Factors affecting farmers' willingness to adopt crop insurance to manage disaster risk: evidence from Bangladesh

RESEARCH ARTICLE

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Abstract

Climate change and climate-related disasters have had a major impact on agriculture and agricultural livelihoods in Bangladesh, threatening the food security of the entire nation. Non-structural measures such as crop insurance have been recommended as risk management tools for farmers but have not been implemented because of a lack of supporting policies, expertise, and lack of information about farmers' willingness to adopt such strategies. This study aims to fill that research gap by exploring the factors influencing agricultural producers to purchase crop insurance. Primary data were collected from three districts (Mymensingh, Barisal, and Comilla) that are prone to flooding. A multinomial logit model was adopted to investigate the relationships among dependent and explanatory variables. The results indicate that age, loan size, distance from the major river, farming experience, farming type, and risk attitude affect farmers' willingness to pay for crop insurance. Government subsidies and increased awareness of the benefits of crop insurance could improve the outlook for the agricultural sector and help medium and subsistence farmers maintain their livelihoods. The results also provide valuable guidance for local, national, and international stakeholders.

Keywords: flood risk, climate change, crop insurance, willingness to pay, agriculture

JEL code: Q1, Q12, Q14, Q15, Q18

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1. Introduction

Bangladesh is recognized as one of the most susceptible victims of climate change (Alauddin and Sarker, 2014) over the past few years. Bangladeshi agriculture has suffered significant production losses due to natural disasters such as floods, hailstorms, and droughts (Adnan *et al.*, 2019). The increasing severity and frequency of natural disasters is linked to climate change and environmental pollution (Zhang *et al.*, 2011). A significant threat of climate change is that it is likely to affect global food security by mid-21st century (Fahad *et al.*, 2018). Farming is a notoriously risky business and natural disasters such as floods and hailstorms are the most common risk factors that have already placed the food security of Bangladesh at risk (Government of Bangladesh, 2011). Harsh environmental conditions can cause frequent pest or new variety blasts that can forward the entire production to a massive loss. Farmers in developing countries generally have no financial protection from disasters that destroy their crops and cause losses of livestock, agricultural equipment, and land. The farmers' personal adoption capacity is uncertain and inadequate with these catastrophic risks and other risks (market risk, financial risk, biological risk, etc.) that arise because of many other reasons such as their poor socioeconomic condition (Alam *et al.*, 2017). Most of the farmers in Bangladesh who have farm land in environmentally degraded and hazard prone areas usually adopt off farm income and contract farming to minimize financial risk arises from yield loss and market price fluctuation (Islam *et al.*, 2020; Rahman *et al.*, 2020).

Most of Bangladesh (80%) is situated on a floodplain, which, combined with an extensive coastline on the Bay of Bengal, heavy rains during the monsoon, and meltwater from the Himalayas flowing into the Ganges Delta, results in major flooding from March to September annually. Flood is one of the most dominating natural disaster in Bangladesh that causes extensive levels of damage (Alam, 2015). The 2017 flood in Bangladesh damaged approximately 220,000 hectares of rice crops and destroyed more than 80,000 homes, leaving many families without shelter, food, or crops to sell. Climate change has already led to warmer winters, drier summers, and more unpredictable rains in Bangladesh. Yearly crop losses have forced many households to abandon the rice farming that has sustained their families for generations, creating another threat to the agricultural sector in Bangladesh. Therefore, designing policies to help farmers mitigate risks, maintain their businesses, and ensure national food security is of great importance.

Crop insurance is designed to lessen monetary risk and has become an important agricultural risk management tool (Paudel, 2015). Researchers have suggested that crop insurance is the best tool to protect farmers from the effects of climate change and natural disasters (Fahad, 2018; Falco *et al.*, 2014). The concept of crop insurance is quite new to Bangladesh. In 2014, the Asian Development Bank launched a pilot program with a USD 2.5 million budget to bring weather-indexed crop insurance to farmers in selected parts of Bangladesh. Although the program has had some success, the feasibility of setting up an agricultural insurance pool is still unclear due to a number of factors, including insurers' lack of experience, farmers' lack of knowledge of the program and willingness to pay, and the fact that crop insurance is not suitable for farmers in remote areas, who often do not have collateral. Consequently, there is currently no official crop insurance policy in Bangladesh. However, for countries that will be hardest hit by climate change, crop insurance has been proposed as a significant and effective post-disaster risk management (RM) strategy (Habiba and Shaw, 2013). Although a few studies have explored crop insurance as an agricultural RM tool in Bangladesh (Habiba and Shaw, 2013), to the best of the authors' knowledge, no scientific study has explored farmers' attitudes toward crop insurance and the potential of such a program in catastrophic risk-prone areas in Bangladesh. This study therefore aims to identify the factors that may affect farmers' willingness to pay (WTP) for crop insurance as a risk-mitigating approach. To achieve the aim of the present research, the author adopted a group of independent variables, among which; some missed in previous studies. The study found fascinating results in the context of the country that might provide insights to public and private organizations and policymakers who are promoting crop insurance programs as RM tools in disaster-prone areas in Bangladesh.

