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Gendered perceptions on climate change and access to information networks: Evidence from farm households in Bihar

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Abstract

Agricultural households in Bihar face increasing exposure to climate variability, yet gender mediates how risks are perceived and how information is accessed. This paper analyses survey data from 2,354 farm households (1,200 female primary respondents and 1,154 male primary respondents) selected through multistage stratified random sampling. Using descriptive statistics and a Response Priority Index (RPI), the study quantifies gender differences in climate awareness, perceived income loss, and informational constraints. Results indicate that women reported higher awareness of floods (55.08% vs. 49.08% for men) and droughts (55.92% vs. 53.58%), while men were more aware of pests (20.25% vs. 15.83%). Women consistently reported greater perceived income losses, with droughts reducing household income by 10.74% compared to 8.04% for men. Large gaps were observed in access to formal information: only 1.59% of women reported contact with extension agents and 5.17% with Krishi Vigyan Kendras (KVKs), compared to 41.87% and 44.64% of men, respectively. RPI analysis shows that lack of awareness of formal sources was women's most binding constraint (79.93% for extension agents), whereas men cited difficulties in access despite presence (27.88%). The findings suggest that gendered barriers to information exacerbate economic vulnerability to climate shocks. Policy should therefore prioritize targeted outreach through women's self-help groups, improved local presence of KVKs, and quality control of extension delivery are therefore critical to close gender gaps in climate information and inclusive agricultural development.

Keywords: Climate change perception, gender disparities, agricultural information access, Response Priority Index (RPI), rural households

Introduction

Climate change has emerged as one of the most pressing challenges confronting agriculture worldwide. Changes in temperature, precipitation, and extreme weather patterns are increasingly destabilizing farming systems, particularly in developing countries that rely heavily on rainfed agriculture. In South Asia, climate variability has been shown to reduce crop yields, increase production costs, and heighten risks to food and livelihood security (IPCC, 2021) [5]. Crop growth and productivity are highly sensitive to seasonal weather conditions, and disruptions in rainfall distribution, prolonged dry spells, unseasonal rains, and recurrent floods are now common across many agrarian landscapes (Jat *et al*., 2025) [6].

Bihar, located in the eastern Indo-Gangetic plains of India, is among the most climate-vulnerable states in the country. The region is exposed to multiple climatic risks: recurrent floods in its northern districts due to river overflows, and drought-prone conditions in the southern and southwestern districts (Hariharan *et al*., 2020) [4]. With an average annual rainfall of about 1,027 mm, concentrated largely during the monsoon season, Bihar often faces the paradox of both drought and flood in a single cropping cycle (Jat *et al*., 2025) [6]. In addition to rainfall variability, the state has witnessed rising temperatures, frequent heat waves, and more severe pest and disease outbreaks, further amplifying uncertainty in agricultural production. The cumulative impact of these climate shocks has been declining yields, unstable incomes, and growing vulnerability among smallholder farming households who form the backbone of Bihar's agrarian economy.

Gender is an important dimension of climate vulnerability. Women and men farmers have different roles, responsibilities, and adaptive capacities in agriculture, which shape their exposure to and perception of climate change (United Nations, 2009) [9]. Evidence shows that women tend to face greater risks and burdens under climate stress, especially in contexts of poverty and structural inequality (Feitosa & Yamaoka, 2020) [3]. In Bihar, widespread male outmigration has placed women at the forefront of agricultural production and household food security. Despite this increased responsibility, rural women remain disproportionately disadvantaged due to unequal access to land, financial resources, extension services, and adaptive technologies (Aryal *et al*., 2014; Hariharan *et al*., 2020) [1, 4]. These gender gaps restrict women's ability to adopt climate-resilient practices, enhance productivity, and safeguard their livelihoods.

Understanding the gendered nature of climate change perception and access to agricultural information is therefore critical for designing inclusive climate adaptation policies. While earlier studies in Bihar and other parts of India have explored the role of Self-Help Groups (SHGs), microfinance platforms, and women's collectives in strengthening resilience, there is limited empirical evidence on how men and women differ in perceiving climate risks,

quantifying income losses, and accessing information from formal and informal networks. This gap is particularly relevant in Bihar, where more than 13 million women are mobilized under the State rural livelihood programme, yet structural inequalities continue to constrain equitable benefits.

