



Assessing the viability of the non-monetary flood insurance market for Bangladeshi smallholder farmers

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Abstract

Agriculture in Bangladesh is susceptible to numerous climatic hazards, especially flooding. Smallholder farmers in the country have been losing agricultural productions to flooding because they lack flood insurance for decades. Several studies that used the contingent valuation method (CVM) to investigate farmers' willingness to pay (WTP) for insurance demand through monetary payment mode reported that small farmers suffer considerable financial constraints that limit their ability to pay insurance premiums. To avoid this concern, present study designed a novel econometric approach to assessing the validity and reliability of non-monetary WTP estimates in the context of environmental valuation research. By comparing monetary and non-monetary payment systems using the CV method, the study offers non-monetary flood insurance options for Bangladeshi smallholder farmers. For this purpose, 600 farmers in four flood-prone districts of northern Bangladesh were interviewed about their preferences for a hypothetical flood insurance market. To assess the accuracy and precision of non-monetary WTP estimates, a multivariate regression model was used. The results show that farmers with lower incomes favored non-monetary payment choices, and approximately 26% of the overall sample opted to contribute a portion of their seasonal rice crop rather than cash to cover the cost of flood insurance. Regression results show that farmers' in-kind WTP decisions were influenced by a variety of factors, including farmland elevation, frequency of flood returns, non-farm income, and commercialization in agricultural farming, demonstrating the validity and consistency of the non-monetary payment alternative. Findings imply that subsidy policies are insufficient to expand the adoption of non-monetary flood insurance market in Bangladesh.

Keywords Flood risk · Willingness to pay · Environmental valuation · Contingent valuation method · Bangladesh

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1 Introduction

Agricultural productions in low-income countries will face significant challenges in the twenty-first century due to climate change and increased climatic hazards (Sarker et al. 2022; Malhi et al. 2021). The negative effects of climate-related disasters are borne mostly by low-income and non-industrialized nations because of their limited resources and capacity to adapt (Eckstein et al. 2021; Fahad et al. 2018a, b). Natural disasters such as floods, cyclones, storms, and droughts are predicted to have a major impact on agricultural production by the middle of this century, which could jeopardize global food security (Hossain et al. 2020a). The countries in Southeast and South Asia are anticipated to be most affected by this concerning prediction (Vinke et al. 2017; Fahad et al. 2022). In terms of human casualties and adverse social and economic consequences, flooding is widely regarded as the most calamitous natural calamity that has ever struck South Asian nations, particularly Bangladesh (Mirza 2011).

Bangladesh is widely recognized as one of the most flood-prone nations globally due to its expansive floodplain located among major river deltas, the melting of Himalayan snow, heavy monsoon rainfall, deforestation, and uncontrolled urban expansion (Ruane et al. 2012; Hossain et al. 2019a). Bangladesh has experienced floods of varying magnitudes (as shown in Fig. 1) across the whole country. The floods in 1974, 1987, 1988, 1998, 2004, 2007, 2015, 2016, and 2017 were particularly devastating, resulting in significant loss of life and widespread economic destruction (Hossain et al. 2019b). Floods in 1988 and 1998, for example, were enormous, drowning 61% and 70% of the land area, respectively. These floods wreaked havoc on homes, infrastructure, cattle, fisheries, forests, and agriculture, costing an estimated \$1.3 billion and \$2 billion, respectively (Dewan 2015). Due to the absence of a comprehensive policy by the government to mitigate the risk of flooding, the agricultural sector was especially severely impacted by these floods (Banerjee 2010). Most of Bangladesh's rural population relies on agriculture for their livelihood (Hossain 2019); therefore, safeguarding this sector from devastating floods should be a top priority for the country's economic development. Hence, it is imperative to implement risk mitigation measures at the local, national, and regional scales to minimize the adverse impact of flooding on agricultural productivity.

Non-structural solutions, such as flood insurance, can play an important role in safeguarding agricultural crops from flood devastation and lowering farmers' exposure to risk (Jiang et al. 2019; Abbas et al. 2014; Mahmood et al. 2021; Arshad et al. 2016a). There is no well-established flood insurance market in any developing country (Surminski and Oramas-Dorta 2013), but it is the most useful and essential risk tool to cope with flood risk

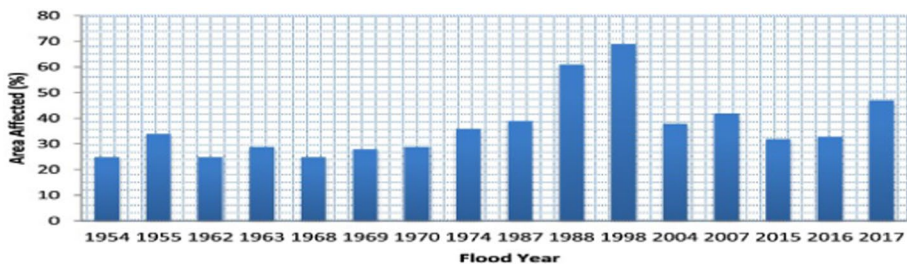


Fig. 1 Extent and frequency of flooding in Bangladesh (Source: Hossain et al. 2020b)

in many developed countries (Atreya et al. 2015; Roder et al. 2019; Zinda and Williams 2021; Champonnois and Erdlenbruch 2021) and has been recommended as the best emerging tool for climate change adaptation (Netusil et al. 2021; Osberghaus 2015; Zhai et al. 2006). Several studies (Furuya et al. 2021; Aliagha et al. 2014; Wedawatta and Ingirige 2012) have shown that it takes small-scale farmers in poor developing countries a lengthy time to make up for monetary losses caused by floods. In this instance, flood insurance can be a quick and effective solution to help affected households recover from a financial setback. Small farmers in flood-prone regions of Bangladesh may be able to reduce their crop losses with flood insurance, but policymakers have not yet established a system to make it available to them (Aheeyar et al. 2019).