The remainder of the paper is structured as follows: Section 2 provides a brief review of previous related literature; Section 3 describes the study area and sampling technique, variable descriptions, and analytical models; Section 4 shows the major findings of the study; Section 5 details the findings of the study; and finally, Section 6 provides the summary and some policy measures in related matter.

2. Literature review

Farmers' risk-management adoption decision, caused by natural hazards, refers to the adjustments in anticipated climatic conditions that will help prevent or mitigate the risks (Wheeler *et al.*, 2013). Farmers' perception of potential risks is a more useful tool for supporting the policies that may address them (Arbuckle *et al.*, 2013; Niles *et al.*, 2013). Many studies have been conducted worldwide, indicating there are many underlying socioeconomic factors that help shape farmers' risk-management adoption decision (Adger *et al.*, 2009; Dey *et al.*, 2018; Iqbal *et al.*, 2016; Nicholas and Durham, 2012; Roumasset, 1999). Some previous literature on risk management has used crop insurance as a vital tool and measured the demand for crop insurance against natural calamities across different countries (Botzen *et al.*, 2009; Fahad and Jing, 2018; Vandever, 2001).

One study conducted by Fahad and Jing (2018) in Pakistan, where, the study revealed that 30% of the total respondents considered crop insurance as an effective disaster risk reduction technique. Budhathoki *et al.* (2019) in their study showed that, 84% of the farmers of Nepal are interested in purchasing area-based crop insurance to prevent financial losses from natural disaster. Studies on farmers' risk perception and adoption decision of crop insurance as a risk management strategy is a very hot issue worldwide and has been examined in many countries, such as China (Yang *et al.*, 2015), Iran (Farzaneh *et al.*, 2017), the USA (Coble and Knight, 2002; Mishra and Perry, 1999), India (Kumar *et al.*, 2011), and Nigeria (Falaki *et al.*, 2013).

According to Alam *et al.* (2017), in Bangladesh, however, not many studies on farmers' adoption decision have been conducted, and most of them have focused on drought (Alam, 2015; Alauddin and Sarker, 2014; Habiba *et al.*, 2012). Some studies have been conducted on riverbank erosion and its socioeconomic impacts (Hutton and Haque, 2003; Islam, 2018; Younus, 2014). In Bangladesh, one study was conducted by Habiba and Shaw (2013); they explained the types of available crop insurance policy worldwide and suggested some suitable policy for Bangladesh. Though they suggested the importance of implementing this policy for the welfare of poor farmers, they did not address the farmers' side (i.e. to what degree farmers want to adopt this policy). Within the context of the previous literature, it is important to examine farmers' willingness to pay for adopting a policy like crop insurance. The present study, therefore, breaks new ground by examining the farmers willingness of adopting a new policy like crop insurance and it might work as a key to promote these vulnerable communities by focusing on local level adoption knowledge in the flood affected areas.

3. Materials and methods

3.1 Study area and sampling

Data from farmers were collected through a questionnaire survey in June and July 2019 by using multistage sampling technique. In the first step, Mymensingh, Barisal, and Comilla districts were selected based on the high density of rice farmers who had experienced natural disasters causing significant losses. In the second step, four Upazilla/sub-divisions from each district were chosen (Figure 1).

Historically, these areas were highly agricultural. However, in the past two decades, the farming patterns have gradually changed due to soil erosion and changes in the groundwater level due to frequent flood; a huge number of farmers have turned to industrial work or day labor after facing successive natural calamities.

In the final stage, we randomly selected farm households from the list provided by the Upazilla council office. Farmers who have continued their agricultural businesses in these areas often rely on credit from informal sources since they do not have easy access to commercial banks for loans or insurance policies.

Figure 1. Data collection areas in Bangladesh.

