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Do Farmers Demand Innovative Financial Products? A Case Study in Cambodia

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Abstract: This study examines Cambodian farmers' demand for weather index insurance (WII), an *innovative financial product*, for managing climate change-related risks. Rice and cassava farmers in Battambang Province of Cambodia were interviewed to understand their preferences for WII. We applied a binary logistic model to quantify the factors that influence farmers' WII demand. We discovered that farmers' marital status and off-farm labor are crucial factors that impact the demand for WII. More importantly, we also investigated gender differences, considering the critical role of women in the agricultural sector and personality differences between men and women. Our findings indicated that for male respondents, being married and having an additional off-farm laborer increase the probability of demand for WII by 72.6% and 36.8%, respectively. For female respondents, the education level is the most significant factor in making purchase decisions. An additional year of education increases the probability of WII demand by 5.0%. Generally, our results are consistent with some prior studies but inconsistent with others. This suggests that further research is necessary to understand the barriers associated with WII schemes and how to overcome them. Regardless, our study provides valuable insights for various stakeholders in implementing WII schemes, including financial professionals, insurance companies, communities, and governments, for designing more flexible WII products, improving farmers' financial literacy, and providing effective post-event support to enhance farmers' resilience to climate change.

Keywords: climate change; innovative financial product; weather index insurance (WII); risk transfer

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1. Introduction

Climate change significantly increases risks arising from extreme weather disasters across the world. To tackle climate change, the G7 leaders have pledged to provide climate insurance to developing countries by launching new initiatives on climate risk insurance (Surminski et al. 2016). Under the support of the International Climate Initiative (IKI) of the German Federal Ministry for Economic Affairs and Climate Action, weather index insurance (WII), an *innovative financial product*, was proposed in Cambodia in 2021.

In Cambodia, agriculture is a fundamental sector, employing one-third of the workforce[1] and accounting for more than one-fifth of the country's gross domestic product (GDP) in recent years.[2] However, the agricultural sector is also the most vulnerable to climate change. Climate change is predicted to shrink Cambodia's GDP by 9.8% by 2050, undermining its goal of becoming a high-income country.[3] Climate-related hazards, sea level rise, and varying hydrological cycles have reduced agriculture, fishery, and labor productivity in Cambodia. Agricultural production losses have been largely caused by

flooding (about 62%) and drought (about 36%) over the past 20 years.[4] To address these threats, Cambodia's 2015 Law on Disaster Management paved the way for a disaster risk reduction–climate change adaptation synergy.[5] With extreme weather and climate events becoming more disastrous, frequent, and intense, it is crucial to implement risk management that can support smallholder farmers and communities in coping with and adapting to the effects of these occurrences. Therefore, WII solutions could be an important strategy for protecting smallholder farmers from both the physical and financial impacts of climate change. Different from traditional insurance, in which indemnity is claimed when an actual loss occurs, WII is based on pre-defined thresholds and trigger points (i.e., an index) of weather parameters (e.g., rainfall or temperature). The payout is triggered when the weather parameter moves beyond the pre-specified threshold and trigger points, regardless of actual losses experienced by the insured. WII products offer several advantages, such as less adverse selection (information asymmetry) and moral hazard, greater transparency, and quicker settlement of claims (e.g., Chiappori and Salanie 2000; Giné et al. 2008; Cole et al. 2013).

This study examines Cambodian rice and cassava farmers' preference for WII products. While WII schemes have been implemented in some developing countries (e.g., India, Bangladesh, and African countries), prior studies showed that the uptake of WII was low (e.g., Cole et al. 2013; Sibiko et al. 2018; Budhathoki et al. 2019). Our study provides additional empirical evidence on WII schemes by investigating the determining factors influencing the demand for WII, identifying relevant limitations, and providing recommendations. Specifically, we conducted interview surveys of rice and cassava farmers in Battambang, a province in north-western Cambodia. We first examined how farmers' socioeconomic and demographic characteristics affected their WII demand. The prior literature has shown that farmers' socioeconomic and demographic factors (e.g., age, education, farming experience, and risk perception) influence their willingness to participate in and pay for WII (e.g., Jin et al. 2016; Matsuda and Kurosaki 2019). However, no consensus has been reached.

