Research Article

Indian Journal of Extension Education
Vol. 62, No. 4 (October–December), 2026, (54-59)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

Socioeconomic Determinants of Farmers' Attitudes toward Climate Adaptation Practices in Northern Bangladesh

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HIGHLIGHTS

- The majority (72.4%) of farmers exhibited a moderately favorable attitude toward climate change adaptation practices in northern Bangladesh.
- Bivariate analysis showed that farmers' attitudes were significantly and positively associated with education, farm size, household income, organizational participation, and access to information.
- In the multiple regression analysis, education and access to extension information emerged as significant predictors of farmers' attitudes, and the final model explained 29.8% of the total variation.

ARTICLE INFO

Keywords: Climate change adaptation, Education level, Information dissemination, Agricultural attitudes, Regression analysis.

https://doi.org/10.48165/IJEE.2026.62408

Citation: Karim, M. R., Sarmin, S., Shahin, A., Hasan, M. F., & Rashid, M. M. (2026). Socioeconomic Determinants of Farmers' Attitudes toward Climate Adaptation Practices in Northern Bangladesh. *Indian Journal of Extension Education*, *62*(4), 54-59. https://doi.org/10.48165/IJEE.2026.62408

Reviewed by: Pratheesh Padathu (pppadath@gmail.com); Marlon Alejos (msa0585@yahoo.com); Mr A K M Kanak Pervez (kp@ru.ac.bd); Dr. Debashis Dash (debashis.agext@gmail.com)

ABSTRACT

The objective of the study was to determine the factors contributing to farmers' attitudes toward climate adaptation practices. Data were collected during 2024 through face-to-face interviews with 98 sampled farmers in the Dinajpur district of northern Bangladesh. Descriptive statistics, Pearson's product-moment correlation, and stepwise multiple regression analysis were used for data analysis. The results indicated that most farmers (72.4%) had a moderately favorable attitude toward climate adaptation practices. Pearson's correlation analysis showed that education, farm size, household income, organizational participation, and information access had significant positive relationships with farmers' attitudes toward climate adaptation practices. Multiple regression analysis revealed that education and information access were the most significant determinants of farmers' attitudes, explaining 36.6% of the variation. In the stepwise regression model, only education and information access emerged as significant predictors, jointly explaining 29.8% of the variation in farmers' attitudes toward climate change adaptation practices. Education alone explained 25.5% of the variation, while the inclusion of information access contributed an additional 4.3%. The findings suggest that improving non-formal education and strengthening extension services through farm and home visits, mass media campaigns, and ICT-based information dissemination can enhance farmers' adaptive attitudes and promote climate-resilient agricultural practices in Bangladesh.

INTRODUCTION

Agriculture plays a significant role in the development of Bangladesh, contributing 11.2% to the national GDP in fiscal year 2024–2025. This sector remains a vital source of employment, engaging about 35% to 40% of the country's labour force (Bangladesh Bureau of Statistics [BBS], 2025). Despite this importance, Bangladesh faces major challenges in achieving sustainable agriculture. The country has a population of over 160 million, projected to increase to around 265 million by 2050, creating

Received 21-04-2026; Accepted 26-05-2026

increasing pressure on limited natural resources and food security (BBS, 2024). Bangladesh ranks 85th in the Global Hunger Index (GHI), indicating serious levels of hunger and food insecurity (Concern Worldwide, Welthungerhilfe, & Institute for International Law of Peace and Armed Conflict, 2025). In addition, Bangladesh is considered one of the most climate-vulnerable countries in the world (Karim & Thiel, 2017; Mamun et al., 2021; Ali et al., 2021). Due to its geographical location, the southern region is highly prone to cyclones, while the northwest frequently experiences drought (Ministry of Environment and Forests [MOEF], 2009). Climate change poses a serious threat to agriculture, particularly in Bangladesh (Food and Agriculture Organization [FAO], 2014), where the sector is among the most affected (Roy et al., 2013).