Grameen bank is one of the very famous microfinance organization in that areas who gives loan to the poor farmer and is trying to promote crop insurance services among the farmers. Consequently, Grameen Bank made a list of farmers category (willing, neutral, not willing) in that area based on their willingness to purchase crop insurance policy (if started in near future). We then randomly selected 200 respondents from that predetermined heterogeneous farmers group who are involved in agricultural production and who have borrowed agricultural credit from Grameen Bank. Further, we calculate heterogeneity among farmers by calculating the χ^2 statistic (Supplementary Table S1). Heterogeneity among farmers' group). The probability values of the χ^2 statistic were significant at 1% level of significance, which shows the clear heterogeneity among the farmers group and WTP of insurance. We collected data from 24 respondents in Trishal Upazilla in Mymensingh and from 16 respondents from other Upazillas. The number of sample respondents is higher in Trishal Upazilla because of the higher concentration of farmers borrowing in these areas. We use the following equation as suggested by Rehman (2015) and Akhtar *et al.* (2019):

$$n = N / 1 + Ne^2 \quad (1)$$

Here, n = sample size in each Upazilla; N = total number of agricultural credit-utilizing farming households in an Upazilla; e = accuracy, which is set at 15% (0.15).

3.2 Farm and farm household characteristics

Farmers have many RM tools at their disposal, such as off-farm and on-farm income diversification, crop insurance, modern technology, modern seed varieties, and agricultural credit. Farmers' adoption strategies are not fixed; rather, they are shaped by farming category (Alam *et al.*, 2017). This study examines the major socio-economic factors that were assumed to affect farmers' WTP for crop insurance in our chosen study areas, including age, loan size, distance from a major river, farm size, Yearly income of farm family, experience, land ownership type, education level, agricultural farming type, off-farm income status, access to information, risk attitude, and risk perception. We choose some of the factors (age, experience, land holding size, education, household income, access of information, risk perception and risk attitude) based on previous research where the researchers showed mixed results of the influence of those factors (Lu *et al.*, 2017; Velandia *et al.*, 2009). We adopt some new factors considering the local condition (distance from major river, frequency of disaster, agricultural farming type, loan size, net income from crop/year, land loss due to flood, off-farm income/year) that influences the decision-making WTP of our respondents. Farmers in the study area adopted one or more risk management strategy like agricultural credit and off farm income on their own, to overcome the agricultural risks by themselves. In the present study, education, age, and farming experience are continuous variables with respect to the number of years. Farm size is measured as the total number of acres managed. Household income is the total yearly earnings of a household in USD, net income from crop is the net monetary gain only from farming and loan size is the total loan amount received by the farmer (USD 1 = BDT 81 at the time). Land loss due to flood measured by ratio of total land operated to land affected area in last two years due to flood mainly. Frequency of disaster was measured by farmers experienced the number of disasters in a year. If farmer experienced more than two disaster was scored 1 i.e. high frequency and 0, otherwise. The distance is measured as the number of kilometers from the farm gate to a major river.

3.3 Risk perception

Farmers were asked to score the severity and likelihood of occurrence of the types of risk on a 5-point Likert scale ranging from 5 (very high) to 1 (very low) to quantify their perceptions of risk. The risk factor was then calculated by adding the consequences and likelihood of occurrence of the risks (Cooper *et al.*, 2014).

3.4 Risk attitude

Following studies on farmers' production risks and RM strategies (Adnan *et al.*, 2019; Akhtar *et al.*, 2019; Torkamani, 2005; Ullah *et al.*, 2016), the certainty equivalent (CE) method is adopted to analyze the risk attitudes of farm families. The technique for estimating this method includes all risky outcomes with discrete payoffs expressed as $R_1, R_2, \dots, R_m, \dots, R_{n-1}, R_n$, with particular probabilities of $P_1, P_2, \dots, P_m, \dots, P_{n-1}, P_n$, where the summation of all probabilities is 1. Suppose that farmers were asked to determine the financial value of two outputs that made them indifferent, between two risky consequences, BDT 1 (total monthly household income of about BDT 50,000) and BDT 0 with the same probability. For example, consider BDT 25,000 as the CE of a farmer with the income level of BDT 50,000 and BDT 0 with equal probability, and this worth is larger than R_{-1} and less than R_n . Then, the probable utility for the CE of R_n is intended using a similar process ($U=0.5$), and the procedure continues until enough data points are obtained. The equation to calculate the CE with the probabilities (0.5) is:

