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# Do gender differences lead to unequal access to climate adaptation strategies in an agrarian context? Perceptions from coastal Bangladesh

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## ABSTRACT

While people around the world are increasingly facing various climate-related stresses, women with limited resources in low income developing societies are often at a greater risk largely because of their pre-existing constraints on social, economic, political, and cultural resources and opportunities. In this paper, we investigate how gender differences influence farmers' access to various resources that are critical for local climate adaptation in coastal Bangladesh. As one of the most climate-vulnerable regions in not only the country but the world, coastal Bangladesh is experiencing a significant increase in sea level rise, tropical cyclones, storm surges, coastal flooding, coastal erosions as well as unpredictable rainfall patterns. All of these climate related stresses directly contribute to the region's increasing exposure to saltwater intrusion in coastal lands and freshwater sources. While a majority of the previous research has focused on community-based climate adaptation, there has been limited attention on how gender differences shape local farmers' climate adaptation strategies. Using mixed-methods research, this article highlights the ways in which male-headed and female-headed farming households have differential access to locally available adaptation resources along with associated constraints or opportunities for adaptation and disaster risk reduction strategies vary substantially. Our findings suggest female-headed farms are less likely to sell their farmland or migrate away in search of non-farm income due to normative gendered expectations and socio-cultural restrictions. Therefore, female farmers are forced to pursue in-place farming adaptation strategies with limited external resources while relying on informal social networks for weather and climate information.

## ARTICLE HISTORY

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## KEYWORDS

Climate adaptation; coastal Bangladesh; gender differences; female-headed farming households; Kalapara

## Introduction

People who live in disaster-prone coastal regions are among the most climate vulnerable populations in the world (Huynh and Stringer 2018). In addition to the physical exposure to various environmental stresses such as coastal flooding, coastal erosions, tropical cyclones, storm surge, rainfall anomalies, and salinity intrusion (i.e. the movement of salt water into coastal lands and freshwater sources), people with limited social, economic, and political resources and opportunities experience the most adverse consequences to their livelihoods and overall health and well-being (IPCC 2014). Evidence suggests that pre-existing social and economic challenges, such as poverty,

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hunger, and marginalisation, interact with climate change phenomena and further amplify the vulnerability of poor and marginalised populations (Thompson-Hal, Carr, and Pascual 2016; Tschakert, St. Clair, and LaMadrid 2013).

Throughout the Global South, this unequal exposure to climate change and differential capacities to cope with those stresses are largely shaped by the deep-rooted structural challenges, such as social marginalisation, religious and ethnic exclusion, unequal land ownership, and inequitable social relationships (Marino and Ribot 2012; Wisner et al. 2004). In most patriarchal societies, gender, the socially constructed roles and expectations for both men and women, can be a determining factor of unequal access to and possession of various livelihood resources including food, land ownership, weather and climate information, and adaptation techniques (Farnworth et al. 2016; Mehar, Mittal, and Prasad 2016). Additionally, female members of rural households have different concerns and resources available to meet their reproductive needs than male household members (Beuchelt and Badstue 2013).

Gender differences often have been used to identify social vulnerability in various agrarian contexts (Bryan et al. 2013; Mehar, Mittal, and Prasad 2016; Ngigi, Mueller, and Birner 2017). Such research illuminates the complex but delicate interactions between humans and the environment where societal forces can aggravate overall climatic vulnerability. Inequalities due to gender differences shape differing levels of access to locally available adaptation resources. In many situations, this unequal access to adaptation resources can further entrench local inequality as well as pre-existing vulnerabilities (Björnberg and Hansson 2013). Therefore, we need to consider the adaptive capacities and adaptation barriers that people may face due to their gender differences.

Scholars agree that climate change has magnified existing vulnerabilities already felt by women in many resource-constrained patriarchal societies (Cannon 2002; Denton 2002; Ngigi, Mueller, and Birner 2017). In the Global South, when agricultural output is impacted by adverse climate consequences, it directly affects the nutrition level of an entire community in which women in particular are disproportionately affected (Kartiki 2011; Beuchelt and Badstue 2013). Similarly, as communities adopt new household strategies to cope with climate stresses, women often find their share of the household work increased. Women face challenges in accessing firewood and water, adapting crop and livestock patterns, and coping with increased conflict over locally available natural resources (Jost et al. 2016). Women subsequently find their physical health deteriorates due to their increased physical responsibilities in this climate vulnerable context (Whyte 2014).

Not only does research suggest that women are inherently more vulnerable to the effects of climate change (Björnberg and Hansson 2013; Ikeda 1995), but they may also face barriers that reduce their adaptive capacity (Kartiki 2011; Juran and Trivedi 2015; Mersha and van Laerhoven 2016). In addition, this climate vulnerability also lead to the victimisation of women in certain circumstances (Evertsen and van der Geest 2020).

In Bangladesh, women typically receive less education, lower access to financial capital, own less than 10% of the land, and receive only 5% of all agricultural assistance services (Alston and Akhter 2016). They also have less power and influence over decisions that are made by male household members (Islam 2018). Women are also limited by sociocultural norms that make it difficult for them to travel alone or enter busy markets unaccompanied (Jost et al. 2016). Such background contexts severely impact women's capacity for risk management and climate adaptation. In rare occasions, women heading their own farming households deviated from local gender expectations pertaining to traditional family maintenance and childcare and pursued their own economic autonomy (Djoudi and Brockhaus 2011). It is estimated that if women had the same access to agriculture and agricultural resources as men, farm yield could have increased by 20–30%, and the total amount of food insecure people around the world would have decreased by 12–17% (FAO 2011).