Furthermore, the literature has also demonstrated that female farmers play an important role in agricultural production (e.g., Chanana-Nag and Aggarwal 2020; Osabohien et al. 2021) and that women have different personality traits compared to men (e.g., Eckel and Grossman 2008). Relevant gender heterogeneity has been documented for index insurance preference in China (Jin et al. 2015) and Bangladesh (Akter et al. 2016), for example. We further investigated the gender differences of Cambodian farmers in demanding WII. Finally, we identified challenges and limitations in implementing the proposed WII scheme and provided relevant recommendations.

Our study contributes to the growing research interest of WII in the mitigation of and adaptation to climate change. Although WII schemes have been conducted in some developing countries, the studied scheme is the first pilot program in Cambodia. This study is an early mover in investigating the potential of WII in Cambodia. At the same time, we pay strong attention to the gender heterogeneity issue in demand for WII products. According to the International Labour Organization (ILO), 39% of Cambodia's female employment is in agriculture, with an equivalent percentage of male employment (same note 1). Our results will provide significant implications and insights regarding risk transfer and risk sharing between private parties, financial institutions, and governments in Cambodia.

The rest of our study proceeds as follows. A literature review is conducted in Section 2. Section 3 presents the methodology and descriptive statistics. Section 4 describes the econometric model. Section 5 discusses the empirical results. Section 6 concludes and Section 7 presents the limitations and recommendations.

2. Literature Review

Weather-index-based insurance is becoming an effective risk management strategy in the agricultural sector. With different legal structures, agricultural systems, and financial

situations, the development of WII varies across countries. Carter et al. (2017) reviewed index insurance for agriculture in developing countries. They showed that the take-up is fairly low without substantial subsidies. Vroege et al. (2019) provided a review of index insurance in Europe and North America. Many types of index insurance have been found in practice, varying with weather parameters, yield levels, and satellite imagery.

Carter et al. (2017) summarized some barriers preventing the uptake of agricultural index insurance, such as basis risk,[6] high cost, low level of insurance knowledge, and trust in the insurance product and its provider. Clement et al. (2018) conducted a global review on how basis risk impacts the demand for index insurance. They demonstrated that alternative risk management (e.g., index insurance) is particularly welcomed by developing countries. The possible reasons might be social unrest and climate change, which lead to low production and income. Of the 19 studies reviewed by Clement et al. (2018), nearly 70% were from developing countries, such as Ethiopia, Ghana, India, Kenya, and Nicaragua. While index insurance is becoming more attractive, the demand for the product is still low for both developed and developing countries (e.g., Cole et al. 2013; Clement et al. 2018; Sibiko et al. 2018; Budhathoki et al. 2019).

Prior studies showed that there are price concerns regarding paying for crop insurance. Aditya et al. (2020) found that while farmers are willing to purchase crop insurance, they would pay a lower amount than the existing premium. However, others demonstrated that the insurance premium might not be the main issue (Budhathoki et al. 2019; Matsuda and Kurosaki 2019). Other possible factors influencing farmers' demand for index insurance include climate risk and insurance knowledge (Akter et al. 2017; Budhathoki et al. 2019), risk perspective and attitude (Hossain et al. 2022), credit access (Carter et al. 2016; Ahmed et al. 2020), and trust in insurance products (Hill et al. 2013; Akter et al. 2016).

Furthermore, with the important role of women in the agricultural sector (Nyasimi and Huyer 2017; Chanana-Nag and Aggarwal 2020; Osabohien et al. 2021) and differing personality traits between men and women (Eckel and Grossman 2008; Croson and Gneezy 2009), it is worth examining the gender heterogeneity in managing climate risks (Singh et al. 2010). Jin et al. (2015) found different preferences in male and female farmers for climate change adaptation strategies in China. Based on Bangladesh data, Akter et al. (2016) also documented gender differences in insurance knowledge and the trust of insurers, driving heterogeneous preferences for WII. As such, more attention should be paid to improving relevant agricultural practices to develop gender-specific mitigation and adaptation strategies, through government policy support or other initiatives from communities and financial professionals.

