



Research article

Paddy Farmers' Perception and Indigenous Decision to Climate Change Risks: Insights from Bagerhat District of Bangladesh

Fatema Khatun¹ and Md. Nasif Ahsan^{2*}¹Department of Business Administration, Bangladesh Army University of Science and Technology (BAUST), Saidpur-5310, Bangladesh²Economics Discipline, Khulna University, Khulna-9208, Bangladesh

ABSTRACT

This study investigates paddy farmers' perceptions of climate change impacts and their indigenous adaptation strategies in the coastal Bagerhat district of Bangladesh. Applying a multi-stage sampling technique, we collected primary data from 120 farmers in two upazilas namely Fakirhat and Rampal and assessed farmers' climate vulnerability and analyze factors influencing their adaptation decisions. We deployed logistic regression models for the data analysis. Results suggest that farmers perceive increasing temperatures, irregular rainfall, and severe impacts from floods, cyclones, and salinity intrusion. Income loss and crop failure emerge as the most severe climate-related problems. The climate vulnerability index (0.094) suggests farmers are moderately vulnerable, with high sensitivity but low adaptive capacity. To cope with climatic risks, farmers primarily adopt indigenous strategies like increasing irrigation, early harvesting, and changing planting dates. Factors significantly influencing adaptation choices include age, education, household size, farm distance, land area, extension services access, and income sources. Key constraints to adaptation are lack of government support and financial resources. The study recommends location-specific institutional planning, improved irrigation facilities, enhanced agricultural extension services, and better access to farm credit to support farmers' adaptation efforts. These findings provide valuable insights for policymakers to design targeted interventions that will enhance paddy farmers' resilience to climate change in coastal Bangladesh. Future research using longitudinal data could further elucidate the long-term dynamics of farmers' adaptation strategies and outcomes.

ARTICLE INFO

Article timeline:

Date of Submission:

12 May, 2024

Date of Acceptance:

01 August, 2024

Article available online:

01 September, 2024

Keywords:

Vulnerability

Mixed-farming

Household

Coastal

Bangladesh

Introduction

Nowadays, climate change, a highly discussed issue by the global community and the policy-decision makers, is posing significant environmental and socioeconomic risks (Bedeke, 2023; Afuye et al., 2021; Nhemachena et al., 2020; Banerjee, 2015). Sea-level rise and globally increased temperature are the most predicted consequences of climate change (Shivanna, 2022; Uddin et al., 2014). In addition, changing times and patterns of winter and rainy seasons, increasing salinity intrusion, rapid collapse of glaciers, and weakening ecosystems may be the pressing climate change concerns (Mikhaylov et al., 2020; Gutu et al., 2012). The extreme change in climatic characteristics distresses the lives of millions of people, declines farm productivity and creates food shortages (Tripathi and Mishra, 2017; Haokip et al., 2020). Farmers who depend on climatic elements, mainly rainfall, are more

vulnerable (Mekonnen et al., 2021; Abid et al., 2015). Because of climate change-triggered vulnerability, food security is one of the most concerning issues for developing countries, especially in South Asia (Jha et al., 2023).

Over a fifth of the world's population lives in South Asia, the world's most disaster-prone region (Sivakumar & Stefanski, 2011). South Asia is most vulnerable to climate change due to population expansion, natural resource degradation, and poverty (Chandio et al., 2023). This region is the living place of people who are mostly facing the problem of food insecurity despite the Green Revolution (Mughal and Fontan, 2020; Abid et al., 2015). South Asian climatic trends and unpredictability have been characterized by rising air temperatures and more extreme occurrences during the previous century (Wang et al., 2017). More than 750 million people in South Asia could be

*Corresponding author: anasif.ahsan@econ.ku.ac.bd

negatively impacted by climate change in the form of natural global average temperature might rise by about 1.5 degrees Celsius over the next two decades, the IPCC report predicted South Asia will see hotter weather, longer monsoon seasons, and higher droughts (IPCC, 2021).

Rural areas of Bangladesh rely heavily on agriculture for both subsistence and income. Almost 47% of the total population is directly or indirectly engaged in agricultural activities in coastal Bangladesh (Billah et al., 2017). Though the service sector contributes the most among all sectors in Bangladesh, agriculture adds 11.38% to its GDP (FY 2022-23) (B.B.S., 2023a). Again, 44% of national employment is generated by this sector where the share of the crop sector is almost 55% (B.B.S., 2023b). Hence, we cannot ignore the agricultural sector's contribution (IRBD, 2018). Anthropogenic activities continuously destroy this sector (Billah et al., 2017; Ullah and Rahman, 2014). However, natural hazards often constrain agricultural production. Estimates suggest that Bangladesh will lose almost 30% of its crop production by the year 2100, with rice production decreasing by 8.8% and wheat production declining by 32% by 2050 (Kamruzzaman, 2015).

The southern region of Bangladesh, basically the coastal region and river delta, is severely affected by cyclones, floods, flash floods, and storm surges. In November 2007, the cyclone Sidr caused the death of 3,363 people (DCPP, 2008). The crop sub-sector of the agricultural sector incurred a loss equivalent to US\$ 411.60 million, and livestock was seriously damaged, accounting for nearly US\$ 19.30 million due to cyclone Sidr. In the same catastrophic event, the fisheries sector lost approximately US\$ 416.30 million (GoB, 2008). On 25 May 2009, the devastating tropical Cyclone Aila washed away the southern part of Bangladesh, causing a significant loss of human lives, livestock, animals, and assets (Roy et al., 2009). In eleven coastal districts of Bangladesh, almost 3.9 million people were adversely affected by Cyclone Aila (Tajrin & Hossain, 2017). Embankments covering 1,742 kilometers were damaged by up to 22 feet of tidal surges during Aila (Rahman, 2022). During the cyclone, almost 46% of standing crops were lost in that harvest season (Aid, 2009). After Aila, more than five severe cyclones hit Bangladesh, among which cyclone Fani (2019) damaged crops on just over 63 thousand hectares of land, cyclone Bulbul (2019) affected 22,836 hectares of standing crops, and cyclone Amphan (2020) destroyed 1,76,007 hectares of agricultural land (Dhaka Tribune, 2021).

All devastating disasters force paddy farmers to perceive agricultural production-related risks due to climate change. Depending on their awareness and perception, they take different indigenous methods to cope with those risks. The indigenous decision includes less consumption, selling assets or livestock, etc. (Alam et al., 2020). Farmers of coastal Bangladesh continuously practice several adaptive and indigenous decisions. However, the adaptation and indigenous decision level is deficient (Barua & Rahman, 2017).

Studies revealed that perceiving climate change is the first step to adopting indigenous decisions against climate change impacts (Abid et al., 2014, Barua & Rahman, 2017). However, the perception of climate change is not a static issue but rather a dynamic concept. It also needs to consider and address socioeconomic and environmental challenges (Ndamani and Watanabe, 2015), specifically at the local level (Alam et al., 2020, Alam et al., 2017). For instance, salinity intrusion, cyclones, storm-surge, river-ban erosion, and water scarcity are the notable visible adverse climate change impacts in southwest coastal Bangladesh (Ashrafuzzaman et al., 2022). Perceptions are also influenced by heterogeneity in determinants such as age, sex, education, experience, cultural attributes, availability of resources, and so on (Kamruzzaman, 2015). Understanding how paddy farmers perceive it is crucial to designing and formulating effective policies and aid programs for capacity building in the agricultural sector. Again, precise knowledge about the determinants of paddy farmers' indigenous decisions is also essential for further advancement (Abid et al., 2014; Rakib and Anwar, 2016). However, all the determinants are location and context-specific (Kamruzzaman, 2015). So, it is necessary to evaluate how paddy farmers perceive climate change and how they cope with the impacts. Therefore, from the social science perspective, this study evaluates paddy farmers' perceptions and the determinants affecting their indigenous decisions towards various impacts of climate change.

The rest of this paper displays the conceptual framework in section 2; methods and materials, including study locations, data collection and sampling techniques, and analytical approaches in section 3; results and discussion in section 4; and conclusion and policy implications in section 5.

Conceptual Framework

Numerous studies demonstrated that climate change was responsible for a variety of alterations to the atmosphere, including a rise in temperature, different patterns of precipitation, sea level rise, flooding, a shift in the monsoon, and a reduction in the number of cold days (Kumar, 2016; Reddy et al., 2022; Shivanna, 2022; Uddin et al., 2014). Fluctuations in climatic parameters put pressure on natural systems and resources (Pramanik et al., 2021). Over several decades, these occurrences had the cumulative effect of lowering the output of both crops and cattle (Sabella et al., 2020). Farmers perceive the condition of local indigenous techniques from the previous impact of climate change on paddy production. Paddy farmers' perception of the condition of local indigenous techniques is further influenced by several socioeconomic conditions and external factors (Pramanik et al., 2021). External factors include access to institutional services, extensional services, market access, and farm location. Even though farmers and policymakers are aware of the phenomenon of climate change, they often fail to adapt to the effects of climate change because of socioeconomic and institutional impediments, such as a lack of willingness, insufficient capital or resources, misbelief, and a lack of information (Asrat & Simane, 2017; Tripathi & Mishra, 2017). Due to

the high number of marginal and subsistence farmers in the South Asia region, agriculture in this area is highly vulnerable to climate change (Manjunath et al., 2017; Asrat & Simane, 2017). Most of these farmers have a low level of education or none at all, and their access to resources is minimal (Manjunath et al., 2017). Farmers prioritize the maintenance of their productivity and financial stability over the preservation of the environment. Consequently, it is essential to comprehend farmers' perceptions of climate change, the accuracy with which they perceive it, and the effectiveness of agricultural adaptation to climate change (Reddy et al., 2022).