Against this backdrop, the present study examines gendered perceptions of climate change events, associated income losses, and disparities in access to agricultural information networks among farm households in Bihar. By employing gender-disaggregated data and applying robust statistical techniques such as chi-square tests, t-tests, and Response Priority Index (RPI), the study aims to provide deeper insights into how vulnerabilities and constraints differ across men and women farmers. The findings are expected to inform the design of gender-responsive extension systems and climate adaptation interventions that ensure equitable access to resources, knowledge, and decision-making for both men and women in agrarian communities.

Materials and Methodology

Study Area and Context

The study was undertaken in Bihar, one of the most climate-vulnerable states in eastern India. Bihar lies in the Indo-Gangetic plains and has an area of 94,163 km². The state is divided into four major agro-climatic zones, each facing distinct climatic challenges. Northern districts are highly prone to recurrent floods due to rivers like the Kosi and Gandak, whereas southern and southwestern districts frequently experience droughts, dry spells, and erratic rainfall patterns. The average annual rainfall is around 1,027 mm, concentrated mainly during the south-west monsoon season (June-September), while summers are marked by extreme heat waves, and winters often witness declining minimum temperature. These climatic extremes have resulted in fluctuating crop yields, reduced productivity, and severe risks to household income security.

Agriculture in Bihar is dominated by small and marginal farmers, who account for more than 90% of the farming population. With the continued male outmigration for non-farm employment, women are increasingly taking on a central role in agricultural production and household food security. Despite their active engagement, women farmers face constraints in accessing land, finance, extension services, and climate-resilient technologies. This makes Bihar a suitable context for examining the gendered perceptions of climate change, associated income losses, and access to agricultural information networks.

Sampling Framework and Respondents

A multistage stratified random sampling technique was employed to ensure representativeness of all agro-climatic regions. In the first stage, districts were purposively selected from flood-prone, drought-prone, and mixed-risk areas to capture variations in climatic exposure. In the second stage, blocks and villages were chosen on the basis of farming intensity and the presence of both male- and female-headed households actively engaged in agriculture. Finally, households were randomly selected from village lists to avoid bias.

The final sample consisted of 2,354 farm households, including 1,200 female primary respondents (FPRs) and 1,154 male primary respondents (MPRs). Female respondents were defined as the primary women engaged in farming and household agricultural decisions, while male respondents were typically the household heads or spouses involved in farm management. Collecting data from both men and women in the same agrarian settings allowed for gender-disaggregated comparisons of climate change awareness, perceived income losses, access to information, and constraints.

Data Collection and Nature of Data

Data were collected through a structured interview schedule administered by trained investigators during the agricultural season. To ensure validity and reliability, the schedule was pre-tested in non-sample villages, and modifications were incorporated before full-scale administration. The interview schedule was organized into the following sections:

1. **Perceptions of climate change:** Awareness of drought, floods, hailstorms, pest and disease outbreaks, unmanaged weed infestations, and extreme temperature fluctuations.
2. **Perceived income loss:** Percentage of household income lost due to climate-related shocks, categorized by type of event.
3. **Access to agricultural information:** Frequency and source of information accessed through extension agents, Krishi Vigyan Kendras (KVKs), farmer groups, NGOs, traders/dealers, friends, relatives, and other farmers.
4. **Constraints in information access:** Barriers faced by men and women in obtaining timely and reliable agricultural knowledge from both formal and informal channels.

All responses were carefully recorded, coded, and cross-verified with household members to reduce recall bias.

Analytical Tools and Statistical Methods

Both descriptive and inferential statistics were used to analyse the data

Tabular analysis

It is used for the presentation of some of the analysed gender disaggregated data such as perceptions on climate change, income losses and information access and constraints. Appropriate percentage analysis was worked and presented in the form of table (Table 1, 2, 3).

t-tests were applied to test the significance of mean differences in continuous variables, such as perceived income losses between male and female respondents.

