and livelihoods. It imposes substantial impacts on ecological systems, economic structures, and social well-being (Adger, 2010; Grimm et al., 2013). India, with its extensive geographical diversity and heavy reliance on monsoon-driven agriculture, is among the most vulnerable countries to climate change (Rahaman & Ansari, 2025). Regions such as Western Uttar Pradesh and Western Bihar in North India are experiencing severe effects, with erratic rainfall, droughts, and floods becoming constant challenges to farming and daily survival (Aggarwal, 2003; Kalra et al., 2007; Pathak, 2023).

However, these environmental shifts don't affect everyone in the same way. Gender fundamentally dictates how women and men experience climate variability differently and have varying adaptive capacities to the risks it poses (Singh et al., 2021). There is a deep-seated gender gap in how this crisis is felt; women in rural and marginalized communities often carry the heaviest burden (IPCC, 2021). This is due to social and economic hurdles, such as local cultural norms, limited access to essential resources like land and credit, and a lack of representation at the decision-making table, which make it much harder for them to adapt to a changing climate (Agarwal, 2010).

Adaptation strategies to climate change are not only about protecting communities from environmental risks but also about creating new avenues for sustainable employment. Gender-sensitive adaptation strategies can be defined as those that involve preparedness and response to the risks and vulnerabilities of natural disasters or the physical environment due to climate change, viewed through a gender perspective lens (IPCC, 2014). These strategies are not only about targeting women for preparedness and management processes, but also about identifying women's distinct capacities and knowledge regarding climate vulnerabilities. In order to enhance the sustainability and equity of climate responses, women should have access to financial and technical training and participate in governance and cooperatives (Kaaria et al., 2016).

Evidence suggests that women are affected severely compared to men, particularly in agricultural and low-income settings (Sorensen et al., 2018; Singh et al., 2021; Nelson et al., 2022). They experience unique vulnerabilities because of their roles in food production, caregiving, and managing natural resources. Therefore, Gender-sensitive adaptation strategies are necessary to transform existing gender inequalities and promote strategies and initiatives for equitable and inclusive resilience (Adger et al., 2000; Huyer et al., 2021).

This study aims to identify and assess gender-sensitive adaptation strategies at the household level in two regions of northern India: Western Uttar Pradesh and Western Bihar, with the goal of addressing climate change impacts and enhancing community resilience and sustainability.

2. Conceptual Approach

Climate change is undoubtedly a defining challenge of the 21st century, with profound socio-economic and environmental consequences worldwide (IPCC, 2023). While climate change affects all sectors of society, its impacts are not distributed equally; rather, marginalized groups and women face sensitive vulnerabilities due to socio-economic and structural inequities (Dankelman, 2010; UN Women, 2021). Gender is critical in determining resilience and adaptive capacity, particularly in developing countries where traditional social structures limit women's access to resources and decision-making processes (Carr & Thompson, 2014; Pearse, 2016; Singh et al., 2021).

Women in rural and agrarian economies, particularly in South Asia, are excessively affected by climate variability due to gender-based labor division and socio-economic constraints (Kabeer, 2019). The unequal distribution of adaptive resources, including technology, financial services, and land rights, significantly affects their ability to cope with climate-related risks (Denton, 2002; Kaijser & Kronsell, 2014). They play a pivotal role in climate-resilient agriculture, particularly in the rural economies of northern India, where they comprise a substantial portion of the agricultural labor force. Thus, the

feminization of agriculture has been observed in many regions, particularly in Western Bihar, where men migrate to urban areas in search of alternative employment, leaving women responsible for both household and farm management (Agarwal, 2018; FAO, 2023).

The study of various gender-sensitive adaptation strategies and their effectiveness is crucial for understanding the actual progress made in addressing climate change impacts. The existing literature indicates that substantial progress has been made in understanding gender-sensitive adaptation strategies across various states in India. However, important gaps still exist in adopting a comparative regional perspective. Moreover, most studies rely on secondary data, with limited household-level primary surveys capturing the differing responses of men and women to climate stress. Therefore, this study fills these gaps by conducting primary fieldwork in Western Uttar Pradesh and Western Bihar, providing comparative evidence on gendered adaptations, their effectiveness, and the implementation challenges they pose.