The Intergovernmental Panel on Climate Change (IPCC) predicts that global temperatures may increase by 1.8°C to 4.0°C by the end of the 21st century, increasing climate variability and the frequency of extreme weather events (Coumou et al., 2014). Consequently, climate change is expected to alter regional food production systems and technological innovations (Karim, 2015), affecting food security both directly and indirectly.

Bangladesh adopted Green Revolution technologies in the 1960s to meet growing food demand through improved crop varieties, irrigation, and chemical fertilizers and pesticides. Although these technologies significantly increased cereal production, excessive use of chemical inputs has caused land degradation, reduced soil microbial activity, and groundwater contamination (Roy et al., 2013). Therefore, climate-resilient farming practices such as drought-tolerant varieties, vermicompost, crop diversification, intercropping, pheromone traps, and perching for insect control are essential for addressing climate change impacts and ensuring long-term agricultural sustainability (Morand & Barzman, 2006).

Previous studies showed that socio-economic characteristics significantly influence farmers' attitudes toward agricultural practices (Haque et al., 2007; Rahman et al., 2020). Following the successful achievement of the Millennium Development Goals (MDGs), Bangladesh promoted climate adaptation practices in line with the Sustainable Development Goals (SDGs). The agricultural sector, particularly through the Department of Agricultural Extension (DAE), plays a key role in promoting climate adaptation practices aligned with SDG 2 (Zero Hunger) and SDG 13 (Climate Action).

In Bangladesh, most climate-related studies have focused on policy issues (Ali & Meisner, 2017), while limited research has examined adaptation practices (Mahashin & Roy, 2017) and climate change impacts on food security (Hasan et al., 2018). Although some studies explored farmers' attitudes toward sustainable agriculture, organic farming, and aquaculture (Haque et al., 2007; Hasan et al., 2019), very limited studies have applied econometric approaches to identify determinant factors influencing attitudes toward climate adaptation practices. Therefore, this study aims to assess farmers' attitudes toward climate adaptation practices and identify the key contributing factors.

METHODOLOGY

Biral Upazila in Dinajpur District was purposively selected for the study. The area lies between 25°31′ and 25°46′ north latitude and 88°26′ and 88°38′ east longitude. The main reason for selecting the area was its location in the Barind Tract Agro-Ecological Zone (AEZ), which is characterized by moderate to severe drought conditions that adversely affect agriculture. These geographical conditions make the northern region of Bangladesh highly vulnerable to drought impacts (Rahman et al., 2022). Subsequently, three villages out of nine villages in the sub-district were selected randomly. An updated list of farmers adopting climate adaptation practices under the DAE was prepared with the assistance of the Sub-Assistant Agricultural Officer (SAAO). The total number of farmers adopting climate adaptation practices was 265, constituting the study population. A sample size of 98 was determined using the formula of Miller and Brewer (2003):

$$n = N/\{1 + N (\alpha^2)\}$$

where N is the population, n is the required sample size, and α is the margin of error (fixed at 0.08). Data were collected through face-to-face interviews using a structured interview schedule from November to December 2024.

Based on literature review, judge rating, and questionnaire pre-testing, 10 socio-economic characteristics were selected as independent variables to explain farmers' adaptive attitudes. Farmers' attitudes toward climate adaptation practices were considered the dependent variable and measured using a five-point Likert scale developed by Likert (1932), widely used in attitude studies (Hasan et al., 2019; Rahman et al., 2020). A total of 18 statements covering insect pest control (7), water management (4), and soil management (7) were used. Among them, 11 were positive and 7 were negative statements arranged randomly to minimize response bias. Responses ranged from 5 (strongly agree) to 1 (strongly disagree) for positive statements and vice versa for negative statements. Total attitude scores ranged from 18 to 90, where lower scores indicated less favorable attitudes and higher scores indicated more favorable attitudes toward climate adaptation practices.

To identify the socio-economic factors influencing farmers' attitudes, correlation analysis, multiple linear regression, and stepwise multiple regression were employed. Similar analytical approaches were followed by Jayasingh and Mishra (2024), Shahin et al. (2024) and Rashid et al. (2026).

