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Article

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

Assessing rural farmers' willingness to pay for crop insurance scheme: Evidence from Rwanda

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Abstract: Agriculture plays a significant role in Rwanda's economic growth but is still highly rain-fed with risks and losses caused by adverse natural and climate shocks. Agricultural insurance schemes are widely recognized as potential risk management strategies. This study aims to examine the determinants of farmers' willingness to insure maize farms and the premium farmers are willing to pay for crop insurance. The data used in this study were obtained from a household survey conducted in Eastern Rwanda and a sample of 325 households was drawn. A double-hurdle model is used for empirical analysis and the findings show that education, land tenure, farm size, group membership, and insurance awareness have a positive effect on maize farmers' decision to adopt crop insurance. Regarding the determinants of willingness to pay, education, land tenure, farm size, credit access, and income positively influenced the insurance premium maize farmers were willing to pay whereas household size negatively influenced the premium farmers were willing to pay for crop insurance. The study recommends policy frameworks that strengthen the education in rural communities about the usefulness of crop insurance to enhance farmers' participation in crop insurance and increase the premium farmers will be willing to pay for crop insurance. Besides, the study highlights the importance of building the capacity of farmers' groups or cooperatives to promote the uptake of crop insurance as well as the premium to be paid. The study also recommends the improvement of farmers' access to credit facilities to allow farmers to get the financial capability.

Jules Ngango

ABOUT THE AUTHOR

Jules Ngango is currently working as a lecturer in the department of Economics, College of Business and Economics, at the University of Rwanda (UR). He holds a Doctor of Philosophy (PhD) in Agricultural Economics. His research areas are Development Economics, Agricultural Economics, Resource and Environmental Economics, Production Economics, and Applied Econometrics. Research interest includes technology adoption, impact assessment, technical efficiency, productivity analysis, agricultural and land policy, food security, and food value chains. Jules has experience in conducting both field based and desk based research, acquired through formal training and working with both local and international non-government research organizations. He also co-worked in the Food System Transformative Integrated Policy conducted by International Food Policy Research Institute (IFPRI).

PUBLIC INTEREST STATEMENT

Since 2019, the government of Rwanda introduced a subsidized agriculture insurance scheme. The agriculture insurance scheme was designed to alleviate risks and losses incurred by farmers due to unpredictable natural disasters, diseases, and pests that affect their crops and livestock. Despite the benefits of crop insurance highlighted in the literature, the outreach and uptake in SSA have been very low. In particular, less than 1% of farmers in Rwanda have crop insurance. This study examines the rural farmers' willingness to pay for crop insurance scheme in Rwanda. The study has shown that education, land tenure, farm size, group membership, and insurance awareness have a positive effect on maize farmers' decision to adopt crop insurance. Moreover, the study revealed that education, land tenure, farm size, credit access, and income positively influenced the insurance premium maize farmers were willing to pay.

Subjects: Agriculture & Environmental Sciences; Agricultural Development; Agricultural Economics; Agriculture and Food

Keywords: crop insurance; willingness to pay; contingent valuation method; double-hurdle model; Rwanda

1. Introduction

The agriculture sector plays an important role in Rwanda's economic development and the achievement of sustainable development goals, particularly the one that seeks to eradicate extreme poverty and hunger (Ngango & Hong, 2021b). Agriculture accounts for roughly a third of Rwanda's gross domestic product (GDP) and approximately 70% of the working population are employed in the agriculture sector (NISR, 2017). However, despite the substantial contribution of agriculture to Rwanda's economy, it is still highly rain-fed and the adoption of improved farm inputs and technologies remains low (Nahayo et al., 2017; Tigabu et al., 2015). In addition, agriculture is susceptible to adverse climate hazards, pests, and diseases outbreak (Ntukamazina et al., 2017). Okoffo et al. (2016) noted that the effect of climate shocks such as droughts and rainfall variability, natural disasters like floods, and biological hazards such as pests and diseases result in crop failure and food insecurity.

The literature indicates that the agricultural risk management system is primarily dominated by three channels: (i) risks are either controlled at the farm level; (ii) through government initiatives; and/or (iii) market-oriented strategies (Antón & Kimura, 2011). Typically, farmers attempt to manage and adapt to some of the above-mentioned risks through the adoption of irrigation, crop diversification, crop residue retention, conservation tillage, and drought-tolerant seed varieties, among others (Bogale, 2015; Okoffo et al., 2016). Previous studies indicated that these adaptation strategies tend to be less effective and profitable for farmers (Bogale, 2015; Ellis, 2017; Fonta et al., 2018; Ntukamazina et al., 2017; Okoffo et al., 2016). Governments of most developing economies have been supporting the agriculture sector through risk-associated agricultural policies like export taxes, minimum support prices, and restrictions (Ali & Gupta, 2011; Tangermann, 2011). Nevertheless, various researchers have shown government interventions in the market distort markets and trade away from production optimum level (Boettke, 2010; Huang & Du, 2017).