$$U(25,000) = 0.5u(0) + 0.5u(50,000) = 0.5(0) + 0.5(1) = 0.50 \quad (2)$$

The CEs are then applied to a cubic utility function to attain the utility of each farm household as follows:

$$u(w) = \alpha_1 + \alpha_2 w + \alpha_3 w^2 + \alpha_4 w^3 \quad (3)$$

Cubic utility function is a combination of risk aversion, risk perception, and risk attitudes (Binici *et al.*, 2003). Absolute risk aversion can be mathematically written as follows:

$$r_a(w) = -(U'(w) / U''(w)) \quad (4)$$

where U' and U'' are the first- and second-order derivatives of wealth and $r_a(w)$ is a parameter of absolute risk aversion. The coefficient for this function is positive if the respondent is risk-averse, negative if not risk-averse, and zero if the respondent is indifferent to risk. The risk behavior of respondents equals 1 if they are risk-averse and 0 otherwise.

3.5 Analytical models

■ Multinomial logit

A multinomial logistic regression model is employed to analyze the data. In this study, the dependent variable is categorical, and parameters can be recognized and compared to a baseline category of the dependent variable. The multinomial density for one observation is defined as:

$$f(y) = p_1^{y_1} \times \dots \times p_m^{y_m} = \prod_{j=1}^m p_j^{y_j} \quad (5)$$

The probability that individual i chooses the j^{th} alternative is $p_{ij} = pr(y_i = j) = F_j(x_i, \beta)$. The functional form of F_j should be selected so that the probabilities lie between 0 and 1 and sum over j to 1. The multinomial logit model is used with alternative-invariant regressors. The equation for mlogit with paradox x is:

$$\text{Log} \left(\frac{\pi_i}{\pi_j} \right) = \alpha_i + \beta_j x, j = 1, 2, \dots, J - 1 \quad (6)$$

Let P_{ij} = the probability that one farmer i will have j^{th} performance

Here $i = 1, 2, \dots, 200$ and $j = 1, 2, 3$, then the two multinomial logit equations are as follows:

$$\log \left(\frac{p(y_i = 2 | x_i \text{Age} + \dots + x_i \text{riskperception})}{p(y_i = 1 | x_i \text{Age} + \dots + x_i \text{riskperception})} \right) = \beta_0 + \beta_1 x_i \text{Age} + \dots + \beta_{12} x_i \text{riskperception} \dots \dots \dots \quad (7)$$

$$\log \left(\frac{p(y_i = 3 | x_i \text{Age} + \dots + x_i \text{riskperception})}{p(y_i = 1 | x_i \text{Age} + \dots + x_i \text{riskperception})} \right) = \beta_0 + \beta_1 x_i \text{Age} + \dots + \beta_{12} x_i \text{riskperception} \dots \dots \dots \quad (8)$$

WTP is the dependent variable. Farmers are willing to pay =1; farmers' decision is neutral =2; and farmers are unwilling to pay =3. Farmers who have a willingness to pay for crop insurance are the base category. Among natural calamities, flooding was most frequently identified as the worst (51%, 102 farmers), followed by hailstorms (22.5%, 45 farmers), pest attacks (15%, 30 farmers), and drought (11.5%, 23 farmers), as shown in Figure 2.

Figure 2. Severity of natural disasters according to farmer perceptions.

We calculate the variance inflation factor (VIF) to find out whether there is any multicollinearity or not in the independent variables. Our estimated result ranges from 1.63 to 2.28 (a VIF value of more than 5 indicates high multicollinearity), indicating a moderate correlation between variables in the model which is not severe enough to require attention and will not affect the significance of coefficients (Akinwande *et al.*, 2015; O'brien, 2007). The VIF was computed using the equation below:

$$VIF = \frac{1}{1-R_i^2} \quad (9)$$

■ Relative risk ratio

To evaluate the likelihood of choosing a different outcome over the baseline category, a relative risk ratio (RRR) is adopted. The coefficients of the estimated multinomial logistic model show the relative changes of the log of odds with respect to the base category. The RRR of a coefficient specifies how the risk of an outcome falling in the comparison group compared to the risk of an outcome falling in the reference group changes with the variable in the equation. $RRR > 1$ shows that the increase in the value of the predictor variable increases the risk of the outcome falling in the comparison group relative to the referent group. An $RRR < 1$ indicates that the risk of the outcome falling in the referent group increases compared to that in the comparison group. In other words, $RRR < 1$ means the outcome is more likely to be in the referent group.

