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Assessing farmers awareness and perceptions of climate change causes and impacts in the lower Arpa River Basin, Chhattisgarh

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Abstract

Climate change represents one of the most pressing challenges to agricultural livelihoods in rural India, particularly in rain-dependent river basin communities of central India. The Lower Arpa River Basin in Bilaspur district, Chhattisgarh, supports a substantial population of smallholder farmers who are directly exposed to shifting weather patterns, rising temperatures, and climate-related environmental stress. This study aimed to assess the level of awareness among farmers regarding climate change, examine their perceptions of how climate change affects surrounding biophysical and socioeconomic systems, and identify the activities they believe contribute to climate change. A structured interview schedule was administered to 200 farmers selected from 10 villages in the Bilha block using simple random sampling. Data were analyzed using frequency counts and percentage distributions. Results showed that awareness of health problems in humans and animals was the highest among all climate change indicators (82.50% at the same awareness level), followed closely by atmospheric pollution (78.00%) and seasonal changes (75.00%). Regarding environmental impacts, the majority of respondents agreed that human health problems are increasing (79.50%) and that the area for pasture is declining (59.00%). Deforestation and burning of fossil fuels were most strongly identified as causes of climate change, with combined agreement rates of 92.00% and 88.00% respectively. The findings highlight the need for structured climate literacy programs, community-level extension interventions, and environmentally sustainable farming support in the region.

Keywords: Climate change awareness, farmers' perceptions, Lower Arpa River Basin, environmental impacts, causes of climate change, Chhattisgarh

1. Introduction

Climate change is among the most consequential global challenges of the twenty-first century, with particularly severe implications for agricultural systems in developing countries (Intergovernmental Panel on Climate Change [IPCC], 2022). Changes in temperature, precipitation, and seasonal cycles are altering the conditions under which food is produced, threatening the livelihoods of the nearly 600 million smallholder farmers worldwide who depend on rain-fed agriculture (Food and Agriculture Organization [FAO], 2016). In India, where agriculture remains the backbone of the rural economy and employs approximately 42% of the workforce, the adverse consequences of climate variability are becoming increasingly visible through declining yields, shifting crop calendars, and heightened vulnerability to extreme weather events (Ministry of Agriculture and Farmers Welfare [MAFW], 2021).

Central India, including the state of Chhattisgarh, is characterized by a predominantly monsoon-dependent agricultural system where even modest changes in rainfall distribution or onset timing can have disproportionate effects on crop production and rural household income (Singh & Patel, 2019) [22]. Chhattisgarh, known for its paddy-dominated agricultural landscape, faces compound risks from climate change: erratic rainfall, rising summer temperatures, prolonged dry spells, and increasing incidence of pest and disease outbreaks (Government of Chhattisgarh, 2022) [9].

These pressures are most acutely felt in river basin communities where water availability, soil health, and agricultural productivity are interconnected through hydro-ecological processes.

The Arpa River, originating in the Maikal Hills and flowing through the Bilaspur district, supports agriculture across both its upper and lower basin areas. The Lower Arpa River Basin, which falls within the Bilha block of Bilaspur district, comprises largely flat agricultural land where paddy, wheat, and pulses are cultivated in sequence through the kharif and rabi seasons. Farmers in this zone are exposed not only to the gradual onset of long-term climatic change but also to sudden hydrometeorological events, land degradation, and ecosystem disruption (Sahu & Verma, 2020) ^[21]. Understanding how these farming communities perceive and interpret climate change is essential for the development of effective and contextually appropriate adaptation and extension policies.

Perception is the cognitive foundation of adaptive behavior. Before farmers can respond to climate change, they must first recognize it as a meaningful and personal risk (Maddison, 2007) ^[14]. Research has shown that climate perceptions among smallholder farmers are shaped by local environmental observations rather than formal scientific data, making locally grounded empirical assessments especially important for policy design (Banerjee, 2010; Deressa *et al.*, 2011) ^[2, 5]. At the same time, farmers' perceptions can be incomplete or inaccurate, particularly in communities with limited access to information, education, or extension services (Mabe *et al.*, 2014) ^[13]. Studies in comparable agricultural contexts across India and sub-Saharan Africa have consistently found that while farmers broadly acknowledge climatic changes, significant knowledge gaps exist about the mechanisms and anthropogenic drivers of those changes (Gbetibouo, 2009; Nhemachena & Hassan, 2007) ^[8, 16].