However, despite their gender identities under common circumstances, people typically employ multiple responses and adaptation strategies based on their needs, available resources, and individual or collective capacities (Alam, Alam, and Mushtaq 2017). They found that in rural Bangladesh, regardless of farm size, 91% of households had adjusted their planting time according to new

weather patterns, 93% had begun cultivating high yielding rice varieties, 83% were cultivating vegetables, and 54% added livestock rearing. Therefore, understanding geographic and individualised contexts is increasingly important to explain the role of gender on farmers' adaptation to climate change and their risk management strategies (Jost et al. 2016).

There are relatively few studies that tried to understand existing environmental stresses perceived by the affected communities themselves (Rahman et al. 2018). Perceptions of those affected people and their resources, opportunities, and barriers to cope with localised environmental stresses can provide critical insights on the existing adaptation practices along with associated challenges as well as opportunities at both finer and coarse scales (Moser 2010; Parry 2001). This article unpacks the effect of gender on farmers' access to locally available resources that can be crucial for climate adaptation in coastal Bangladesh.

We argue that men and women facing the direct effects of climate change have access to different resources and therefore pursue adaptation differently. Findings highlight the adaptation barriers that women are facing largely due to normative gendered expectations on household and community levels, added livelihood stresses because of changing patterns of weather and climate, as well as limitations and inefficiency of locally available government services and supports that are critical for implementing any localised adaptation.

## Study area and research approach

### Study area

Coastal Bangladesh is at the frontline of global environmental change, and people in the region are constantly exposed to risks including sea level rise, salinity intrusion, coastal flooding, coastal erosion, unpredictable changes in rainfall patterns, and increased frequency and intensity of tropical cyclones (Hossain 2015). The region is approximately 47,201 square kilometres, which is 32 percent of country's total landmass (Figure 1).

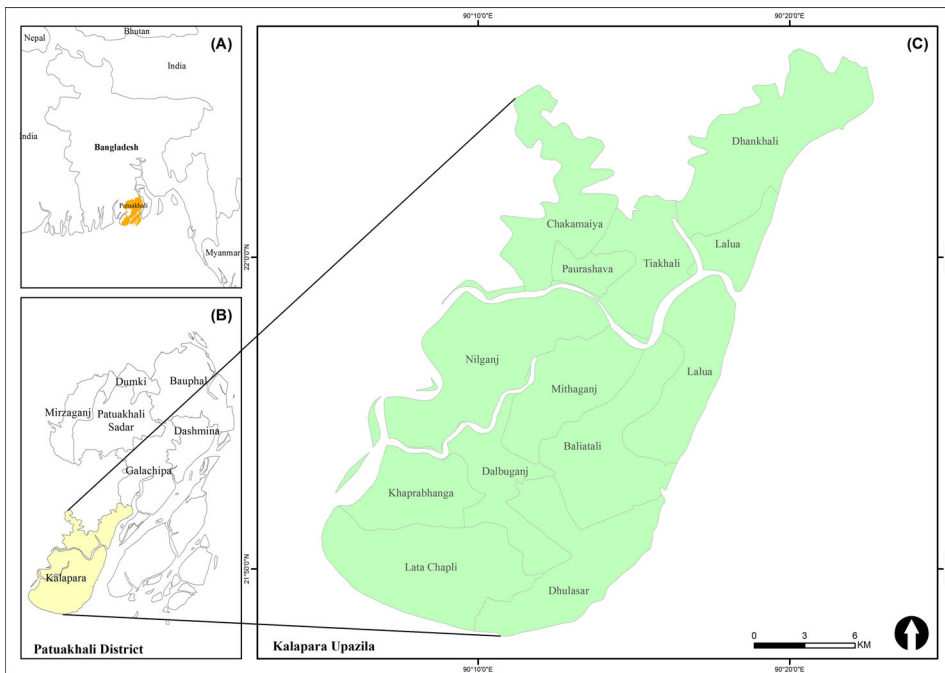


Figure 1. Study area.

The geographical focus of this article is Kalapara Upazila (a local administrative unit; sub-district), which is the southern-most coastal sub-district of Patuakhali. It is one of the most climate vulnerable areas in the country. Kalapara is approximately 492 sq. kilometres in size and has a population of 238,000. The area was chosen as the study site because of its vulnerable location and exposure to various climate stresses, local dependency on farming, and fishing as major livelihood options, and perennial loss of agriculture lands and productivity because of various natural hazards. People in Kalapara are constantly and increasingly forced to adapt to climate-related stresses (See Table 1) (Upazila Disaster Management Committee 2014).

Smallholder farming is the most common form of income-producing activity in Kalapara (Hoque 2014). Traditionally, farmers in Kalapara have five major growing seasons: summer (April–June), monsoon (July–August), pre-winter (Sept–Nov), winter (Nov–Jan), and post-winter (Feb–March). In summer, the crop production is minimal, producing only a small amount of vegetables typically used for household consumption. Additionally, summer farming is not cost-effective due to increased irrigation expenses. However, monsoon season brings significant rain, and the majority of farmers use that time for rice cultivation. This is season when local farmers produce the largest amount of crops. In pre-winter and winter seasons, farmers focus on smaller crops such as cauliflower, lentils, and potatoes. During post-winter conditions, farmers prepare for growing rice again, and harvesting extends to the end of monsoon season. For smallholder farmers, they consume as a household first and then sell surplus crops in local markets to supplement household incomes. For large commercial farmers, their priority is to sell crops for profit in local and national markets rather than their own household consumptions.