■ Hausman test for endogeneity

The Hausman test for endogeneity usually identifies endogenous regressors in a regression model. The model that has endogenous regressors will cause ordinary least square (OLS) to fail, since one of the assumptions of OLS is that there is no relationship between a predictor variable and the error term. However, before choosing the best regression method, a Hausman test is conducted (Supplementary Table S2). Results of the Hausman test) to determine if the interpreter variables are endogenous. The Hausman statistics are dispersed as χ^2 . The results of the Hausman test indicate that the model including all categories of WTP holds the assumption of the independence of irrelevant alternatives (IIA). The coefficient of these two models is not significantly different and the means assumption is not violated. This proves that the residuals in each equation are uncorrelated and we can adopt multinomial logit.

4. Study findings

4.1 Descriptive analysis

Table 1 presents the descriptive statistics of several variables used in this study. WTP is the dependent variable and the mean age of respondents is 41, with an average of two years of educational background. Farmers had an average of six years of farming experience, an average yearly income of USD 5,604, and an average loan size of USD 7,918. Families have an average of two acres of farmland. Farm families faces disaster more than one time in an average in a year.

Agricultural farming type is an important factor in determining farmers' WTP for crop insurance. Different types of farming have varying effects on farmers' RM decision. There are two general groups of farmers in the study area: (1) risk averse and (2) risk prefer. After using the CE method, farmers are scored 1 if they are risk averse and 0 otherwise. We assume risk perception as the risk perception of floods.

Farmers having an average 2,139.25 USD per year as net income from crop which is 38% of the total income and an average 0.22-acre land loss during last two years consecutive flood. The descriptive result also shows that farm families have in an average 1,235.26 USD income per year which is 22% of the total family income.

4.2 Multinomial logit results

The results from multinomial logistic regression analysis in Table 2 show that seven independent variables are statistically significant: age, loan size, distance from a major river, experience, rice farming, livestock farming, and risk attitude. Age shows a positive coefficient with significant (5% for neutral) and (1% for not willing) responses on WTP crop insurance. In other words, willingness to purchase crop insurance decreases as farmer's age increases. This result differs from those of Fahad *et al.* (2018) and Farzaneh *et al.* (2017) who found a positive correlation between age and willingness to purchase crop insurance.

Table 1. Descriptive statistics of the variables.

Variable	Description of the variables	Obs ¹	Mean	Std. Dev. ¹
WTP_state	Willingness to pay status of the farmer	200	2.329949	0.793961
Loan size	Loan size of the farmer in USD ¹	200	7,918	3,910
Age	Farmer's age	200	40.53299	8.256425
Distance	Distance of farmland from major river (km)	200	2.827411	1.522169
Farm size	(in acres)	200	2.030457	0.862534
Family income	Yearly income of the farm family in USD ¹	200	5,604	2,545
Experience	Farmer's experience	200	5.852792	3.077843
Land ownership type	(1 = owner, 0 = otherwise)	200	0.4568528	0.4994
Access to information	(1 = if access is high, 0 = otherwise)	200	1.745944	0.481342
Frequency of disaster	Occurrences of disaster in a year (1 = high, 0 = otherwise)	200	1.425941	0.446113
Education level	Farmer's education level	200	2.553299	0.92772
Agricultural farming type	Farming type	200	4.532995	2.791236
Off-farm income status	Off-farm income of the farmer (1 = yes, 0 = otherwise)	200	1.634518	0.482792
Off farm income/year	Income from off farm sources in USD ¹	200	1,235.257	720.1268
Income from crop	Yearly net income from crop in USD ¹	200	0.220305	0.192178
Losses from disaster	Loss of land due to river erosion (area in acre)	200	2,139.249	1,423.264
Risk attitude yes	Risk attitude of farmers (1 = risk averse, 0 = otherwise)	200	1.451777	0.498937
Risk perception	Risk perception of flood (1 = high risk, 0 = otherwise)	200	1.700508	0.459203

¹ Obs = number of observations; Std. Dev. = standard deviation; USD 1 = BDT 81.

Figure 3. Farmers' willingness to pay decisions according to distance from a major river.

Figure 4. Farmers' willingness to pay decisions according to land ownership type.

Figure 5. Farmers' willingness to pay decisions according to availability of off-farm income.