Market-oriented strategies such as derivatives, futures, swaps, and options have been similarly used as price risk management in varied countries (Isakson, 2015; Kuzman et al., 2018), especially in developed and emerging economies like the UK, USA, India, and South Africa. For example, Ali and Gupta (2011) have shown that the commodity forward and futures markets have experienced tremendous growth, with more notified goods, and participants in India, and argue that future markets exchange offers new opportunities for risk-averse people to shift agricultural commodity price risks to risk-taker people, farmers use contracts to hedge risks associated with agricultural commodities price volatility. However, the use of such practices by the farmers in Africa, especially in developing economies such as Rwanda is limited due to different reasons: (1) inadequate financial infrastructure (Staritz et al., 2018; Zimmermann & Haase, 2017); (2) difficult to administer for perishable commodities such as livestock (Thomas, 2018); and (3) non-existing of market-oriented trade policies in such countries (Britain, 2018).

Alternative to the forward and futures markets is crop insurance, the existing literature revealed that crop insurance is a potential risk management tool for farmers in developing and developed economies to mitigate losses against adverse natural and climate hazards (Abugri et al., 2017; Bogale, 2015; Ellis, 2017; Fonta et al., 2018; Okoffo et al., 2016; Wang et al., 2020). Recently, many governments in sub-Saharan Africa (SSA) have launched various crop insurance schemes to support vulnerable farmers in getting access to a market-based risk management instrument to manage risks arising from climate hazards, pests, and diseases (Ellis, 2017). Notable benefits of crop insurance include: (i) the index-based crop insurance can reduce the issues of moral hazard

and adverse selection because an index read from weather stations is exogenous and cannot be tampered with the intervention of participating farmers (Fonta et al., 2018); (ii) when there are crop damages and losses, it takes a short time for indemnification which implies that crop producers will not have to sell assets or depend on emergency food aid to survive in the case of natural, climate, and biological hazards (Ellis, 2017; Fonta et al., 2018); (iii) insured farmers are more likely to make a large investment in agricultural technologies to boost productivity (Fonta et al., 2018); and (iv) crop insurance improves the ability of farmers to adapt to various risks which may also increase farmers' resilience.

Despite the benefits of crop insurance highlighted in the literature, the outreach and uptake in SSA have been very low (Fonta et al., 2018; Sibiko et al., 2018). In particular, less than 1% of farmers in Rwanda have crop insurance (Minagri, 2020). According to Fonta et al. (2018), the lack of basic knowledge about the concept of crop insurance, difficulties in obtaining weather-related information, and the high cost of insurance premiums are the key factors considered to affect the low prevalence of crop Insurance in SSA. Moreover, the lack of credit access because banks and microfinance institutions in developing economies consider agriculture as a highly risky business (Abugri et al., 2017). Information asymmetry and low level of private sector involvement in the development of crop insurance programs (Okoffo et al., 2016). To improve the adoption rate of crop insurance schemes in Rwanda, empirical research on farmers' willingness to pay (WTP) for crop insurance is needed. A better understanding of how farmers perceive the merits of crop insurance and how much they can afford to pay for agricultural insurance products will help financial institutions, government organizations, policymakers, and all other stakeholders to find solutions to the low uptake of crop insurance. The objective of this study is to investigate the insurance adoption decision and the premium amount farmers are willing to pay for crop insurance schemes to mitigate risks and losses due to adverse climate hazards, pests, and diseases in maize production. A contingent valuation method (CVM) was used to elicit the WTP for crop insurance among rural farmers in Rwanda. A double-hurdle model is also used to examine the factors that determine the farmers' willingness to insure maize farms and WTP for crop insurance.

In investigating the willingness to pay for agricultural insurance, previous research studies used the CVM which measures the demand for non-market goods in experimental economics. CVM relies on a direct questionnaire approach, asking a sample of individuals to state their hypothetical maximum WTP for a specific public good (Idris et al., 2022). Besides, various econometric models such as Heckman 2-step estimator, double-hurdle, probit, and logit models were employed along with the contingent valuation survey. For example, Belay et al. (2020) used the CVM to assess the households' WTP for soil conservation practice on communal lands in Ethiopia. A Bivariate probit model was used to examine the influence of the hypothesized explanatory variables on farmers' willingness to pay for communal land soil conservation. In Tanzania, Lalika et al. (2017) used a CVM to elicit the small-holder farmers' WTP for watershed conservation services in Pangani River Basin. They also applied a probit model to examine the factors conditioning the maximum amount respondents are willing to pay.