Only a limited number of the local farmers in the region can afford modern agricultural machinery and tools to increase farm productivity due to financial constraints (Ahmed and Cokinos 2017). Lack of access contributes to lower crop yield and lost income potential among these smallholder farmers, which reproduces heightened vulnerability to climate change impacts and entrenched poverty (Hossain 2015).

Even though all people who live in disaster-prone regions in Kalapara are highly vulnerable to climate change, smallholder farmers, particularly those who already struggle with their limited resources and capacities, experience the most adverse consequences (Carter et al. 2007; Ahmed 2018). In recent years, even though there has been substantial progress on climate adaptation initiatives in the country, many people still face heightened vulnerability because of their pre-existing social, cultural, economic, and structural barriers. For women in particular, these conditions often compromise their access to locally available adaptation resources.

## Research methods

This research followed a mixed-methods approach with data collected between September 2017 and January 2018. The primary author, who is familiar with local culture and is a native speaker, conducted the entire field study with the assistance of five local field assistants (two male and three female). Male field assistants were from Muslim and Hindu backgrounds, and female field assistants

**Table 1.** Disasters in Kalapara (2000–2020).

Disaster type	Year	Impacted sectors/resources
Cyclone	2007, 2009, 2013	Crop, livestock, infrastructure (e.g. roads, embankments, rural homesteads), and human lives
Salinity	Yearly	Crop, plants, livestock, human health
Coastal flooding	2000, 2013	Crop, fish, livestock, homesteads, human lives
Water logging	Yearly	Fish farming; livelihood
Riverbank erosion	Yearly	Farmland, homesteads, rural infrastructure
Heavy rainfall	2017, 2020	Crop, livestock, homesteads

were from Hindu, Muslim, and ethnic minority backgrounds. The composition of this team composition helped the primary author to design, conduct, and interpret culturally appropriate questions and responses. After the initial development of the questionnaire, the primary author conducted a workshop with field assistants to get their insights on adhering to local social and cultural sensitivities. After the initial development of the questionnaire, the field research team conducted a pre-test with 10 randomly chosen local farmers. However, these interviews were carefully administered to get reflections on gendered perspectives. Based on those insights, local research team revised the questionnaire again, resulting in its final version.

Semi-structured interviews, in-depth case studies, and focus groups provided specific insights into gender differences in adaptation strategies. The total number of households at the study site was 1049 (Hoque 2014). After completing 250 household interviews, the research team determined that a saturation point had been reached and no new information was being learned. When combined with time and financial resource constraints, it was determined, using best practices that an appropriate sample size had been reached (Carr et al. 2018).

Households were selected through purposive sampling and asked to respond to our questionnaire only when their experiences, livelihoods, and climate impacts met specified criteria including (1) farm dependency as their primary livelihood, (2) household-level exposure to rainfall variability, sea level rise, tropical cyclones, and salinity intrusion and (3) negative impacts on farm outcomes because of various environmental crises. The person who was primarily in charge of farming and farm-related decision-making for the household was the person selected to participate in our study. Respondents were asked to recall their experiences over the past 10 years. We recognise that this is a significant period of time and that answers were most likely reflective of the most recent events. However, we believe that it was still important to ask respondents to think about change over time as the severity of climate change has been accelerating more recently and that what they are currently experiencing may be a new phenomenon attributable to this change.

All interviews were conducted in local languages. Rural farmers could be conservative and thus the research team approached each household with respect to local culture. During the interview, there was enough flexibility to incorporate life stories and additional information and insights in addition to pre-determined questions.

The respondents were spread geographically throughout Kalapara. In total, 28 villages (locally known as *Moujas*) were included. However, respondent households were not evenly distributed among villages, as there were ethnic minority clusters in some villages. The same was true for Hindu minority farming communities. Both Hindu and ethnic minority farmers, who practice Buddhism, tend to cluster in specific regions or areas because of their communal priority or local resource ownerships. Muslim farmers, who were the majority in the region were the most widely distributed across Kalapara.

In addition to the household interviews, we also conducted 20 in-depth case studies with willing participants selected from the same 250 households sampling frame. Using convenience sampling, we recruited 10 males and 10 females who were exemplary local farmers. They were either successful in their farming practices or were struggling to maintain their farms. We intentionally oversampled female farmers in order to make sure that we were able to draw distinctions between male and female perspectives and adaptation strategies. Using a deductive research approach, these participants were allowed to share their own climate change narratives with minimal prompting by the research team. Information collected from these case studies was analysed using the method of narrative analysis, which is an analytical framework whereby researchers interpret stories and shared information that are told in the context of research (Berg 2009). These in-depth case studies expanded the local narratives on farm livelihoods in climate-stressed conditions in holistic manner.

The third component of our methodology included two focus groups: one with 8 male farmer households and one with 8 female farmer households. These focus group participants were also selected using a convenience sampling from the 250 household interview sampling frame.