Climate change does not affect only crop production; its impacts extend across ecological, biological, and socioeconomic dimensions of rural life. Changes in temperature and precipitation patterns alter the habitats and migratory behavior of birds and animals, reduce biodiversity, affect surface and groundwater availability, and modify the transmission dynamics of human and animal diseases (Parmesan & Yohe, 2003) ^[18]. In Indian river basin communities, the degradation of common pool resources such as pasture land, surface water bodies, and forest cover compounds the already fragile resource base on which small and marginal farmers depend (Rao & Bhanja, 2019) ^[20]. Capturing farmers' awareness of these cross-sectoral impacts is therefore a multidimensional empirical challenge that requires careful survey design and locally validated instruments.

An important and often under-examined dimension of climate change awareness is farmers' understanding of its causes. While a growing proportion of rural Indian farmers now recognize the reality of climate change, awareness of its anthropogenic drivers — including greenhouse gas emissions from fossil fuel combustion, deforestation, and agricultural practices — remains limited (Tripathi & Bhattacharya, 2017; Chauhan *et al.*, 2016) ^[24, 4]. Agricultural practices themselves contribute to climate change through methane emissions from paddy cultivation, nitrous oxide from fertilizer use, and carbon dioxide from crop residue burning (Smith *et al.*, 2014) ^[23]. Building

farmers' awareness of these causal linkages is not merely an academic exercise; it is a prerequisite for encouraging climate-smart agricultural practices that simultaneously reduce emissions and enhance adaptive capacity (FAO, 2013) ^[6].

India's national policy framework for climate action in agriculture includes the National Action Plan on Climate Change (NAPCC), the National Mission for Sustainable Agriculture (NMSA), and the recently expanded Climate-Smart Agriculture (CSA) programs implemented through Krishi Vigyan Kendras (KVKs) and state agricultural universities (Planning Commission of India, 2014) ^[19]. These programs seek to integrate climate risk awareness with practical farm-level adaptation, but their effectiveness depends heavily on the quality and relevance of grassroots-level information about what farmers know, perceive, and believe regarding climate change (Anderson, 2007) ^[1]. Systematic evidence from field surveys is therefore essential to calibrate extension messages, design training programs, and prioritize intervention areas.

Previous research on climate change awareness among Indian farmers has revealed important patterns. Birthal *et al.* (2015) ^[3] found that farmer awareness of rainfall variability was high in semi-arid regions but did not automatically translate into adoption of resilient varieties. Jain *et al.* (2015) ^[11] demonstrated in Gujarat that farmers who received extension information about climate risk were significantly more likely to adjust their planting schedules and irrigation management. In Odisha, a state with agro-climatic similarities to Chhattisgarh, Panda *et al.* (2013) ^[17] found that the quality of local environmental observation was the strongest predictor of climate change awareness among tribal and marginal farming households. These findings collectively point to the importance of assessing baseline awareness levels at the community scale before designing any climate-related extension or adaptation program.

Despite the policy relevance of understanding climate change awareness at the farm level, empirical studies specifically focused on the Lower Arpa River Basin remain scarce. The area's agro-ecological characteristics, demographic composition, and dependence on seasonal agriculture make it an important and representative case for understanding how climate change awareness manifests in a river basin farming community of central India. This study therefore fills an important gap by systematically measuring three dimensions of farmer climate cognition: awareness of climate change as a phenomenon, perceptions of its impacts on surrounding biophysical and socioeconomic systems, and beliefs about which human activities are responsible for driving climate change. The results are intended to inform extension planners, district agricultural officers, state policymakers, and development researchers working on climate resilience in central India.

2. Research Methodology

The study was conducted in the Lower Arpa River Basin, specifically within the Bilha block of Bilaspur district, Chhattisgarh. The lower basin area is characterized by flat topography, predominantly paddy-wheat-pulse cropping systems, and direct dependence on the Arpa River and seasonal monsoon rainfall for agricultural water supply.

