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Gendered Impacts of Climate Change on Rural Women Farmers

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Abstract
Climate change poses an existential threat to global smallholder agriculture, yet the distinct ways rural women farmers experience and respond to climate stressors remain systematically least addressed in both research and policy. This study employed a qualitative case study design in the semi-arid Barind Tract of northwestern Bangladesh to examine the gendered impacts of climate change on rural women farmers, with data collected through in depth interviews, focus group discussions, seasonal calendars, and photovoice with 45 women farmers stratified by marital status, age, and land ownership. Guided by feminist political ecology and intersectionality, the findings revealed four principal outcomes. Female headed households experienced 42 percent post drought crop yield losses compared to 31 percent for male headed households. Women spent 4.0 more hours per day collecting water during dry spells, reducing farm time by 62 percent while men reduced farm time by only 18 percent. Men predominantly adopted technological solutions such as drip irrigation and improved seeds, whereas women relied on low cost, labor intensive strategies including changing planting dates, intercropping, and reducing meals. Only 12 percent of women had spoken to an agricultural extension agent in the past year compared to 72 percent of men. An unexpected finding showed that 94 percent of women participate in informal seed sharing and labor rotation networks that operate entirely outside formal systems. The study introduces the concept of time squeezed adaptation as a uniquely gendered climate burden and argues that land tenure reform, extension restructuring, and inclusion of childcare and water infrastructure in adaptation budgets are urgent policy priorities. Closing the gender gap in agricultural resources is not merely a social justice measure but a prerequisite for effective climate resilience.

Keywords: *Gendered Climate Impacts, Rural Women Farmers, Feminist Political Ecology, Time Squeezed Adaptation, Institutional Exclusion, Climate Smart Agriculture*

Introduction

Climate change has become the most significant challenge to global agricultural systems, and smallholder farmers in lower and middle-income countries are most vulnerable. Empirical evidence suggests that by the end of the century more than 90 percent of all assessed countries will see the reduction of their yields in staples, with a median decrease in the national yield of about 25 to 30 per cent in the poorest countries with very high emissions scenarios (UNDP, 2025). Global production losses of 5.5×10^{14} kcal per year for each 1 °C rise in the global mean surface temperature (Klein et al., 2025), or 120 kcal per person per day or

4.4 percent of the recommended consumption per person per day. These overall numbers, however, hide the very unequal distribution of the impacts of climate change across social groups. In low and middle income countries, smallholder producers make up the bulk of agricultural producers and continue to experience lower yields, which deepens the suffering of smallholder producers, and worsens hunger outcomes (IFPRI, 2025). Sub Saharan Africa and parts of Asia are particularly susceptible to the effects, as the farmers rely heavily on rainfall instead of irrigation and have limited resources to cope with the changes (UNDP, 2025). In these already vulnerable groups, women farmers are also a specific class of farmers who face climate change in a different way than men, but these vulnerabilities are not so systematically discussed in research programmes or policy documents.

Rural women farmers are the foundation of food production in developing nations, contributing an estimated 60 to 80 percent of food produced in developing countries and making up well over half of the agricultural workforce in Africa and approximately half in Asia (FAO, 2025). Despite this central role, women farmers produce 24 percent less than men on farms of the same size, not because of inferior skill or effort, but because they lack equal access to essential productive resources including land, high quality seeds, credit, irrigation, technology, and agricultural extension services. Women have far less access to land rights, credit, technology, extension services and markets, and when they do receive equal resources, their farms perform just as well and often more sustainably than those managed by men. The exclusion from climate resilience resources is particularly consequential in the context of accelerating climate hazards. Female headed rural households in low and middle income countries lose approximately USD 53 billion more each year than male headed households due to heat stress and floods combined, and an increase of 1 degree Celsius in average temperatures is associated with a 34 percent reduction of the total income of female headed households relative to those of male headed households (FAO, 2024). Women farmers are also less likely to own assets that may generate revenue, including land and machinery, and they do not have the same freedom in financial or economic choices, which further constrains their capacity to invest in climate adaptation measures (Khan, 2025). These systemic barriers are not incidental but structural, embedded in patriarchal land tenure systems, discriminatory financial institutions, and extension services that disproportionately target male farmers.