Several studies (Ali et al. 2020; Abebe and Bogale 2014; Patt et al. 2010) also reveal that small-scale farmers struggle to pay insurance premiums due to their low financial resources. Thus, insurance demand in developing countries is generally low (Navrud and Vondolia 2019). A study conducted in Vietnam by Brouwer et al. (2013) reported that small-scale farmers were unable to pay their insurance installments on a consistent basis. In another study by Hossain et al. (2022) reports that low-income households in flood-affected districts of northern Bangladesh are considerably more vulnerable to flooding and incur much higher damage costs than wealthier households. Moreover, credit constraints among Bangladeshi small farmers have been a significant issue affecting agricultural productivity and rural livelihoods (Rabbany et al. 2021a, b). The results of the above studies indicate that poor households in Bangladesh would not be able to buy commercial insurance even if an insurance market existed there. In an effort to alleviate financial constraints of smallholder farmers, this study offers non-monetary payment alternatives for flood insurance in Bangladesh by comparing non-monetary and monetary payment mechanisms using the contingent valuation (CV) method. A non-monetary payment technique for flood insurance entails providing compensation for flood insurance coverage using alternative forms of payment instead of conventional currency. This may encompass barter agreements, exchanges of commodities and services, or alternative methods of value transfer that may not entail direct monetary transactions. Thus, this research aims to introduce a novel econometric technique for explaining the significance of non-monetary WTP estimates in the context of environmental valuation research.

In a number of developing countries, the CV method has been utilized effectively to solve a range of difficulties, including as flood risk exposure (Reynaud et al. 2017; Abbas et al. 2014), wetland conservation (Semu and Workie 2019; Siew et al. 2015), groundwater contamination (Pham et al. 2020; Vo and Huynh 2017), and sanitation and water quality (Akhtar et al. 2018; Whittington et al. 1990). The CVM framework is based on the desire and capacity of individuals to express their preferences for a product or service in monetary terms (Hanemann et al. 1991). CVM with monetary bid amounts may produce many zero bidders (Brouwer et al. 2008) in a semi-subsistence economy where people are not used to paying cash for goods and services, leading to a downward bias in anticipated WTP (Fahad and Jing 2017). Therefore, CV based on cash transfers may be an ineffective valuation technique in underdeveloped semi-subsistence rural economies.

In recent years, the concept of merging non-financial and financial willingness to pay (WTP) measurements has attracted considerable interest in CV research. There are some studies have been conducted either with a mix of monetary and non-monetary payments (Kohlin 2001; Fonta and Ichoku 2005; Mekonnen 2000; Maharana et al. 2000) or with non-monetary choices (Echessah et al. 1997; Swallow and Woudyalew 1994) alone. As for example, to evaluate the value of wetlands in eastern Africa, Emarton (1998) applied a modified version of CVM termed participatory valuation method. Using this method,

participants were asked to compare the value of environmental goods to the value of other goods or categories relevant in their region. Applying a CV method originally developed for the African rice industry, Shyamsundar and Kramer (1996) determined the value of land use restrictions for forest users. In another study, Asquith et al. (2008) notice that participants prefer to exchange environmental services in-kind rather than monetary terms. Researchers such as Vondolia et al. (2014), Rai and Scarborough (2014), Kohlin (2001), and Maharana et al. (2000) proved significant performances in evaluating benefits to the local people from environmental protection and resource use by combining non-financial and financial payment choices in CV studies, while Mekonnen (2000) was unable to demonstrate substantial empirical findings of participants' choice for non-financial payment. Researchers such as Brouwer et al (2006) and Fonta and Ichoku (2005) employed in-kind payment approaches to highlight the strategic biases in the cost of public goods.

The CV method is increasingly used to account for non-monetary payments, which has raised concerns regarding the reliability of such measurement technique. The ability of economic theory to adequately explain non-monetary WTP estimates is critical for ensuring the credibility and acceptability of environmental valuation studies that combine both non-monetary and monetary WTP. Even though the reliability of non-monetary WTP estimation procedure has not been studied before, they may provide a more trustworthy welfare evaluation than the monetary payment mode, which is still unknown in many flood-prone developing countries. Furthermore, the acceptability of non-monetary flood insurance demand among flood-affected rural poor farm households in low-income countries, as well as its economic estimation, has received little attention in previous studies. Surprisingly, no previous study has investigated the farmers flood insurance demand either through monetary or non-monetary mode of WTP in the flood-prone districts of northern Bangladesh. Therefore, the goal of the study is to investigate the reliability and validity of non-monetary WTP estimations and the effectiveness of this method among the farmers in flood-prone, semi-subsistence rural Bangladesh. This study set out to address this knowledge gap by offering recommendations to policymakers in Bangladesh on how to design a non-financial flood insurance approach to protect smallholder farmers' agricultural productivity from flooding.

2 Methodology

2.1 Study area

This research examined the feasibility of introducing a disaster insurance policy in some of the country's most disaster-prone districts using data collected from a subset of a larger survey of rural households in Bangladesh. To identify the sample areas for this study, in-depth interviews were carried out with the government representatives from the Department of Environment (DOE), Water Resource Planning Organization (WARPO), and Bangladesh Water Development Board (BWDB). Finally, four most vulnerable flood-prone districts (Lalmonirhat, Gaibandha, Nilphamari, and Kurigram) of northern Bangladesh under the Rangpur division were selected. The map of the studied area is shown in Fig. 2. Several rivers, such as the Tista, Dhorla, Brahmaputra, Dudhkumar, Fulkumar, Zinzirum, Jamuna, and Koratoa, flow through these regions, making them particularly prone to flooding (Paul et al. 2013). This region experiences moderate to severe flooding from June to September at least once every 2–3 years. Cultivation of different crops, especially the Boro