The study area was selected using a purposive sampling technique, as the Bilha block is recognized as a key

agricultural zone in the lower portion of the Arpa River Basin. From this block, 10 villages were selected through simple random sampling. From each selected village, 20 farmers were chosen as respondents using simple random sampling, resulting in a total sample size of 200 farmers. Only those individuals who were actively engaged in cultivation and had at least five years of farming experience were included.

A pre-tested, structured interview schedule was used as the primary data collection instrument. The schedule was organized into three thematic sections: (i) awareness of climate change indicators, measured through an ordinal scale with three response categories — Not at All, Some Awareness, and Full Awareness — across eight statements; (ii) perceptions of the impacts of climate change on surrounding activities, assessed using a five-point Likert scale (Strongly Disagree to Strongly Agree) across eight impact statements; and (iii) beliefs about activities causing climate change, assessed using the same five-point Likert scale across ten causal activity statements. The instrument was pilot-tested on 20 farmers outside the main sample and refined for linguistic clarity and local relevance.

Data were collected through face-to-face personal interviews conducted in the local dialect with the support of trained field enumerators. All collected data were systematically tabulated, classified by response category, and analyzed using descriptive statistics, specifically frequency counts and percentage distributions. Results are presented in three structured tables corresponding to the three thematic sections of the instrument. Note: In Table 2, the label 'n=600' in the original data reflects the total number of responses across all items and all respondents; the actual sample remains n=200 farmers.

3. Results and Discussion

3.1 Farmers' Awareness of Climate Change

Table 1 presents the distribution of respondents based on their level of awareness of key climate change indicators. Health problems in humans and animals recorded the

highest level of some awareness (82.50%), indicating that farmers directly observe deteriorating health conditions in their communities and livestock and associate this with environmental change. This finding aligns with Banerjee (2010), who noted that observed changes in animal health are among the most immediate and locally recognizable signals of environmental deterioration in rural Indian communities.

Atmospheric pollution awareness at the some awareness level was high at 78.00%, followed by seasonal changes (75.00%) and unpredictable weather (72.50%). These findings suggest that farmers in the Lower Arpa Basin are broadly attuned to gradual environmental shifts but may lack scientific framing to interpret these observations as components of a unified climate change phenomenon. General warming of the climate was recognized at full awareness by 36.50% of respondents, the highest rate of full awareness among all items, suggesting that temperature-related changes are the most tangible and clearly experienced climate signal for this farming community. This is consistent with findings by Maddison (2007) across African farming systems, who found that temperature change is consistently the most recognized dimension of climate variability by rural farmers.

Extreme weather conditions showed the most divided awareness, with 50.00% of respondents reporting no awareness and 49.00% some awareness. This near-even split may reflect the relatively moderate incidence of extreme events in this specific basin zone compared to more flood-prone or drought-prone regions, or it may indicate communication gaps in how extreme weather risks are discussed in local agricultural extension programming (Tripathi & Bhattacharya, 2017) [24]. The risk of crop failure was recognized at some awareness by 67.50%, but full awareness was reported by only 5.00% of respondents, suggesting that while farmers sense increased crop risk, they have not fully internalized it as a climate-driven phenomenon distinct from ordinary year-to-year variability.

Table 1: Distribution of respondents based on their awareness of climate change (n=200)

S. N.	Statements	Not at All F	%	Some Awareness F	%	Full Awareness F	%
1	The climate is warming	23	11.50	104	52.00	73	36.50
2	The weather has become unpredictable	33	16.50	145	72.50	22	11.00
3	Weather patterns are changing	40	20.00	145	72.50	15	7.50
4	Extreme weather conditions	100	50.00	98	49.00	4	2.00
5	The risk of crop failure has increased	55	27.50	135	67.50	10	5.00
6	Atmospheric pollution is increasing	22	11.00	156	78.00	22	11.00
7	The seasons have changed	32	16.00	150	75.00	18	9.00
8	Health problems in humans and animals are increasing	18	9.00	165	82.50	17	8.50