Regarding the WTP for crop insurance, Fonta et al. (2018) and Ellis (2017) employed the CVM and Heckman two-stage analysis to assess the farmers' WTP for crop insurance in Burkina Faso and Ghana, respectively. Okoffo et al. (2016), Adzawla et al. (2019), and Senapati (2020) employed the double-hurdle model to investigate the farmers' WTP for crop insurance in Ghana and India. on the other hand, Abugri et al. (2017), Arshad et al. (2016), and Afroz et al. (2017) used the probit and logit models along with the contingent valuation survey to investigate the WTP for crop insurance in Ghana, Pakistan, and Malaysia, respectively.

Unlike most previous studies that focused on investigating the determinants of WTP for crop insurance, the primary contribution of this study is the use of a double-hurdle model to assess both the determinants of farmers' willingness to adopt crop insurance (participation decision) and the amount (premium) farmers are willing to pay for crop insurance. Consequently, this study is

expected to provide insightful information to guide policymakers, academics, and investors to mitigate losses against adverse natural and climate hazards and enhance investment in the agricultural sector. This study aims to address four fundamental questions: 1) what is the proportion of farmers that are willing to adopt crop insurance? 2) Which amount of money (premium) farmers are willing to pay for crop insurance? 3) What are the important factors that determine the farmers' willingness to insure maize farms (i.e., the decision to adopt crop insurance)? 4) What are the significant variables that influence the insurance premium farmers are willing to pay?

2. A brief overview of Rwanda's agriculture and crop insurance program

Rwanda is endowed with promising rainfall and climate conditions for farming. However, the mountainous structure of Rwanda has been favorable to depleting soils through rapid runoff of surface water and soil erosion (Ngango & Hong, 2021b). The Rwandan agriculture system is dominated by subsistence farming on small plots of land and is highly rain-fed. According to Ansoms et al. (2018), the average land holding in Rwanda is about 0.75 hectares per household and the land is largely fragmented which hinders the adoption of agriculture mechanization (Pottier, 2006). About 10% of the households are landless and on average, the household land holding is allocated into 4–5 small plots, often in multiple locations (Ntihinyurwa et al., 2019). The fifth Integrated Household Living Conditions Survey conducted by the National Institute of Statistics of Rwanda indicated that the proportion of farmworkers in paid farming activities has increased over time from 8.2% in 2005/2006 to 15.9% in 2016/2017 (NISR, 2017). The proportion of independent small-scale farmers has decreased over time from 71.3% in 2005/2006 to 53.2% in 2016/2017 (NISR, 2017).

The major crops produced in Rwanda's agriculture include maize, rice, beans, Irish potatoes, cassava, banana, wheat, soybean, coffee, tea, and chill pepper among others. To achieve food security, in 2007, the government of Rwanda introduced the crop intensification program (CIP) which focused on the provision of extension services to farmers, land use consolidation, distribution of agricultural inputs, and upgrading the postharvest handling technologies (Nahayo et al., 2017). Maize is the main staple food crop grown in Rwanda, forming a significant part of household consumption and accounting for roughly 55% of total food expenditure (Ngango & Hong, 2021c). Rice is another staple crop prioritized by the government of Rwanda to enhance rural livelihoods and bridge the gap between domestic food production and demand (Kathiresan, 2011). Therefore, due to the predominance of maize production in Rwanda as well as the Eastern province, maize farmers were selected as the respondents in this study.

In 2019, the government of Rwanda introduced a subsidized agriculture insurance scheme. The agriculture insurance scheme was designed to alleviate risks and losses incurred by farmers due to unpredictable natural disasters, diseases, and pests that affect their crops and livestock (Minagri, 2021). Initially, the implementation of the crop insurance scheme started with 10 districts including Nyagatare, Kirehe, Bugesera, Gatsibo, Gisagara, Gicumbi, Huye, Rulindo, Rwamagana, and Ngoma. Meanwhile, the livestock insurance product was initially implemented in the districts of Nyagatare, Gatsibo, Nyanza, Musanze, Gicumbi, Burera, Rwamagana, and Ruhango, while the scheme will be scaled up countrywide later (Minagri, 2021). The government of Rwanda subsidized the agriculture insurance scheme by up to 40%, to allow farmers in the pilot districts to easily afford to pay the insurance premiums. In this pilot phase, the Ministry of Agriculture and Animal Resources signed a partnership agreement with three local insurance companies (i.e., RADIANT, PRIME, and SONARWA) to ensure a successful implementation of the agricultural insurance program (Minagri, 2021).