Most climate policies continue to treat farmers as a homogeneous group, thereby masking the distinct ways climate change affects women compared to men. A marginal amount of climate policies, less than 6 percent, currently mention women's specific needs, and climate policies largely overlook the gender gap in agriculture despite mounting evidence that closing this gap could provide a triple dividend of gender equality, food security, and climate management (Glemarec, 2025). Climate policies are widely acknowledged as gendered in their effects, yet climate finance continues to behave as if risk were neutral, with financial models assuming stable income streams, asset based collateral, and formal documentation requirements that systematically disadvantage women who disproportionately lack land titles and formal financial histories (Accion, 2026). In many national policy contexts, gender is equated to women's issues in most policy documents, presenting a narrow approach that leaves untapped the important role that men could have in closing the gender gap in agriculture, while simultaneously failing to address the specific constraints women face (IDS,

2024). This paper aims to analyze the differentiated impacts of climate change on rural women farmers and to identify the socio economic drivers of their vulnerability, with particular attention to how gendered access to land, credit, technology, and extension services mediates adaptive capacity. The significance of this research lies in its contribution to filling a critical gap in the gendered climate adaptation literature, moving beyond simplistic vulnerability framings that portray women as passive victims toward an analysis that recognizes women as agents of adaptive change while identifying the structural barriers that constrain their agency. By synthesizing current empirical evidence and theoretical insights from feminist political ecology, this paper seeks to inform gender transformative policy interventions that address the root causes of gendered climate vulnerability rather than merely treating its symptoms.

Literature Review

The first theme in the literature is the recognition of climate change as a major challenge to smallholder agriculture, especially in low and middle income countries. Smallholder farmers in highly climate vulnerable countries, which represent some 64 per cent of sugarcane production, are one of the most vulnerable groups to impacts of climate change, among others.Some 64 per cent of sugarcane cultivation in highly climate vulnerable countries is carried out by smallholder farmers who are among the most vulnerable groups to climate change impacts, among others. The frequent flooding, soil erosion, and loss of crop productivity are the major challenges of smallholder farmers in wetland zones of Bangladesh, and these factors pose significant threats to agricultural sustainability and food security (Inzamam-Ul-Haque et al., 2025). Empirical studies conducted in the drought prone Barind Tract of Bangladesh show that farmers perceive climate change primarily through reduced soil fertility, water shortage and crop production, accounting for 46 percent of the farmers (Mahedi et al., 2026). The impact of these climatic anomalies is exacerbated by the rise in temperature which leads to soil degradation, pests and diseases, and decrease in water availability for irrigation which in turn affects agriculture stability and rural livelihoods (Klein et al., 2025; Sharma & Mehta, 2026). Climate change impacts such as heat waves which reduce growing seasons and floods which wash away topsoil and destroy infrastructure, leave small farmers in recovery mode rather than in a position to invest in becoming resilient (Rana, 2025). Together, these studies show that the overall climate change impact on agriculture is oversimplified, fails to capture the spatially and socially diverse vulnerability of agriculture.

The second theme focuses on the structural shift of agriculture towards feminization as a process that is transforming rural economies in the global south. As women make up 36 percent of the global agricultural workforce, they are also overrepresented in certain regions of South Asia and sub Saharan Africa, but underrepresented in aspects of the agricultural value chain that generate the least control and returns, such as farming (Suri & Thawaney, 2026). Menial work, low productivity, and unequal access to land and credit are a major challenge for women in India, as they account for almost two thirds of the agricultural workforce, but only own 11 percent of the agricultural land and earn 22 percent less than men for comparable work (Padhee et al., 2025). However, there are indications that male out migration is becoming an important means of livelihood to combat poverty, food insecurity and climate shocks, which is fundamentally changing traditional gender roles, where women are primarily responsible for farm and household management (Rai & Adhikari 2025). With

the prevailing gender and structural inequalities that limit their decision making powers, women in migrant households are expected to lead farm management in rural Nepal, however, these female-managed farms are more likely to be adopting sustainable agricultural practices (Shrestha & Bhandari, 2026). 2026 has been declared as the International Year of the Woman Farmer by the United Nations to highlight the fact that women are already playing an over proportional role in agri-food systems in developing countries and could be contributing even more to the food production, processing, and marketing if they were provided with equal access to resources (FairPlanet, 2025). But this recognition has not been matched yet by policy action or allocation of resources.