These groups were asked to discuss in more detail their farming experiences and obstacles they faced due to their socioeconomic and cultural contexts. They were also encouraged to discuss local infrastructure challenges (e.g. lack of roads, electricity), local climate-related impacts (e.g. floods, salinity intrusion), adaptive capacities to cope with those stresses (i.e. access to non-farm income sources), adaptation needs (i.e. increased government supports), and information use on their farm-related decisions (i.e. agro-meteorological information). The information collected through the focus groups was also analysed using narrative analysis (Berg 2009). These focus groups allowed for a more in-depth conversation than the initial household interviews permitted and added a degree of specificity to farming adaptation strategies and climate change that the in-depth case studies did not. In addition, our over-sampling of female farmer perspectives allowed us to better understand the gendered dimensions of adaptation strategies present in the communities. When combined, the qualitative data collected across methodologies helped to provide a holistic perspective to the complex nature and patterns of gendered dimensions of climate adaptation in resource-poor climate vulnerable regions like coastal Bangladesh.

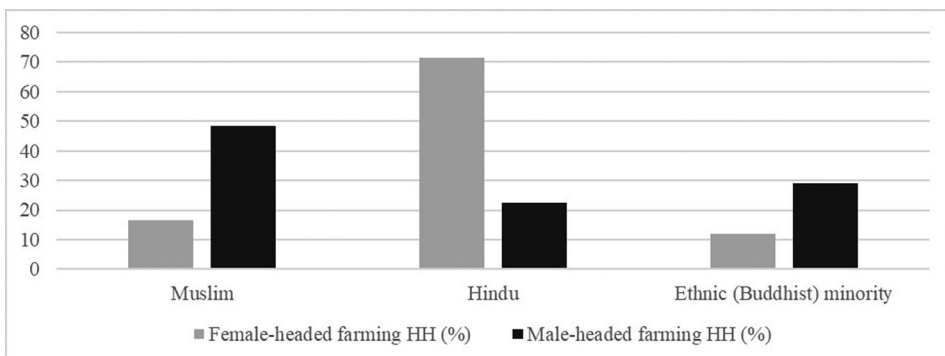
## Results

### Household demographics

Of the 250 households interviewed, 53.6% were male-headed farming households ( $n = 134$ ), and 46.4% were female-headed farming households ( $n = 116$ ). In these female-headed farming households, there were still male head-of-households present; however, men were not the primary decision makers when it came to farming, since they were mostly engaged in non-farm activities, such as small business ownership, or working in factories or shops as wage labourers.

Our finding that almost half of the households are led by female farm-decision makers is attributable to three factors. First, due to increased climate vulnerabilities, research suggests male members of the household were more likely to migrate seasonally or even permanently to nearby urban centres seeking non-farm work in order to support their families which inherently increased the prevalence of female-headed farming households (Kartiki 2011).

Secondly, in Kalapara, a large share of the local interviewed population is Hindu (45.2%) and, among Hindus, females face lower cultural and religious barriers than Muslim females for engaging in work outside their homes, which would also account for a larger number of female-headed farming households in this region. Specifically, we found (Figure 2):



**Figure 2.** Religious distribution of farming households.

Thirdly, most of the households interviewed were categorised as smallholder farmers. Smallholder farmers owned or rented up to 1.49 acres of land (approximately, 0.6 hectares) in Kalapara, which is more than the national average. In most cases, the cultivated cropped land among smallholder farmers is between 0.26 and 0.32 hectares (Rapsomanikis 2015; BBS 2019). Most of these smallholder farmers fall within the “poverty threshold” as defined by the World Bank, which is now less than US\$ 2 a day. Because of existing poverty conditions, smallholder farmers often cannot afford to hire additional farm labours. The engagement of female household members in farming activities fill that gap (Figure 3).

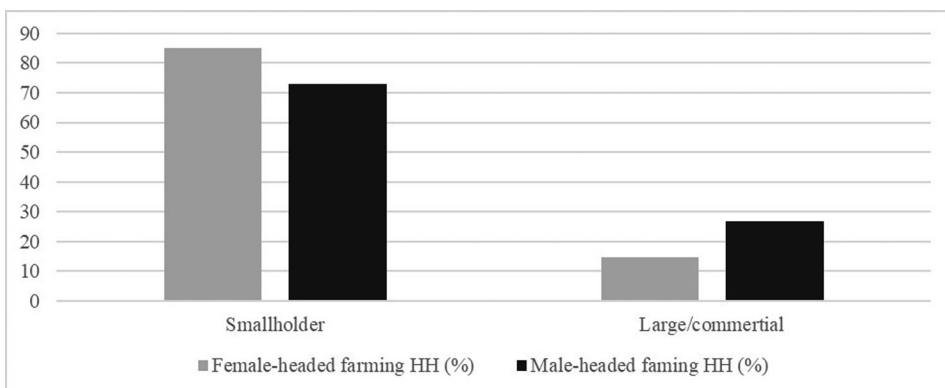
Smallholder farmers are usually the most severely impacted by various climate-related events. In addition, smallholder farmers typically maintain their farm for their own family’s consumption first and for household income second. Depending on household needs and overall production outcomes, they may or may not have any crops left to sell at the end of each season. Even though the majority of local farmers are smallholder farmers, the intersection of farm size and gender means that female-headed farming households remain in the most precarious situation when climate-related events occur. Lastly, we asked about the households’ adaptation needs, opportunities, and barriers based on the local context. Of households that were interviewed, 52.4% of household income comes directly come from farming. This is in addition to the farming that produces a year’s worth of household consumption. This information demonstrates how critical farming is for basic survival among rural farming communities.