3. Materials and methods

3.1. Theoretical framework

The theoretical explanation underpinning this study is the theory of utility maximization. According to the utility maximization theory, a household takes the decisions of insuring or not insuring his/

her farm and the amount of money to pay (insurance premium) if those decisions can maximize not only the profits but also his/her level of utility or satisfaction (Adzawla et al., 2019). Typically, each farmer has his/her own level of utility that he/she wishes to attain, and such utility guides farmers' choices and decisions (Okoffo et al., 2016).

Following Adzawla et al. (2019), the random utility framework is commonly used to model the discrete choice scenarios that farmers make (i.e., either to insure the farm or not to insure). From the random utility framework, it is assumed that farm households are risk-neutral and decide to adopt an innovation that maximizes their utility function subject to input costs and other constraints (Ngango & Hong, 2021a). In the present study, farmers are faced with two alternative choices (i.e., adopt crop insurance or not) and their choice is based on the highest level of utility associated with a particular alternative choice. This means that when the adoption decision is associated with the highest level of utility, then the farmer will opt for that option.

To undertake the economic analysis of these types of relationships, we embraced the stated preference approach. This study employed the CVM to narrow the theoretical diagnosis of the empirical work. CVM is a stated preference method generally employed to estimate the total economic value of environmental goods and services that are not tradable at markets (i.e., with no market value; Kaji et al., 2019). The CVM involves the use of household and farm-level surveys to elicit information on the value farmers assign to non-market goods and services. CVM is underpinned by the theory of consumer behavior and the theory of the maximization of utility. The implication of this method is to obtain an appropriate premium amount by analyzing farmers' expected utility both with insurance and without insurance (Senapati, 2020). Generally, CVM aims to measure both the WTP and willingness to accept (WTA) for a particular public good (Idris et al., 2022). The WTP is a proper approach when an individual is *acquiring* the good, while the WTA is appropriate if the individual is *losing* the good (Senapati, 2020).

3.2. Analytical framework

In the literature, a number of econometric approaches have been employed to analyze the participation behavior among farmers. These models have been applied depending on the nature of data available and the question at hand (Mwema & Crewett, 2019). In particular, the probit and logistic regression models have been used to examine the dichotomous issue of the probability of adopting a new agricultural innovation or not in various studies (Audu & Aye, 2014; Khonje et al., 2015; Lefebvre et al., 2014; Mango et al., 2018; Ngango & Hong, 2021a; Shiferaw et al., 2014). Since our objective is to investigate whether the farmer is willing to insure the farm or not and if yes, determine the amount of money a farmer is willing to pay for crop insurance, the use of probit, logit, and Tobit models will not be appropriate. Therefore, this study used a double-hurdle model proposed by Cragg (1971) for this purpose.

Our double-hurdle model embodies two stages, the first hurdle is the decision of whether or not to insure farms (participation decision) and the second hurdle is the intensity decision which involves the estimation of insurance premium farmers are willing to pay. Following Engel and Moffatt (2014), the double-hurdle model accommodates two equations as a combined probit and Tobit estimator. The first hurdle can be empirically measured using a probit model. Thus, the probit regression on the willingness-to-insure (WTI) is specified as:

$$WTI_i^* = x_i'\alpha + \varepsilon_i \; where \; \varepsilon_i \sim N(0, \sigma^2)$$
$$WTI_i = \begin{cases} 1 \; if \; WTI_i^* > 0 \\ 0 \; if \; WTI_i^* \leq 0 \end{cases} \quad (1)$$

In the above equation, WTI_i^* is the latent variable that takes the value of 1 if a farmer is willing to insure his/her farm and 0 otherwise. x_i represents a vector of explanatory variables which are hypothesized to influence the farmers' WTI; α is a vector of parameters to be estimated; ε_i is the

error term which is assumed to be independent and normally distributed with mean zero and constant variance σ^2.

The second hurdle which estimates the amount of money (insurance premium) the farmer is willing to pay, is estimated using a Tobit regression truncated at zero as;

$$WTPamt_i^* = z_i'\beta + \mu_i$$
$$WTPamt_i = \begin{cases} WTPamt_i^* \ if \ WTPamt_i^* > 0 \\ 0 \ if \ WTPamt_i^* \leq 0 \end{cases} \quad (2)$$

where $WTPamt_i$ is the latent variable describing the amount of money maize farmers are willing to pay for crop insurance. z is a vector of explanatory variables, β is a vector of parameters, and μ_i is the error term.