The efficacy of adaptation solutions to climate change is contingent mainly upon community understanding, as

indicated by the farmers' perception of the associated risks (Ado et al., 2019). When it comes to the process of agriculture adapting to the effects of climate change, the perception of risk, belief systems, psychological distance, trust, and the willingness to contribute to social capital are all crucial factors (Azadi et al., 2019; Saptutyningsih et al., 2020). Considering the farming flexibility (availability of actionable options, availability of resources, and unknown risks), farmers make both on-farm and off-farm decisions, which ultimately affect the overall well-being of the farmers. Based on the discussion mentioned above, we devised a conceptual framework based on the vulnerable nature of paddy production to the effects of climate hazards in Figure 1.

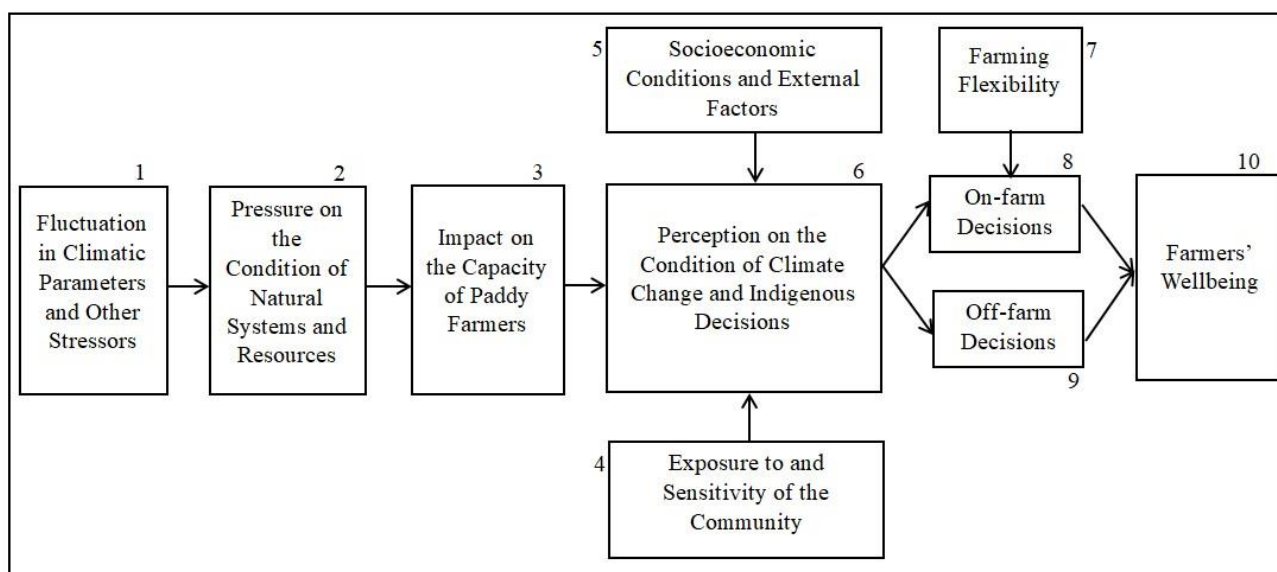


Figure 1. Conceptual framework on paddy farmers' perception and indigenous decision to climate change risks (Adapted from Jha and Gupta, 2021; Waaswa et al., 2021)

The diagram in Figure 1 starts with fluctuations in climatic parameters and other stressors, leading to the exposure and sensitivity of the community. This creates pressure on the condition of natural systems and resources, impacting the capacity of paddy farmers. Socioeconomic conditions and external factors influence farmers' perception of climate change and their indigenous decisions. These perceptions lead to on-farm and off-farm decisions, ultimately affecting farmers' well-being.

Methods and Materials

Study Locations

This research chose a study area based on a criterion: it is highly susceptible to natural hazards, mainly tropical cyclones, salinity, and floods. Based on this criterion, our primary focus was on the Bagerhat district of Bangladesh as the primary study area. This district is located in a coastal region of Bangladesh that is particularly vulnerable to the effects of climate change (Akash et al., 2023; Ali and Hossen, 2022; Hoque et al., 2021). The Bagerhat district is renowned for its notable geophysical and economic characteristics. This region is adjacent to the Sundarbans, a mangrove forest (Nahin et al., 2020). The

district covers an area of 3959.11 square kilometers (Banglapedia, 2019). It has nine Upazilas: Kachua, Chitalmari, Fakirhat, Bagerhat Sadar, Mongla, Morrelganj, Mollahat, Rampal and Sarankhola. From the available options, we purposively chose two upazilas, Fakirhat and Rampal (see Figure 2), which are classified as the primary interior coastal zones in Bagerhat District (Uddin and Kaudstaal, 2003). Fakirhat Upazila is located at 21°46.8' north latitude and 89°42.5' east longitude and Rampal lies at 21°34' north latitude and 89°39.8' east longitude (Figure 2). Rampal Upazila is very close to the Mongla Sea Port.

Data Collection and Sampling Techniques

The study primarily relied on primary data. Data were gathered via in-person interviews. Therefore, it is crucial to create a well-organized and reliable questionnaire. Initially, a questionnaire was prepared. The preliminary questionnaire underwent a pilot survey with seven respondents from each Upazila for pre-testing purposes. The final version of the questionnaire was refined by eliminating extraneous questions and incorporating necessary questions that were adjusted based on the pilot survey.

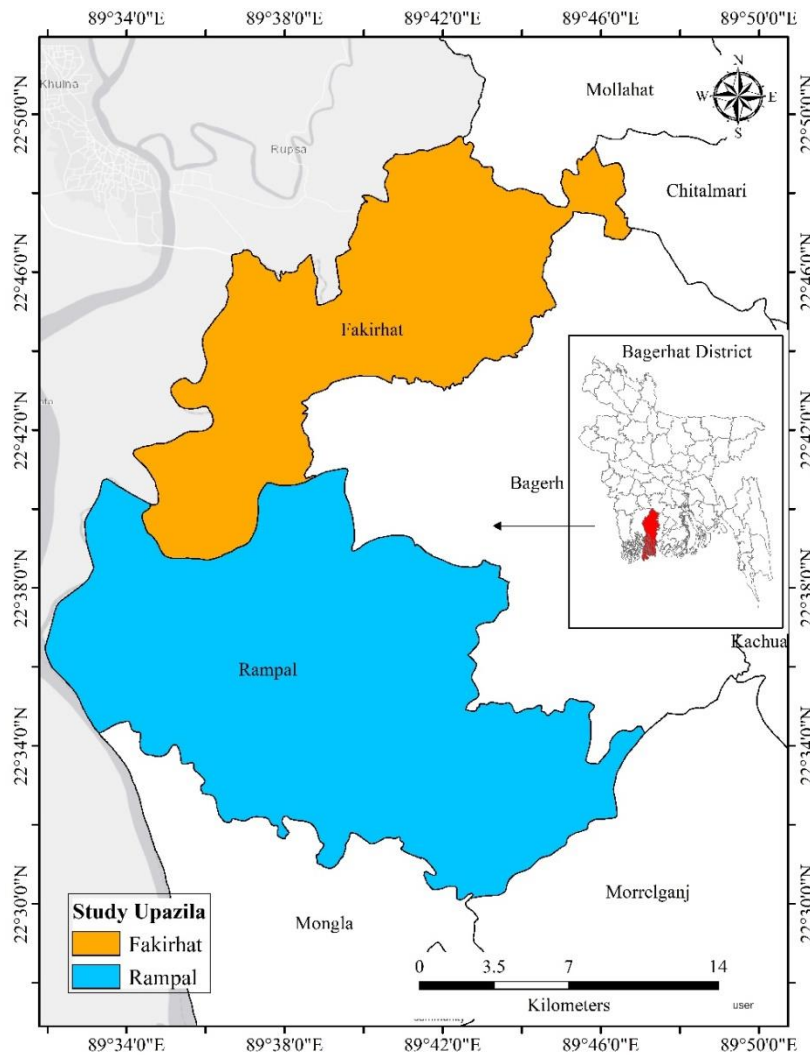


Figure 2. Study Locations

We employed a multi-stage sampling technique to choose a representative sample from the designated study area. The Bagerhat district of Bangladesh was purposefully chosen as the primary study region during the first phase. In the second phase, Fakirhat and Rampal Upazilas were purposefully selected from the nine Upazilas in Bagerhat district. During the third stage, a random selection was made among the eight Fakirhat Upazila unions, resulting in two unions being selected. Out of the ten unions in Rampal Upazila, only two were chosen. In the fourth phase, a selection of three villages from each union was made on a random basis. During the last phase, a systematic random sampling procedure was used to collect ten samples from each village. We chose every fifteenth household on the right side and then the next fifteenth one from the left side of the road that approaches from the central point of the village toward inside the village. We finally selected 120 households for data collection. The survey population solely consists of paddy farmers. We could not go beyond 120 respondents due to budget constraints. Data was collected from January-February 2019. Assuming the whole Bagerhat district suffered a similar level of exposure, we chose two neighboring Upazilas in this district to perform our study.