Chi-square tests were used to evaluate differences in categorical responses, such as access to specific information sources, between genders.

Response-Priority Index (RPI)

To quantify the constraints ranked by the respondents regarding the lack of access to information access from various institutional sources. This approach addresses the methodological concern of whether to assign greater weight to the frequency of a particular response or to its rank in terms of priority. The RPI method accounts for both dimensions by incorporating the Proportion of Responses (PR) and the Priority Estimate (PE) for each item or reason, allowing a composite measure of relative importance (Rao, 2011) [8].

Mathematically, the RPI for the *i*th item is given by:

$$(RPI)_i = \frac{\sum_{j=1}^{k} f_{ij} X_{[(k+1)-j]}}{\sum_{i=1}^{N} \sum_{j=1}^{k} f_{ij}} \quad (1)$$

Where,

$(RPI)_i$: Response-Priority Index for i[th] item.

f_{ij}: Number of responses for the j[th] priority of the i[th] item (i=1,2,3…N; j=1,2,3…k)

$\sum_{j=1}^{k} f_{ij}$: Total responses for the *i*th item

K: Number of ranked positions considered (typically 3 in this study: Rank 1 = most important, Rank 2 = moderately important, Rank 3 = less important)

$X_{(k+1)-j)}$: Weight assigned to the *j*th rank (i.e., Rank 1 gets the highest weight)

$\sum_{i=1}^{N} \sum_{j=1}^{k} f_{ij}$: Total number of responses across all items

Larger the RPI, higher will be the importance for that item.

Data Analysis and Software

Data entry and preliminary tabulation were carried out in Microsoft Excel 2019. Inferential statistical analyses, including t-tests and chi-square tests, were performed using STATA version 14.2, which also fac ilitated computation of their significance levels. The Response Priority Index (RPI) calculations were carried out using Excel functions, while tables were formatted for clarity and presented. Together, these tools provided a reliable framework for analyzing gendered differences in climate change perception, economic vulnerability, and informational constraints

Results and Discussion

Gendered difference in awareness on climate change events

Table 1 reveals notable gender disparities in climate change awareness among farm households. Women demonstrated greater awareness of many of the climate change phenomena, particularly too frequent rains or floods (55.08%) and droughts (55.92%), compared to men (49.08% and 53.58%, respectively). The difference in awareness of floods was statistically significant at the 1% level. In contrast, men reported significantly higher awareness of crop pests and diseases (20.25%) followed by unmanaged weed infestations (2.25%) than women (15.83% and 1.33%). This gender disparity suggests that men may be more exposed to field-level changes like pest and weed incidence, while women are more attuned to macro-climatic events like floods, drought and hailstorms. These findings resonate with patterns reported in the Bangladesh study by Bryan *et al*., (2021) [2], where women showed lower awareness of technical and field-specific practices due to their limited access to formal agricultural information sources.

Table 1: Gendered awareness on climate change events

Climate change events	FPR (n=1200)	MPR (n=1154)
Drought	55.92	53.58
Too frequent rain or floods	55.08***	49.08
Hailstorm	38.00	36.00
Crop pests/diseases (Increased severity / New pests and diseases)	15.83***	20.25
High temperature	9.08	9.58
Unmanaged weed infestation/ New weeds	1.33*	2.25

Note: MPR and FPR denote Male Primary Respondent and Female Primary Respondent, respectively. *and *** represents the intergroup difference is statistically significant at p< 0.10 and p<0.01 level respectively.

Gendered perception on income loss (%) due to climate change events

The findings reveal that female-headed households consistently experienced greater income losses due to climate-related shocks compared to male-headed households. Significant differences were observed for droughts, floods, pest and disease attacks, and unmanaged weed infestations, with losses among female-headed households significantly higher at the 1% level. These patterns suggest that women perceive and experience a greater degree of economic vulnerability. Several factors may explain this disparity: female-headed households often have smaller landholdings, limited access to climate-resilient technologies, reduced bargaining power in markets, and fewer opportunities to access credit or extension services. Moreover, with less access to adaptive resources and risk management strategies, women are more exposed to the impacts of climate variability, leading to higher reported income losses. These findings underscore the urgency of designing gender-responsive climate adaptation interventions that specifically address the structural disadvantages faced by female-headed households.