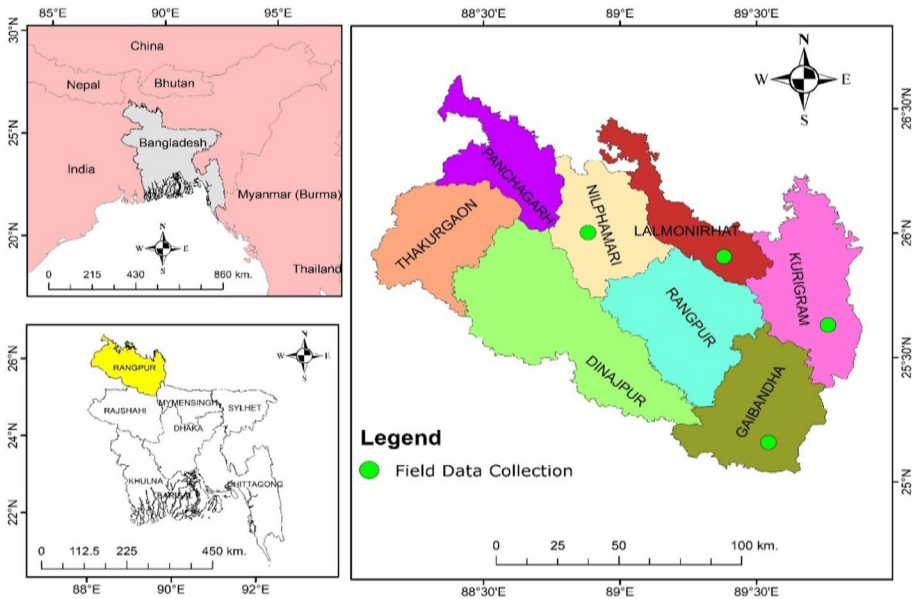


Fig. 2 Map of the study area

and Aman rice, is the main economic activity in this region. Boro rice (locally known as Irri) is often cultivated during the dry season (December–January), while Aman rice is cultivated extensively during the wet season (June–July) (Banglapedia-agriculture 2016). A small portion of the population relies only on fishing as a form of supplemental income. The region under consideration is among the most underdeveloped in the nation in terms of medical and health services, microcredit access, road transport connectivity, and other modern infrastructural capabilities, such as access to potable water and electricity. The region also has high poverty rates because of its lack of non-agricultural job opportunities and its vulnerability to frequent natural catastrophes. There is neither a formal nor an informal mechanism in these areas for distributing/sharing the risk of natural disasters.

2.2 Survey and questionnaire design

To choose households in each village, systematic random sampling was employed to conduct interviews at almost every fifth home on the right side of the village’s main road. A total of 25 respondents were interviewed in each village, totaling 150 respondents per Upazila (lower administrative unit). The household survey encompasses 12 (as shown in Table 1) Upazils comprising approximately 32,224 square kilometers and 38,17,472 people (BBS 2011). The final case study questionnaire was developed using three pilot tests with approximately 40 heads of household and focus group discussions from various parts of the study area. The development of the survey instrument began in March of 2021 and was completed by May 2021. From August through November of 2021, three well-trained and experienced interviewers interviewed 600 heads of household for the final survey. Before performing the actual interviews, the interviewers who took part in the general survey underwent 3 days of training and some pre-tests. About 50 questions were used in the final

Table 1 Sampled regions. *Source* 2021 Field Survey

Name of districts	Name of Upazilas	Inter-viewed farmers
Gaibandha	Saghata	50
	Fulchari	50
	Gaibandha Sadar	50
Kurigram	Rowmari	50
	Nageshwari	50
	Rajarhat	50
Lalmonirhat	Aditmari	50
	Kaliganj	50
	Lalmonirhat sadar	50
Nilphamari	Dimla	50
	Domar	50
	Jaldhaka	50
Total		600

survey, which was split into three sections: (a) demographic information such as the farmers' age, educational background, employment status, income level, standard of living, and family size; (b) information about the occurrence and severity of natural disasters, including frequency, duration, depth, nature, and preparedness; and (c) CV questions inquiring about the respondent's WTP for flood insurance. The WTP for flood insurance was determined using a double-bounded dichotomous choice (DB-DC) CV format. Participants were presented with the following insurance plan options:

"I want to ask some questions regarding launching a flood insurance policy in your area. The basic concept of insurance is to pay a weekly premium that accumulates to a yearly total. If a flood destroys your Aman rice between September and October, you will be compensated. If you file a claim, a surveyor will assess your damaged field. The insurance company will compensate you based on the surveyor's findings."

Following an in-depth discussion of the hypothetical flood insurance policy, three WTP questions were posed. Respondents were initially asked if they would sign up for a flood insurance scheme to safeguard their crop losses. If a respondent selected "no" in the first WTP inquiry, then they were asked to provide an explanation for why they would not be purchasing flood insurance. Participants who could not afford to make a monetary contribution were given the option of contributing in-kind and asked how much of a certain crop they would be willing to pay.

Following the initial WTP question, those who answered "yes" were given the choice of a weekly premium between 0.23 US\$ (20 BDT) and 0.59 US\$ (50 BDT). The six opening bids were all utilized. To eliminate starting point bias, all bid levels were distributed to the participant randomly (Mitchell and Carson 1989). Followed by a DC yes/no question, respondents were given the option of answering two closed-ended WTP questions: one for a lower and one for a higher price. Respondents who refused to pay the amount for which they had bid were questioned regarding their decision. Those who were unable to pay the suggested weekly premium due to financial constraints were given the option of making a

payment in-kind as an alternative. Then, in an open-ended format, participants who were willing to accept in-kind payments were asked to demonstrate their highest WTP.

2.3 Empirical model

2.3.1 Reliability and construct validity for CV response

Among the many survey-oriented alternatives to market valuation, the CV method is a popular choice. This method has been employed by the many researchers, such as Mitchell and Carson (1989), Arrow et al. (1993), and Paparrizos et al. (2021) to evaluate the monetary worth of non-market environmental services and goods. Traditionally, in CV surveys, respondents are generally asked to assign a monetary value to their projected WTP for a hypothetical good and service. This technique has a lot of flaws due to the fact that it is based on assumptions. Therefore, verifying the accuracy of the responses is a crucial step in the CV evaluation analysis. This study uses the CV technique to evaluate a hypothetical flood insurance market where agricultural commodities are used as premiums instead of monetary currencies.

Arrow et al. (1993) and Smith (1993) concur that validity and reliability are two of the most important factors in determining the appropriate nature of CV responses. An indicator of reliability demonstrates how repeatable and stable a measure is. According to Kealy et al. (1990), the dependability of contingent validity is easily explained by the presence or absence of consistency (or inconsistency) in the responses. To prove that CV-based responses are valid, most of the variances in WTP must be explained by differences in variables that can be predicted by theory. To establish the reliability of WTP values, Mitchell and Carson (1989) suggested using an R^2 value greater than 0.15 when regressing hypothetically predicted dependent variable against the explanatory variables.