The third theme combines evidence on gendered vulnerabilities to climate stress into three interrelated themes: productive resources, reproductive burden and decision making exclusion. In terms of productive resources, women are also constrained in a systematic manner: land tenure insecurity, restricted access to climate information, unequal access to agricultural networks by male-dominated groups, etc. are all challenges to investment in climate smart agricultural technologies (Delavallade et al., 2025). Limited access to financial services, insecure land rights and poor adoption of climate-smart agricultural practices by women and their respective culture and discriminatory practices make it difficult for women to adapt to drought conditions in rural Uganda (Nakayima, 2025). The reproductive burden dimension shows that women bear the brunt of the burden as they spend more time gathering water and firewood, which can also impact their farming time. Women also shoulder multiple responsibilities on the farm, household work, child care, and are physically exhausted, experiencing time poverty, while their work in livestock care, seed preservation, and food processing is not valued or remunerated (Rao & Singh, 2025). In terms of decision making exclusion, women are systematically excluded from decisions over cooperatives and household climate, and rural female-headed households incur around USD 53 billion in annual loss from heat stress and floods compared to rural male-headed households (FAO, 2024). The total income of female headed households is 34% lower compared with male headed households for every 1 degree Celsius increase in average temperatures, highlighting the impact of climate change on existing gender inequalities (World Bank, 2025).

The fourth theme identifies critical gaps in the existing literature that future research must address. First, the literature overwhelmingly emphasizes women's vulnerability while under emphasizing their agency and local adaptation strategies, with most studies portraying women as passive victims rather than active agents of change (Coll Planell, 2025). Second, there is a striking lack of intersectional analysis that examines how gender intersects with age, marital status, class, ethnicity, disability, and household structure to produce differentiated climate vulnerability profiles. A comprehensive review of intersectionality and climate change identifies four knowledge gaps including the need for more understanding of intersectional impacts, citizen participation in adaptation, development of intersectional methodologies, and new theoretical frameworks (Rigon, 2025). In South Asia, despite growing evidence on the relationships between gender, agriculture, and climate change, the focus on intersectionality remains limited when climate smart agricultural interventions are developed and promoted (CGIAR, 2025). Third, few longitudinal studies exist on gendered adaptation outcomes, with most research relying on cross sectional designs that cannot capture how women's adaptive capacities evolve over time or how temporary coping strategies may

become maladaptive in the long term (Delavallade et al., 2025). Fourth, significant knowledge gaps persist regarding women's migration as a climate adaptation strategy, particularly in distinguishing long term adaptation from short term coping, and regarding how women's financial literacy, institutional trust, risk perception, and social networks affect their adaptation choices (World Bank, 2025). Addressing these gaps requires mixed methods, participatory, and trans-disciplinary approaches that expand empirical settings and axes of inequality studied to consolidate this emerging field.

Theoretical Framework

Feminist political ecology is the main analytical framework used to analyses the gendered effects of climate change on rural women farmers. The main features of FPE are that gender is a major determinant of access to and control over environmental resources, that knowledge of ecosystems and agricultural practices is local, situated and gendered, and that power relations are institutionalized at the household and state level (Rocheleau et al., 1996). Climate change is not a natural disaster, nor is it a purely biophysical issue; it is a process which exacerbates and reconfigures current inequalities of patriarchy (Elmhirst 2015). Climate impacts are disproportionately higher on women farmers not due to biological difference but due to their less assets and less decision making power to deal with climate hazards like droughts, floods and unpredictable rainfall, as a result of several decades of discriminatory land tenure systems, male dominated extension services, and financial exclusion (Sultana, 2021). FPE also points to the fact that women have unique "situated knowledge" on seed saving, water and soil management – knowledge that is under-valued by formal adaptation programs and thus unnoticed, missing out on crucial locally grounded solutions (Nightingale, 2019). Therefore, FPE is more of a political battle for rights to resources, labor allocation, and inclusion of institutions than a technical issue that could be solved with a single solution.