The results of this study also showed that loan size has a significant (5%) negative correlation with unwillingness or neutrality to purchasing crop insurance. In other words, if farmers take more credit as a risk management tool to run their agricultural farming smoothly, then they prefer to adopt crop insurance policy. The results of this study reveal that distance from the farmland to a major river has a significant positive (5%) relationship to farmers' unwillingness to pay for crop insurance. This finding is very relevant in the context of our study area because farmlands near to the river face higher risk of frequent production loss due to riverbank erosion or flood than the farmland far from the river. Farm size and household annual income from farming have a positive correlation with WTP for crop insurance, which is consistent with some

previous literature (Akter *et al.*, 2009; Alam, 2015; Alam *et al.*, 2017; Arshad *et al.*, 2016; Farzaneh *et al.*, 2017). Experience in agricultural farming shows a very strong negative (1%) correlation to unwillingness to pay (-1.1) and neutrality (-0.8).

Further, the study results also reveal that rice farming and livestock farming type positively affects farmers' WTP. Our study findings confirm that farmers with a risk-averse attitude are more interested in purchasing crop insurance to ensure a secure farming business. Risk perception of flooding also plays an important role in farmers' crop insurance decisions. The present study did not find any significant correlation for income from crop, and farmers WTP of crop insurance. The scenario is same for the independent variables land loss and off farm income/year.

Table 2. Multinomial logistic regression estimation of factors affecting purchase of crop insurance.¹

Variables	Neutral			Not willing		
	Coef.	P>z	z	Coef.	P>z	z
Age	0.156194	**	1.96	0.157789	*	1.83
Loan size	-8.5E-05	**	-2.37	-7.2E-05	**	-1.94
Distance from river	1.632547	**	2.53	1.373815	**	2.07
Farm size	-0.06714		-0.12	-0.695062		-1.12
Family Income /year	-9.74E-07		-0.02	-4.3E-05		-0.77
Experience	-0.87105	***	-3.05	-1.12734	***	-3.59
Land-ownership type	-0.84992		-0.91	-1.40884		-1.31
Access of Information	-0.95228		-0.92	-1.44172		-1.27
Frequency of disaster	-2.3563		-0.74	-4.35741		-1.31
Education level						
Not educated	0.655382		0.39	0.47625		0.28
Primary	0.675951		0.43	-1.00794		-0.63
Senior high school	0.42814		0.17	-17.9829		0.00
Farming type						
Rice farming	-1.37127		-0.94	-4.26852	**	-2.22
Fruit farming	3.280712		0.58	0.672991		0.12
Vegetable farming	3.277707		0.21	2.637345		0.17
Livestock farming	-1.91129		-1.37	-2.7883	*	-1.81
Poultry farming	0.745705		0.41	-0.80781		-0.36
Fisheries	-18.1554		-0.01	-2.80527		-0.84
Flower plantation	-2.15484		-1.47	-1.99502		-1.31
Income from crop and off-farm						
Off-farm income status	0.378112		0.31	0.299352		0.23
Off farm income/year	0.0000		1.810	0.0000		1.690
Income from crop	-0.00000		-0.12	0.00000		-0.21
Losses from disaster						
Land loss	-0.2164		-0.140	-0.6176		-1.41
Risk attitude						
Risk averse	-5.54989	*	-3.38	-19.1326		-0.02
Risk perception						
Flood risk	-1.51719		-1.06	15.80376		0.01

¹ ***, **, * = significant at 1, 5 and 10% level, respectively. LR $\chi^2(44) = 264.87$; Prob > $\chi^2 = 0.0000$; Pseudo $R^2 = 0.6651$; number of observations = 200.

4.3 Results from relative risk ratio

Table 3 shows that the result of the relative risk analysis of the associated explanatory variables to the outcome (WTP) is like the result from Table 2 and do not show any contradictory results with the previous multinomial logit analysis rather helped us to interpret the results more clearly. The advantage of doing RRR lied in its capacity of interpretation which is easier to understand by all the reader of the study. In the case of logit model, it only shows the value of coefficients whereas the relative risk ratio explains how the unit change of one independent variable influence the change of one dependent variable.

In terms of age and distance, the results show that the increase of value of these two variables significantly decreases farmers' WTP. In case of the variables loan size, experience, rice farming category, livestock farming category, and risk averse, the value showed $RRR < 1$, which indicates that the farmers who have higher loan size, long years of farming experience, involved in rice farming or livestock farming, and are risk averse in nature are more willing to purchase crop insurance policy.