RESULTS

Descriptive statistics of the selected characteristics

The descriptive statistics of selected characteristics are presented in Table 1. The age of the farmers ranged from 23 to 52 years, with a mean value of 35.59 and a standard deviation of 6.662. This indicates that most of the farmers belonged to the young to middle-aged category. The mean education level of the farmers was 6.18 (SD = 3.774), indicating that most completed primary to secondary education. The average family size was 5.43, which is higher than the national average family size of 4.3 (BBS, 2025). The average farm size was 0.27 ha (SD = 0.387), indicating that most farmers belonged to marginal to small farm categories. The average annual household income was BDT 66.96 thousand. Farmers participated in training programs for an average of 2.39 days and received credit averaging BDT 26.60 thousand. The mean

Table 1. Descriptive statistics of the selected socio-economic characteristics

Characteristics	Description/Unit	Range	Mean	St. Dev.
Age	Measured in years	23-52	35.59	6.662
Education	Years of education completed	0.5-17	6.18	3.774
Family size	Number of members in the family	3-11	5.43	1.705
Farm size	Total household cultivated land in Hectare	0.01-2.40	0.27	0.387
Household income	Total annual income ('000' BDT.)	30-300	66.96	32.311
Training access	Number of days participated in training	0-5	2.39	1.231
Credit received	Amount of money received from different sources like bank or NGOs ('000' BDT)	0-200	26.60	30.082
Organizational participation	Participation in organization is measured by a score	0-5	1.40	1.00
Information access	The extent of contact with different extension sources measured in score	8-33	20.78	4.883
Farming experience	Farming engagement measured in years	2-30	8.80	4.580

organizational participation score was 1.40. Information access scores ranged from 8 to 33, with a mean of 20.78. The average farming experience was 8.80 years, with a standard deviation of 4.883.

Farmers' attitude towards climate adaptation practices

The total attitude score for individual respondents ranged from 18 to 90, while the observed scores ranged from 45 to 85, with a mean of 70.52 and a standard deviation of 5.116. Based on the observed scores, farmers were classified into three categories: "less favorable (45–58)", "moderately favorable (59–72)", and "highly favorable (73–85)". Data presented in Table 2 show that more than two-thirds (72.4%) of the farmers had moderately favorable attitudes, while 26.5% had highly favorable attitudes, and only 1.1% had less favorable attitudes toward climate adaptation practices. Therefore, it could be said that the majority of farmers showed a moderately favorable attitude toward climate adaptation practices. This finding is supported by previous studies from different perspectives (Haque et al., 2007; Hasan et al., 2019; Rahman et al., 2020).

Table 2. Categorization of farmers based on their attitude toward climate adaptation practices

Categories	Percent	Mean	SD
Less favorable (45-58)	1.1		
Moderately favorable (59-72)	72.4	70.52	5.116
Highly favorable (73-85)	26.5		

Multiple regression analysis for estimating factors contributing to farmers' attitudes

According to Nicol and Pexman (2010), the results of multiple regression analyses are typically presented using two tables: a correlation matrix for predictor and dependent variables (Table 3), and regression output tables summarizing multiple regression results. Accordingly, Pearson's Product-Moment Correlation (r) was used to examine the associations between independent variables and farmers' attitudes toward climate change adaptation practices (Table 3). Among the ten selected socioeconomic characteristics, five variables such as education, farm size, household income, organizational participation, and information access showed significant positive relationships with farmers' attitudes toward climate adaptation practices. These findings indicate that improvements in these factors are associated with more favorable attitudes toward adaptation practices.

The correlation results (Table 3) show that education ($r = 0.512$, $p < 0.01$), farm size ($r = 0.284$, $p < 0.01$), household income ($r = 0.254$, $p < 0.05$), organizational participation ($r = 0.457$, $p < 0.01$), and information access ($r = 0.357$, $p < 0.01$) were significantly and positively related to farmers' attitudes toward climate adaptation practices. Age ($r = -0.178$), family size ($r = -0.035$), training access ($r = 0.096$), credit received ($r = 0.040$), and farming experience ($r = 0.137$) were not significantly related to farmers' attitudes.