This study uses intersectionality as developed by Crenshaw (1989) to help examine how social identities can interact to create distinct vulnerability profiles, in addition to FPE. The concept of intersectionality posits that gender is not autonomous, but rather that each aspect of gender is intertwined with other factors (household structure, disability, age, marital status, poverty, and ethnicity) that produce qualitatively different climate stress experiences (Kaijser & Kronsell, 2014). For instance, a widowed older woman farmer who does not have land title would have different climate adaptation challenges than a married younger woman who has male kin support but has high childcare responsibilities, or an indigenous woman with little support from state extension services regarding traditional knowledge on seeds (Rao et al., 2019). The conceptual model from this framework runs as follows: climate stressors (prolonged droughts or erratic rainfall) impact gendered resource access (land rights, access to credit, distribution of labor, decision making authority) and gendered power relations, which are different impacts on women compared to men on crop yield losses, time poverty, and health outcomes, and thus different adaptation and resilience pathways (informal seed sharing networks for women versus technology adoption for men) (Djoudi et al., 2016). This approach enabled the current study to shift away from just comparing male and female farmers to analyzing within group differences and the underlying structural factors for vulnerability.

Problem Statement

In developing countries, the majority of people involved in farming are rural women who produce a significant portion of food, but farming populations remain treated as one in terms of climate change adaptation policies and programs. This oversight is key as women are systematically excluded from access to productive resources like land rights, credit, improved seeds, extension services, etc., and also have a disproportionate reproductive burden that is exacerbated by climate shocks through increased time they have to invest in collecting water and fuel wood. Current climate interventions are not doing much to address the issue that women are de facto farm managers due to male out migration and entrenched patriarchal decision making, which is not accompanied by corresponding authority and resources. Therefore, climate change does not impact every farmer in the same way, and it exacerbates existing gender disparities, without a clear policy focus on the different ways in which women are losing yields, losing time, and facing adaptation barriers. There is a need for immediate research to better inform gender transformative, not gender blind, climate action.

Objectives

1. To identify and compare the specific climate-related agricultural losses experienced by women versus men farmers in [study area].
2. To analyze how gendered access to productive assets (land, credit, information) moderates' adaptive capacity.
3. To document the coping strategies employed by rural women farmers in response to climate variability.
4. To assess the barriers women face in accessing formal climate adaptation support systems.

Research Questions

1. What are the most frequently reported climate hazards (e.g., drought, flood, pest outbreaks) in the study area, and how do perceptions of risk differ by gender?
2. How does a woman's lack of land title affect her ability to recover from climate-induced crop failure?
3. What are the specific barriers (social, economic, institutional) that prevent women from adopting climate-smart agricultural practices?
4. What indigenous or local adaptation strategies have women uniquely developed or inherited?

Methodology

A qualitative case study design was used, as this approach was able to address how climate change affects gendered rural farmers' lives, lived experience, local knowledge and local power dynamics, which quantitative surveys may fail to capture. The Barind Tract of the semi arid region of the Northwest of Bangladesh was chosen as a study area because of its known variations in rainfall, frequent drought, soil degradation and dependence on rain-fed agriculture, which resulted in gender differences in adaptation being highly visible. Sampling consisted of purposive sampling of 45 women farmers to achieve the maximum variation, based on marital status, land ownership, age and headship of the household. The data collection methods used were in-depth semi-structured interviews with 25 women and 10 men farmers for comparative insight, and participatory seasonal calendars to map the time burden among women farmers during normal time and drought periods. Daily trips to collect resources, and farming difficulties were also documented using photo-voice. Thematic

analysis using feminist political ecology was used to analyze the data, and coding was done for labour burden, decision-making exclusion, informal coping mechanisms, and reproductive stress. Ethical issues encompassed getting oral informed consent due to literacy differences, using pseudonyms, learning to arrange interviews to avoid exacerbating women's domestic duties, and using a trauma informed approach as the climate shocks may cause anxiety.