Table 3. Relative risk ratio (RRR).¹

Variables	Not willing			Neutral		
	RRR	P>z	1-RRR	RRR	P>z	1-RRR
Age	1.1709	*	-0.17503	1.1691	**	-0.2555
Loan size	0.9999	*	0.00014	0.9999	**	0.0001
Distance	3.9504	**	-2.78786	5.1169	**	-4.0594
Farm size	0.1938		-5.43092	0.9351		-1.5483
Income/year	1.0000		0.00002	1.0000		0.0003
Experience	0.3239	***	0.81198	0.4185	***	0.6976
Land-ownership type	0.2444		0.84746	0.4275		0.6446
Access of information	0.2365		0.86535	0.5951		0.4049
Frequency of disaster	0.8054		0.19459	1.8546		-0.8547
Education level						
Not educated	0.6211		0.38097	5.9259		-4.1905
Primary	0.3650		0.57520	5.9659		-4.8350
Senior high school	0.0000		1.00000	8.5344		-7.5815
Farming type						
Rice farming	0.0140	**	0.99773	0.2538		0.8984
Fruit farming	1.9601		-0.53454	457.718		0.8959
Vegetable farming	13.976		-14.2105	447.601		-446.60
Livestock farming	0.0615	*	0.99406	0.1479		0.8984
Poultry farming	0.0519		0.94813	0.7708		0.2292
Fisheries	0.0605		0.80904	0.0000		1.0000
Flower plantation	0.1360		0.84179	0.6021		0.3979
Income from crop and off-farm						
Off-farm income status	1.3490		0.23210	1.4595		0.3123
Off farm income/year	1.0003		-0.00003	1.00003		-0.00003
Income from crop	0.0018		0.99814	0.00744		0.99256
Losses from disaster						
Land loss	0.9998		0.00002	0.99997		0.00003
Risk attitude						
Risk averse	0.0000		1.00000	0.0014	***	0.9986
Risk perception						
Flood risk	0.0000		1.00000	0.7514		0.2486

¹ ***, **, * = significant at 1, 5 and 10% level, respectively.

5. Discussion

Among the various independent variables influencing the WTP of crop insurance, the variable age of the farmer had a negative coefficient with the willingness to purchase crop insurance. This result differs from those of Fahad *et al.* (2018) and Farzaneh *et al.* (2017), who found a positive correlation between age and willingness to purchase crop insurance. Possible explanations include differences in location, cultures, products, and perception of risk severity. Older farmers in risk-prone areas have faced severe challenges, and many have never received any support from public or private bodies. Therefore, they may be more comfortable generating secure off-farm income by engaging in other small business-like small grocery shops, or tea stall to meet family needs and avoiding the complexity of bank-related work like crop insurance. The variable loan size and farmer groups WTP to purchase this policy showed a positive correlation.

Farmers in Bangladesh prefer to take credit to manage high input prices (input subsidy is minimum and not easily accessible to ultimate poor farmers), and sometimes they take credit to meet the profit/yield loss due to natural calamities. However, the money from the loan/credit itself is a risk (Rahman *et al.*, 2020). Farmers fear the chance of being defaulters and failing to repay the loan in time, which will again create an extra burden by increasing the interest rate of the received credit or make disruption in cash flow. This study expands the findings of (Fahad *et al.*, 2018), who indicated that only access to credit increases WTP for crop insurance. This study outlines the comprehensive results for farmers with various loan amounts and their different responses to WTP for crop insurance. The results also showed that the distance from the farmland to the nearest river has a significant negative correlation with WTP for crop insurance.

Farzaneh *et al.* (2017) showed that distance from the insurance office has a significant positive impact on WTP for adopting crop insurance. However, we did not consider this variable as a motivating factor in adopting crop insurance by considering the location of our sample areas. In place of that variable, the researcher adopted the variable distance from the river as a significant predictor variable in our study area. The main reason behind this is due to, Bangladesh is a country of frequent natural calamities like consecutive floods, cyclones, and land loss due to soil erosion of the riverbank. The findings of the correlation between experience and WTP for crop insurance confirm those of (K.S. *et al.*, 2018) but differ from those of Velandia *et al.* (2009). However, the difference among results indicates that the WTP of a crop insurance policy depends on the difference in local conditions and adjustment of long-term local knowledge with risk perception.