Table 2: Gendered perception on income loss (%) due to climate change events

Climate change events	FPR (n=1200)	MPR (n=1154)
Drought	10.74*** (25.36)	7.12 (19.49)
Too frequent rain or floods	14.08*** (29.98)	7.60 (20.66)
Hailstorm	4.44 (17.63)	3.68 (14.94)
Crop pests/diseases (Increased severity / New pests and diseases)	18.87*** (31.83)	8.51 (20.01)
High temperature	13.12 (29.31)	11.25 (21.92)
Unmanaged weed infestation/ New weeds	33.44*** (40.07)	4.63 (13.93)

Notes: *MPR* and *FPR* denote Male Primary Respondent and Female Primary Respondent, respectively. Values in parentheses represent standard deviations. * and *** indicate that the intergroup difference is statistically significant at the p < 0.10 and p < 0.01 levels, respectively.

Gendered access to Agricultural Information by Source and Frequency

Table 3 highlights stark gender disparities in access to agricultural information across various sources. Women consistently reported significantly lower access compared to men, particularly through formal channels such as extension agents (1.59% vs. 41.87%) and Krishi Vigyan Kendras (KVKs) (5.17% vs. 44.64%). Even through informal sources like friends, relatives, and other farmers, large gaps persisted. Notably, traders and seed dealers emerged as the most dominant source of agricultural information for both men and women, with 94.89% of men and 8.91% of women reporting access. Among those who accessed them, both genders exhibited high repeat engagements, highlighting traders' central role in disseminating agricultural knowledge. However, heavy reliance on traders and seed dealers raises concerns, as existing evidence shows that private seed dealers often prioritize profit, sometimes promoting outdated or low-quality seeds and misguiding farmers (Kala-Satheesh *et al*. 2024) [7]. The unchecked proliferation of aged wheat varieties in Bihar despite the presence of newer varieties has been partly attributed to such market inefficiencies, where seed dealers may misrepresent seeds for higher gains. Thus, while traders and dealers provide a readily accessible channel for information, the quality and objectivity of information disseminated through these actors remain questionable. This dynamic suggests that both the initial access to and the quality of agricultural information are gendered and market-mediated, reinforcing broader patterns of inequality noted by Bryan *et al*., (2021) [2]. Strengthening formal extension services and regulating private sector engagement are therefore critical to ensure that farmers, particularly women, receive accurate, timely, and high-quality information to support climate-resilient agricultural practices.

Table 3: Gendered access to Agricultural Information by Source and Frequency

Source list	Whether respondent access to agricultural information from the given sources		Chi^2 statistics	Respondent have accessed more than once (Percent of those who accessed information)				Chi^2 statistics
	FPR (%) (n=1200)	MPR (%) (n=1154)		Obs.	FPR (%)	Obs.	MPR (%)	
Extension agent	1.59	41.87	-23.84***	19	57.89	484	75.83	-1.77*
Farmer group	1.25	4.67	-4.92***	15	67.74	54	71.12	-0.25
Friends and relatives	23.66	96.36	-35.89***	284	88.36	1112	88.38	-0.01
KVK	5.17	44.64	-22.25***	62	37.50	515	60.00	-3.38***
NGOs	0.67	2.17	-3.09***	8	73.33	25	83.33	-0.62
Another farmer	15.75	95.33	-38.76***	189	87.85	1101	93.35	-2.66***
Traders and dealers	8.91	94.89	-41.72***	107	85.92	1096	83.66	0.61

Note: *MPR* and *FPR* denote Male Primary Respondent and Female Primary Respondent, respectively. *and *** represents the intergroup difference is statistically significant at p< 0.10 and p<0.01 level respectively.