In Kalapara, households are experiencing salinity intrusion in their croplands, sea level rise, unpredictable rainfall patterns, coastal erosions, tropical cyclones, storm surge (Figure 4) and decreasing agricultural production and water scarcity for farming and household consumption. 99.6% of respondents believed that weather and climate patterns had changed in last 10 years and were directly responsible for a decrease in farming productivity.

Farmers reported that salinity intrusion is currently felt at a reduced level. This is largely because of improved water management in coastal zones. Also, a large share of interviewed farmers felt there has been a gradual increase of monsoon rains along with increased variability in overall rainfall in last 10 years, which has had an adverse impact on local rain fed agriculture and overall farm productivity.

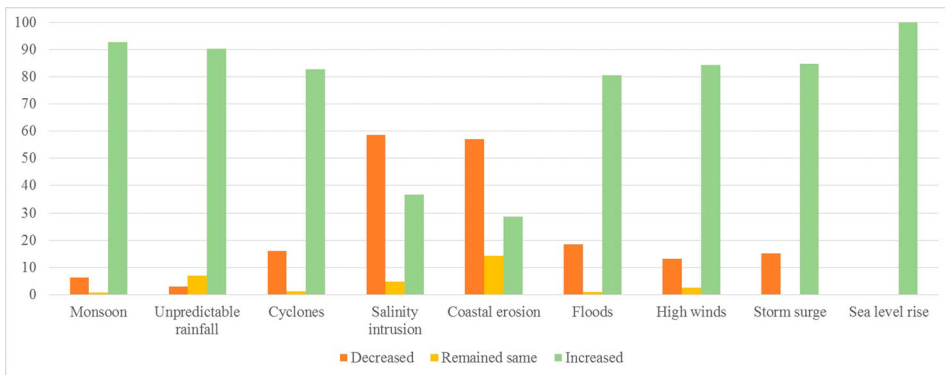
### ***Gendered influence on adaptation decisions***

Interviewed farmers were asked whether they observed that male and female farmers pursued different farm-level adaptation strategies to adverse climate change impacts. The majority of both male (63.4%) and female (65.5%) farmers indicated that they believed men and women pursued different adaptation strategies citing different options and resources available.



**Figure 3.** Farm categories among male and female-headed farming households.





**Figure 4.** Farmers' perception on weather and climate changes in last 10 years.

The majority of male farmers indicated that they did the farming, and their wives helped them only when it was necessary. In addition, female members of those households were responsible for maintaining the household activities and child care, along with homestead gardening to support the family's own food needs.

Additionally, many male farmers viewed farm production as a complex process that only they could handle. Several male farmers expressed their expectations for a traditionally gendered division of labour around the household including the farm.

"Female does female's jobs, and male does male's jobs. Female does not work in field. Our society is not like that." (Muslim male smallholder farmer)

"She does less labor-intensive work. Mostly she does homestead vegetable farming. I do rice farming in the field with my boys." (Hindu male smallholder farmer)

"I do farming; my wife does household works." (Ethnic male smallholder farmer)

In each instance, male farmers did not think that women had a place in farming due to sociocultural expectations about their capabilities and obligation to other household tasks. However, female farmers told a slightly different story. They indicated that their farm engagements and farm-level adaptation to climate change were affected by several factors. In some instances, their husbands either had passed away or had migrated to neighbouring urban areas and were not home on a daily basis. In some instances, husbands were still present in the household but were engaged in non-farm activities, such as running a small rural business.

A Hindu female large farmer, stated, "I work in farm. My husband work in Dhaka [capital city]." Due to her husband's absence, she had taken over the majority of his farming responsibilities. An ethnic female smallholder farmer, also noted in her husband's absence: "I do everything by myself, since I am single." Without men to perform traditionally masculine tasks, these women adapted their own behaviours even though they deviated from traditional female expectations (Figure 5).

Additionally, when their husbands were present, women suggested a division of specific farm tasks where their husbands would practice rice cultivation while they would partake primarily in household labour. A Hindu female smallholder farmer, reaffirmed these traditional expectations: "I work at home and vegetable garden. My husband does rice farming in the field." However, many women noted more egalitarian partnerships in meeting household needs.

"We work together" (A Hindu female smallholder farmer)

"I do farming and my husband does non-farming activities." (A Hindu female smallholder farmer)

"I do farming, and my husband helps me." (A Muslim female large farmer)



**Figure 5.** Female farmer working on her farm.

"I do entire farming; my husband does non-farm work." (A Hindu female smallholder farmer)

"I do farming with my husband and son. We work together." (A Hindu female smallholder farmer)

These women all indicated a sense of partnership between themselves and their husbands, which also existed outside of normative cultural expectations. They also indicated this newly negotiated division of labour was being instilled in their children. Overall, these women were more likely to see themselves as equal partners and less as supporting players in their attempts to help their families cope with changing family responsibilities due to the impact of climate change on farming practices.

After discussing the household division of labour, respondents were asked about their adaptation strategies. Using tested open coding practices (Berg 2009), their responses were summarised into six different categories: (i) change in cropping calendar, (ii) change in crop type, (iii) change in cropping pattern, (iv) reduction of farmland, (v) change in occupation, and (vi) migration. There were no significant differences between genders when it came to changes in cropping calendar and crop type. When it came to cropping patterns, 90.5% of female farmers reported that they changed their patterns, while 87.3% of male farmers reported the same.