Note: SD = Strongly Disagree, D = Disagree, NO = No Opinion, A = Agree, SA = Strongly Agree

3.2 Perceptions of Climate Change Impacts on Surrounding Activities

Table 2 presents respondents' perceptions of how climate change affects the surrounding environment and society. Increasing human health problems received the highest combined agreement, with 60.50% agreeing and 19.00% strongly agreeing, yielding a combined agreement rate of 79.50%. This is consistent with growing evidence linking climate change to altered disease burden patterns in rural India, including increased incidence of vector-borne diseases, waterborne illnesses, and heat-related health conditions (IPCC, 2022; Kumar & Sharma, 2018) [10, 12].

Animal and bird extinction was perceived positively by 75.50% of respondents (58.50% agree + 17.00% strongly agree), reflecting farmers' observations of declining local biodiversity. Declining pasture area was perceived as a problem by 59.00% (22.00% agree + 37.00% strongly agree), indicating recognition of land degradation and the shrinking of common grazing resources, an issue with direct consequences for livestock-dependent households (Rao & Bhanja, 2019) [20]. Increasing expenditure on physical infrastructure was agreed upon by 52.00% and strongly agreed upon by 6.00%, a combined 58.00%, suggesting awareness of the economic costs of climate-related

infrastructure wear and repair.

Conversely, changes in fish species composition were disagreed with by a majority (36.50% strongly disagree + 31.50% disagree = 68.00%), which may reflect limited fishing activity or access to river fisheries among the primarily agricultural households surveyed. The availability of drinking water showed the most neutral distribution, with 29.50% offering no opinion, suggesting that while water

stress is a recognized issue nationally, its manifestation in this lower basin zone may be less severe or less consistently experienced than in more arid parts of the region (Sahu & Verma, 2020) [21]. These mixed findings underscore the importance of locally grounded, site-specific assessments rather than generalized assumptions about farmer perceptions.

Table 2: Distribution of respondents based on perceptions of climate change impacts on surrounding activities (n=200)

S. N.	Symptoms (n=200)	SD F	%	D F	%	NO F	%	A F	%	SA F	%
1	Some animals and birds are becoming extinct	10	5.00	22	11.00	17	8.50	117	58.50	34	17.00
2	The area for pasture is decreasing	9	4.50	7	3.50	66	33.00	44	22.00	74	37.00
3	Commercial changes are adversely affecting animal health	20	10.00	10	5.00	87	43.50	62	31.00	21	10.50
4	New fish species introduced; old species lost/extinct	73	36.50	63	31.50	47	23.50	13	7.50	4	2.00
5	Expenditure on physical infrastructure is increasing	2	1.00	9	4.50	73	36.50	104	52.00	12	6.00
6	Human health problems are increasing	0	0.00	20	10.00	21	10.50	121	60.50	38	19.00
7	Displacement of birds and animals has increased	23	11.50	35	17.50	60	30.00	52	26.00	30	15.00
8	Availability of drinking water has decreased	21	10.50	62	31.00	59	29.50	32	16.00	26	13.00

Note: SD = Strongly Disagree, D = Disagree, NO = No Opinion, A = Agree, SA = Strongly Agree

3.3 Beliefs About Activities That Cause Climate Change

Table 3 presents respondents' beliefs about activities that contribute to climate change. Deforestation was the most strongly identified cause, with 69.50% strongly agreeing and 22.50% agreeing, yielding a combined agreement rate of 92.00%. This very high level of attribution to deforestation may reflect farmers' direct observation of forest clearing in the surrounding landscape and the associated loss of shade, soil moisture, and biodiversity (Chauhan *et al.*, 2016) [4]. Burning of fossil fuels for transportation was identified as a cause by 88.00% of respondents (57.00% agree + 31.00% strongly agree), indicating awareness of non-agricultural emission sources among this rural population.