According to Bateman and Turner (1992), the most significant factor in determining the veracity of contingent value responses is the degree to which the evaluation of the CV method corresponds to the actual value of the assets under investigation. One sort of validity distinct from construct validity is referred to as “convergent validity,” and it relates to the consistency of WTP estimates across the time period. Multiple surveys covering at least two time periods are required for assessing convergent validity, whereas measuring construct validity often involves determining the extent to which economic theory emphasizes empirical choice/behavior. Mitchell and Carson (1989) provide the idea of construct validity to determine whether or not the model’s prediction of the dependent variable’s values and signs is accurate. When coefficients for explanatory variables have the anticipated signs and are statistically significant, regression results strongly support construct validity.

Fahad and Jing (2017) state that the household’s capacity to pay, the appropriateness of the individual from the risk exposure levels, and the identified risk level all play a role in determining the WTP of a household to reduce its risk exposure. The calculated level of risk depends on both the external risk and the measures taken to protect oneself from that risk. Possible notation for the theoretical model regarding WTP and risk is as follows:

$$WTP_i = f(I_i, D_i, R(P_i X_i)) \quad (1)$$

I_i denotes household income, D_i indicates disutility from risk exposure, R_i reveals risk exposure characterized by self-protection measures (P_i) and exogenous risk factors (X_i) and whereas WTP_i refers to households’ financial or in-kind risk-sharing contributions.

The underlying framework of WTP for risk mitigation is assumed to be constant in this study's statistical model; regardless of either it is expressed in monetary or non-monetary terms. The primary goal of this research is to show how farmers prefer to get flood insurance to protect their crops and other assets against future flood damage. It is anticipated that farmers' non-monetary/in-kind WTP to share/minimize crop damage caused by flooding will vary significantly based on a number of factors. Farmers' vulnerability to flood risk is the first factor that determines how much they are willing to pay to minimize various risks, especially for crop damage. To determine the exposure level of exogenous risk, this study used three distinct indicators: (i) the elevation of farmland, (ii) the frequency of flood returns, and (iii) farmland proximity to the major river.

Farmers' level of preparedness to deal with damage is a second factor that is thought to play a significant role in determining WTP (implicit insurance scheme). Income diversification is a widely recognized ex-ante risk management approach in rural settings, as evidenced by Wan et al. (2016) and Peng et al. (2022). As a result, it is likely that the pattern established by households earning income from sources other than agriculture will serve as a reference for the in-kind premium. Fahad et al. (2018a, b) reported that people's WTP to reduce their exposure to risk declines as their diversification of income beyond agriculture increases. The WTP will also be clarified in terms of capacity to pay. As predicted by conventional theory, WTP is assumed to be a positive function of household income; however, because the majority of farmers in the study area are smallholder farmers who engaged in semi-subsistence agriculture, their monetary income does not reflect their true financial capacity. Given these facts and the current situation, it appears plausible to argue that the amount of crop yield is a better measure of WTP differences than monetary earnings. Damage to crops is a significant factor in estimating the costs associated with flood risk. Consequently, it is anticipated that farmers' WTP to reduce flood risk will differ based on their historical vulnerability to crop loss.

Lastly, determining the WTP for lowering flood risk is likely to be heavily influenced by the type of farming practiced. The degree of risk aversion will also depend greatly on the extent to which rural farm units are commercialized (subsistence level). In broad sense, the likelihood of insurance need increases with the degree to which farming is practiced on a commercial scale (FAO 2014). Due to the increasing commercialization of agriculture (see Fig. 3), insurance is becoming a more viable option for farmers seeking to reduce the financial impact of uncertain outcomes. The empirical evidence for flood insurance participation behavior confirms the hypothesis that insurance demand and commercialization are positively correlated (Brouwer and Hoyt 2000).

Theoretically and statistically, it stands to reason that as agricultural commercialization progresses, the non-monetary WTP for risk sharing among farm units will increase (Fahad and Jing 2017). Todaro (1995) concurs that non-marketed household production falls under the category of subsistence agriculture. However, when it comes to self-consumption, the amount of output that can be used as a measure of subsistence is entirely subjective. Farmers who sell less than half of their harvest are considered subsistence farmers as defined by Mosher (1970). In this study, CoM, a continuous variable, was used to avoid a strict definition of subsistence agriculture. The CoM variable measures the fraction of a farm's total crop production that is sold on the market and reflects the level of commercialization on each farm. As more farms are converted into businesses, the value of CoM grows, leading to an increase in WTP for flood insurance. Therefore, the resulting statistical model for making estimates assumes the below form:

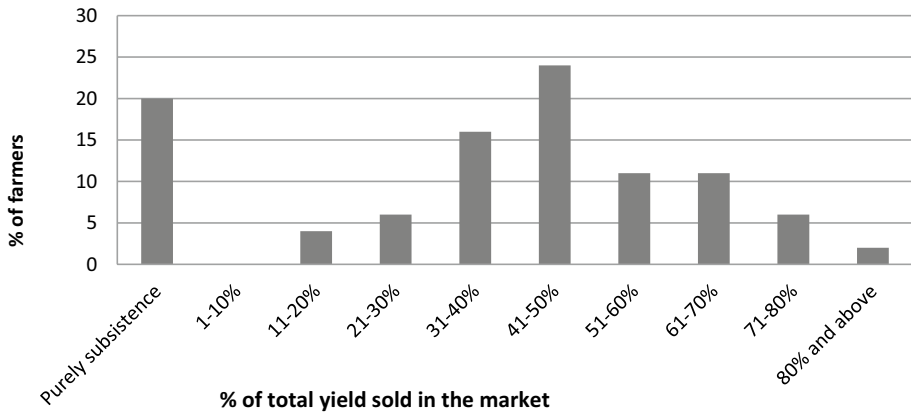


Fig. 3 Commercialization level in agricultural farming

$$\text{Non - monetary WTP} = f(\text{Hgh, Dis}_R, \text{Crop_Dam, Fre_FR, CoM, Crop_Pro, Other_Inc}) \tag{2}$$

where Hgh indicates the height of farmland. Dis_R represents the kilometer distance from the river. Crop_{Dam} represents the total crop loss from the previous disaster in metric tons (MT). Fre_{FR} indicates frequency of flood returns (annual frequency of flooding). Level of commercialization represented by CoM (the proportion of a farm’s yield that is sold). Crop_{Pro} represents the annual crop output of farmers in MT. Other_{Inc} indicates non-farming income sources.