Table 3. Correlation between Farmer's attitude towards climate adaptation practices and independent variables

Independent variables	Value of 'r' with 96 d.f.
Age	-0.178
Education	0.512**
Family size	-0.035
Farm size	0.284**
Household income	0.254*
Training access	0.096
Credit received	0.040
Organizational participation	0.457**
Information access	0.357**
Farming experience	0.137

Note: *p < 0.05, **p < 0.01

However, correlation analysis only indicates the direction and strength of relationships but does not measure the magnitude of contribution. Therefore, stepwise multiple regression analysis was conducted to determine the relative contribution of significant predictor variables to farmers' attitudes toward climate change adaptation practices. The stepwise regression procedure involves entering and removing predictor variables sequentially based on statistical criteria (Karim et al., 2017). Based on the correlation results (Table 3), five significant variables were entered into the multiple regression. All assumptions for regression analysis were tested and satisfied. The normal P–P plot indicated that residuals were normally distributed, showing no significant deviation from the straight line. Since the sample size exceeds 30, the Central Limit Theorem (CLT) further supports the normality assumption.

The scatter plot indicated a linear relationship between dependent and independent variables. The Durbin–Watson statistic (2.131) confirmed the independence of residuals. Additionally, Pearson correlation coefficients were below 0.9, and Variance Inflation Factor (VIF) values were below 5 (Table 4), indicating no multicollinearity among the independent variables. The model was statistically significant ($p < 0.001$), rejecting the null hypothesis that there is no significant contribution of the selected characteristics to adaptive attitudes. This confirms a significant linear relationship between the dependent variable and at least one predictor variable. Since independent variables were measured in different units, standardized coefficients were used for meaningful comparison (Hasan et al., 2019). In multiple regression analysis, the results indicated that education and information access were statistically significant predictors contributing to farmers' attitudes, while the model explained 36.6% of the variation in farmers' attitudes toward climate change adaptation practices ($R^2 = 0.366$), indicating a good model fit (Biswas et al., 2026). Although the model explains a meaningful share of variation in farmers' attitudes, approximately 63.4% of the variance remains unexplained. This unexplained component might be reflected in institutional and social factors.

The significant two variables in multiple regression were further included in the stepwise regression analysis. In Table 5, the stepwise regression results show that the first model indicated that education alone explained 25.5% of the variation in farmers' attitudes toward climate change adaptation practices. In the second model, the inclusion of information access increased the explained variation to 29.8%, contributing an additional 4.3% explanatory power. These findings suggest that, although several variables were significantly correlated with farmers' attitudes, only two significant predictors such as education and access to information significantly emerged as strong predictors. Overall, the results underscore the critical role of non-formal education and extension-based information access in shaping farmers' attitudes toward climate change adaptation practices.

DISCUSSION

The moderately favorable attitude of most farmers toward climate change adaptation practices reflects growing awareness of climate-related risks and sustainable farming practices. This finding is consistent with previous studies (Haque et al., 2007; Hasan et al., 2019; Rahman et al., 2020), which suggest a gradual positive shift in farmers' perceptions toward climate-resilient agriculture. The results of the correlation analysis indicate that socio-economic factors such as education, farm size, income, organizational participation, and access to extension services are associated with farmers' attitudes toward climate change adaptation practices. Farm size and household income significantly influence farmers' attitudes, as farmers with larger landholdings and higher income levels generally have greater financial capacity and risk-bearing ability, enabling them to invest in new technologies and long-term adaptation strategies (Kassie et al., 2013; Shitu et al., 2018; Rahman et al., 2020). These findings are supported by Sthitaprajna and Shasani (2026), who identified economic motivation, annual income, and larger farm size as significantly correlated with adaptive capacity and attitude. Similarly, organizational participation enhances farmers' exposure to information, peer learning, and collective decision-making, which collectively contribute to more favorable attitudes toward climate adaptation (Aryal et al., 2018; Munasib & Jordan, 2011), aligning with their findings that social participation is a significant determinant of adaptive capacity.