However, in this process of farm-level adaptation, 3.7% male farmers reduced their farmlands, while only 0.9% female farmers did the same. In these cases, farmers sold off their unproductive lands due to increased salinity and invested in non-farm activities or intensified cultivations. However, since the average size of the farmlands owned by female-headed farming households was smaller than male farmers, selling even unproductive lands was not a viable option for these female farmers.

Even though changing occupations is not a major component in local adaptation strategies, 3% of male farmers reported a change in primary occupation, while only 0.9% female farmers did the same. Usually, female farmers have fewer social and financial resources, opportunities, and capacities to change their occupations than the male farmer households. These barriers contribute to their ability to change occupations even when climate change necessitates it.

We also found that many local farmers in Kalapara were not considering a change of location or migration even though they were facing a number of environmental stresses. Only 19.4 percent of male farmers considered migration as a viable long-term adaptation strategy, while 9.3 percent of female farmers considered the same option. The factors that might influence this outcome are twofold: first, environmental stresses were still viewed as manageable, and so they didn't feel sufficient pressure to change their livelihoods or migrate. Second, rural societies are often socially inclusive. Generally, the attachment to the place and community is much higher than any urban society. This might have reflected in respondents' adaptation decisions. In addition, a sense of insecurity or uncertainty in new destination always played a role. For example, an ethnic male smallholder farmer mentioned "What we will do in new place? What we will eat there?" Facing known challenges was preferable to the unknown.

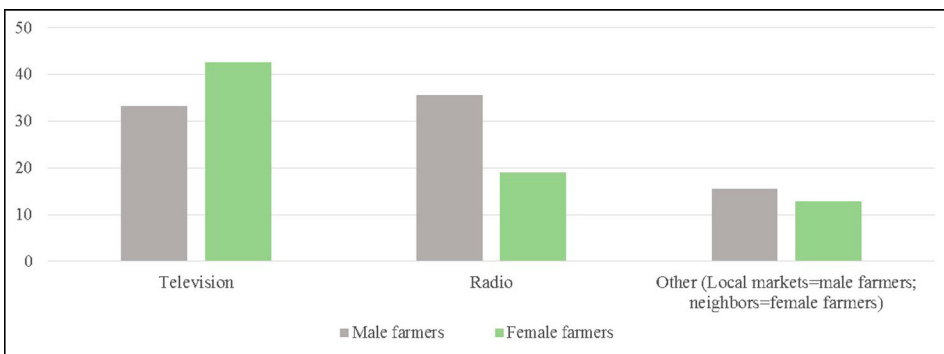
Similar concerns were particularly evident among female farmers. A Hindu female large farmer suggested, "I can die anywhere. Better to stay here." Another Hindu female smallholder farmer also shared a preference for the known rather than the unknown: "Disaster can happen anywhere! So I do not think of leaving my land and property." An ethnic female smallholder farmer simply questioned, "How can we migrate leaving our land and properties?" They would not simply be leaving their farming and households behind but their entire culture and way of living. An ethnic female smallholder farmer clearly states this concern: "We are here for three generations. How can we migrate leaving our land, property, and generations-long memories?"

When it came to female farmers, we found that the decision not to migrate is not just related to geographical or ancestral roots, but also to uncertainty, logistics, fear, lack of information, and a lack of social ties or networks in the receiving areas.

### Access to agrometeorological information

Agrometeorological information is among one of the most important resources for farmers when it comes to adapting farming practices due to climate change. Information provided to the farmers has traditionally appeared in the form of early warning systems, short-term weather forecasts and other related agro-advisories. More sophisticated weather and climate information is now being developed, which would help local farmers to take risk-informed decisions.

Traditionally, local farmers in Bangladesh adjust to weather and climate anomalies by altering their livelihood decisions, as well as through mobilising and reallocating available household resources. In most cases, farmers also look to external sources of support in times of environmental crisis. One such external source is information on local changes in weather and climate patterns, and farmers get that information from multiple sources (Figure 6).



**Figure 6.** Sources of weather and climate information by local farmers (%).

Female-headed farming households rely more on television for their information than male-headed farming households. However, male farmers are more likely to get their information from the radio. They also have larger access to local markets, while female farmers are dependent on neighbours. This indicates that in rural areas, female farmers are more dependent on informal social networks than the male farmers when it comes to getting any weather and climate information.

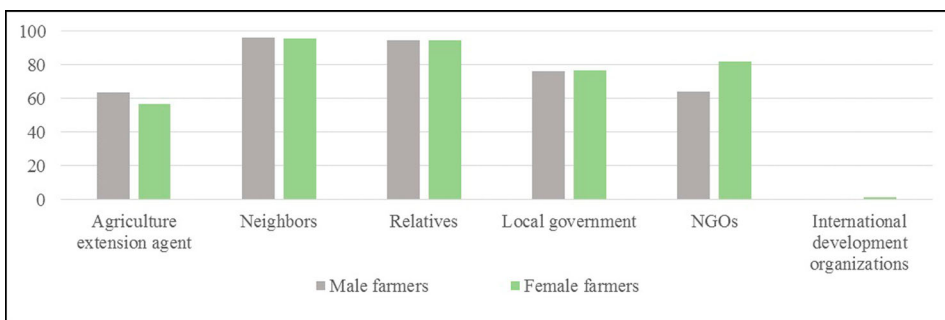
### *Personal interactions as part of individual-level adaptation*

When farmers were asked about their interactions with available social networks (e.g. agriculture extension agent, neighbours, local government) as part of their adaptation efforts, it was evident that male-headed farming households had higher access to agriculture extension agents locally, known as block supervisors, than female-headed farming households (Figure 7). In addition, both male and female farmers obtained information from other sources (e.g. neighbours, relatives, and local government) at relatively the same rates. However, we learned that female farmers have more access to NGO services. We suggest that this is because many NGOs (e.g. ADAMS, CODEC) have a mandate to serve the local women in order to reduce gender inequalities. For example, when it comes to microfinance interventions in Bangladesh, the majority of the beneficiaries are women (Khandker 2005).