3. Study Area

The study was conducted in two broad regions of North India, Western Uttar Pradesh and Western Bihar, for a comparative analysis of gender-sensitive adaptation strategies. The region, Western Uttar Pradesh, is situated in the north-western portion of the Indian state of Uttar Pradesh, lying between 26°44'32" and 30°24'22" North latitudes and 77°05'03" and 80°26'57" East longitudes (Census of India). The region covers 71,231 sq. km, accounting for 29.28 per cent of Uttar Pradesh's total geographical area (Census of India, 2011). Western Bihar region is situated in the western part of the state of Bihar and lies between 24°20'10" N to 27°31'15" N latitudes and 83°19'50" E to 86°43'21" E longitudes (Census of India). The total land area of the region is approximately 63,754 square kilometers, constituting 64.43 per cent of the total geographical area of Bihar.

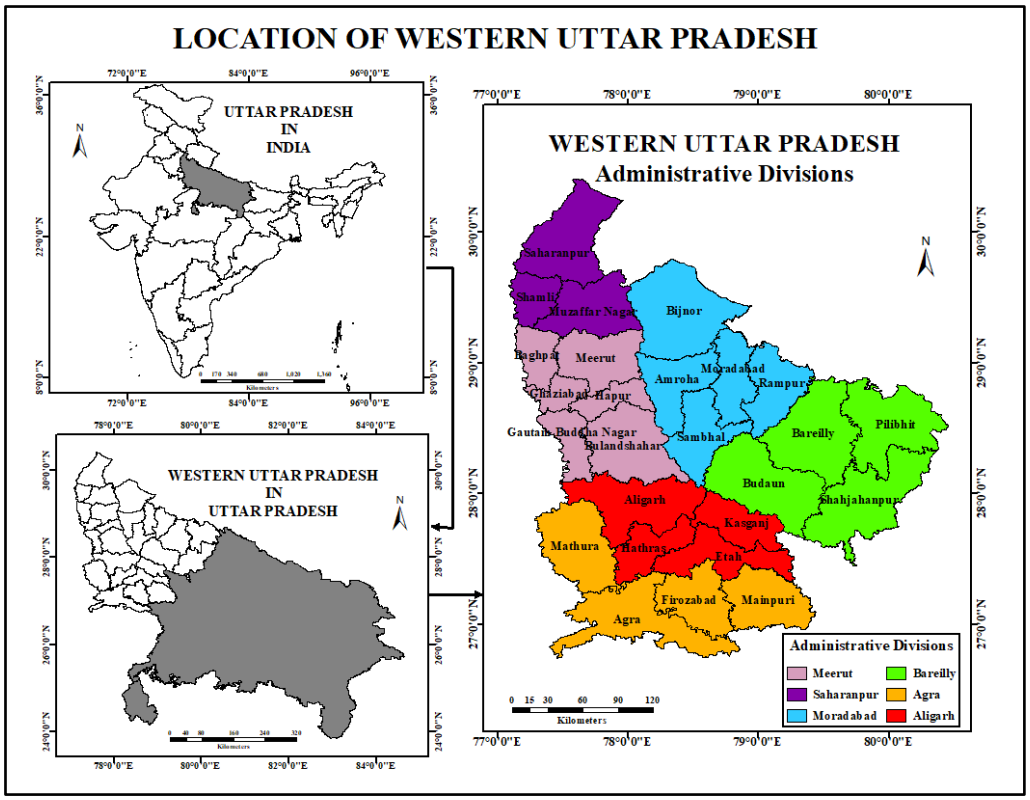

Figure 1: Locational Map of Western Uttar Pradesh
Source: Base map obtained from Survey of India, 2025

One of the major concerns that Western Bihar is facing is the male-dominant out-migration. This phenomenon forces women to be inclusively engaged in agriculture and household work, which

limits their ability to explore and participate in different sectors of employment. In western Uttar Pradesh, the scenario is different. Although the out-migration of the population is male-dominated here, the women are progressing more compared to Western Bihar. Women are gradually advancing towards participation in secondary and tertiary activities due to the proximity to major important cities such as Delhi, Meerut, Ghaziabad, Moradabad, etc., more urbanization, and a higher female literacy rate. In this context, this comparative study on gender-sensitive adaptation strategies assumes special significance.