3.3. Study area, data collection, and variables source

The study was conducted in the Eastern Province of Rwanda during the 2018–2019 cropping season. The survey was conducted from July to August 2019 using a structured questionnaire via face-to-face interviews with the heads of households. A representative sample of this study consists of 325 households randomly selected from Bugesera, Kirehe, and Nyagatare districts of the Eastern Province of Rwanda (see Figure 1). These three districts were among the ten districts selected in the pilot phase of the crop insurance scheme introduced in 2019 by the Ministry of Agriculture and Animal Resources (MINAGRI). The annual average rainfall distribution in the study area ranges between 740 and 1130 mm, and the rainfall is generally well distributed throughout the year.

A multistage sampling technique was used to obtain the sample households covered by this paper. In the first stage, after consulting MINAGRI, the three districts were purposively selected based on the National Agriculture Insurance Scheme (NAIS) coverage and intensive maize production in these districts. From each of the selected districts, four administrative sectors were randomly selected due to the predominance of maize farms in the second stage. In the third stage, a random sample of respondents was selected in each sector for personal interviews. Based on the list of farmers obtained from agricultural extension officers at the sector level, a total of 1197 individual households were counted and recorded in all 12 sectors. Due to the limited resources and time, 34 respondents were randomly selected in each sector, which make up a total sample of 408 household farmers. Nevertheless, after cleaning the data collected, we end up with a total sample of 325 household farmers. Additional details about the survey and sample representativeness are described in Ngango and Hong (2021c).

The data obtained from the contingent valuation scenario includes information on household socioeconomic characteristics, institutional and farm-level characteristics, crop insurance awareness, and questions related to household WTP for crop insurance premium. According to MINAGRI officials, the Government of Rwanda subsidizes 40% of the agriculture insurance scheme and the farmer pays the remaining 60% to get the payment approval. Regarding the crop insurance in the NAIS, the cost of insurance for each crop depends on the value of all materials and inputs used in the production of that particular crop (i.e., cost of investment in labor, seeds, fertilizers, pesticides, irrigation, and mechanization).

The choice of variables used in this study was guided by previous literature on the willingness to participate and pay for crop insurance (Abbas et al., 2015; Abugri et al., 2017; Addey et al., 2021; Adzawla et al., 2019; Afroz et al., 2017; Arshad et al., 2016; Budhathokia et al., 2019; Fonta et al., 2018; Ntukamazina et al., 2017; Okoffo et al., 2016; Sibiko et al., 2018) and the context of Rwandan agricultural sector.

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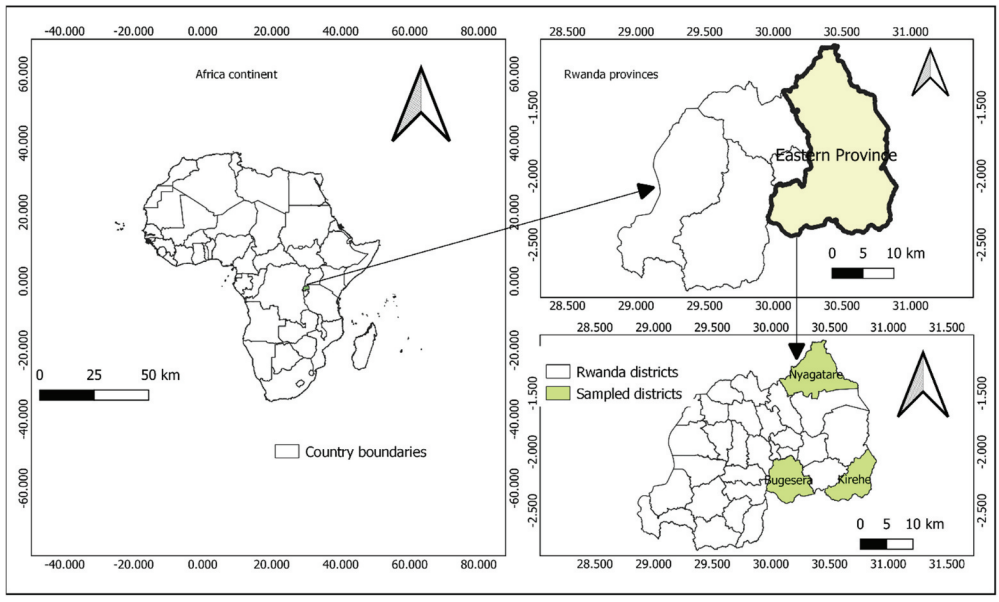

Figure 1. Map showing the study area location.