Analytical Approaches

Climate Vulnerability Index

According to IPCC (2007), vulnerability consists of three dimensions: exposure, sensitivity, and adaptive capacity. In this study, the Climate Vulnerability Index (CVI) was prepared to understand the paddy farmers' perceived vulnerability level.

In this study, exposure is considered to be the extent of severity of various climatic change-triggered events and shocks that paddy farmers faced. Sensitivity is defined as the degree to which the climatic exposure battered paddy farmers. Besides, adaptive capacity is understood as the capability of paddy farmers to cope with climatic exposure and sensitivity. Table 1 presents 21 indicators utilized to formulate the climate vulnerability index. This index was estimated employing equation (1) (adopted from Ahmed et al., 2021).

$$CVI = (\text{Mean Index value of Exposure} - \text{Mean Index value of Adaptive Capacity Index}) \times \text{Mean Index value of Sensitivity} \dots\dots\dots (1)$$

The value of CVI ranges from -1 to 1, where -1 refers to the least vulnerability, 0 (zero) implies moderate vulnerability, and 1 denotes extreme vulnerability.

Table 1: Three Dimensions of Climate Vulnerability

Sl. No.	Indicators	Unit of measurement	Dimensions
01	Floods	1 = Not severe at all, 2 = Less severe, 3 = Moderately severe, 4 = Severe, 5 = Extremely Severe	Exposure
02	Cyclones		
03	Drought		
04	Salinity		
05	Irregular rainfall		
06	Lower river water level		
07	Crop failure	1 = Not problematic at all, 2 = Less problematic, 3 = Moderately problematic, 4 = Problematic, 5 = Extremely problematic	Sensitivity
08	Delayed crop maturity		
09	Crop quality infected		
10	Poor livestock productivity		
11	Loss of agricultural land		
12	Soil erosion		
13	Water shortage		
14	Income loss		
15	Increase diseases		
16	Farming Experience	Years	Adaptive Capacity
17	Adult male members in household	Number	
18	Migration	1 = Yes, 0 = Otherwise	
19	Membership in farmers' cooperation	1 = Yes, 0 = Otherwise	
20	Receiving climatic information earlier	1 = Yes, 0 = Otherwise	
21	Climate related information assist farming	1 = Yes, 0 = Otherwise	

Perception Measurement and Different Indices

Paddy farmers adopt diverse and cost-effective tactics in response to their perspective of climate change. Respondents were asked to assess the magnitude and severity of climate shocks using a Five-point Likert Scale. The scale ranges from 1 to 5, with 1 signifying "climatic shocks were not severe at all" and 5 indicating "climatic shocks were extremely severe". In order to assess the magnitude and severity of climate shocks, the Climate Shock Index and Climate Change Problems Index were developed based on the approach outlined by Saroar and Routray (2010) (steps of calculating indices are described in sub-section Climate Vulnerability Index).

Besides, an Indigenous Strategy Index was also created to determine the effective strategies employed by farmers. Participants were instructed to evaluate and prioritize their indigenous techniques using a Five-point Likert scale. Each indigenous method was rated on a scale of 1 to 5, with 1 representing "indigenous techniques were very less effective" and 5 representing "indigenous techniques were highly effective".

However, for performing the Logit Regression Model, two distinct groups were set up in our study: one group mostly implements specific indigenous strategy (adopter) while the other group does not (non-adopter). Paddy farmers who selected "moderately effective", "effective," or "highly effective" among the options are classified as the first category. In contrast, paddy farmers who indicated that a strategy was "less" or "not effective at all" are classified as the second category.

The Logit Regression Model was used to assess the determinants that influence the indigenous methods employed by paddy farmers. The model was chosen because of its binary nature.

$$\text{logit}(p_i) = \log\left(\frac{p_i}{1-p_i}\right) = Y_j = \beta_0 + \beta_{ij}X_{ij} \dots \dots \dots (2)$$

In equation 2, Y_j represents response variables (where, $j = 1, 2, \dots, 8$), β_0 is the intercept term, β_{ij} is the coefficients to be estimated, X_{ij} is the explanatory variables represented in Table 2.

The response variables comprised the eight primary adaptation (i.e., indigenous strategies) categories used in separate models, i.e., Y_1 = Change of planting dates (Model 1); Y_2 = Mixed farming (Model 2); Y_3 = Early harvesting (Model 3); Y_4 = Increase irrigation system (Model 4); Y_5 = Selling livestock (Model 5); Y_6 = Look for daily work (Model 6); Y_7 = Borrow money (Model 7); Y_8 = Sell household assets (Model 8). Additionally, a set of fifteen explanatory variables (X_1 - X_{15}) was employed to ascertain the potential factors influencing farmers' adoption of various indigenous methods (Y_1 - Y_8) (see Table 2). In literature, all the methods and measures innovated and practiced by the farmers themselves are considered indigenous strategies (Alhassan et al., 2018). We considered these strategies (Y_1 - Y_8) as indigenous methods because these methods were traditionally practiced by the paddy farmers, who came from previous generations or originated from the current generation in their respective countries. The coefficient of the logit regression model (Table 7) reveals the direction and statistical significance of the explanatory variable on the binary dependent variable. In addition, the Indigenous Strategy Constraints Index was developed to highlight the primary obstacles paddy farmers encounter in implementing different techniques. Participants were asked to assess and prioritize the limitations they encountered using a five-point Likert scale. On this scale, the range was from 1 to 5, with 1 representing "very low severity" and 5 representing "high severity" for each condition.

Indices Calculation

Indices, including Climate Change Shock Index, Climate

Table 2: Set of explanatory variables used in Eight Logistic Models

Sl. No.	Description of Variables	Unit of Measurement	Symbol	Sources
1	Age of the Respondent	Years	X ₁	Kom et al. (2020); Sarker et al. (2013); Deressa et al. (2009); Nkurumwa et al. (2021); Ahmed et al. (2021)
2	Education of the Respondent	Years of Schooling	X ₂	Kom et al. (2020); Sarker et al. (2013); Deressa et al. (2009); Nkurumwa et al. (2021); Ahmed et al. (2021); Asrat and Simane (2017); Apata (2014)
3	Household Size	No. of Household Members	X ₃	Kom et al. (2020); Sarker et al. (2013); Ahmed et al. (2021); Asrat and Simane (2017); Apata (2014)
4	Household Distance from Farm	Kilometers	X ₄	Asrat and Simane (2017)
5	Access to Credit	1 = Yes, 0 = Otherwise	X ₅	Sarker et al. (2013); Deressa et al. (2009); Apata (2014)
6	Cultivable Land Area	Decimals	X ₆	Sarker et al. (2013); Deressa et al. (2009); Asrat and Simane (2017); Apata (2014)
7	Homestead Land Area	Decimals	X ₇	Authors' compilation (2023)
8	Cultivable Land Fertility	0 = Not having good fertility, 1 = Having good fertility	X ₈	Asrat and Simane (2017)
9	Cultivating Season	0 = Once, 1 = More than once	X ₉	Authors' compilation (2023)
10	Access to Extension Services	1 = Yes, 0 = Otherwise	X ₁₀	Sarker et al. (2013); Asrat and Simane (2017)
11	Access to Subsidy	1 = Yes, 0 = Otherwise	X ₁₁	Sarker et al. (2013); Kurukulasuriya and Ajwad (2007)
12	Assets Holding	BDT	X ₁₂	Sarker et al. (2013)
13	Livestock Holding	BDT	X ₁₃	Sarker et al. (2013); Deressa et al. (2009); Apata (2014)
14	Annual Income from Paddy	BDT	X ₁₄	Sarker et al. (2013); Deressa et al. (2009); Nkurumwa et al. (2021); Asrat and Simane (2017); Apata (2014)
15	Annual Income from other Sources	BDT	X ₁₅	Nkurumwa et al., (2021); Asrat and Simane (2017); Apata (2014)

Change Problems Index, Indigenous Strategy Index, and Indigenous Strategy Constraint Index, were calculated as follows:

$$M_n = \frac{R_i}{R_{max}} \dots\dots\dots (3)$$

In equation 3, M_n is each variable's total index value, R_i is each variable's absolute response value, and R_{max} is the maximum possible response value of each variable. As no weight is assigned for any specific variable, the index is computed as the arithmetic mean of the variable. That is,

$$M_x = \frac{M_n}{N} \dots\dots\dots (4)$$

In equation 4, M_x is the mean index value, and N is the number of total observations. Here, the mean index value ranges from 0 to 1. In the case of severity measurement, zero (0) implies the level of no severity and one (1) represents the level of high severity, while considering the effectiveness of a measure, zero (0) implies the level of no effectiveness and one (1) represents the level of high effectiveness.