2.3.2 Estimation of the monetary WTP for flood insurance

To determine monetary WTP for flood insurance, the following logit response probabilities were estimated using (a) SB (single-bounded) and (b) DB (double-bounded) DC CV techniques (Hanemann et al. (1991).

$$P_{r\{Y_i=1\}} = \frac{e^{\beta x}}{1 + e^{\beta x}} \tag{3}$$

$P_{r\{Y_i=1\}}$ indicates the likelihood that a participant will accept a particular bid amount, Beta (β) represents the set of unknown parameters in a vector of variables, and x represents the set of independent variables that help to explain β .

In order to determine DB WTP, four distinct results were observed when premium bids were presented in a double-bounded format. These results are classified as follows:

- WTP (NN) =Denying both the initial and subsequent offers
- WTP (YY) =Choosing both the initial and subsequent offers
- WTP (YN) =Choosing the initial offer and denying the subsequent offer
- WTP (NY) =Denying the initial offer and choosing the subsequent offer

with Arshad et al. (2016b):

$$\begin{aligned}
 P_i^{NN} &= 1 / (1 + e^{-(\alpha + \beta \text{ Initial Bid})} - 1 / (1 + e^{-(\alpha + \beta \text{ Lower Bid})}) \\
 P_i^{YY} &= 1 / (1 + e^{-(\alpha + \beta \text{ Higher Bid})}) \\
 P_i^{YN} &= 1 - 1 / (1 + e^{-(\alpha + \beta \text{ Lower Bid})}) \\
 P_i^{NY} &= 1 / (1 + e^{-(\alpha + \beta \text{ Higher Bid})}) - 1 / (1 + e^{-(\alpha + \beta \text{ Initial Bid})})
 \end{aligned}$$

First Offer=Initial Bid Value. Higher bid=subsequent bid with a higher value if the initial bid value was “Yes.” Lower bid=a subsequent lower bid if the initial bid is rejected.

The likelihood of a household’s WTP for the hypothetical monetary flood insurance program was calculated using the following formula:

$$L_{DB} = \sum R_i^{YY} \log P_i^{YY} + \sum R_i^{YN} \log P_i^{YN} + \sum R_i^{NY} \log P_i^{NY} + \sum R_i^{NN} \log P_i^{NN} \quad (4)$$

where i = number of respondents; R_i indicates response category of each response ‘ i ’,

The mean WTP is computed using the following equation:

$$\text{WTP}^* = \frac{\ln(1 + e^a)}{|\beta|} \quad (5)$$

where the absolute value of the bid coefficient is denoted by $|\beta|$.

GAUSS’s referendum CV program (developed by Cooper (1999)) was used to estimate DB logit regressions and calculate the average WTP. Researchers like Anoop and Suryaprakash (2008); Arshad et al. (2016b) etc. used this program to elicit farmer’s monetary WTP.

2.4 Characteristics of the overall sample

Table 2 illustrates the key socio-demographic profiles of the sampled participants. In this study, interviews were conducted with 600 participants and the average households consisted of about 6 family members. The age of those who participated in the survey, on average, was 45.32 years old. Approximately 22% of household heads in the study area had inadequate literacy skills, indicating a low level of literacy. The majority of homes do not have access to electricity. The households in the sample are dispersed within a three-kilometer radius of the region’s major rivers. Participants in the study use a wide range of sanitary facilities, the most common of which are water-sealed latrines. The majority of households rely on tube wells as their primary supply of potable water. The most important sources of energy are tree leaves and animal waste.

Agriculture is the primary revenue source for 91% households in the study area. The farming being investigated as part of this research falls into the category of semi-subsistence farming. Figure 3 appears that two-thirds of farm households sell roughly 50% of their produce at the local market. Approximately 5% of families operated their farm on purely commercial purposes, whereas 20% of agricultural units are subsistence-based and consume all of their own output. The majority of farmers (about 55%) own their own farms, with the remaining farmers working as share croppers (tenants) or day laborers. The land ownership status of farmers coexists with both monetary and non-monetary goods and services. On average, the distance between major rivers and agricultural land is about 2 km. Throughout the surveyed areas, the cultivated land was roughly more or less similar in size typically 2 hectares, with the majority of farms located at low altitudes, making them susceptible to flooding of up to 6 feet during the wet season. On an average, each farmer

Table 2 Socio-demographic profiles of the sampled participants

Different variables	Explanation	Sample mean
No. of households	Total number of households	600
Families' head	Measured in percentage	100
Participants' sex	Percentage of men	100
Participants' ages	Years	45.32
Annual mean income	Measured in US Dollars	1682.67
Employment categories	Measured in percentage	91.23
	Agricultural farmers	
	Service holder	1.95
	Agricultural day laborers	2.04
Educational background (%)	Others	4.78
	Measured in percentage	22.11
	Uneducated	
Elementary schooling (1–5 class)		54.37
	Secondary education or higher	23.52
Typical size of a family	Number of person in a family	06.35
Electricity users	Measured in percentage	62.43
Fuel source	Measured in percentage	75.87
	Cow dung/straw/leaves/twigs	
Utilization of latrines	Measured in percentage	78.54
Using tube well for drinking water	Measured in percentage	98.74
Farming land average	Measured in hectare	02.35
Aman rice production on average	Average production per hectare in Metric Ton	6.43
Damage of Aman rice on average	Average damage per hectare in Metric Ton	5.23

Based on a 2021 study, the average exchange rate for 1 USD was 84 BDT

produces roughly 13 tons of rice per year during the wet season. Most respondents experienced crop damage from moderate to severe flooding approximately once every 3 years.

3 Results and discussion

3.1 Overview of the basic WTP findings

The findings of the WTP are succinctly illustrated in Fig. 3. A majority of respondents (84%) replied positively to the first WTP question (WTP in principle question). More than half (56%) of the 84% respondents refused to pay the start bid amount. These respondents were then offered a lower bid in a follow-up WTP question.