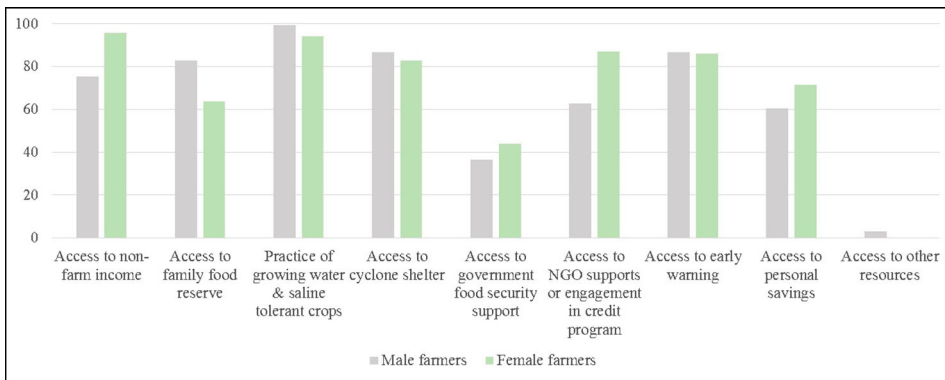
However, male and female headed farming households have similar levels of access to local government services. One explanation could be that female farmer households perceive that they can access these services in times of crisis if one of their male family members (e.g. husband, son, brother, father in-law) can also access information or supports from local government offices. No men reported any aid from international development organisations. Only 1.7% of women indicated that they received support from international development organisations. The reality is that these agencies provide financial support to local NGOs, leaving the farmers to believe that is where the support is coming from rather than the larger organisations themselves.

Farmers were also asked about the types of adaptation resources they had access to (Figure 8). Locally, female farmers had more access to non-farm income than male farmers. This is most likely due to the fact that female-headed farming households were more likely to be engaged with informal labour markets and the selling of handicrafts which provides non-farm income for their households. In addition, they may also still have male family members performing non-farm labour either locally or abroad.

Our study suggests that male-headed farming households have more access to reserve foods, practice growing water and saline tolerant crops, and better access to cyclone shelters in the region than the female-headed farming households. However, female-headed farming households



**Figure 7.** Types of interactions as part of risk reduction efforts (%).



**Figure 8.** Types of available risk reduction and adaptation resources (%).

were in a better situation when it came to personal savings, which was also likely due to having male family members earning supplemental wages outside the farming household.

## Discussion

Existing research has made it clear that women are inherently more vulnerable than men when it comes to climate change and its associated risks due to pre-existing vulnerabilities (IPCC 2014; Alston and Akhter 2016). Most evidence also suggests that climate vulnerability will only reinforce existing gender inequalities (Mehar, Mittal, and Prasad 2016) and will place women at greater risk as climate disasters continue to increase in frequency and severity (Cannon 2002; Juran and Trivedi 2015). This unequal nature of climate vulnerability can substantially undermine female-headed farming households' ability to cope with climate stresses and to produce crops for family consumption and economic wellbeing.

This situation suggests that it is critical for any nation to understand who is vulnerable and under what contexts. Our findings show that female-headed farming households tend to be smallholder farms while their male-headed farming household counterparts are large farmers. Farm size alone puts women at a disadvantaged position when it comes to adaptation strategies available to them.

When it comes to specific gendered differences in access to and implementation of adaptation strategies, female farmers were more likely to change their cropping patterns and less likely to sell their limited farmland, change their occupation, or to migrate to a new location free from climate stresses. As for strategies for gaining weather and climate information, female farmers were reliant on television and limited informal social networks, while male farmers had access to television, radio, and both formal and informal social networks. Lastly, male farmers had greater access to local agricultural agents while women had more access to NGOs focused on reducing gendered vulnerabilities and inequality.

Having a deeper understanding of the gendered implications of climate change adaptation strategy is important for two reasons. First, such research illuminates barriers to access and provides areas needing improvement for organisations seeking to help communities adapt to climate change. Understanding the barriers to access women face is especially critical as they are already in an extremely vulnerable situation. This vulnerability between men and women also translates into different adaptation needs and challenges. Government and other development partners will only be successful when considering these differences when implementing various location-based adaptation interventions.

Second, these differences in vulnerability and access to resources that are critical for climate change adaptation intersect with existing social, cultural, and economic determinants. Our

findings confirm that the source for agrometeorological information or other forms of weather and climate information differs between male and female farmers. If a female farmer does not own a television, she has to depend on her informal social networks to gather any sort of climate-related information. Meanwhile, male farmers have greater access to televisions, radios, and more formal social networks such as local markets and other farmers than do female farmers. This is significant because local markets, as a social space in rural society, play a vital role for disseminating and exchanging agro-meteorological information. If women lack access to these social spaces, they are missing critical adaptation information and strategies.