4. Results and discussion

4.1. Descriptive statistics

Table 1 presents the results of the summary statistics of variables used in this study. Only about 39% of maize farmers in the sample area are aware of the crop insurance scheme, and 73% are willing to pay for crop insurance. Regarding the household characteristics, the average age of the sampled household heads is about 45 years and the majority of households are male-headed (71%). The average level of formal education is around 7 years and the average household size is about 4.5 members which is very close to the national average household size (4.4 according to the Fifth Integrated Household Living Conditions Survey (EICV5) conducted in 2016/2017). The average landholdings are roughly 0.92 ha while on average, the livestock ownership is about 1.29 TLU in the study area. Table 1 also shows that 58% of the farmers are members of groups or cooperatives, while the average number of contacts with extension agents was estimated to be approximately 31 times during the 2018–2019 cropping season.

About 42% of the households reported having access to credit, while 35% acknowledged having access to weather forecast information. In terms of land tenure, Table 1 indicates that on average, landowners represent 64% of the sample. Land in Rwanda is considered as an important asset used by households to get access to credit (Nilsson et al., 2019). Further, 43% of households in the sample reported being risk-averse. On average, the yearly household income is estimated to be about 618,406 RWF or US$ 627.50.

4.2. Household's willingness to insure and premium amount to pay for crop insurance

Maize farmers' willingness to insure farms and the WTP for crop insurance per annum are reported in Table 2. In our sample, most respondents (74%) were willing to insure their maize farms. This implies that farmers in the Eastern province of Rwanda are aware of the significance of insuring their farm crops to protect them against weather shocks (floods, droughts, pests, diseases, and fire outbreaks). Regarding the premium amount farmers are willing to pay for crop insurance, Table 2 shows that the estimated average insurance premium that farmers were willing to pay was about 19,206 RWF (US$ 18.61) per hectare per annum. Of the 241 respondents who were willing to insure their maize farms, the majority (78%) were willing to pay between 15,001–20,000 RWF per hectare per annum. Though, only 14% of the respondents were willing to pay more than 20,000 RWF per hectare per annum as an insurance premium.

Table 1. Variable definition and descriptive statistics

Variable	Description and measurement	Sample mean	Std. dev.
Age	Age of household head (years)	45.36	12.87
Gender	1 if the household head is male, 0 otherwise	0.71	0.43
Education	Number of years of schooling	6.55	3.12
Household size	Total number of household members	4.49	1.70
Farm size	Farmland under maize production (hectare)	0.92	0.51
Group membership	1 if a farmer is a member of an association of farmers, 0 otherwise	0.58	0.46
Extension services	Contacts with extension agents (number per year)	31.27	10.35
Credit access	1 if a farmer has access to credit, 0 otherwise	0.42	0.40
Weather information	1 if a farmer has access to weather forecast information, 0 otherwise	0.35	0.28
Risk attitude	1 if a farmer is risk-averse, 0 otherwise	0.43	0.57
Livestock ownership	Amount of livestock owned in tropical livestock units (TLU)	1.29	1.24
Land tenure	1 if the land is owned by a farmer, 0 if rented	0.64	0.34
Insurance awareness	1 if a farmer is aware of crop insurance, 0 otherwise	0.39	0.45
Income	Yearly household income in ('000 RWF)	618.41	276.49
WTP	1 if the farmer is willing to pay the crop insurance, 0 otherwise	0.73	0.37

Note: RWF denotes the Rwandan Franc currency unit and the exchange rate was 1,031.79 RWF to a US Dollar in June 2022.

Although the majority of maize farmers were willing to insure their farms, it can be noticed that their willingness to insure does not automatically imply that a large proportion would pay a higher insurance premium. Even though the government of Rwanda subsidized the crop insurance up to 40%, the pre-determined insurance premium to be paid by maize farmers (60%) of 21,248 RWF (US $ 20.59) appears to be higher than the average premium farmers were willing to pay for crop insurance in the study area. Compared with other SSA countries, this average amount of money Rwandan farmers were willing to pay is lower than the mean WTP (US$ 40) reported by Abugri et al. (2017) in Ghana, but it is higher than the mean WTP (US$ 14.3) reported by Fonta et al. (2018) in Burkina Faso. In addition, compared to the total production cost of producing maize, (Batirbaev et al., 2013) identified the farmers' input cost was about 23 RWF/kg in Rwanda, including the cost of seeds and fertilizer. Since the average production of maize in Rwanda was 1.5 tons/hectare (Minagri, 2021), then the total production cost (tone/hectare) was about 30,750 RWF (US$31.21). So, the farmers are willing to insure at least 65.68 % of the total production cost.