Results

Socioeconomic Profile of the Respondents

Table 3 presents the socioeconomic profile of the respondents of this study. The average age of the

respondents was estimated at 40.06 (±8.96) years, which means most of the respondents were in middle age. The average household size was found to be 5.39 (±1.46) persons, which is higher than the national average (4.3 persons) reported by the Bangladesh Bureau of Statistics (BBS) (BBS, 2022). However, schooling years demonstrated a poor literacy level among the respondents. The mean schooling years were 3.53 (±3.27) years for sampled respondents. More than one-third of the respondents had no academic involvement. Nearly two-fifths of the respondents (38.33%) had only passed the primary level. One-fourth of the respondents have passed the secondary level. Very few respondents have passed the higher secondary level.

Most respondents (90%) lived in their own houses, and the rest lived in rented or relatives' houses. The average asset value of the respondents was BDT 30.53(±43.54) thousand. It indicated high inequality among respondents regarding asset accumulation, as the standard deviation was much higher than the average. Additionally, the average value of the livestock holding of the respondents was BDT 179.17(±133.04) thousand.

Table 3: Summary of household characteristics

Households' characteristics	N	Value (SD)* [Min-Max]*
Age (Years)	120	46.03(8.93) [28-60]
Household size (number)	120	5.39 (1.46) [3-10]
Educational level (schooling year)	120	3.53 (3.27) [0-12]
Ownership of accommodation		
Owned house (%)	108	90.00
Rented house (%)	8	6.67
Relative's house (%)	4	3.33
Farming experience (years)	120	26.83 (10.33) [7-45]
Assets holding (thousands in BDT)	120	30.53 (43.54) [2.2-353.5]
Livestock holding (thousands in BDT)	120	179.17 (133.04) [0.8-551]
Yearly income from paddy (thousands in BDT)	120	27.02 (14.35) [10-65]
Yearly income from other sources (thousands in BDT)	120	38.21 (15.76) [0-60]
Household distance from cultivable land (kilometers)	120	0.23 (0.124) [0.1-0.5]
Cultivable land area (decimals)	120	52.48 (33.30) [20-200]
Homestead land area (decimals)	120	8.62 (6.07) [0-30]
Fertility of cultivable land		
Low (%)	51	42.50
Medium (%)	30	25.00
High (%)	39	32.50
Having access to credit	66	55
Having access to extension services	35	29.17
Having access to subsidy	41	34.17
Member of farmers' organization/group/club	22	18.33
Seasonal migration	30	25

*where applicable

It was observed that all the respondents had, on average, 26.83(\pm 10.33) years of experience in farming. Their average annual income from paddy cultivation was BDT 27.02(\pm 14.35) thousand. In contrast, annual income from other sources was BDT 38.21 (\pm 15.76) thousand. Results showed that farmers earned more from other sources than from paddy cultivation. The average household distance from cultivable land was 0.23 (\pm 0.124) Kilometers. The mean cultivable land area reported by the respondents was 52.48 (\pm 33.30) decimals, whereas the mean homestead land area was 8.62(\pm 6.07) decimals. The average land size for paddy cultivation of our sampled respondents was found 52.48(\pm 33.31) decimal; however, no significant difference was found in this case between the farmers in two Upazillas ($z=0.7112$; $p<0.478$).

The fertility of the land is considered an important factor that affects total agricultural production (Shang et al., 2014). This study indicated that a major portion of the land in the study area possessed low and medium fertility levels. Only 32.50% of the paddy farmers reported their cultivable land as highly fertile.

Farmers required access to financial assistance to boost their productive capacity and overall agricultural efficiency (Gershon et al., 2020). Estimation showed that merely 55 percent of those who participated in the survey had access to various forms of credit.

Our study found that approximately 27% of the paddy farmers received credit in cash, and nearly 4.17% of the respondents received credit in the form of inputs. Nevertheless, almost 24% of the sampled farmers received credit in both forms. In this case, the concern is that nearly half of the respondents did not have access to any credit. In addition, only 29.17% of respondents had access to agricultural extension services. The level of access to

extension services was not satisfactory, as most of the respondents had no access. Nearly 12% of the respondents received agricultural extension services from various government organizations, and slightly over 17% reported that they got these services from various non-government organizations (NGOs). Furthermore, among all the respondents, only one-third had access to the subsidy. In this study, one-fourth of the respondents face seasonal migration. Farmer organizations have been suggested as a vital approach to improve the living standard of the farmers in underdeveloped and developing countries who face limited access to essential resources (Tolno et al., 2015). In this study, a mere fraction of farmers (18.33%) was affiliated with a farmers' association or cooperative. Yearly average income (from both agricultural and non-agricultural sources) was found BDT 65,225(\pm 11,719) and in this case, no significant difference for the respondents between the two Upazillas was found ($z=0.698$; $p<0.9945$).

Perception toward Climatic Shocks and Risks

Bangladesh's climate is typically monsoon, with a warm and dry season from March to May, a rainy season from June to October, and a cold period from November to February (Nahin et al., 2020). Because of its vigorous changing features, the coastal region of Bangladesh is not the kind that is uniform and stable (Brammer, 2014). The dynamic nature of the coastal area has led to the loss of wetlands, coastal flooding, the salinization of water resources, a decrease in fish stock, and the destruction of the coastal environment and biodiversity (Brammer, 2014; Hossain et al., 2016; Hasan et al., 2021).

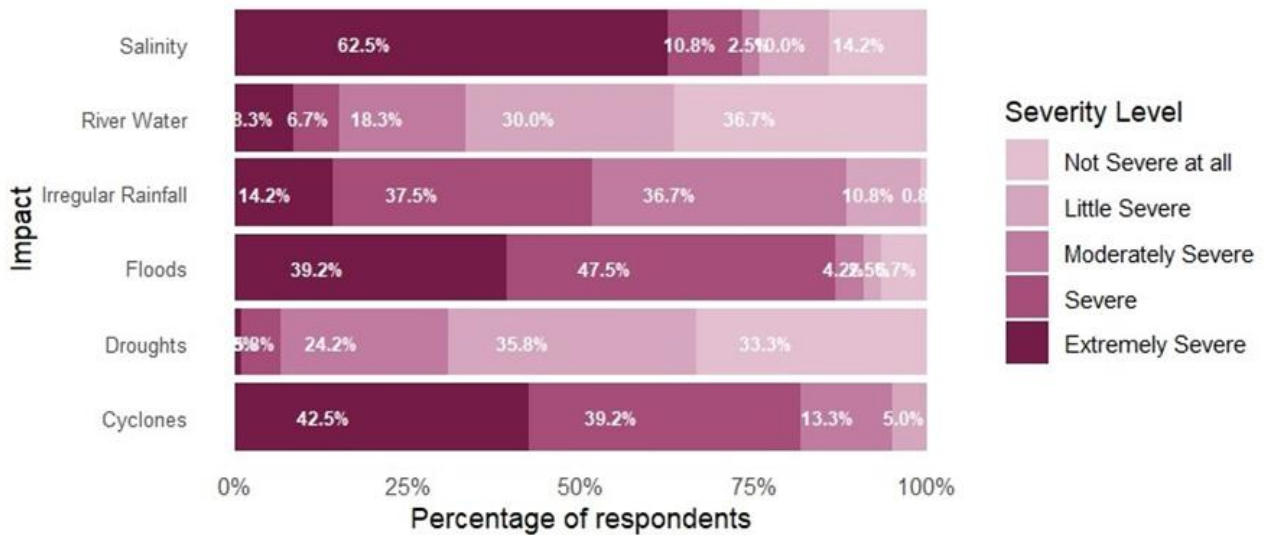
If farmers get information on climatic events before occurring climatic shocks and events, they will be able to

take proper measures against climatic shocks and risks. In this study, most of the surveyed farmers (almost 97.50% of the total respondents) mainly depended on family, friends, and neighbors to get climate information in advance, though television has a significant role as a medium of information. Only two-fifths of the total respondents listened to the radio to get information. Government agencies played an inferior role in transforming climatic information in the study area.