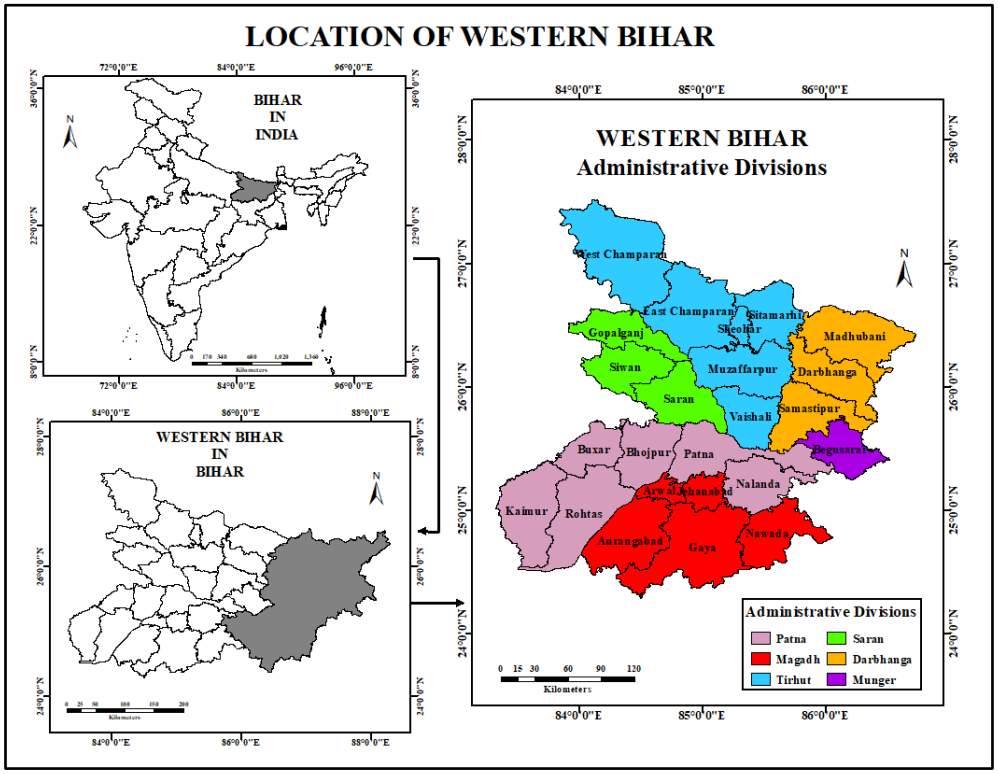

Figure 2: Locational Map of Western Bihar
Source: Base map obtained from Survey of India, 2025

4. Materials & Methods

4.1 Sampling Technique

This study aims to explore the gendered dimensions of climate change adaptation strategies. Western Uttar Pradesh and Western Bihar were chosen as comparative regions due to their socio-economic vulnerabilities, livelihood structures, agricultural dependence, contrasting climatic conditions, and gendered adaptation capacities. Both regions represent diverse yet comparable agro climatic conditions, cultural practices, and rural livelihood patterns, making them ideal for a micro-level comparative study.

Four districts from each of the two regions were selected to represent a balanced geographical spread and to ensure diversity in economic activities, demographic composition, and infrastructural development. Each district has been purposively selected from different administrative divisions to capture the inter-regional variation. Within each selected district, two blocks were chosen to further refine the representativeness of the study. From each block, four villages were identified, resulting in a total of 64 villages across both regions. The selection of these villages was guided by considerations of accessibility, population density, and socio-economic conditions. Finally, systematic random sampling was employed to select 25 households from each of the 64 villages, leading to a total sample size of 1,600 households. This method was adopted to reduce selection bias and to ensure that every household had an equal chance of being included. This household-level selection ensures that the study is firmly

grounded in the lived experiences of rural communities. The details of these districts, blocks, and villages are represented in Table 1.