Table 2. Descriptive information about farmers' willingness to insure and premium amount to pay for crop insurance

Variable	Description	Frequency	Percentage (%)
Willingness to insure farms	Yes	241	74
	No	84	26
Insurance premium farmers are willing to pay (RWF/hectare/annum)			
	0–15,000	19	8
	15,001–20,000	188	78
	>20,000	34	14
Minimum	13,451.75		
Maximum	24,603.26		
Mean	19,206.14		

Note: RWF denotes the Rwandan Franc currency unit and the exchange rate was 1,031.79 RWF to a US Dollar in June 2022.

4.3. Factors determining household's willingness to insure and insurance premium

Table 3 presents the results of the double-hurdle model for determinants of farmers' willingness to insure (WTI) and willingness to pay (WTP) for crop insurance. The chi-square values for both WTI and WTP models are statistically significant at the 1% level, implying the predictive importance of the double-hurdle model in explaining the WTI decision and the insurance premium. The Pseudo R-squared values of 0.564 and 0.391 imply that about 56.4% and 39.1% of the variation in farmers' WTI and WTP for crop insurance, respectively, are explained by the variation in the fourteen explanatory variables. The results of the first hurdle emphasize the significance of education, land tenure, farm size, group membership, insurance awareness, household size, and credit access variables in influencing the farmers' WTI maize farms and WTP for crop insurance. In particular, the farmer's level of education has a positive and statistically significant ($p < 0.05$) relationship with the likelihood of adopting crop insurance, which implies that highly educated farmers are more likely to insure their farms. This result confirmed our a priori expectation and is in line with the findings of Okoffo et al. (2016), Adzawla et al. (2019), and Senapati (2020). Typically, farmers with a higher level of education are expected to be more aware of the benefits of agricultural insurance products which may also encourage early adoption (Hill et al., 2013).

Table 3 also indicates that the insurance premium farmers are willing to pay is positively and significantly ($p < 0.05$) influenced by education level. In particular, if the level of education increases by one year, the amount farmers are willing to pay for crop insurance increases by about 1.92 RWF. Similarly, studies conducted by Ellis (2017) and Abbas et al. (2015) revealed that a higher education level is associated with an increased amount farmers were willing to pay for crop insurance. Although household size has no significant effect on farmers' WTI maize farms, it has a negative and significant ($p < 0.05$) effect on the insurance premium farmers are willing to pay. However, this result contradicts the findings of Okoffo et al. (2016), which revealed that household size has a positive influence on farmers' WTP for crop insurance. Land tenure was identified to have a positive and significant ($p < 0.05$) effect on both WTI decisions and the insurance premium farmers are willing to pay. This implies households who own pieces of land are more likely to insure their maize farms and pay more insurance premiums. Likewise, a study conducted by Abugri et al. (2017) indicated that land ownership increases the likelihood of adopting drought-index crop insurance and premium in Ghana.

Farm size is another significant ($p < 0.05$) variable that has a positive influence on both households' WTI maize farms and the amount farmers are willing to pay for crop insurance. That is, the

Table 3. Estimation results of the double-hurdle model for determinants of farmers' WTI and WTP for crop insurance

Variable	WTI (First Hurdle)		WTP (Second Hurdle)	
	Coefficient	Std. error	Coefficient	Std. error
Age	−0.074	0.108	−0.023	0.050
Education	2.317**	1.052	1.915**	0.666
Gender	−0.049	0.095	−0.447	0.761
Household size	0.160	0.329	−0.113**	0.029
Land tenure	1.755**	0.436	2.974**	0.964
Farm size	1.243**	0.358	3.822**	0.837
Group membership	0.679**	0.200	0.906	0.610
Extension services	−0.134	0.396	0.175	0.724
Credit access	−0.061	0.093	0.462**	0.195
Weather information	0.257	0.588	−0.306	0.829
Risk attitude	−0.406	1.141	−0.750	1.031
Livestock ownership	0.863	1.574	1.028	2.316
Insurance awareness	1.362**	0.637	0.275	0.664
Income	1.005	0.763	1.149**	0.415
Constant	−1.827	3.509	10.472**	0.763
Regression diagnostics				
	Number of obs. = 325		Number of obs. = 221	
	Log-likelihood = −68.134		Log-likelihood = −147.245	
	LR $x^2(14)$ = 191.14		LR $x^2(14)$ = 247.63	
	Prob>x^2 = 0.000		Prob>x^2 = 0.000	
	Pseudo R^2 =0.564		Pseudo R^2 = 0.391	

Note: Asterisks indicate the level of significance: ** $p < 0.05$.

larger the area under maize production, the greater likelihood that the farmer would be willing to insure his/her maize farm. Moreover, a one hectare increase in farm size increases the insurance premium amount by 3.82 RWF. This finding corroborates the studies of Fonta et al. (2018) and Abugri et al. (2017) in Burkina Faso and Ghana, respectively. However, this result is contrary to Senapati (2020) who revealed that farm size negatively influences both WTI and WTP amounts for rainfall insurance product in rural India.