In the field survey, farmers were asked two questions: what were the temperature and rainfall trends in the last five years? Every paddy farmer perceived that temperature goes up severely every year. On the other hand, in perceiving the precipitation patterns, most respondents said that the amount of rainfall decreased over the last five years, while only 3.33% of them argued that the rainfall pattern was not changing over the last five years. Besides, almost 90% of the respondents revealed that rainfall intensity was lowering over the last five years. These results are in line with Figure 1 (box 1).

Every farmer does not perceive the causes behind changing climate conditions in the same way. Perception differs from person to person and location to location. The study revealed that the highest portion of the total respondents suspected that the wrath of God is the main cause behind climate change. Over one-third of them reported that lousy management of natural resources is one of the main reasons for climate change. However, nearly 31% of paddy farmers also reported that the increased population is another leading reason for changing climate. This issue is also shown through perception of the condition of climate change (box 6) in Figure 1.

Paddy farmers reported that a large quantity of yield production was destroyed, and massive losses were incurred annually because of various climatic shocks such as floods, cyclones, droughts, salinity intrusion, irregular rainfall, etc. Figure 3 demonstrates the perceived severity levels of different climate events, including floods, cyclones, droughts, salinity intensity, irregular rainfall, and lower river water levels.



Source: Field survey, 2019

Figure 3. Perceived severity level of different climatic events

Bagerhat is a coastal area, which makes it vulnerable to cyclones (Hoque et al., 2021). Over the last few decades, this region has been affected by several significant natural catastrophes. The destruction caused by Cyclones Sidr and Aila, amongst others, was devastating (Rahman & Esha, 2022). Figure 4 indicates that when cyclones took place, paddy farmers of Fakirhat Upazila were less vulnerable than the farmers of Rampal Upazila.

Groundwater in almost the entire Bagerhat district is likely salty due to the deposition of tidal connate water during Holocene aquifer development and the intrusion of salinized surface water (Ayers et al., 2016). Results from Figure 4 suggest that in the case of Rampal Upazila, the salinity intrusion was highly severe and much higher than in Fakirhat Upazila. The study also showed that the effect of floods and cyclones in Rampal Upazila was extremely severe than in Fakirhat Upazila. These issues are presented through the pressure on the condition of natural systems and resources (box 2) in the conceptual framework in Figure 1.

On the other hand, farmers of both Fakirhat and Rampal upazilas experience severe irregular rainfall. This irregular rainfall prevents the salts from being flushed out during the monsoon and requires additional irrigation during the dry season (Salehin et al., 2018). However, the severity of droughts is not so acute in both Fakirhat and Rampal upazillas, respectively, as suggested by Figure 4.

Perception of Problems Emerged due to Climate Change

Persistent climate change would exacerbate the social and economic difficulties that the most impoverished individuals currently confront, intensifying their vulnerabilities due to their inadequate social safety nets and reliance on climate-sensitive natural resources (Sarker et al., 2023). Paddy farmers in our study perceived that they faced many problems, including income loss, crop failure, poor livestock productivity, lowering crop quality, water shortage, delayed crop maturity, increased diseases, soil erosion, and loss of agricultural land due to continuous climatic parameter changes. These problems reduced their capacity to resist any unfavorable situation led by the

effect of climate change. These are reflected through the impact on the capacity of paddy farmers (box 3) in the conceptual framework in Figure 1.

Table 4: Climate Change Problem Index

Problem	Percentage (%)					Fakirhat Upazila		Rampal Upazila	
	NS	LS	MS	SV	ES	MIV	Rank	MIV	Rank
Crop failure	0	1	2	13	85	0.96	2	0.97	2
Delayed crop maturity	3	20	33	27	18	0.68	6	0.66	6
Crop quality infected	2	6	23	45	25	0.73	4	0.81	4
Poor livestock productivity	3	1	6	23	67	0.86	3	0.94	3
Loss of agricultural land	76	19	3	2	1	0.28	9	0.25	9
Soil erosion	49	39	8	3	1	0.29	8	0.37	8
Water shortage	2	18	42	29	9	0.71	5	0.60	7
Income loss	0	0	0	8	93	0.97	1	1.00	1
Increase diseases	1	13	43	38	5	0.65	7	0.68	5

Note: NS = Not Severe at all, LS = Less Severe, MS = Moderately Severe, SV = Severe, ES = Extremely Severe, MIV = Mean Index Value

Table 4 demonstrates the climate change problem index due to climate change. Both in Fakirhat and Rampal Upazilas, income loss and crop failure were considered as two drastic problems caused by climate change.

However, climate change has a direct impact on livestock output by affecting the performance of animals. Additionally, it had an indirect impact by affecting the environment (Tiruneh & Tegene, 2018). Respondents reported that poor livestock productivity was also a strenuous problem in both Upazilas, with index values of 0.86 and 0.94, respectively.

Besides, being exposed to high temperatures, increased levels of carbon dioxide, and ozone depletion, the output and quality of fresh fruit and vegetable crops can be impacted directly and indirectly (Mattos et al., 2014). Estimations show that the problem of lowering crop quality was highly stiff in Rampal Upazila, compared to Fakirhat Upazila.

One of the well-documented effects of climate change is the change in growth timing of plants. Due to climatic change, vegetative and reproductive phases are changing (Haokip et al., 2020). The problem of delayed crop maturity resulting from climate change was severe in both Upazilas, with a mean index score of 0.68 and 0.66.

Additionally, the study showed that paddy farmers of both upazilas appeared to have the same level of problems due to water shortage and increased diseases due to the adverse effects of climate change. On the other hand, soil erosion and loss of agricultural land were considered slightly problematic in both Fakirhat and Rampal Upazilas.

Dimensions of Climate Vulnerability

Farmers' beliefs on vulnerability significantly impact shaping perceptions of climate change risk and influence the three aspects of vulnerability: exposure, sensitivity, and adaptive capacity (Ahmed et al., 2021).

Table 5: Dimensions of Climate Vulnerability Index (CVI)

Vulnerability Factors	Mean Index Value	Minimum Index Value	Maximum Index Value
Exposure (severity of climatic shocks)	0.535	0	1
Sensitivity (climate related stimuli)	0.728	0	1
Adaptive capacity (socioeconomic features)	0.420	0	1
Vulnerability (climate vulnerability index)	0.094	-0.533	0.834

Table 5 lays out the three aspects of vulnerability that might be considered to understand better how paddy farmers are vulnerable to various weather conditions. A Climate Vulnerability Index (CVI) value of 0.094 demonstrated that farmers were moderately vulnerable. A positive CVI score of 0.094 indicated that farmers were more vulnerable to climate-related events and risks compared with their ability to adapt and mitigate the consequences of unfavorable environmental impacts. The

analysis revealed that sensitivity (0.728) contributed most to the overall vulnerability. At the same time, the least contributing factor was adaptive capability (0.420). According to the findings, farmers were moderately exposed to the negative impact of climate change, had a moderate to extreme level of sensitivity, and possessed a low adaptive capacity to overcome adverse climatic impacts and risks. These perspectives are reflected through

exposure to and sensitivity to the community (box 4) in Figure 1.

Indigenous Decisions to Climate Change Risks

Coastal areas are mainly vulnerable to flooding, cyclones, salinity intrusion, and river erosion (Hoque et al., 2021). The adverse effects of climatic change have significantly decreased agriculture productivity (Ju et al., 2021). Paddy farmers use their indigenous knowledge to fight against these adverse effects and risks. Several local methods are used to mitigate these risks in farming, such as changing cropping patterns and dates, mixed farming, and technology adoption (Ahmed et al., 2021).

Table 6 outlines a variety of on-farm and off-farm indigenous methods that paddy farmers had implemented to adapt to the effects of climate change, which is also revealed through on-farm decisions (box 8) and off-farm decisions (box 9) in the conceptual framework in Figure 1. In our study, the respondents utilized various indigenous methods, including changing planting dates, mixed farming, early harvesting, increasing irrigation, selling livestock, looking for daily work, borrowing money, and selling household assets to enhance their well-being.

Paddy farmers used more than one strategy among the eight indigenous strategies. Increasing irrigation, early harvesting, and changing planting dates were reported as the significant efficacious indigenous methods practiced by paddy farmers (Table 6). Nearly eighty percent of paddy farmers increased their level of irrigation to fight against drought and irregular rainfall. Additionally, approximately 67.5% of respondents harvested their crops early to hold their ground against potential cyclones, storms, and flash floods. Extended dry periods and droughts can cause crop diseases and insect pests to proliferate and destroy crops, ultimately leading to low yields and food poverty. Changing planting dates can reduce the effects of crop damage or loss from persistent and lousy weather conditions. More than sixty-two percent of surveyed farmers changed their planting dates to resist the adverse effects of drought and unpredictable precipitation. Besides, around 46% of paddy farmers reported practicing mixed farming to use their land effectively and enhance land productivity. However, paddy farmers sold livestock and household assets for financial assistance. Sometimes, they looked for daily work and borrowed money to support their family need.