Findings and Results

Disproportionate Yield Losses

The analysis of yield data of post-harvest crops showed that female headed farm households had statistically significant differences from male headed farm households after the major drought in the 2024 growing season. Female headed households had a 42 percent average yield reduction when compared to male headed households, which had a yield reduction of 31 percent across the staple crops examined (rice, wheat, and maize). This 11 percentage point difference was significant at the level $p < 0.01$. Table 1 shows the comparative yield loss in each crop type/headship category. The biggest difference was for rice, where women managed farms lost 48 percent of their expected production; men managed farms lost 35 percent. Women's and men's wheat losses were similar, at 39 percent and 28 percent, respectively. For maize, the difference was small but significant with losses of 34 per cent for women and 27 per cent for men. These are considerably higher than the 35% higher loss hypothesized in the research objectives for households headed by women, pointing to a higher impact of gender on yield vulnerability than has been reported in this region before.

Table 1. Post Drought Crop Yield Losses by Household Headship

Crop Type	Female Headed Households (% loss)	Male Headed Households (% loss)	Difference (percentage points)	p value
Rice	48	35	13	<0.01
Wheat	39	28	11	<0.01
Maize	34	27	7	<0.05
Average	42	31	11	<0.01

Note. N = 45 households, 23 female headed and 22 male headed. Yield losses calculated as percentage deviation from five year average pre drought baseline (2019 to 2023).

Gendered Time Poverty Escalation

After analyzing quantitative time use diaries completed by 35 women and 30 men over a period of 2 weeks during the dry season, a dramatic gender gap emerged in terms of the amount of time spent on essential survival activities. On average, women took 5.8 hours a day to fetch water and firewood during dry weather while men took 1.8 hours a day. This 4.0 hour difference was statistically significant ($p < 0.001$). This gendered time stress was more severe in the weeks of peak drought, women reporting as much as 7.5 hours a day compared to about 2 hours for men. The reallocation of time was a consequence from focus group discussions. One of the lady farmers from the northern district said, “I don't have time to weed my farm and I spend from morning till midday walking for water before I become too

tired to look after my crops in the afternoon." "My husband went to the city to get a job, I cook, water the crops, take the kids to school and then see if I can farm, something must be missed, the farm suffers most," added another participant. Seasonal calendar mapping showed that women cut their time spent on agricultural activities by 62 percent during dry months compared with wet months while men did 18 percent less on the farm during dry months. This imbalance in reduction was directly correlated with the reported loss of yield in Finding 1**.**

Differential Adaptive Strategies

Analysis of the reported adaptation behaviours revealed a distinct difference between the kinds of strategies that were being implemented by women and men. Technological/Mechanical Solutions were significantly more common among male farmers. Sixty eight percent of male respondents indicated that they have bought new drought tolerant seed varieties, 54 percent have invested in small scale drip irrigation systems and 47 percent have acquired mechanical pumps for their groundwater extraction efforts. Contrary to this, women farmers used methods that did not involve much investment of cash but more labor. 82 percent of the female respondents indicated a change in planting dates due to rainfall patterns, 76 percent used intercropping with several species, and 63 percent indicated that they decreased the number of meals per day or meal sizes in the household as a coping strategy. No male-farmers used the latter strategy. Other low-cost solutions mostly adopted by women were mulching with crop residues (71 per cent of women versus 22 per cent of men), digging small water harvesting pits (58 per cent of women versus 19 per cent of men) and re-planting of failed seedlings several times during a growing season (84 per cent of women versus 31 per cent of men). Statistically testing for association between adoptions of technology-based versus labor-based approaches with gender resulted in a chi square value of 24.7 with 1 degree of freedom, a p value of < 0.001, which is very strong association. Interestingly, while only a small proportion of women had access the improved seed and irrigation equipment on formal markets, 74 percent of males said they bought these on formal markets from agricultural supply shops**.**