Concerning the social capital and network factors, the study found a positive and significant ($p < 0.05$) association between group membership and farmers' WTI maize farms. A plausible explanation for this is that group membership enhances the likelihood of adopting crop insurance because farmers' groups and/or cooperatives play important roles in the delivery of agricultural advisory services as well as other public agricultural services (Abebaw & Haile, 2013). Besides, farmers who are regular members of cooperatives or farmers' groups are in a better position to gather useful information regarding the benefits of crop insurance and other innovations and technologies (Manda et al., 2020).

The access to credit has no significant influence on farmers' WTI maize farms but has a positive and significant ($p < 0.05$) effect on the insurance premium farmers are willing to pay, which is consistent with "*a priori*" expectation of this study. In general, access to credit facilities (e.g., at commercial banks, microfinance, and Savings and Credit and Cooperatives) play

an important role in increasing the tendency of farmers to purchase crop insurance uptake (Addey et al., 2021; Fonta et al., 2018). Similar results have been given in previous studies on WTP for crop insurance (Abugri et al., 2017; Fonta et al., 2018). Another significant ($p < 0.05$) variable that has a positive influence on farmers' WTI decision is insurance awareness. This implies that households with sufficient knowledge of crop insurance program were more likely to show their interest in the insurance program. This result is in line with the findings of Ellis (2017), Fonta et al. (2018), and Senapati (2020). The results also indicated that household income positively and significantly ($p < 0.05$) influences the amount farmers are willing to pay for crop insurance. This result is consistent with the study by Adzawla et al. (2019) but contradicts the findings of Okoffo et al. (2016).

5. Conclusions and policy implications

Agricultural insurance schemes have been identified as potential agricultural risk management strategies to address possible losses against adverse natural and climate hazards such as floods, droughts, pests, and diseases. In particular, crop insurance provides rewards because farmers can be indemnified when they encountered climate shocks. This implies that crop producers will not have to sell assets or depend on emergency food aid to survive. Crop insurance also improves the ability of farmers to adapt to various risks and allows them to make a large investment in agriculture. Therefore, this study sought to examine the factors that determine maize farmers' willingness to insure their farms and the premium farmers are willing to pay for crop insurance. The study reveals that the majority of maize farmers (74%) were willing to insure their farms. Yet, only 14% of the respondents were willing to pay more than 20,000 RWF per hectare per annum as an insurance premium. Even if the majority of maize farmers were willing to insure their farms, it can be noticed that their willingness to insure does not automatically imply that a large proportion would pay the higher insurance premium. Moreover, the average premium farmers were willing to pay for crop insurance in the study area was US$ 18.61 per hectare per annum which appears to be lower than the pre-determined insurance premium set by MINAGRI for maize farmers (US$ 20.59).

Regarding the empirical analysis, the double-hurdle model was employed to assess the determinants of farmers' willingness to insure maize farms and the premium they are willing to pay for crop insurance. Our findings reveal that education, land tenure, farm size, group membership, and insurance awareness have a positive influence on maize farmers' decision to take up the crop insurance. Concerning the determinants of WTP amounts, education, land tenure, farm size, credit access, and income positively influenced the insurance premium maize farmers were willing to pay whereas household size negatively influenced the premium maize farmers were willing to pay for crop insurance.

The study recommends policy frameworks that strengthen education in rural communities and information dissemination about the functionality and usefulness of crop insurance. This could enhance the levels of farmers' participation in the purchase of crop insurance and it might increase the premium farmers will be willing to pay for crop insurance. The study also highlights the importance of building the capacity of farmers' groups or cooperatives to promote the uptake of crop insurance as well as the premium to be paid. Moreover, the improvement of farmers' access to credit facilities is highly recommended to allow farmers to get financial capability and be able to pay a higher insurance premium. Finally, this study recommends future research to examine the willingness to participate and pay for crop insurance among both non-participants and participants in the government crop insurance scheme. Furthermore, there is a need for future studies to investigate the farmers' willingness to insure and willingness to pay for crop insurance in all food crops.

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