Table 6: Indigenous Decisions and Indigenous Strategy Index

Local Indigenous Methods		Adopters (%)	Mean Index Value	Effectiveness
On-farm Indigenous Method	Increasing irrigation	79.17	0.74	Effective
	Early harvesting	67.50	0.69	Effective
	Changing of planting dates	62.50	0.65	Effective
	Mixed farming	45.83	0.46	Moderately Effective
Off-farm Indigenous Method	Selling livestock	51.67	0.54	Moderately Effective
	Borrowing money	46.67	0.49	Moderately Effective
	Looking for daily work	43.33	0.47	Moderately Effective
	Selling household assets	12.50	0.14	Very Less Effective

Factors affecting Indigenous Decisions on Climate Change Risks

Eight Logit Regression Models were separately conducted to ascertain the impact of socio-demographic and economic factors of farmers on their adoption of various indigenous techniques. Table 7 and Table 8 shows the factors that influence the adoption of local indigenous methods. These issues are also presented through socioeconomic conditions and external factors in box 5 of Figure 1.

Age of the Respondents

The age of the respondents affects adaptation strategies to climate change (Deressa et al., 2009). More aged people were more likely to perceive the matters involved in farming and climate change well. They are more familiar with different indigenous methods regarding climate change. The findings in Table 7 and Table 8 suggest that a

one-year increase in age is associated with 0.9% intensification in the likelihood of early harvesting ($p < 0.10$) and 1.5% escalation in the probability of selling livestock ($p < 0.05$).

Education Level of the Respondents

Our empirical result denotes that an additional year of education enhanced the likelihood of selling livestock by 3.6% and condensed the probability of borrowing money by 3.5% (Table 7 and Table 8) Education qualification is one of the most crucial indicators to understand the level of perception of climate change and indigenous strategies. A higher level of education indicates a better perception of climate change and more risk reduction capability through improved indigenous strategies. Sarker et al. (2013) argued that farmers with higher levels of education are expected to adapt better to the extreme effects of climatic changes.

Table 7: Results from Logit Regression Model

Explanatory Variables	Response Variables (Local Indigenous Decisions)							
	Increase irrigation system	Early harvesting	Change of Planting Dates	Mixed farming	Selling livestock	Borrow money	Look for Daily Work	Sell household assets
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	Coefficient (Standard Error)							
Age of the Respondents (years)	-0.016 (0.032)	0.047* (0.028)	0.038 (0.032)	0.011 (0.029)	0.058** (0.03)	-0.014 (0.026)	-0.016 (0.026)	0.083 (0.098)
Educational Level of the respondents (Years)	-0.071 (0.084)	0.098 (0.073)	-0.02 (0.078)	-0.048 (0.08)	0.143* (0.083)	-0.142** (0.07)	-0.048 (0.071)	0.162 (0.202)
Household size	-0.163 (0.183)	0.379** (0.18)	-0.114 (0.171)	0.312* (0.176)	0.144 (0.163)	-0.061 (0.144)	-0.087 (0.149)	0.227 (0.696)
Household Distance from Farm	6.02** (2.729)	-2.391 (1.98)	0.205 (1.941)	0.972 (2.284)	-0.684 (2.028)	3.135* (1.834)	3.377* (1.88)	11.37* (6.185)
Access to Farm Credit	0.197 (0.788)	-0.188 (0.675)	-0.008 (0.741)	-2.295*** (0.87)	-0.935 (0.701)	0.062 (0.63)	-0.051 (0.649)	-3.407 (2.654)
Cultivable Land Area (decimals)	0.01 (0.011)	-0.005 (0.009)	0.032** (0.01)	0.028*** (0.01)	-0.02* (0.011)	-0.007 (0.009)	-0.012 (0.01)	-0.38** (0.155)
Homestead Land Area (decimals)	0.004 (0.055)	0.051 (0.051)	-0.17*** (0.1)	-0.049 (0.052)	-0.011 (0.051)	-0.044 (0.048)	-0.016 (0.046)	0.445* (0.262)
Cultivable land fertility	-0.676 (0.924)	-0.448 (0.739)	0.833** (0.74)	0.427 (0.855)	-0.087 (0.786)	0.347 (0.711)	0.368 (0.767)	-3.332* (1.779)
Cultivating season	-0.066 (0.562)	0.36 (0.469)	1.278 (0.536)	2.124*** (0.55)	0.367 (0.523)	0.361 (0.471)	1.119** (0.51)	-4.401 (2.987)
Access to extension services	-0.885 (1.115)	1.724** (0.88)	-0.823 (0.972)	2.688*** (0.99)	1.573** (0.8)	0.904 (0.736)	0.568 (0.757)	5.982 (4.024)
Access to subsidy	1.346* (0.771)	-0.819 (0.615)	-0.866 (0.707)	-0.045 (0.649)	-0.839 (0.623)	0.442 (0.538)	-0.299 (0.551)	-2.673 (2.311)
Assets holding (in log)	-0.029 (0.289)	0.0 (0.237)	0.404 (0.251)	0.002 (0.277)	-0.071 (0.244)	-0.171 (0.221)	-0.323 (0.236)	2.931** (1.27)
Livestock holding (in log)	-0.069 (0.174)	0.003 (0.149)	0.241 (0.165)	0.024 (0.168)	0.68*** (0.19)	-0.089 (0.145)	-0.194 (0.148)	1.665* (0.867)
Annual income from paddy (in log)	-0.195 (0.62)	0.29 (0.547)	1.07* (0.613)	1.6*** 0.596	0.081 (0.566)	-1.55*** (0.54)	-1.244** (0.54)	1.237 (1.603)
Annual income from other sources (in log)	-1.317 (1.072)	-0.158 (0.377)	-0.066 (0.192)	0.327* (0.175)	0.40** (0.201)	-0.079 (0.146)	0.034 (0.173)	0.662 (1.811)
Constant	18.64 (14.869)	-4.498 (8.405)	-18.2** (8.11)	-24.29*** (8.42)	-14.38* (7.79)	19.4*** (7.004)	17.56** (7.25)	-64.62 (41.948)
Observations	120	120	120	120	120	120	120	120
Chi-square (p-value)	19.285 (p<0.201)	22.983 (p<0.085)	40.552 (p<0.000)	53.109 (p<0.000)	42.979 (p<0.000)	21.391 (p<0.125)	25.189 (p<0.047)	59.763 (p<0.000)
Pseudo-R ²	0.157	0.152	0.255	0.321	0.259	0.129	0.153	0.661
AIC	135.532	160.357	150.223	144.412	155.243	176.430	171.027	62.662
BIC	180.132	204.957	194.823	189.012	199.843	221.030	215.626	107.262

*, **, and *** are significant at the p < 0.10, p < 0.05, and p < 0.01 level, respectively.

Table 8: Results from the Marginal Effect of Logit Regression Model

Explanatory Variables	Response Variables (Local Indigenous Decisions)							
	Increase Irrigation System	Early Harvesting	Change of Planting Dates	Mixed Farming	Selling Livestock	Borrow Money	Look for Daily Work	Sell Household Assets
	Model 9	Model 10	Model 11	Model 12	Model 13	Model 14	Model 15	Model 16
	Marginal Effect (Standard Error)							
Age of the respondents (years)	-0.002 (0.004)	0.009* (0.005)	0.008 (0.007)	0.003 (0.007)	0.015** (0.007)	-0.003 (0.006)	-0.004 (0.006)	0.000065 (0.0003)
Educational Level of the respondents (Years)	-0.008 (0.009)	0.020 (0.015)	-0.004 (0.016)	-0.012 (0.020)	0.036* (0.021)	-0.035** (0.02)	-0.012 (0.017)	4.75e-07 (0.00000)
Household Size	-0.017 (0.020)	0.075** (0.03)	-0.024 (0.036)	0.077* (0.044)	0.036 (0.041)	-0.015 (0.036)	-0.021 (0.036)	9.33e-07 (0.00000)
Household Distance from Farm	0.639** (0.329)	-0.476 (0.395)	0.043 (0.411)	0.241 (0.567)	-0.171 (0.507)	0.777* (0.455)	0.820* (0.457)	1.31e-06 (0.00001)
Access to Farm Credit	0.021 (0.085)	-0.037 (0.133)	-0.002 (0.157)	-0.52*** (0.159)	-0.229 (0.166)	0.015 (0.156)	-0.012 (0.158)	-0.00036 (0.00015)
Cultivable Land Area (decimals)	0.001 (0.001)	-0.001 (0.002)	0.007** (0.003)	0.01*** (0.003)	-0.005* (0.003)	-0.002 (0.002)	-0.003 (0.002)	-2.17e-06 (0.00001)
Homestead Land Area (decimals)	0.000 (0.006)	0.01 (0.010)	-0.04*** (0.01)	-0.012 (0.013)	-0.003 (0.013)	-0.011 (0.012)	-0.004 (0.011)	2.56e-06 (0.00001)
Cultivable Land Fertility	-0.059 (0.071)	-0.082 (0.123)	0.193 (0.179)	0.103 (0.200)	-0.022 (0.196)	0.084 (0.168)	0.087 (0.174)	-0.0001 (0.00041)
Cultivating Season	-0.007 (0.059)	0.072 (0.095)	0.274** (0.113)	0.48*** (0.102)	0.091 (0.130)	0.089 (0.115)	0.262** (0.112)	-0.0001 (0.00024)
Access to Extension Services	-0.109 (0.146)	0.284** (0.12)	-0.183 (0.224)	0.57*** (0.146)	0.365** (0.161)	0.222 (0.175)	0.139 (0.186)	0.00397 (0.00147)
Access to Subsidy	0.125* (0.075)	-0.171 (0.132)	-0.191 (0.157)	-0.011 (0.161)	-0.206 (0.148)	0.11 (0.133)	-0.072 (0.131)	-0.00001 (0.0001)
Assets Holding (in log)	-0.003 (0.031)	-0.000 (0.047)	0.085 (0.052)	0.000 (0.069)	-0.018 (0.061)	-0.042 (0.133)	-0.079 (0.057)	0.00002 (0.00007)
Livestock Holding (in log)	-0.007 (0.019)	0.001 (0.030)	0.051 (0.036)	0.006 (0.042)	0.169*** (0.05)	-0.022 (0.036)	-0.047 (0.036)	9.58e-06 (0.00004)
Annual Income from Paddy (in log)	-0.021 (0.065)	0.058 (0.109)	0.227* (0.129)	0.39*** (0.148)	0.020 (0.141)	-0.383*** (0.133)	-0.302** (0.13)	7.12e-06 (0.00003)
Annual Income from other Sources (in log)	-0.140* (0.077)	-0.031 (0.074)	-0.014 (0.041)	0.081* (0.044)	0.101** (0.050)	-0.02 (0.036)	0.008 (0.042)	3.81e-06 (0.00002)
Observations	120	120	120	120	120	120	120	120