Table 1: List of Selected Districts, Blocks, and Villages

Western Uttar Pradesh			Western Bihar		
Districts	**Blocks**	**Villages**	**Districts**	**Blocks**	**Villages**
Agra	Fatehpur Sikri	Sikri Hissa Iv	Buxar	Dumraon	Bhojpur Kadim
		Doora			Bhojpur Jadid
		Uttoo			Mungasi
		Suphaera			Dheka
	Kheragarh	Kagarol		Simri	Simri
		Ayela			Dhakaich
		Pairatia			Raipur Kalan
		Cheetpur			Gop Bharauli
Aligarh	Atrauli	Kazimabad	Siwan	Barharia	Lakri
		Bhavigarh			Kail
		Mohsanabad			Nasir Chhapra
		Sindhaura			Tilbhiriya Khurd
	Khair	Gomat		Darauli	Darauli
		Rajpur			Don Buzurg
		Janhera			Ram Punak
		Manpur Kalan			Karmaul
Moradabad	Munda Pandey	Devapur Mustahkam	Gaya	Gaya Town	Chakand
		Siras Khera			Bitho
		Bikanpur			Ghazipur
		Salempur			Hasanpur
	Chhajlet	Kori Rawana		Imamganj	Malhari
		Akbarpur Chaudhuri			Babhandih
		Shukla Urf Sumla			Kuin Bar
		Jebara			Majra
Muzaffar Nagar	Khatauli	Nawala	Begusarai	Khudabandpur	Phaphot
		Mansoorpur			Meghaul
		Mirapur Khurd			Mohanpur
		Rukanpur			Chak Jaddu
	Muzaffar Nagar	Sujru		Barauni	Ninga
		Nara			Papraur
		Madpur			Ckak Ahmad
		Mirapur			Jamalpur

4.2 Data Collection

In the present study, the primary instrument for collecting data from respondents across the two extensive regions was a structured questionnaire. This questionnaire was carefully designed to ensure uniformity in responses, facilitate comparative analysis across regions, and gather comprehensive information relevant to the objectives of the study. It contains information on climate change awareness, gender roles, and their involvement and participation in climate adaptation strategies, as well as details of the different adaptation strategies adopted by the respondents to cope with the adverse effects of climate change. Data were gathered by a dedicated team comprising researchers, field investigators, and trained assistants. The data collection process was conducted from January to April 2025 across all 64 villages in Western Uttar Pradesh and Western Bihar.

4.3 Data Analysis

The raw data collected from the field were systematically entered into MS Excel and IBM-SPSS spreadsheets for initial organization and verification, and to calculate and run different statistical

tests. Frequency and percentage analysis were employed to examine the distribution patterns of respondents across the selected variables. The use of percentages helped in standardizing data by expressing the number of individuals within each category relative to the total sample size. This approach facilitated clearer comparisons and enabled the identification of trends and variations among different respondent groups.

5. Result and Discussions

5.1 Gender-Sensitive Adaptation Strategies

We have discussed gender-sensitive adaptation strategies for women in Western Uttar Pradesh and Western Bihar, based on primary data collected from sampled households under four major categories: training programs for women in agriculture, access to credit for women entrepreneurs, women-led cooperatives, and community-based resource management. It is important to note that out of the 1600 households surveyed, 1132 members (70.75%) responded to this particular aspect during data collection. The remaining 468 household heads (29.25%) chose not to express their opinion because they lacked information or awareness about the gender-sensitive adaptation strategies. Figure 3 shows that Muzaffar Nagar in Western Uttar Pradesh and Gaya in Western Bihar record the highest percentages of responded households, i.e., 80.50% and 82.00%, respectively.