Around two-thirds of those respondents who rejected the first bid accepted the second (lower) bid value. On the other hand, respondents who accepted the first bid amount were offered a higher bid level in a follow-up WTP question. Around 65% of the respondents who accepted the first bid level also accepted the higher bid level. Respondents who refused to pay the second bid value or both the monetary bid amounts were asked in a follow-up question why they were not willing to pay. The most frequently reported reason for rejecting the monetary bid was “income constraint (77.7%)” followed by reasons like “I did not like the

terms and conditions of the proposed insurance scheme,” “I do not believe that I will actually be compensated for my damage,” and “I am unable to assess the usefulness of the proposed insurance scheme,” etc. Respondents who refused to pay due to income constraints were furthermore asked whether or not they would be willing to pay a risk premium in-kind by giving up part of their harvest. Half of the respondents who said “no” to the first WTP question and around two-third of the respondents who rejected monetary bid amounts for financial constraints indicated that they would pay risk premium in-kind. These groups of respondents were subsequently asked to indicate their maximum WTP in-kind in terms of a seasonal crop yield in an open-ended question.

The results of the WTP study indicate that 159 out of 600 participants (constituting over 26% of the entire sample) chose to buy flood insurance in exchange for a portion of their seasonal crop rather than cash. Findings indicate that farmers in the study areas often have limited financial resources, resulting in a low demand for insurance. The results of this study concur with those of Johnson et al. (2019); Al-Maruf et al. (2021); and Wang et al. (2022). Several factors, as highlighted by these studies, contribute to the low insurance demand among farmers. These include farmers’ lack of familiarity with new insurance options (Janzen et al. 2021), distrust of insurance products (Wang et al. 2022), mistrust of insurance providers (Platteau et al. 2017), absence of a successful insurance model from which to learn, limited government support, and information asymmetry. In order to increase the uptake of insurance by smallholder farmers, Tadesse et al. (2015) proposed a number of strategies, including government subsidies, index-based insurance plans, and more adaptable and precise targeting of insurance programs. Index insurance, according to Carter et al. (2017), is still in its infancy and will be more likely to be acquired by farmers if redesigned and repackaged. Based on the discussion, the study’s findings indicate that government incentives and well-designed insurance products are required to enhance insurance premium adoption among smallholder farmers in Bangladesh.

3.2 Contrast of WTP in monetary and non-money terms

In a comparative study of monetary and non-monetary payment methods, Eqs. (2), (3), and (4) were utilized to determine which option was most effective for smallholder farmers. Table 3 displays descriptive statistics based on reported non-monetary WTP. Given that rice is a major agricultural crop in the region, households’ annual WTP for rice ranges from 4 to 162 kg, with 41 kg being the average. This is equivalent to 0.21% of a typical household’s average yearly rice yields. The analysis revealed a substantial degree of variability in the estimation of households’ annual WTP as it was compared to the actual rice production of each farmer, taking into account their respective minimum and maximum WTP estimates. The difference between the average non-monetary WTP and the single- and double-bounded WTP estimates is presented in Table 4.

In monetary terms, the estimated average WTP for in-kind products is equivalent to 0.18 US\$. Table 4 demonstrates that the average in-kind WTP estimate is 30% of the DB WTP and

Table 3 Statistical descriptions of household WTP in-kind (annual rice crop weight in kg for each household)

	<i>N</i>	Min.	Maxi.	Average	Mean trimmed	SD
WTP (Each household’s annual rice crop in kg)	112	4.01	162.14	41.21	34.85	23.53

Table 4 Outcomes from WTP (on average)

	SB model	DB model	Value in money of in-kind WTP
Mean WTP (US\$ per week)	0.35	0.44	0.18
Standard error	0.10	0.07	0.04
95% Conf. intervals	0.24–0.53	0.36–0.43	0.12–0.15
N	502	502	159

40% of the SB WTP, which is a substantial decrease from the expected in-cash DB and SB WTP estimates. The significance of this exercise lies in comparing the standard errors (SEs) of several WTP estimates and noting their closeness (or differences). The SE for the SB WTP measure is the highest compared to the DB WTP and in-kind WTP measures. The confidence intervals for the DB WTP and in-kind WTP estimates are therefore smaller than those for the SB WTP estimate. The results suggest that in-kind payment methods are better than cash SB and DB estimates due to the reduced SE of in-kind payments.

Each respondent’s in-kind WTP is compared with their monetary bid from the bidding game to determine whether or not the values are consistent (see Table 5). Figure 4 displays the gap between the respondents’ greatest in-kind WTP and the initial and follow-up monetary bids they were offered. In 90% of cases, neither the initial nor the subsequent bid comes close to the stated in-kind WTP’s market value. The test results are presented in Table 5, which show that there is less than a 1% difference between the maximum in-kind WTP, the initial bid, and the final bid.

The study’s findings indicate that non-monetary payment method will be helpful for smallholder farmers in Bangladesh to resolve their financial crisis and can be used as an alternative to monetary payment method. Asquith et al.(2008), Echessah et al.(1997), and Swallow and Woudyalaw (1994) found that in developing countries with high subsistence levels, non-monetary payment mechanisms are preferred over cash exchange for non-market products. Brouwer et al. (2008) demonstrate how to avoid zero monetary bids in stated preference experiments by using non-monetary numeraires. It has also been shown through the use of the CV method by Vondolia et al. (2014) and Brouwer et al. (2008) that respondents are more likely to report a positive WTP under non-monetary means as compared to monetary modes of payment. In addition, respondents who favor lexicographic options may be more receptive to non-monetary exchanges like labor time for environmental goods and services, as suggested by O’Garra (2009). Following these findings, Rai and Scarborough (2014), Vondolia et al. (2014), and Gibson et al. (2016) investigated the expanded usage of in-kind transection modality to elicit participants’ stated preferences. In lieu of

Table 5 WTP average deviation between first and last bid non-monetary values (results of paired sample tests)

	Average deviation	Standard Deviation	Value of t (2-tailed sig.)
1st bid (every week) and weekly WTP in-kind monetary value	32.42	11.73	23.78 (p < 0.001)
Final bid (every week) and weekly WTP in-kind monetary value	22.75	11.21	18.66 (p < 0.001)