*, **, and *** are significant at the p < 0.10, p < 0.05, and p < 0.01 level, respectively.

Household Size

Our results in Table 7 revealed that early harvesting appeared to be positively correlated ($p < 0.05$) with the size of the household, implying an additional member in the average household would result in a 7.5% rise in the likelihood of practicing early harvesting methods (see Table 8). If families have more earning members, they will earn more, save more, and be more capable of coping with climate change.

On the other hand, if they have more kids, expenditures will increase, and adapting capability may be reduced. Sometimes, farming practice also depends on household size. Large household associates with high labor endowment enable farms to undertake various agricultural tasks when facing environmental and natural hazards and this finding is in line with the study of Apata (2011). Besides, estimation found that large household size increased the probability of adopting mixed farming by 7.7% ($p < 0.01$) (Table 8).

Distance of Households from Farmland

Distance of household from farmland had a significant positive impact, indicating paddy farmers who were located far from the farm had more chances to choose the following indigenous strategies compared to the paddy farmers who were located near farmland: increasing irrigation system, borrowing money, looking for daily work, and selling other assets except livestock. Table 8 shows that one decimal increase in distance between farm and household increases the probability of increasing the irrigation system by 63.9% ($p < 0.05$) and amplifies the chance of borrowing money by 77.7% ($p < 0.10$) and looking for daily work by 82% ($p < 0.10$).

Access to Farm Credit

Surprisingly, access to farm credit has a negative and significant effect on practicing mixed farming ($p < 0.01$). It implies that increased finance availability is inversely correlated with the likelihood of farmers adopting a mixed farming plan. The probability of practicing mixed farming would decrease by 51.8% (see Table 8) if paddy farmers had access to farm credit compared to farmers who did not have access. In general, farmers' access to credit is the indication of the availability of funds, which is positively associated with the choice of various indigenous strategies (Kurukulasuriya and Ajwad, 2007) and the ability to adjust to different climatic conditions (Rawlani and Sovacool, 2011).

Cultivable Land Area

Cultivable land size amplifies the chances of changing planting dates and practicing mixed farming but reduces the probability of selling livestock and looking for daily work. In particular, farmers who owned their agricultural property were more interested in investing more in their land to get a good return and cope with the changing climate. One decimal increase in cultivable land size increases the chance of changing planting dates and practicing mixed farming by 0.07% ($p < 0.05$) and 0.07% ($p < 0.01$), respectively (Table 8). The positive impacts of cultivable land size on adopting different strategies, such as changing planting dates and practicing mixed farming, align with the study of Kom et al. (2020). On the other

hand, one decimal increase in cultivable land size reduces the probability of selling livestock by 0.5%. Previous studies produced the same outcomes (Alauddin and Sarker, 2014; Ali and Erenstein, 2017; Abid et al., 2016). However, increasing cultivable land size declines the likelihood of selling household assets.

Cultivable Land Fertility

Depending on the fertility of cultivable land, farmers cultivate their land using different inputs and methods. The cost of cultivation also depends on the land's fertility to some extent. Results showed that the likelihood of selling household assets would reduce if cultivable land had excellent fertility at a 10% significance level (Table 7).

Number of Cultivating Seasons

The number of cultivating seasons has a strong and positive effect on changing planting dates ($p < 0.05$), practicing mixed farming ($p < 0.01$), and looking for daily work ($p < 0.05$). Farmers who cultivate their land once a year can expand their cultivating season, change planting dates as needed, and practice mixed farming, giving them more earnings. Analysis (in Table 8) shows that if the cultivating season increases, the probability of changing planting dates will increase by 27.4%, practicing mixed farming by 47.5%, and looking for daily work by 26.2%.

Access to Extension Services

The availability of agricultural extension services significantly influences agricultural production. Providing farmers with accurate information regarding cropping patterns, production techniques, crop rotation, and indigenous tactics would enhance their ability to achieve the desired crop yield and financial returns (Katungi et al., 2008). Our analyses suggest that increased access to extension services resulted in a 57.3% higher likelihood of engaging in mixed farming, a 28.4% higher likelihood of early harvesting, and a 36.5% higher chance of selling livestock (Table 8). This result is also consistent with the findings of Deressa et al. (2009).

Access to Subsidy

The findings of this study indicated that subsidies had no substantial impact on most indigenous measures, except for irrigation. Farmers received financial benefits (i.e., a rebate on fuel for operating irrigation pumps), which impacted irrigation utilization. The results demonstrated that paddy farmers who had access to subsidies exhibited a higher propensity (12.5%) to enhance their irrigation systems ($p < 0.10$, see Table 7 and Table 8) in contrast to those who lacked such access. This finding is supported by the study of Sarker et al. (2013).

Assets Holding

The asset is one of the crucial factors of the socioeconomic characteristics of the respondents. Holding more assets, farmers can adopt indigenous farming technology to cope with climatic shocks (Sarker et al., 2013). Concerned result denotes asset holding also had a positive impact on selling household assets ($p < 0.05$), which meant the farmer who possessed more assets was more likely to sell household assets to meet financial needs in times of emergency led by climate change (see Table 7).

Livestock Holding

Livestock inventory is expected to be another crucial socioeconomic factor for the respondents. Generally, it is the source of irregular household income. Sometimes, it brings regular income also. More livestock inventory helps strengthen resistance to climatic shocks. Our analysis indicated that an increase in the livestock inventory of paddy farmers was associated with a 16.9% higher likelihood in the probability of selling livestock at a 1% significance level.

Annual Income from Paddy

The annual income from farming operations is a good measure of a farmer's ability to invest in agricultural technology since it indicates their level of financial stability (Knowler and Bradshaw, 2007). Our analysis (from Table 7 and Table 8) showed that the income generated from cultivating paddy had a notable and favorable impact on changing planting date (22.7%, $p < 0.10$) and practicing mixed farming (39.7%, $p < 0.01$) because it helped farmers to resist with the adverse effect of extreme climatic events by changing planting date and engaging in mixed farming practices. Conversely, it had a

substantial and adverse impact on seeking work daily ($p < 0.05$) and obtaining borrowing ($p < 0.01$). Higher income from paddy reduced paddy farmers' inclination to seek daily work (30.2%) and borrow money from other sources (38.3%).

Annual Income from Other Sources

When farmers have other sources of income, they are more resilient to any climatic shock. Table 8 demonstrated that income generated from other sources exhibits an 8.1% higher likelihood of practicing mixed farming and a 10.1% higher probability of selling livestock.

Constraints to Local Indigenous Decisions

Table 9 illustrates the main constraints to indigenous decisions, including lack of support from the government, lack of financial resources, lack of inputs, lack of support from NGOs, no or less access to water for irrigation, lack of information on climate change, lack of market access and lack of knowledge and experience. Results (see Table 9) demonstrated that respondent farmers of both Fakirhat upazila and Rampal upazila appeared to have the same obstacles to making various indigenous decisions in the face of unfavorable and extreme climatic conditions.