3. Methodology and Descriptive Statistics

When detailed comparative information is lacking, one appropriate approach to exploring potential solutions is a case study (Al-Maruf et al. 2021). In this study, we interviewed smallholder farmers who plant rice or cassava in three districts, namely Komrieng, Bavel, and Thma Koul in Battambang Province of Cambodia. This province is representative of Cambodia since it has the largest rice and cassava production in the country.[7] It produces on a commercial scale, primarily for export. Farmers in the Thma Koul and Bavel districts mainly cultivate rice, and those in the Komrieng district grow cassava as their primary crop. In recent years, climate change has had a substantial impact on production and farming experience (Touch et al. 2017). Consequently, Battambang Province is ideal for piloting crop insurance. Moreover, given that it is not only one of the largest provinces in Cambodia in terms of population and cultivated land for rice and cassava, but also has active agricultural cooperatives and farmer organizations in the districts, the findings of this study could be applied to other provinces in the country.

3.1. Sample Size

To choose an appropriate sample size from the population in the study areas, we used the following formula (Masud et al. 2017):

$$N = \frac{M}{1 + Md^2}$$

where N is the sample size, M is the number of households in the study areas, and d is the margin of error. The margin of error can be calculated from the confidence level. In our study, M is 75,951 as of 2020.[8] We used a confidence level of 90%, i.e., a margin of error of 0.1 (Tran et al. 2022). From the above formula, a sample size of 100 was obtained, which provides guidance on an acceptable sample size: any survey sample size that is larger than 100 should be appropriate.

3.2. Data Collection

We collected data through three main channels: individual interviews with rice and cassava farmers, key informant interviews with agricultural cooperative leaders and commune authorities, and focus group discussions. Individual interviews with farmers were led by the technical staff of the Provincial Department of Agriculture, Forestry, and Fisheries (PDAFF). Key informant interviews with leaders of agricultural cooperatives and commune chiefs were also conducted. Focus group discussions were led by staff from the Cambodian Farmer Federation Association of Agricultural Producers (CFAP) and other relevant project members. A total of 143 households were randomly chosen from the three districts (Komrieng, Bavel, and Thma Koul). Face-to-face interviews with the heads of the 143 households were conducted from 1st April to 10th April 2022. The household head is considered the main member of the household who has substantial farming experience and can make a wide range of important decisions for the family. Interview questions included farmers' socioeconomic and demographic characteristics, climate change awareness, risk attitude, and demand for WII products.

3.3. Descriptive Statistics

3.3.1. Socioeconomic and Demographic Characteristics

The descriptive statistics of household respondents' socioeconomic and demographic characteristics are shown in Table 1. Each variable's mean value (Mean) and standard deviation (SD) for the full sample, as well as male and female samples, are presented. We also examined the mean differences between the male and female samples and reported their t-statistics.

The average age of the full sample was 50 years old, with an SD of 13 years. There was a mean difference of 0.5 years between male and female respondents, but this was statistically insignificant. On average, 85% of respondents were married, whereas males had a higher marriage rate (95%) compared with that of females (73%). The difference in marriage rate (22%) between males and females was statistically significant. The average education level of respondents was 6.9 years (equivalent to a primary school education). For the household size, the average number of persons was 4.8, with an SD of 1.6, and there was no significant difference between households with a male head and a female head. The average numbers of adults and children in each household were 3.4 and 1.3 persons, respectively, without a significant difference being found in the male- and female-headed households.

Households' average farm size was 4.5 ha, and there was a 0.9 ha difference between the male- and female-headed households. For the household labor workforce, the number of laborers in total was an average of 2.7 persons for the full sample. Most of the laborers of each household worked on their farms. On average, for both total labor and farm labor, there was a statistically significant difference of 0.5 persons, with a bigger number in the male-headed households. Correspondingly, households' main income (78%) was from crop

farming at 12.4 million Riels. Furthermore, no significant differences in total income, farm income, and off-farm income were found for male- and female-headed households.

Table 1. Descriptive statistics of socioeconomic and demographic characteristics.