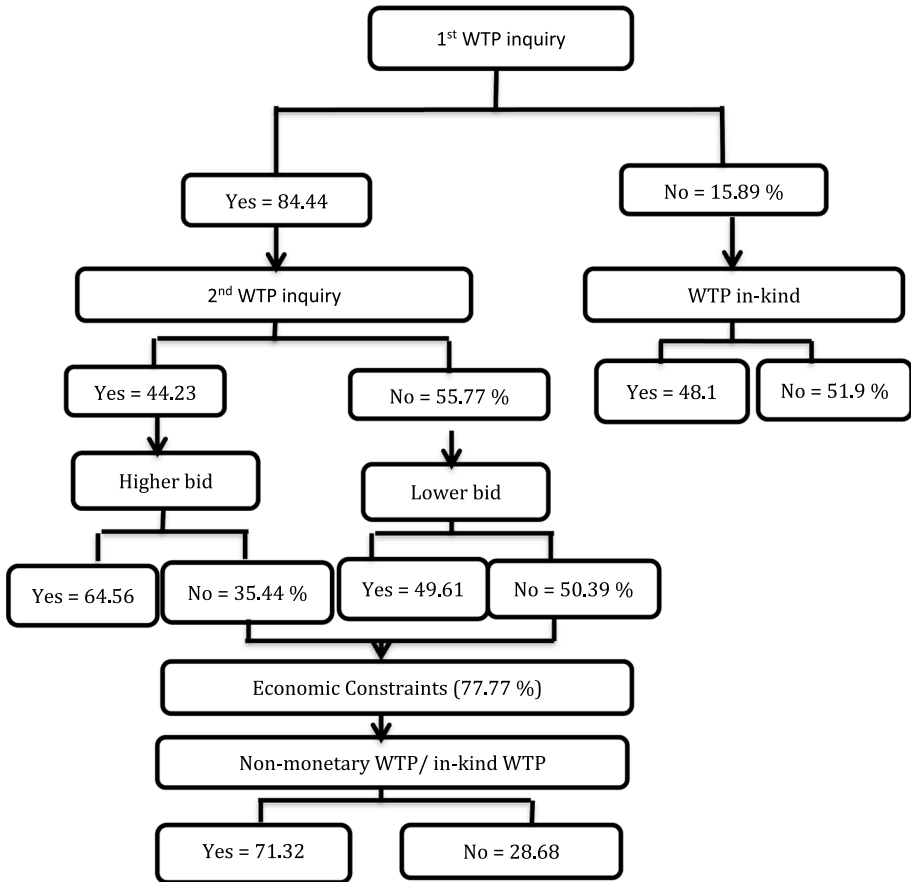


Fig. 4 Summary WTP results

the CV method, Vondolia and Navrud (2019) employed a choice experiment model and found that in Ghana, non-financial transection modalities are associated with greater levels of uncertainty. Therefore, future research can be conducted by applying both the CV and choice models to determine which payment option is most effective, particularly in the semi-subsistence economy.

3.3 Validation of the non-monetary WTP estimates

To evaluate the consistency and validity of non-monetary WTP estimates, a multivariate linear regression model was employed in this study. Equation (2) was used to estimate the statistical model, and SPSS software (version 15) was used to run the model. The results of the linear regression on the reported absolute non-monetary WTP values are presented in Table 6. The regression model’s calculated R^2 value surpasses 0.18, the minimal value deemed to be acceptable for explaining changes in independent variables. Due to the statistical significance of the F test result, it can be determined that one or more coefficients on explanatory variables are statistically distinct from zero. Even

Table 6 Estimates of linear WTP models where the dependent variable is in-kind WTP (amount of crops per family in each week)

Independent elements	Marginal results	SE	<i>p</i> value	Impact	
				Expected	Empirical
<i>Measures of vulnerability</i>					
Dis_R (farmland distance from river) (in km)	−0.83	1.156	0.57	−	−
Hgh (farmland elevation (extremely low = 0, low = 1, medium = 2, medium high = 3, and high = 4))	−12.81	3.014	0.00	−	−
Fre_FR (frequency of flood returns)	3.16	1.62	0.08		
<i>Characteristics of farming</i>					
CoM—level of commercialization (production/sales)	22.84	7.16	0.003	+	+
Crop-Pro (crop production)	0.241	0.216	0.346	+	+
<i>Implicit Insurance</i>					
Other_Inc (other sources of income besides agriculture)	−7.432	4.014	0.063	−	−
Statistics for models					
Constant	60.15	12.64	0.00		
<i>R</i> ²	0.21				
Adjusted <i>R</i> ²	0.18				
<i>F</i>	5.01				
<i>N</i>	159				

SE = Standard Error

though certain coefficients for the independent variables do not fulfill the threshold for statistical significance, all coefficients theoretically have the expected sign.

The outcomes of the multivariate linear model validate and confirm the accuracy of the non-financial WTP estimations obtained from the CV survey. Since there was a statistically positive significant relationship (*p* value < 0.01; *r* = 0.97) between the variables crop damage and crop yield, the crop damage (Crop_Dam) variable was removed from Eq. (2). A correlation test was used to see whether farmers’ reported changes in in-kind WTP were associated with the extent of flood damage they had suffered. Table 6 shows an expected positive relationship between the variables of reported in-kind WTP and crop damage (*r* = 0.19; *p* value < 0.02). This study finds that farmers who have suffered greater crop losses as a result of floods are more likely to pay for in-kind insurance premiums to mitigate flood risk.

The variable distance of farms from the main river (Dis_R) has the predicted sign, but is not statistically significant (*p* = 0.57), indicating that as distance from the main river increases; a farmer’s non-monetary WTP for risk sharing reduces. On the other hand, there is an expected negative correlation (*p* = 0.00) between the variable of farmland height (Hgh) and farmer’s in-kind WTP. This result suggests that landowners in low-lying locations are ready to pay a greater premium to mitigate the risk of crop and other asset losses. In comparison with the other risk exposure variables, the height variable has the largest marginal effect and is statistically significant at a level of less than 1%.