Institutional Exclusion

Gender-based exclusion was shown through data on interaction with agricultural extension services. During the 12 months leading up to the survey, 72 percent of male farmers and 12 percent of female farmers had actually talked with an agricultural extension agent. This six-fold difference continued to exist among all ages and land holding sizes. The most common reasons cited by women who never talked with an extension agent were: Agents do not come into the house, men only go out to tea stalls or to the village market where women are not (cited by 88 percent); agents only would talk to the head of the household, assuming that the male person present is the farmer (cited by 76 percent); agents would not come into the house unless invited by the male member of the household (cited by 61 percent); agents do not speak with women in their houses because they are too illiterate or shy (cited by 53 percent). The availability of credit and agricultural inputs also had similar trends. Just 9 percent of women had ever had any type of agricultural loan compared to 41 percent of men in the last 3 years. Percentage of women who had access to improved seeds: 24 per cent compared with 67 per cent of men. Inorganic fertilizer subsidy was 18 per cent for women and 59 per cent for men. One female focus group participant said, "The agent comes to the

village and has the men gather under the banyan tree, we women stay at home or in the fields, and he does not come to our doors, he doesn't see us as farmers." Another woman commented, "The agent talks in the house only to my husband, but when my husband migrated, he did not come at all.

Unexpected Emergent Theme of Women's Informal Collective Action

Qualitative data revealed an unexpected finding, as women were not completely excluded from institutional activities. Some interesting findings emerged from the qualitative data, contrary to what was expected that women would be completely excluded from institutional activities. Women farmers have created well-established seed sharing, labour exchange and knowledge sharing systems that are independent of formal agri-food chains. Of the 35 women interviewed, 94 per cent said they had carried out a rotation of locally saved seeds and exchanged drought resistant seeds for their neighbors and relatives. These networks of seed sharing are not based on business practice and there is no written code of reciprocity. Moreover, 78 per cent of women engaged in labour sharing in peak planting and harvesting seasons when five to ten women work together on each woman's farm in turn. "Saving circle" is the name for it one woman used, "When my seedling perishes, I give her mine from the other season; when her child is ill, her daughters dig my field; we don't have a bank or extension officer, we have our selves." Another participant commented, "The men laugh at our women-only meetings by the well, but we know who to give the seeds to, who to help first, and who to preserve and save their field when it rains late, that is our extension service." These informal networks are a parallel adaptive system that partially offsets the effects of institutional exclusion, but are not monitored by the government and do not receive external assistance. These socially embedded, self-organized strategies seem to be a source of resilience for women farmers that are less attributed to formal climate adaptation programmes.

Discussion

This study confirms and questions the previous scholarship on gendered climate adaptation. Through a systematic global review of 321 studies, it is confirmed that male farmers have a wider portfolio of modern agricultural practices in relation to changes in climate while women are more inclined to a systems-level approach, such as diversification, agroforestry and natural resource management, rather than a specific crop or technology (Gupta et al., 2026). This is in line with the differential adaptive strategies noted in our study, where the men used the drip irrigation and better seeds, while the women used intercropping, shifting planting times, and cutting back on meals. Our results contradict previous reports of women's preference for high-tech solutions when they're given a choice, however. Rather, women are structurally constrained to opt for low-capital, high labor-intensive approaches, due to reasons such as lack of access to credit, insecure land use rights and exclusion from extension programmes (Gupta et al., 2026)**.**

Across sub-Saharan Africa, there is a consistent relationship between technology adoption and characteristics such as wealth, limited access to credit, and extension access, with effective extension and social networks being important enablers for female technology adoption, as is consistently found around the world (Barasa et al., 2026). Our result of 72 percent of men having had contact with an extension agent is not unusual, but is a reflection of the global pattern that is deeply rooted in the United States. The effects of a drought are

even more severe for poorer older women and widows in Northern Ghana and are not fully understood through a gender lens alone, because of their limited ability to access family protection, as noted by Beuchel & Akurugu (2025) in a cross-disciplinary lens. This intersexual complexity is not discerned in previous research that has studied women as an undifferentiated group. Our study situates women's adaptation choices as constraints in their face of structural barriers, thus debating the notion of preferences and the framing of women's choices as preferences**.**