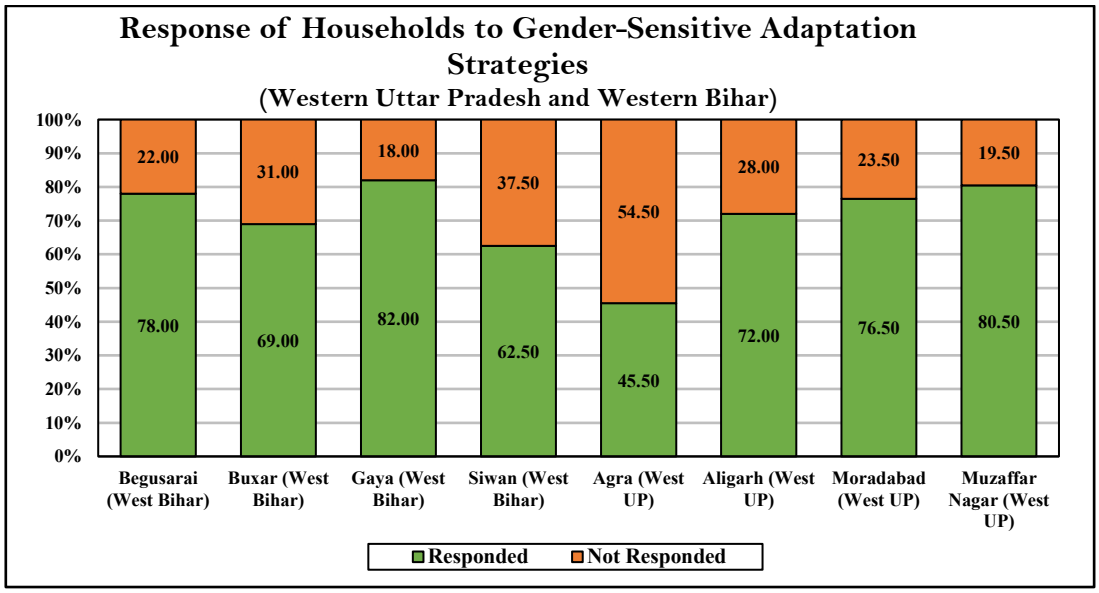

Figure 3: Response of Households to Gender-Sensitive Adaptation Strategies in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

5.1.1 Training Programs for Women in Agriculture: During the field survey, household heads were asked whether any gender-sensitive adaptation strategies were implemented there. At the broader regional level, Western Bihar (17.32 per cent) has a more positive response than Western Uttar Pradesh (11.11 per cent) in at least one training program for women in agriculture. Figure 4 illustrates that in Western Bihar, the Gaya district records the highest positive response, with 25.61 per cent of respondents agreeing to implement a training program for women in agriculture. This is followed by Begusarai (18.59%), Buxar (13.04%), and Siwan (9.60%) lastly. On the other hand, Aligarh district (15.28%) in Western Uttar Pradesh reports the highest concentration of respondents who acknowledge the implementation of gender-sensitive adaptation strategies, specifically in the form of training programs for women in agriculture (Figure 4). The percentage of respondents in Moradabad, Agra, and Muzaffar Nagar is 11.76 per cent, 8.79 per cent, and 8.07 per cent, respectively.

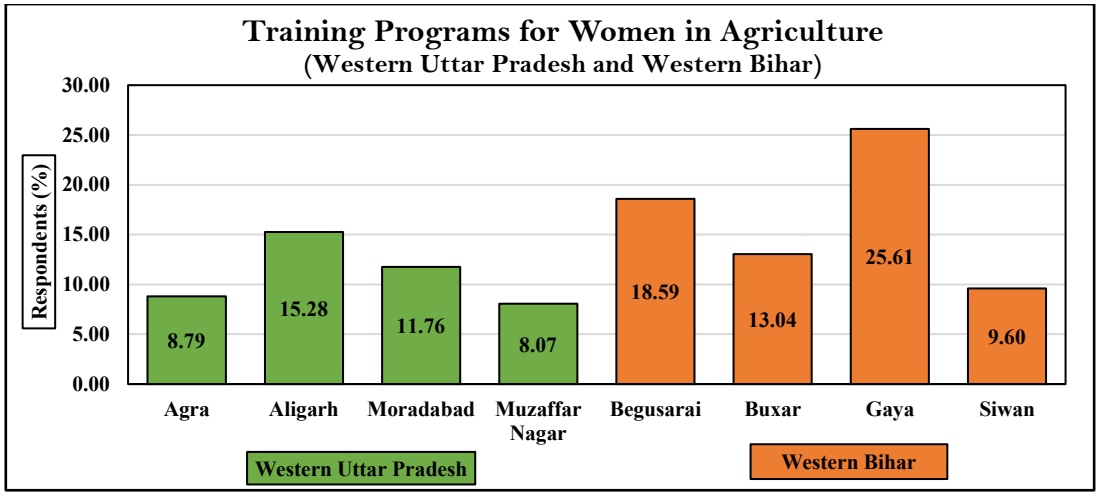

Figure 4: Training Programs for Women in Agriculture in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

5.1.2 Access to Credit for Women Entrepreneurs: During the field survey, when household heads were asked about the accessibility of credit for women entrepreneurs in the respective regions, Western Uttar Pradesh (11.29%) recorded a significantly higher average level of credit access for women than Western Bihar (6.35%). This suggests a more conducive financial environment for women entrepreneurs in Western Uttar Pradesh. At the district level within Western Bihar, Gaya has the highest percentage (9.76%) of women entrepreneurs with access to credit (Figure 5). This is followed by Buxar (6.52%), Begusarai (4.49%), and Siwan, which have the lowest access at only 4.00%. In contrast, Western Uttar Pradesh presents a stronger and more uniform pattern of credit access across districts. Muzaffar Nagar records the highest access at 14.91%, followed closely by Agra (10.99%) and Aligarh (10.42%). Moradabad reports a slightly lower figure at 8.50%, but still significantly above the average of Western Bihar districts. This distribution indicates a relatively favourable environment for women's financial inclusion and entrepreneurial support in the region.