The coefficient of the variable frequency of flood returns (Fre_FR) has the expected theoretical sign and is statistically significant with in-kind WTP at less than 10% level. This suggests that farmers' WTP for risk sharing decreases if natural catastrophes occur less frequently over a certain time period. Farmers' non-monetary WTP decisions are positively correlated with the variable of annual crop production (Crop_Pro). Given that the present study focuses mostly on semi-subsistence agriculture, it makes plausible that agricultural crop production has a greater impact on farmers' ability to cover costs than monetary revenue. Prior studies conducted in Pakistan (Bashir et al. 2010; Mehmood et al. 2017, 2018) underscore the notion that agricultural crop productivity and technical efficacy can be enhanced through the expansion of financial resources accessible to producers. As an alternative to providing monetary compensation, producers can alleviate the financial strain associated with flood insurance by increasing their yields. According to Table 6, the coefficient value of variable Crop_Pro is not statistically significant with the dependent variable at less than 10% level; thus, this variable has a modest effect on reported in-kind WTP to contribute a portion of their seasonal rice crop rather than cash to cover the cost of flood insurance.

The most robust explanatory variable for commercialization is the CoM coefficient, which measures degree of commercialization and is demonstrated by sale/production. A significant positive correlation ($p=0.003$) has been observed between the variable of CoM and farmers' non-monetary WTP decision. This finding implies that as a farm household becomes more commercialized (as determined by the proportion of marketable output to total production), the WTP for risk sharing increases (see Fig. 3). Lastly, as expected, there was a negative relationship between farmers' in-kind WTP and the other income ('Other_Inx) variable. On the basis of these findings, it appears that households whose income is derived from sources other than agriculture are more likely to pay a lower flood insurance premium. Farmers in the study area who engaged in non-agricultural activities besides agriculture were less likely to pay a portion of their rice harvest as a risk premium installment.

The relationship between farmers' decisions regarding non-monetary WTP for flood insurance and their socioeconomic and demographic characteristics has not been previously studied; however, empirical research on monetary WTP and flood insurance demand conducted in various locations of the globe which backs up the regression analysis findings. For example, Hossain et al. (2022) investigated the farmers' WTP for flood insurance in Bangladesh's most flood-prone areas of northern districts. The study indicated that household income, farmers' subjective risk perception and risk preference (risk aversion) toward flood, off-farm income, flood experience, distance from river, and plinth of house strongly affected farmers' monetary WTP for flood insurance. To find out what factors affect the demand for flood insurance, Abbas et al. (2014) undertook an experiment in Pakistan in 2014. They observed that farmers' preferences for obtaining catastrophe insurance continuously and significantly varied with their experience with natural disasters, exposure level to catastrophes incidence, level of wealth, and cost of the insurance scheme. Similar results were observed by Arshad et al. (2016b) in Pakistan while examining the demand for monetary WTP for crop insurance among farmers. As a result, the aforementioned results of monetary flood insurance demand studies support the findings of non-monetary WTP estimations.

4 Conclusion and policy recommendations

In this article, an empirical analysis of non-monetary WTP responses is presented. The study was conducted in semi-subsistence, flood-prone underdeveloped regions, and responses were collected using the CV method. To assess the potentiality and construct validity of smallholder farmers' non-monetary WTP for flood insurance, this research used data and traditional indicators from a large-scale survey of households in flood-prone districts of northern Bangladesh. Using a combination of monetary and non-monetary or exclusively non-monetary WTP measures, numerous developing countries conducted a number of CV studies across the globe. However, the reliability and construct validity of non-monetary WTP responses have not been rigorously investigated. To address this research gap, this study developed a novel econometric method for evaluating the accuracy and precision of non-monetary WTP estimates in the context of environmental valuation research, enabling researchers to circumvent monetary constraints.

Findings show that about 26% of the entire sample preferred to use a portion of their seasonal rice crop than cash to cover the cost of flood insurance. The reported WTP for rice ranges from 4 to 162 kg per household per year, with an average WTP of 41 kg. Comparing estimates of non-monetary WTP to estimates of monetary WTP using the SB and DB approaches reveals that individuals with limited financial resources preferred non-monetary payment choices. Regression results demonstrate that non-monetary payment alternative is constructively valid and reliable which supports economic theory. Several variables, including field elevation, flood return frequency, source of non-farm income, and commercialization of farming, have been found as influencing farmers' non-monetary WTP decisions. The study findings imply that a rise in farm revenue from sources other than agriculture reduces the need for insurance uptake, whereas an increase in farm commercialization enhances the farmers' use of non-monetary flood insurance WTP. Non-monetary payments can thus be used to determine the value of non-market goods and services when methods based on monetary exchanges are insufficient. Non-monetary WTP mode can also assist in determining the lower bound of WTP for zero bidders, which can improve the efficiency of CV in a semi-subsistence economy such as Bangladesh. In addition, systematic research is required to fully comprehend the potential benefits of combining financial and non-financial payment modes (dual system) using the CV approach which would provide more information about the group's demographics, economics, and reasons for preferring non-financial payment. Future research can incorporate the CV and choice models to acquire a better understanding of which type of payment alternatives is most advantageous, particularly in rural areas with semi-subsistence economies. This study also offers valuable information in the form of maximum WTP for flood insurance in both monetary and non-monetary terms. Based on this information, a more practical financial viability study can be carried out to better understand the gap between expected risk premium paid by the insured and expected indemnity payment paid by the insurer. Being limited in scope, this study did not encompass a comprehensive evaluation of the financial feasibility.

The outcomes of this research have also substantial policy implications for the possibility of establishing non-monetary flood insurance system in Bangladesh. Considering the drawbacks of insurance programs is crucial to conduct a comprehensive analysis. Insurance, typically a private venture, aims to balance risk and profitability. Concerns such as public confidence and the recurrence of catastrophic events like flooding may, however, confound the execution of this approach. The frequency of disasters may lead to a significant increase in insurance costs for a large portion of the population, resulting in higher

premiums. Furthermore, the adequacy of payments for recurring flooding is a concern. Insurance payouts might cover some damages, but if floods happen frequently, it might not be sufficient to fully cover all expenses. Thus, a government-directed and supported approach is required to settle and overcome the obstacles that profit-oriented private insurance companies face in order to develop a successful non-monetary flood insurance market through a public–private partnership.

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Declarations

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