Variable	Description	Full Sample (N = 143)		Male (N = 81)		Female (N = 62)		Difference	
		Mean	SD	Mean	SD	Mean	SD	Mean	t-Statistic
Age	Age of a respondent in years	49.52	12.70	49.73	13.35	49.24	11.90	0.49	0.23
MaritalStatus	Married = 1, otherwise (single/divorced/widowed) = 0	0.85	0.36	0.95	0.22	0.73	0.45	0.22	3.62
Edu	Education level in years (No schooling = 0, Primary school = 6, Secondary school = 9, High school = 12, University and above =16)	6.85	2.97	7.53	2.77	5.95	3.00	1.58	3.23
HHSize	Number of persons in the household	4.75	1.61	4.62	1.58	4.92	1.64	−0.30	−1.11
Adult	Number of adults	3.43	1.49	3.38	1.31	3.48	1.71	−0.10	−0.39
Child	Number of children (<15 years old)	1.32	1.15	1.23	1.16	1.44	1.14	−0.20	−1.03
FarmSize	Total farm area (ha)	4.46	3.80	4.83	4.45	3.96	2.69	0.87	1.45
TotalLabor	Number of total laborers in the household	2.69	1.30	2.91	1.26	2.40	1.30	0.51	2.36
FarmLabor	Number of laborers working on the farm	2.22	1.13	2.42	1.14	1.97	1.09	0.45	2.42
OffFarmLabor	Number of laborers working outside the farm	0.47	0.98	0.49	1.05	0.44	0.90	0.06	0.36
TotalIncome	Total yearly income ('000 Riels)	15,897.26	14,349.70	17,432.85	15,927.42	13,891.10	11,807.63	3541.75	1.53
FarmIncome	Yearly income from farming ('000 Riels)	12,354.98	12,367.07	13,273.45	13,362.85	11,155.05	10,920.91	2118.40	1.04
OffFarmIncome	Yearly income from outside of farming ('000 Riels)	3542.28	5619.63	4159.40	6573.75	2736.05	3959.04	1423.35	1.61

3.3.2. Risk Attitude and Awareness of Crop Insurance

Risk aversion can be an important factor that influences smaller households' decisions to use innovative technology to adapt to extreme weather events (Haile et al. 2020). In our interviews, farmer respondents were required to assess their climate risk awareness and risk-taking level by ranking from 0 to 10, where a value of 0 represents the farmer as a low-level risk-taker (i.e., risk aversion), and 10 as a high risk-taker. Before providing a ranking number, the question was clearly explained to respondents to ensure that they made a reasonable assessment of their risk tolerance. Finally, we obtained an average of 4.5 on farmers' risk attitudes, with a standard deviation of 2.4.

During the interview process, we found that crop insurance awareness was low. Only 10% (14 out of 143) of respondents said that they knew about crop insurance, and none had used it previously. Accordingly, due to the low awareness of crop insurance, we could not obtain sufficient information on solutions to some of the questions, such as "why don't you purchase insurance?", "how do you rank the insurance importance?" In the final section of this study, we present the limitations and recommendations that we identified in the interview surveys.

4. Econometric Model

Based on a respondent's preference for WII, the relevant variable takes a value of 1 (if yes) or 0 (if no). Accordingly, a binary logistic model[9] was considered proper for conducting the empirical analysis and is written as:

$$Y_i = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_i \quad (1)$$

where Y_i is the binary dependent variable vector, with a value of 1 if farmer i demands a WII product, and 0 otherwise. α is the intercept of the regression equation. X_i is the set of independent variables, as described in Table 1; moreover, respondents' risk aversion is also included, as this may work as a channel influencing farmers' farming and other investment strategies (Haile et al. 2020; Falco et al. 2021). n is the number of independent variables. β_i is the estimated coefficients, and ε_i is the error term.

5. Results and Discussion

5.1. Full Sample

Table 2 reports the regression results of Equation (1) for the full sample.[10] Two models were tested, and the estimated coefficients and marginal effects on farmers' demand for WII are presented. Model (2) extends Model (1) by separating several variables (*HHSize*, *TotalLabor*, and *TotalIncome*) into their components.

Table 2. Regression results of the binary logistic model for the full sample.