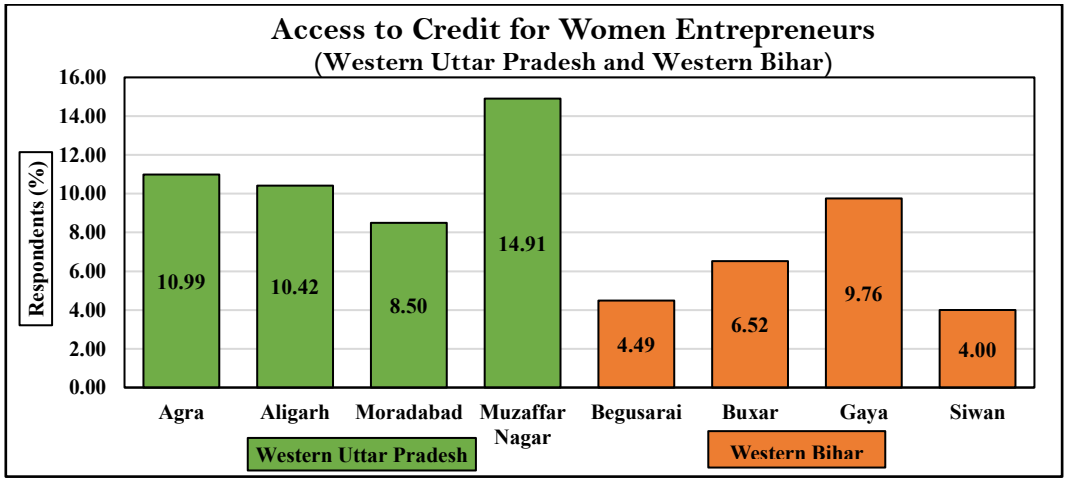

Figure 5: Access to Credit for Women Entrepreneurs in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

5.1.3 Women-led Cooperatives: Western Uttar Pradesh recorded a higher average response of 13.30%, compared to 9.78% in Western Bihar, in terms of women's cooperative engagement. This regional difference reflects a more enabling environment for women's participation and empowerment initiatives in Western Uttar Pradesh, potentially influenced by stronger institutional outreach, infrastructure, and awareness levels. At the district level within Western Bihar, Siwan has the highest positive response at

14.40%, followed by Begusarai at 12.18% (Figure 6). Meanwhile, Gaya and Buxar report lower levels at 7.93% and 5.07%, respectively. In comparison, Western Uttar Pradesh demonstrates both higher averages and significant intra-regional variation. Moradabad reports the highest response at 19.61%, followed closely by Muzaffarnagar (18.01%) and Agra (13.19%), while Aligarh shows a notably low response of 7.64%. This disparity highlights localized constraints in Aligarh, possibly stemming from socio-cultural barriers or weaker institutional linkages.