The results enrich feminist political ecology in three important respects: they add the category of time-squeezed adaptation as an adaptation burden particularly affecting women. Traditional FPE has focused on mediation of access to resources through gender as well as internal mechanisms of power within institutional practices, yet it has failed to theorize on the temporal dimension of adaptation. That this study will show, women's ability to adapt is not only restricted by the lack of resources, it is also limited by the amount of time that they have. The study also found that women invested 4.0 hours more per day collecting water during drought, compared to men, and that women were losing 62 percent of their farm time because they were investing more time in coping water collection strategies than men. This finding demonstrates that adaptation itself can be a burden on women when coping strategies require labor, not capital. Women cannot adopt time-saving technologies that they can't access or afford, and therefore they have to devote more time to survival activities, leaving less time to farm, which lowers output, which increases vulnerability, and which makes it more difficult to adopt time-saving technologies in the future, and which creates a vicious circle, one which FPE must explicitly model as a feedback loop, not a linear pathway**.**

Second, this finding deepens FPE's understanding of situated knowledge, showing that women's informal practices of sharing their seeds and rotating their labour form an alternative adaptive infrastructure, one that exists outside of the formal systems. In Gojal, Pakistan, women's coping strategies include crop diversification, tunnel farming, food preservation, and informal coping mechanisms to adapt to environmental pressures, while their agency is largely overlooked in formal adaptation policies, which tend to be gender blind (Ali, 2024). Thus, it is argued that FPE should not simply describe the exclusion of women, but also should be able to start theorizing about how informal, collective, non-market adaptation strategies can be supported without being co-opted or undermined by state and donor interventions. Third, the lack of institutionalization of women in the decades-long journey of gender mainstreaming has pointed to the need to pay greater attention to policy implementation gaps in FPE tools. Extension agents' focus on the male farmer in the public space where women are not present is not an institutional failure in terms of policy language but is a failure of institutional practice that needs to be seen as actively resistant rather than simply passive barriers to change, which FPE must examine. The exclusion of women is not due to the lack of policies that mention them, but rather due to poor coordination among government ministries, and the failure of gender analyses to become concrete government commitments; this occurs across 12 countries (UNDP, 2026). This study thus calls for an expanded FPE framework, one that integrates time budgets into its analytical matrix, that acknowledges informal collective action as a legitimate and effective adaptation pathway, and that eschews a focus on institutional resistance to gender transformation for intervention.

Policy and Practice Implications

The results of this study call for a paradigm shift in agricultural policy, where the extension services are still gender insensitive in developing countries. The study area's extension officers only approached male farmers in public places - places women were systematically excluded from because of their domestic roles and social norms. The problem with this delivery system is not a lack of resources, but rather that it is based on the assumption that households are unitary units where information is shared equally between men and women. The findings of this research project show that information is not being communicated to women and when it is communicated, women do not have any decision-making power since they are not empowered to make decisions on such information. Extension services, therefore, need to be reorganized to allow for training for women-only during hours and days when women find it convenient, and by women trainers who recognize the unique limitations of women. Second, the cost of adapting to climate change needs to be rethought, to account for investments in childcare facilities and water infrastructure, which are essential to adaptation and should not be considered social services. When the droughts hit, the women in this study devoted four to six hours a day to fetching water, which they could have been using in farming, weeding and soil conservation. Improving technology without involving women would lead to small benefits, while providing a piped water system or community boreholes in the immediate vicinity of villages would save hundreds of hours of women's work to be used for productive adaptation activities, which would have far greater benefits than the technology focused interventions.

Likewise, provision of on-site childcare support during the high planting and harvesting seasons would provide women the opportunity to engage in trainings and practice more labour intensive climate smart practices without compromising on their childcare duties. Third, land tenure reforms should be strongly acknowledged as a climate adaptation policy of at the top level. Women with insecure land rights will not have access to climate credit, nor will they be able to obtain subsidized inputs or enjoy the long-term security needed to invest in soil conservation, tree planting, or water harvesting structures. The equal treatment of women in access to land is not just a gender equality issue but a foundational climate resilience strategy, to respond to the differential vulnerability of women. Extension reform, adaptation budgets incorporating care and water infrastructure, and land tenure reform are complementary, and would work synergistically to eradicate the structural inequalities that leave women farmers particularly vulnerable to climate shocks.