In the multiple regression analysis, the results indicated that education and information access were the most significant determinant factors contributing to farmers' attitudes, while the model explained 36.6% of the variation in farmers' attitudes toward climate change adaptation practices, indicating a good fit (Biswas et al., 2026). The unexplained variation might reflect institutional and social determinants that were not included in the present analysis, such as communication skills and technical competence of extension officers, the quality of farmer–extension officer relationships, the extent of social capital and peer influence, and the role of local institutional structures in shaping access to extension services (Billah et al., 2025; Biswas et al., 2026).

In the stepwise regression analysis, education played a particularly important role in shaping adaptive attitudes. Educated farmers are more likely to understand climate risks, process information effectively, and adopt appropriate adaptive strategies (Haque et al., 2007; Mango et al., 2017). The contribution of education is also consistent with Sthitaprajna and Shasani (2026), who reported that education, along with scientific orientation and

Table 4. Summary of multiple linear regression analysis showing the significant variables

Independent variables	B (Un-standardized)	Std. Error	Beta (Standardized)	t	Sig.	Tolerance	VIF
Education	0.391	0.144	0.289**	2.725	0.008	0.615	1.627
Farm size	1.990	1.227	0.151	1.621	0.108	0.797	1.254
Household income	0.012	0.014	0.075	0.818	0.416	0.826	1.210
Organizational participation	1.000	0.538	0.196	1.859	0.066	0.622	1.608
Information access	0.196	0.097	0.188**	2.017	0.047	0.797	1.254

Constant (Intercept) = 61.301, R = 0.605, $R^2 = 0.366$, Adjusted $R^2 = 0.331$, F (5,92) = 10.614, $p < 0.001$, Durbin–Watson = 2.131

Table 5. Stepwise regression showing the contributing variables to adaptive attitude

Model	Variables Entered	Unstd. Coeff. (B)	Std. Coeff. (β)	Adjusted R^2	R^2 Change (Contribution %)	t-value	Sig.
1	Constant + Education	0.694	0.512	0.255	0.255 (25.5%)	5.841	0.000
2	Constant + Education + Information Access	0.245	0.234	0.298	0.043 (4.3%)	2.644	0.010

organizational participation, significantly enhances farmers' adaptive capacity. This highlights the importance of human capital in strengthening adaptive behavior. In addition, access to information through extension services emerged as another important determinant influencing farmers' attitudes. Timely access to relevant information on weather, soil, and crop management helps farmers make informed decisions under changing climatic conditions (Hasan et al., 2018; Mulwa et al., 2017), while Sthitaprajna and Shasani (2026) similarly emphasized the role of information source utilization and extension participation in enhancing adaptive capacity. This emphasizes the critical role of agricultural extension systems in supporting climate-resilient farming practices.

Overall, the stepwise regression results further confirm that education and access to extension services are the most influential determinant factors of farmers' attitudes toward climate change adaptation practices. These findings indicate that knowledge and information access play a central role in shaping adaptive attitudes (Ghanghas et al., 2015). Overall, the findings suggest that improving educational attainment and strengthening extension service delivery are key strategies for enhancing farmers' positive attitudes toward climate change adaptation practices and promoting sustainable agricultural development.

CONCLUSION

Correlation analysis revealed that education, farm size, income, organizational participation, and access to extension services were significantly associated with farmers' attitudes. However, stepwise regression results confirmed that education and access to extension information were the most important determinant contributing to farmers' attitudes. The findings highlight the importance of non-formal education and effective extension services in shaping farmers' adaptive behavior and attitudes. Therefore, these two factors should be prioritized in future climate adaptation strategies and policymaking. The study recommends strengthening government and non-government non-formal education and extension programs to promote climate change adaptation practices. ICT-based awareness campaigns should also be enhanced to promote favorable attitudes. Future research should examine the socioeconomic impacts of climate-resilient practices in different regions, as climate change effects vary across locations and contexts.

DECLARATIONS

Ethical approval and informed consent: No ethical approval is needed for this study, however, the informed consent was sought from participants.

Conflict of interest: The authors hereby declare that there is no conflict of interest.

Acknowledgement: We would like to acknowledge and give special thanks to the Insitutute of Research and Training (IRT), Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh for their funding in conductng the research and publication in the journal. We are also grateful to the respondents for providing the data.

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