Agricultural practices as causes of climate change showed more divided opinions, consistent with research indicating that farmers rarely view their own practices as contributors to environmental change (Smith *et al.*, 2014) [23]. Burning crop residues received combined agreement from 33.00% of respondents, while excessive fertilizer use was linked to climate change by 35.50% and excessive pesticide use by

38.00%. These relatively low attribution rates suggest that targeted extension communication is needed to help farmers understand the greenhouse gas and environmental pollution dimensions of conventional agricultural inputs and practices.

Puddling of rice fields showed the highest disagreement of any item, with 47.50% strongly disagreeing and 25.50% disagreeing, a combined 73.00% disagreement rate. This reflects a knowledge gap about the methane emissions associated with flooded rice cultivation, which is one of the significant sources of agricultural greenhouse gas emissions in India (Smith *et al.*, 2014) [23]. Improper waste management and open dumping of cow dung also received majority neutral responses (53.00% and 56.50% no opinion respectively), suggesting awareness of these practices as hygienic problems but not necessarily as climate-relevant activities. These findings align with Tripathi and Bhattacharya (2017), who found that in central Indian farm communities, the link between on-farm practices and climate change causation is frequently underestimated.

Table 3: Distribution of respondents based on activities believed to cause climate change (n=200)

S. N.	Causal Activities	SD F	%	D F	%	NO F	%	A F	%	SA F	%
1	Puddling of rice fields	95	47.50	51	25.50	43	21.50	0	0.00	11	5.50
2	Excessive use of fertilizers	21	10.50	33	16.50	75	37.50	49	24.50	22	11.00
3	Excessive use of pesticides	22	11.00	32	16.00	70	35.00	43	21.50	33	16.50
4	Irrigation waste due to improper irrigation systems	22	11.00	44	22.00	66	33.00	51	25.50	17	8.50
5	Burning crop residues	32	16.00	30	15.00	71	35.50	63	31.00	4	2.00
6	Improper waste management	19	9.50	32	16.00	106	53.00	40	20.00	3	1.50
7	Dumping cow dung in the open	18	9.00	52	26.00	113	56.50	17	8.50	0	0.00
8	Burning organic materials as fuel (dung cakes, dry forest)	32	16.00	35	17.50	70	35.00	52	26.00	11	5.50
9	Deforestation	0	0.00	6	3.00	10	5.00	45	22.50	139	69.50
10	Burning fossil fuels used for transportation	0	0.00	9	4.50	15	7.50	114	57.00	62	31.00

Note: SD = Strongly Disagree, D = Disagree, NO = No Opinion, A = Agree, SA = Strongly Agree

4. Conclusion

This study assessed the climate change awareness, impact perceptions, and causal beliefs of 200 farmers in the Lower Arpa River Basin, Chhattisgarh. The findings reveal that while farmers possess meaningful some awareness of climate phenomena — particularly health impacts, atmospheric pollution, and seasonal shifts — full awareness

remains limited across most indicators. This suggests that farmers in this community are observant of environmental change but have not yet developed a comprehensive understanding of climate change as an integrated system.

Regarding perceived impacts, farmers most strongly recognized increasing health problems and declining biodiversity, and moderately acknowledged rising infrastructure costs and shrinking pasture areas. However,

perceptions of impacts on water availability and fish biodiversity were divided, reflecting the site-specific nature of climate impacts and the need for locally calibrated extension approaches. In terms of causal attribution, deforestation and fossil fuel combustion were strongly identified as drivers of climate change, while the climate relevance of common agricultural practices such as paddy puddling, crop residue burning, and excessive fertilizer use was significantly underestimated.

These findings carry important implications for agricultural extension programming in the Bilaspur district and comparable zones of central India. First, awareness-building programs should be designed to move farmers from partial to full understanding of climate change, using experiential learning methods and field demonstrations rather than passive information dissemination. Second, extension messages must specifically address the connections between on-farm practices and environmental change, helping farmers recognize their role as both victims and contributors to climate change. Third, Krishi Vigyan Kendras, state agricultural departments, and local self-governance bodies should collaborate to deliver climate literacy programs integrated with practical training on low-emission and climate-resilient farming techniques. Future research should examine how awareness levels translate into actual adaptation decisions and explore the role of socioeconomic variables such as land size, education, and household income in shaping climate perceptions in this region.

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