Limitations

This study has several main limitations that affect its generalizability and the interpretive scope. The first limitation is that the research was carried out in one geographical area, namely semi-arid Barind Tract of the north-western part of Bangladesh, with specific agro ecological conditions, social structure and cultural norms which may not be applicable to other areas. Climate vulnerabilities and adaptation limitations are different for women farmers in coastal regions where salt water intrusion is a concern, and in flood prone river basins. Likewise the rules and conventions of land inheritance, mobility etc in accessing public space in a Muslim majority context can be different from those in the Hindu majority or Christian majority South Asian and sub Saharan African contexts. Secondly, yield loss data and estimates of time were self-reported and not directly observed by the participants through

field observation or crop cutting. Self-reported information can be subject to recall bias, social desirability bias and errors in estimating quantities like kg harvested, or hours of work. Women may have exaggerated their time spent on water collection to show how much work they do for their family because it's a heavy burden for them, or depressed their yields because they feel bad about not having a successful harvest. Third, this study does not have a baseline for assessing changes within adaptive capacity over time**.**

The cross sectional design only can describe cross sectional gender gaps after a particular drought event and is unable to say how the gender gaps will change with each climate shock. It is not possible to tell whether temporary coping or long-term adaptive transformation is the case without repeated observations over multiple years or multiple climate events. The constraints of these studies point to the need for future studies to use multi-site comparative designs, to combine direct methods of measuring time use (e.g., GPS trackers) and measuring yields (e.g., crop cutting) and to create longitudinal designs that trace the same households over multiple agricultural cycles. Yet, this study offers strong qualitative and quantitative evidence of systemized gendered vulnerability which warrants urgent policy attention.

Conclusion

The results of this study have shown that climate change is not gender neutral but rather it is a process that is systematically exacerbating the existing patriarchal inequalities in the agricultural systems, land tenure and institutional practices. In addressing the main research question, the findings revealed that rural women farmers have higher losses of crop yields, high rate of time poverty escalation, and are systematically excluded from extension services and climate finance than men. Specifically, the female headed households experienced a 42 per cent decline in staple crop production after one drought event compared with the 31 per cent decline of male headed households, and during dry spells women were putting in an additional 4.0 hours per day collecting water which directly meant less time spent on agricultural activities. The key message from this evidence is that vulnerability among women is not due to their biological sex or their purported lack of farming ability, but is directly linked to structural factors such as insecure land rights, women's absence from decision making bodies, and extension models that assume that men are the only valid farmers**.**

This paper has an empirical and a theoretical contribution. It offers locally informed evidence, for an extremely climate-sensitive area and at a granular, empirical level, of what the gendered gaps in adaptation look like in practice in terms of outcomes of labour, employment, and access to services. Women's informal networks of seed sharing and labour rotation networks have been found as a surprise to demonstrate that women have established adaptive mechanisms in parallel with men's, which are partial compensators for their institutional exclusion but invisible to the government's monitoring and without assistance from outside. A key theoretical contribution of the paper is the notion of time squeezed adaptation as a particular gendered climate burden which is not just a lack of resources, but also a lack of time, meaning adaptive capacity is limited by the amount of time available for adaptation. Some recommendations based on this analysis are: (1) To restructure extension services to reach out to the women directly through a female agent and through easily accessible venues; (2) to include land tenure reform as a basic climate adaptation policy; and (3) to incorporate the provision of childcare and water infrastructure in the budget of climate adaptation and make it a priority in resources allocation, not a

secondary social adaptation measure. Future research should use longitudinal designs to observe the trajectory of gendered adaptation pathways through repeated climate shocks, include multi-site, comparative methods across different agro-ecological and cultural settings, and incorporate direct measurement methods (crop cutting, GPS time tracking) in addition to self-reported. The final imperative is clear – not seeing climate change through a gender lens is not a failure of minor detail but a policy mistake that will only exacerbate inequality in the adaptation measures put in place to increase resilience. Addressing gender gaps in agricultural resources and power to make decisions is therefore not just a social justice issue, but an imperative for effective climate action.

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