Table 9: Constraints to Local Indigenous Methods

Constraints	Percentage (%)					Fakirhat Upazila		Rampal Upazila	
	NS	LS	MS	SV	ES	MIV	Rank	MIV	Rank
Lack of support from government	0	0	1	13	87	0.96	1	0.98	1
Lack of financial resources	3	1	4	11	82	0.92	2	0.96	2
Lack of inputs (e.g., seeds)	12	19	32	24	13	0.65	3	0.59	3
Lack of support from NGOs	13	25	33	15	13	0.61	4	0.55	4
No access to water for irrigation	14	36	38	9	3	0.51	5	0.49	5
Lack of information on climate change	38	18	27	11	7	0.47	6	0.45	6
Lack of knowledge and experience	74	20	6	0	0	0.27	8	0.26	7
Lack of market access	74	16	6	3	1	0.31	7	0.25	8

Note: NS = Not Severe at all, LS = Less Severe, MS = Moderately Severe, SV = Severe, ES = Extremely Severe, MIV = Mean Index Value

Lack of government support (index values of 0.96 and 0.98 for Fakirhat and Rampal Upazilas, respectively, see Table 9) and lack of financial resources (index values of 0.92 and 0.96 for Fakirhat and Rampal Upazilas correspondingly, see Table 9) were regarded as extremely severe constraints to take indigenous decisions marked by more than 80% of the respondents. Due to a lack of financial resources, farmers did not adopt their expected indigenous strategies to mitigate the effects of climate change. This outcome is supported by the study of Bryan et al. (2009), Antwi-Agyei et al. (2014), and Peterson (2013).

Over one-third of the respondents claimed that lack of support from NGOs, no or less access to water for irrigation, lack of information on climate change, and lack of inputs are moderately problematic in the study area. As noted by Ndamani and Watanabe (2015), Boyd et al. (2013), Measham et al. (2011), and Ozor (2010), the lack of access to climatic information poses severe challenges

to the use of indigenous options. Due to a lack of helpful information, paddy farmers may not be aware of the latest advancements in adapting options to climate change and may not make necessary modifications. It creates significant gaps between paddy farmers and helpful information that should assist them in farming. So, farmers cannot take the appropriate precautions to lessen their losses. These issues are considered under farming flexibility (box 7) in the conceptual framework in Figure 1.

Several studies illustrate that the high cost of agricultural inputs and facilities creates a scarcity of farm inputs poses threats to adapting different strategies of the farmers as those are beyond their resource capabilities (Antwi-Agyei et al., 2014; Ozor, 2010; and Devkota, 2018). However, in Fakirhat Upazila, lack of input and support from NGOs were more challenging constraints faced by the paddy farmers than by the farmers in Rampal Upazila.

Insufficient irrigation facilities are most likely related to farmers' inability to use the already available water because of technological limitations (Antwi-Agyei et al., 2014). In Bangladesh, paddy farmers have poor resource accumulation. They cannot afford adequate investment in irrigation technology and endure their farming during extreme climatic events (i.e., flash floods and drought). The problem of no or less access to water for irrigation is moderately severe in both Upazilas, with an index score of 0.51 and 0.49, respectively.

The ability of farmers to negotiate for better prices for their yield is weakened when they have a lack of access to markets. Our analysis showed that the lack of market access was less severe than any other barriers (Table 9). This result is also consistent with Ndamani and Watanabe (2015).

Summary of Key Findings

Our empirical results revealed that every respondent paddy farmer perceived that temperature increases notably every year. Farmers experienced severe irregular precipitation with low intensity of rainfall. However, in this study area, floods, cyclones, salt intrusion, and irregular rainfall harshly hurt paddy growers (see Table 4). Most respondent farmers suspected that God's anger caused climate change. Other reasons behind climate change were increasing population, unplanned industry, and inept management of natural resources. Income loss, crop failure, poor livestock productivity, and lower crop quality were more severe problems that emerged due to the devastating consequences of climate change (see Table 4). Results further revealed that farmers experiencing moderate to extreme sensitivity to climate-related stimuli had a low adaptive capacity to overcome unfavorable climatic impacts and risks (see Table 5). To adapt to climatic risks, paddy farmers took several effective indigenous methods, including increasing irrigation facilities, early harvesting, and changing their planting schedules (see Table 6).

Results from Model 1 (in Table 7) and Model 9 (in Table 8) showed that household distance from the farm and accessibility to subsidy positively affected the adoption of an increased irrigation system. It was further observed that household size and accessibility to extension services also directly impacted the implementation of early harvesting of yields (Model 2 in Table 7 and Model 10 in Table 8). Another on-farm indigenous method was the planting date adjustment, which was positively affected by cultivable land area, fertility, and annual income from paddy (Model 3 in Table 7). Model 4 (in Table 7) revealed that household size, cultivating season, access to extension services, and annual income from paddy and other sources had a statistically significant and positive impact, and access to farm credit had a negative effect on practicing mixed farming.

Besides, the findings from Model 5 (in Table 7) indicated a significant and positive effect of the age of the respondents, educational level of the respondents, accessibility to extension services, livestock holding, and annual income from other sources, and a negative effect of cultivable land area on selling livestock. In addition, household distance from the farm had a positive impact, and annual income from paddy had a negative impact on two off-farm indigenous decisions: borrowing money and

looking for daily work facing extreme climatic events (in models 6 and 7 in Table 7, respectively). Surprisingly, the findings from model 8 (in Table 7) indicated that factors such as household distance from home, amount of cultivable land, homestead land area, number of cultivable seasons, asset holding, and livestock holding had a statistically significant impact on selling household assets.

Our study finally exposed that the severity of the constraints faced by the paddy farmers to take various indigenous decisions appeared almost the same for both Upazila. The significant constraints were the lack of government support, inputs, and financial resources (see Table 9).

Conclusions and Policy Implications

This study investigated the perception of paddy farmers on the different consequences related to climate change threats in the Bagerhat District of Bangladesh. It also assessed the factors that influence the selection of indigenous strategies by the farmers at a local level. The impacts of floods, cyclones, and saline intrusion were detrimental in our study locations. In this study area, income loss and crop failure caused by the damaging effect of climate change were observed as highly severe. Hence, the perspectives of paddy farmers on climate vulnerability are significantly shaped by their views of the risks triggered by climate change. They were more sensitive to these risks.

Due to the perceived impacts of climate change, paddy farmers have adopted both on-farm and off-farm activities to augment their capacity to cope with the destructive nature of climate change. Indeed, to mitigate the severity, farmers believed that increasing their irrigation systems, implementing early crop harvesting, and adjusting their planting schedules were the most efficacious choices available to them and enhanced their well-being. Understanding significant determinants of paddy farmers' choice of indigenous methods is vital to designing impactful policies in the study area. The empirical results from the eight separate logit models revealed that age, education level, household size, the distance between households and farmland, availability of farm loans, size of cultivable land, cultivable land fertility, number of cultivating seasons, access to extension services and subsidies were expected as the key determinants that motivated paddy farmers to make these choices. However, indigenous strategies encountered substantial constraints such as limited government and non-governmental organizations' support, insufficient resources, and lack of financial support.

The outcomes from this study mainly provide some notes for policymakers because policymakers work to support farmers in enhancing their quality of livelihood and building capacity to fight against the effects of climate change.

First, our study advocates location-specific and well-designed institutional planning for paddy farmers. It is imperative to pinpoint the strengths and weaknesses of different stakeholders who prepare institutional planning for farmers. A bottom-up approach (from the farm level to the national level) should be followed to formulate strategic planning for farmers to demand what they need in the face of peculiar environmental conditions.

Second, increased irrigation facilities are treated as an effective strategy. So, access to water for irrigation should be ensured. As floods, cyclones, and salinity intrusion are extremely severe in the study area, adequate dams and embankment should be constructed to reduce the damages and boost their capabilities.

Third, adequate agricultural extension services and subsidies (such as providing irrigation pumps and appropriate planting materials and inputs) should be made available for farmers for the enhancement of implementing improved irrigation systems and adopting flood and drought-tolerant high-yielding crop varieties to reduce the losses of paddy production and farm income, and to ensure long term agricultural sustainability.

Fourth, with the collaboration of banks and non-bank financial institutions (NBFIs), the government should ensure adequate access to farm credit with low paperwork and flexible terms and conditions so that they can quickly meet their financial needs during climatic shocks.

The analysis of this study is based on only two upazilas with a small sample size from only six villages rather than being a universal survey. Furthermore, in this study, we used cross-sectional data, which does not cover the long-term dynamics that may occur in practicing local indigenous methods and their associated outcomes. Hence, future studies could apply longitudinal data to trace the evolution of implementing different indigenous methods at the local level.

Acknowledgement

Authors are grateful to Sayeda Maria for assisting in some analyses and Mohibullah for helping in preparing the map of the study area.

Conflict of Interest

None of the authors present any conflicts of interest.

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