Variable	Model (1)		Model (2)	
	Coefficient	**Marginal Effect**	**Coefficient**	**Marginal Effect**
Age	0.004	0.001	0.005	0.001
	(0.017)	(0.004)	(0.018)	(0.004)
MaritalStatus	1.039 *	0.220 *	1.149 *	0.233 **
	(0.560)	(0.113)	(0.599)	(0.115)
Edu	0.067	0.014	0.068	0.014
	(0.070)	(0.015)	(0.073)	(0.015)
HHSize	−0.134	−0.028		
	(0.137)	(0.029)		
Adult			−0.120	−0.024
			(0.191)	(0.039)
Child			−0.160	−0.032
			(0.172)	(0.035)
TotalLabor	0.416 **	0.088 **		
	(0.202)	(0.041)		
FarmLabor			0.183	0.037
			(0.235)	(0.047)
OffFarmLabor			0.738 **	0.150 **
			(0.333)	(0.064)
FarmSize	0.037	0.008	0.023	0.005
	(0.069)	(0.015)	(0.082)	(0.017)
log(TotalIncome)	0.019	0.000		
	(0.300)	(0.000)		
log(FarmIncome)			0.165	0.000
			(0.295)	(0.000)
log(1 + OffFarmIncome)			0.040	0.000
			(0.026)	(0.000)
RiskAverse	−0.116	−0.025	−0.114	−0.023
	(0.078)	(0.016)	(0.082)	(0.016)

Table 2. *Cont.*

Variable	Model (1)		Model (2)	
	Coefficient	**Marginal Effect**	**Coefficient**	**Marginal Effect**
Constant	−1.332		−3.713	
	(4.902)		(4.826)	
Observations	143		143	
Log Likelihood	−87.386		−84.168	
Akaike Inf. Crit.	194.77		194.335	
Pseudo R2	0.078		0.112	

Numbers in parentheses are standard errors. ** and * indicate a significance level of 5% and 10%, respectively.

Model (1) shows that both respondents' marital status (*MaritalStatus*) and the number of total laborers (*TotalLabor*) were positive and statistically significant at the 10% and 5% levels, respectively. Married household heads had a higher level of preference for purchasing WII than those who were not married. This could be explained by several possible reasons: (1) the partner of the household head is an additional (potential) laborer on the farm; (2) the partner may have a higher level of education and better knowledge of financial products; and (3) the partner may have the potential capacity to improve household income, by seeking job opportunities off the farm.[11] In addition, if the household has more laborers, the respondent is also more likely to use WII. For each additional laborer, the probability of the respondent's demand for WII increased by 8.8%. Intuitively, more laborers in the household will earn more income, which improves the household's financial situation and makes WII products more affordable.

Other variables in Model (1) had either a positive or negative estimate, but they were statistically insignificant. For example, the estimated coefficient of *Age* was positive but insignificant, as was its marginal effect. This indicates that older respondents are more likely to prefer WII than younger ones, but this difference is not significant, in line with the finding of Maganga et al. (2021). *Edu* had a positive estimate, which is expected because it is assumed that, if a respondent has a high education level, they will be able to understand the advantages of WII in coping with the impact of climate change and, accordingly, have a high demand for WII. However, our survey experience shows that respondents' knowledge is still constrained due to the complexity of WII products.

The household size decreased the probability of demand for WII, but its effect was statistically insignificant (Liu et al. 2019). With more people, especially more dependents like children, in a household, household spending is higher, which leaves fewer savings to purchase WII.

The estimate of *FarmSize* was positive but statistically insignificant, suggesting that respondents' preferences for WII are not closely related to their farm area (Budhathoki et al. 2019). A similar result was found for the household's total income. We assume that high-income respondents are in a good financial situation and, therefore, may be motivated to purchase WII products. On the other hand, richer farmers may have other investment opportunities to protect farming losses instead of purchasing insurance, leading to an insignificant regression estimate on *TotalIncome*.

As for risk aversion,[12] our result presents an insignificant negative effect, indicating that a respondent who is highly risk-averse is less likely to purchase WII (Hill et al. 2013). In contrast, Jin et al. (2016) showed that risk aversion has a positive impact on respondents' preference for WII, while Tang et al. (2021) documented that farmers' risk preferences display different effects in two provinces in China. In summary, the literature has not reached a conclusive result regarding how farmer respondents' risk attitudes influence their demand for WII products.