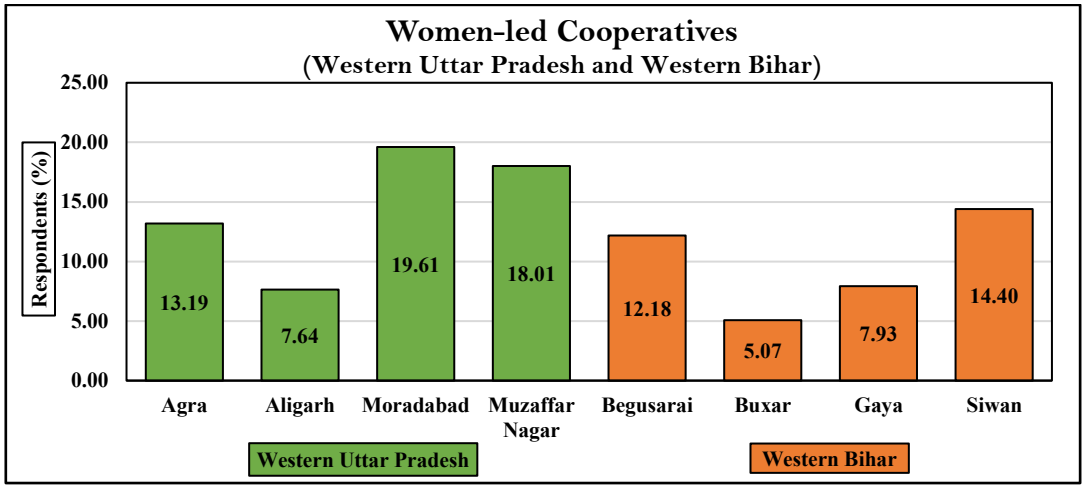

Figure 6: Women-led Cooperatives in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

5.1.4 Community-Based Resource Management: Western Bihar demonstrates a higher average level of presence and effectiveness of Community-Based Resource Management (CBRM) participation (19.90%) compared to Western Uttar Pradesh (15.48%), suggesting relatively greater community involvement in managing shared natural resources such as land, water, and forests in Bihar. Within Western Bihar, Begusarai shows the highest level of participation, with 26.92% of respondents reporting active engagement in community-based resource management initiatives (Figure 7). It is followed by Gaya (20.12%), Buxar (18.12%), and Siwan (12.80%). In contrast, Western Uttar Pradesh shows a more modest and varied pattern of CBRM adoption. Aligarh (18.75%) and Agra (18.68%) report the highest participation rates, indicating localized success in promoting collective natural resource management. However, districts like Moradabad (12.42%) and Muzaffarnagar (13.66%) fall below the regional average, reflecting disparities that may be due to institutional gaps, lack of awareness, or limited community mobilization.

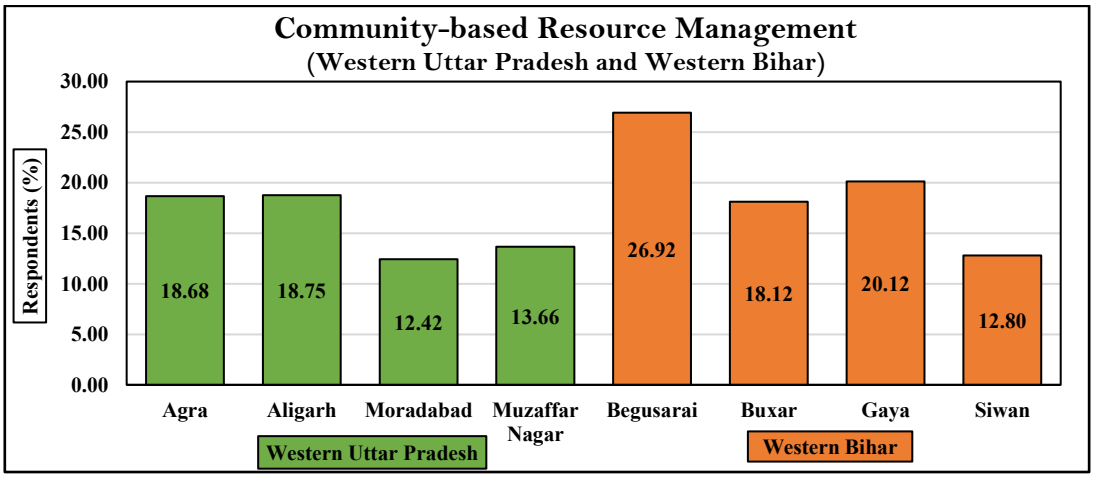

Figure 7: Community-based Resource Management in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

5.2 Effectiveness of Gender-Sensitive Adaptation Strategies

To assess the ground-level impact of adaptation strategies in promoting gender-sensitive adaptation for climate change, respondents were asked to evaluate the effectiveness of these four key interventions: training programs for women in agriculture, access to credit for women entrepreneurs, women-led cooperatives, and community-based resource management. The responses were categorized into three options: not effective at all, somewhat effective, and very effective, to capture the insights of local experience and perception. The results indicate a generally low perception of effectiveness in both regions. In Western Bihar, 61.38% of respondents viewed these strategies as not effective at all, 36.38% found them somewhat effective, and only 2.25% believed they were very effective (Figure 8). A similar trend was observed in Western Uttar Pradesh, where 58.38% perceived the strategies as not effective, 35.50% as somewhat effective, and only 6.13% as very effective. Although Western Uttar Pradesh reflects a slightly more favorable response in the very effective category compared to Bihar, the overall outlook remains pessimistic.