Gendered constraints for not accessing agricultural information from various sources

Table 4 presents the rankings of constraints faced by male and female primary respondents (MPRs and FPRs) in accessing agricultural information from three key sources - extension agents, Krishi Vigyan Kendras (KVKs), and farmers' groups. The Response Priority Index (RPI) analysis highlights clear gender differences in both awareness and accessibility. For extension agents, the most critical barrier for women was lack of awareness about the very existence of such services (79.93%), ranked first. In contrast, men also cited this constraint most often (42.48%), but to a significantly lesser degree. Men's second-most cited constraint was difficulty in accessing the source despite its presence in the locality (27.88%), while women ranked this much lower. Interestingly, women more frequently reported that the source was not present in their locality (13.79%), underlining structural exclusion.

For KVKs, a large proportion of women (69.60%) were unaware of their existence, whereas men (41.52%) reported similar unawareness but at lower levels. Both men and women ranked "difficult to access despite presence" as the second constraint (40.26% vs. 24.57%). Women thus appear constrained at both the awareness and accessibility stages, whereas men are more affected by logistical access. For farmers' groups, unawareness again topped the list for both women (52.49%) and men (55.78%). However, men placed greater emphasis on absence in the locality (35.50%) and difficulty in access (30.83%), while women highlighted absence in the locality (39.70%) more strongly. Minor constraints such as "information not useful or up-to-date," "other more useful sources," and "no need for information last year" ranked consistently lower across all groups, though gender differences remained statistically significant in some cases.

Taken together, these results indicate that women face a dual disadvantage: lack of awareness and structural non-availability while men primarily face accessibility and utility issues. Targeted outreach through women's self-help groups, improved local presence of KVKs, and quality control of extension delivery are therefore critical to close gender gaps in climate information access.

Table 4: Rankings on Gendered constraints for not accessing agricultural information from various sources: RPI analysis

Constraints	Extension agent				KVK				Farmers group			
	FPR (n=573)	Rank	MPR (n=685)	Rank	FPR (n=352)	Rank	MPR (n=643)	Rank	FPR (461)	Rank	MPR (1124)	Rank
Not aware of the existence of the source	79.93***	I	42.48	I	69.60***	I	41.52	I	52.49	I	55.78	I
The source was not present in the nearest locality	13.79***	II	19.71	III	22.73	III	22.40	III	39.70	II	35.50	II
Not easy to access the source although it was present in the locality	2.62***	IV	27.88	II	40.26***	II	24.57	II	10.95***	III	30.83	III
Information will not be useful or up-to-date	0.35***	VI	2.48	V	0.28*	VI	1.40	V	2.82***	IV	00.80	VI
have other more useful sources of information	2.63	III	2.19	VI	2.27**	IV	0.78	VI	1.95	V	1.51	V
There was no need to get the information last year	0.70***	V	5.26	IV	0.85***	V	9.33	IV	1.08*	VI	2.58	IV

Note: *MPR* and *FPR* denote Male Primary Respondent and Female Primary Respondent, respectively. * and *** indicate that the intergroup difference is statistically significant at the $p < 0.10$ and $p < 0.01$ levels, respectively.

Conclusion

This study highlights significant gendered disparities in climate change awareness, perceived income losses, and access to agricultural information among farm households in Bihar. Women were more aware of macro-climatic shocks such as floods and droughts, and consistently reported higher income losses, reflecting their heightened vulnerability to climate risks. In contrast, men demonstrated greater awareness of field-level problems such as pests and weeds, suggesting differentiated exposure and roles within farm households. The analysis of information channels revealed that female respondents had markedly lower access to formal sources such as extension agents and Krishi Vigyan Kendras, relying more on informal networks of relatives and other farmers. Response Priority Index results confirmed that women's exclusion was largely due to lack of awareness and non-availability of formal sources in their locality, while men were more constrained by issues of accessibility and perceived usefulness of information. Together, these findings point to the urgent need for gender-responsive extension strategies. Increasing awareness of formal institutions among women, ensuring the physical presence of services in villages, and building bridges between self-help groups, women's collectives, and formal agencies can significantly reduce the information gap. At the same time, regulating private actors such as dealers and traders is essential to improve information quality and credibility. By addressing these structural and gendered constraints, agricultural policies can enhance equitable access to reliable knowledge, strengthen resilience to climate shocks, and empower women farmers who play a central role in household food security and climate adaptation.

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