Our research has vital policy implications. In the efforts to improve adaptive capacity and resilience, government and national and international development partners should work closely with the farmers to improve their awareness, develop their skills and knowledge, and provide them with financial or non-financial resources to cope with natural hazards. Research shows that women would like to diversify their family income by increasing livestock, planting trees, and setting up non-farm business activities (IFPRI 2018). Yet our study finds they lack access to the tools necessary to accomplish these goals. Agencies interested in helping vulnerable populations adapt to climate change will need to understand the way in which gender, religion, ethnicity, and farm size all shape access to varying adaptation strategies as well as the tools necessary to implement those strategies. In areas like Kalapara, where almost half of the farming households are now female-headed, it is vital for both the local and national economies to help them cope with increasing weather and climate challenges that directly impact their farm livelihoods and general well-being. Providing both informational and financial resources are critical to the adaptation strategies of these households that will in turn benefit the entire country.

In rural societies, the gender difference is critical, because it shapes why, how, and on what levels some households might face poverty, food insecurity, and increased vulnerability more than others. Evidence suggests that “[If] rural women had the same access to agricultural resources as men, yields could increase by 20–30% and the total number of hungry people around the world reduced by 12–17%” (FAO 2011, 5). Since climate change is adversely affecting farmers’ capacity to produce in most parts of the world, it is important to highlight how policy makers and development practitioners can engage both male and female farmers to confront climate vulnerability and improve their capacities to cope with climatic stresses. Without having deeper insights on those differences, it can be highly challenging and non-pragmatic to plan and pursue farm-level adaptation in societies that are highly vulnerable to climate change.

## Conclusion

The future of human race largely depends on how we – social systems in general – will react to the changing patterns of climate. Unfortunately, not all people have the similar capacities to respond to climate stresses. Some communities or people will do better than others. This article contributes to our understanding of diverse and differential climate adaptation and risk management strategies among male and female-headed farming households in coastal Bangladesh. First, we highlight that while women are the most vulnerable when it comes to pre-climate change conditions, they have the least access to adaptation strategies. They are less likely to be able to sell their land, change occupations, or migrate away from drought, salinity intrusion, or coastal erosion. They lack access to weather and climate information and often relying on informal social networks for receiving those. This compromise their ability to respond to various climate crises in timely fashion.

Second our study reflects sociocultural constraints regarding perceptions that farming is treated as “man’s work,” which reinforces the highly gendered context present in coastal Bangladesh which limits the access to adaptation strategies for female-headed farming households. Respondents disclosed firmly held beliefs about the gendered division of labour at home and on the farm. Organisations seeking to reach female farmers will need to be cognisant of these beliefs and act accordingly

to disseminate information and tools that may help them adapt current farming practices as they lack access to non-farm adaptation strategies.

We recognise that this study has some limitations. First, just like many other applied social science researches, this study focused on only one geographical location (i.e. Kalapara, Bangladesh). This is in the south-central coastal region that predominately faces issues of coastal flooding, coastal erosion, and untimely rainfall. Responses in other geographical locations could be different. For example, people in the southwest coastal region suffer more from salt water intrusion and tropical cyclones and may thus adapt differently than farmers in Kalapara. Secondly, previous research has also demonstrated that responses could be mediated by seasonality. This means that during recall, farmers may have been most likely to reflect on their adaptation strategies pertaining to the most current season. Additionally, our study is based on self-report data in which we asked respondents to recall a 10- year period of time. As this is a long period of time, respondents we most likely reflecting on their most recent experiences with weather anomalies. However, due to the increasing severity of such climate events, it seems reasonable to assume that respondents would be able to recall events of similar magnitude in the past, had they actually occurred. Extensive amounts of climate research indicate that the severity of weather conditions described throughout this paper are a relatively new phenomenon and thus allow respondents to recognise that they are facing new weather-related barriers to their existing farming strategies.

Lastly, we recognise concerns of subjectivity in the analysis of our qualitative data. We took several precautions to mitigate researcher bias in our analytical strategies. Our mixed-methods approach was the first component of our strategy. Information from semi-structured interviews was triangulated with our in-depth case studies and focus groups. The primary author also conducted follow-up with respondents by telephone to avoid any misinterpretations of their responses. As a way of conducting interraterreliability, the first author also discussed the findings and cultural nuances with the local field assistants. Authors also complied with rigorous methodological practices concerning deductive research and narrative analysis (Berg 2009; Carr et al. 2018). Qualitative data provides a unique type of insight that cannot be derived from quantitative survey data, and thus holds value to researchers seeking to better understand the lived experiences of the people they are studying.

However, this paper demonstrates how societal inequality shapes adaptation outcomes. Future research should further examine how the intersectionality of multiple identities, such as, gender, religion, ethnicity, farm size, and income can impact adaptation outcomes. This paper clearly provides the foundation for such consideration.

While this research was conducted in coastal Bangladesh, the findings provide critical adaptation insights for other geographical locations facing similar sociocultural and environmental challenges. If countries around the world fail to adequately consider the gendered implications of their adaptation and development strategies, people in general and women in particular located in socioeconomic and environmentally vulnerable regions will continue to face deepening poverty, food insecurity, and inequality, which are obviously not desired antithetical outcomes to the in the lens of the United Nations Sustainable Development Goals.

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