5.3 Implementation Challenges of Gender-Sensitive Adaptation Strategies

Following the assessment of effectiveness, respondents in both regions were asked to identify key challenges impeding the successful implementation of these gender-sensitive adaptation strategies. Respondents were allowed to choose more than one option from the three major categories: lack of funding, limited community engagement, and insufficient training or knowledge. In Western Bihar, the most cited challenge was insufficient training or knowledge, with 62.00% of respondents indicating that a lack of awareness, capacity, and skill-building opportunities hindered women's effective participation in adaptation programs. This was followed by a lack of funding (46.63%) and limited community engagement (35.25%). District-wise, Siwan (69.50%), Buxar (63.50%), and Begusarai (58.50%) reported particularly high concerns around training deficiencies. In Western Uttar Pradesh, the pattern was slightly more dispersed. Limited community engagement emerged as the top concern (49.38%), followed closely by insufficient training or knowledge (47.50%) and lack of funding (42.88%). District-specific data show that Aligarh (57.50%) and Moradabad (52.00%) report high levels of concern regarding poor community integration, while Agra (60.50%) expresses the strongest concern over training gaps.

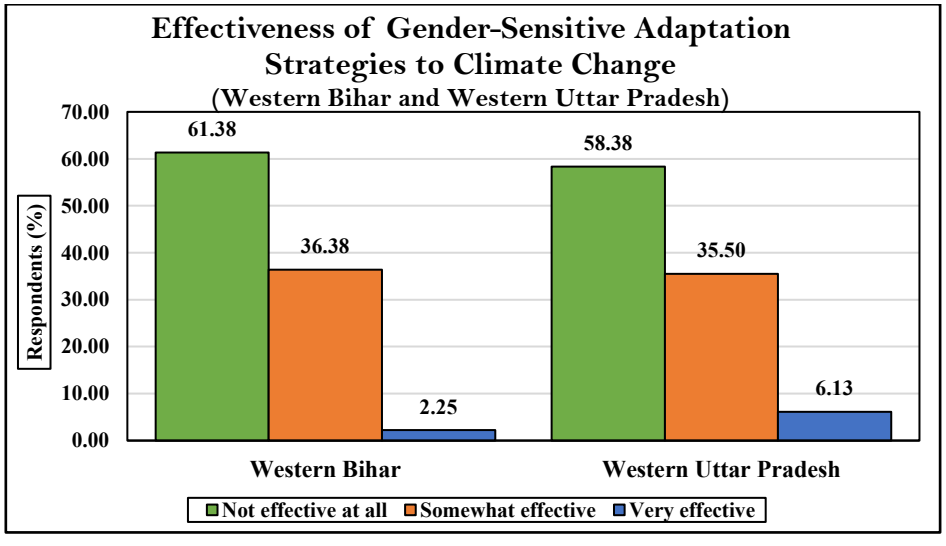

Figure 8: Effectiveness of Gender-Sensitive Adaptation Strategies to Climate Change in Western Uttar Pradesh and Western Bihar
Source: Field Survey (2025)

6. Conclusion

The findings clearly demonstrate a significant gap between the intended goals of gender-sensitive policies and the lived realities of rural communities in Western Uttar Pradesh and Western Bihar. While both regions have introduced programmatic frameworks aimed at empowering women, there is a distinct regional disparity in their execution; Western Uttar Pradesh shows a relative edge in translating these efforts into tangible financial credit and active developmental involvement. Conversely, the uneven patterns observed across districts, particularly in Western Bihar, point to localized failures in institutional presence, governance effectiveness, and the performance of Self-Help Groups (SHGs). Despite pockets of success in districts like Begusarai and Gaya, where participatory governance is more active, an overwhelming sense of uncertainty remains regarding the overall effectiveness of these strategies. This disconnect suggests that current adaptation strategies often lack the necessary depth and contextual responsiveness to overcome deep-seated technical and participatory gaps. Ultimately, for climate resilience to be truly equitable, there is an urgent need to recalibrate these strategies, moving beyond gender-sensitive intentions to ensure that inclusive execution and measurable outcomes become the standard.

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