Further, the study results also reveal that land ownership status positively insignificantly affects WTP. In our study area, farmers who are working on a rent basis are more likely to respond neutral or show no interest in this issue, although; they are also the shareholders of loss and profit. However, this type of rented peripheral group of farmers does not know what the crop insurance policy is, and they mostly prefer leaving that area and finding another non-farm job. This type of migration is a massive threat to the agricultural sector that may cause food insecurity very shortly. The variable education showed no specific influence on the RM decision. Rice farmers (-4.2) and livestock farmers (-2.7) in the category of farming type showed more willingness to pay for crop insurance because they are more vulnerable to natural hazards. Other farmers also expressed interest in crop insurance, but the responses were not significant. Therefore, intensive efforts are necessary to promote crop insurance in the rice and livestock sectors. Households with off-farm income show minimum interest in crop insurance. This result is in line with the findings of Alam *et al.* (2017) and Wang *et al.* (2012). Most farmers who have no off-farm income sources are more interested in adopting crop insurance. The frequency of disaster shows a negative attitude towards neutral and not willing to adopt crop insurance, which means, high frequency of disaster makes farmers more interested in the crop insurance policy. Access to information has an insignificant but positive effect on WTP, meaning farmers who are more informed and have access to updated information on weather, market conditions, and government policies or regulations on agricultural promotion are more interested in crop insurance. In the study area, extension agents are the core source of information for farmers. Farmers are more likely to purchase crop insurance, if exist recurrent interaction with extension agents. The study results also find that farmers having a risk-

averse attitude are more interested in crop insurance that matched with the country's concurrent condition. Many farmers have not enough precautionary savings to bear the loss from frequent natural hazards. Most of the time farmers' group tries to avoid the loss by continuing the off-farm business that is comparatively less risky having minimum fixed profit. Crop insurance might be the better way for these groups of farmers to avoid the risk as well as keep the family business like farming.

The present study shows that household having higher income from the agricultural crop are more willing to adopt crop insurance policy, that is very logical with the practical situation of our studied area. Again, the study revealed that the farmers who have experienced a large amount of land loss showed a positive attitude towards purchasing crop insurance policy. These farmers group faces huge profit loss due to the loss of cultivated land, and they think only the government provided crop insurance policy can save them and save their traditional farming business. Besides all these, farm families having yearly higher income from off-farm sources shows a negative relation with crop insurance purchase decisions. These groups of farmers try to avoid this kind of policy.

6. Conclusions

The main aim of this study was to understand the actual context in which rural farmers in Bangladesh show their willingness to purchase or not purchase crop insurance, to mitigate damage from natural disasters. The results revealed that farm households' socioeconomic factors and area-specific risk perception shaped their adoption decision of crop insurance. The major factors that influence willingness to pay for crop insurance are age, loan size, distance from a major river, experience, farming type, and risk averse nature. Inefficient agricultural policies in post-disaster situations that occur every year discourage farmers from continuing their businesses and migrate to other non-farm activities or even migration to other places, which ultimately will pose a threat to the country's food security. The results of this study should provide support for these efforts by demonstrating the actual willingness of farmers to adopt crop insurance. The findings of this research might help frame a sustainable policy to manage agricultural risk and assure the security of farmers and the sector at both macro and regional levels, especially in the flood affected areas in Bangladesh as well as the other parts of the world having similar local conditions and facing similar issues. The information of factors affecting farmers decision to purchase crop insurance policy may assist as a basis for government line agencies to draft inclusive guidelines for farm risk management. The gathered knowledge from this study on farmers influential factors for WTP of crop insurance may help the government extension workers to expand their awareness program in more vulnerable areas and in a more organized manner.

Although the present research was carried out in a limited number of areas in Bangladesh and involved few farmers, we assume that the findings should be applicable in the other parts of the country too because we chose our study areas which are the most vulnerable to natural disasters and historically rich in agricultural farming activities. However, future research based on large samples and using a distance decay approach might be more helpful for gathering further information that could clarify agricultural farmers' WTP for crop insurance in Bangladesh.

Crop insurance is a widely used risk-mitigation tool that could help these farmers but Bangladesh has no government crop insurance policy. Some foreign organizations, such as the Asian Development Bank, and private bodies, such as the Bangladesh Rural Advancement Committee (BRAC), are striving to establish such a program. The results of this study indicate that the government of Bangladesh should work with private and international organizations to implement a crop insurance program. Given that farmers may not have collateral or may have little knowledge of banking policies, the government should ensure that the necessary information is effectively disseminated among all farmers and that this process is convenient.

Supplementary material

Supplementary material can be found online at <https://doi.org/10.22434/IFAMR2019.0190>

Table S1. Heterogeneity among farmers' group.

Table S2. Results of the Hausman test.

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Conflict of interest

The authors declare there is no conflict of interest.

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