Turning to Model (2), we found that the estimate on *MaritalStatus* was still positive and became significant at the 5% level. The probability of demand for WII increased by 23.3% if a farmer respondent was married. If *TotalLabor* is separated into *FarmLabor* and

OffFarmLabor, the estimates on the two components are positive, but the estimate is only significant for *OffFarmLabor*. This demonstrates that, although the majority of the household laborers work on the farms, off-farm laborers play an important role in farmers' preferences for WII. With more laborers working outside the farm, the households may be in a better financial situation, which, in turn, supports their farming work (Hossain et al. 2022).

For the two components of total income, *FarmIncome* and *OffFarmIncome*, their effects on respondents' preference for WII were positive but statistically insignificant. Regarding all other variables, their estimates had the same signs and retained insignificance as shown in Model (1).

5.2. Subsamples

In this section, we examined the gender difference in the willingness to purchase WII products. Table 3 presents the results of Model (2) for male and female sub-groups. We focused on explaining the significant estimates. Similar to the results for the full sample, the estimate on *MaritalStatus* for the male sample was positive and statistically significant at the 10% level. If the household head was male, being married increased the probability of demand for WII by 72.6%. However, *MaritalStatus* was insignificant for female respondents. We propose that married male farmers are more cautious. To support their family's needs, they are more likely to use insurance to ensure a certain level of income.

Table 3. Regression results of the binary logistic model for the male and female subsamples.

Variable	Male		Female	
	Coefficient	**Marginal Effect**	**Coefficient**	**Marginal Effect**
Age	0.004	0.001	0.020	0.004
	(0.025)	(0.005)	(0.036)	(0.007)
MaritalStatus	3.978 *	0.726 *	1.071	0.202
	(2.286)	(0.390)	(0.743)	(0.132)
Edu	−0.001	−0.000	0.265 *	0.050 **
	(0.116)	(0.021)	(0.130)	(0.022)
Adult	−0.089	−0.016	−0.078	−0.015
	(0.289)	(0.053)	(0.290)	(0.055)
Child	0.039	0.007	−0.547	−0.103
	(0.249)	(0.045)	(0.300)	(0.051)
FarmLabor	0.040	0.007	0.307	0.058
	(0.327)	(0.060)	(0.386)	(0.072)
OffFarmLabor	2.015 **	0.368 ***	0.003	0.001
	(0.885)	(0.144)	(0.470)	(0.089)
FarmSize	0.019	0.004	−0.046	−0.009
	(0.110)	(0.020)	(0.181)	(0.034)
log(FarmIncome)	0.329	0.000	0.225	0.000
	(0.460)	(0.000)	(0.480)	(0.000)
log(1 + OffFarmIncome)	0.039	0.000	0.056	0.000
	(0.037)	(0.000)	(0.042)	(0.000)
RiskAverse	−0.197	−0.036	−0.140	−0.026
	(0.116)	(0.020)	(0.141)	(0.026)
Constant	−8.504		−5.864	
	(8.369)		(7.419)	
Observations	81		62	
Log Likelihood	−43.204		−34.575	
Akaike Inf. Crit.	110.407		93.149	
Pseudo R2	0.162		0.186	

Numbers in parentheses are standard errors. ***, **, and * indicate a significance level of 1%, 5%, and 10%, respectively.

Education is an important factor in influencing the decision to purchase WII, which was only found for female respondents, not for males. Our result shows that each additional year of education increased the probability of demand for WII by 5.0%, consistent with the

results of Jin et al. (2015). Akter et al. (2016) also reported that a lower level of education constrains female farmers' willingness to purchase WII. We argue that female farmers highly value education. When they have sufficient knowledge and good financial literacy skills, they are willing to use innovative financial products to protect themselves from the impact of climate change.

The effect of off-farm labor remained positive and significant in the male sample but not in the female sample. An additional off-farm laborer was associated with a probability increase in WII demand by 36.8%, indicating that off-farm labor is more valued by male farmers.

Other variables were generally insignificant in both the full sample and subsamples. However, the variables of *Child* and *FarmSize* displayed further gender differences. The number of children had a positive effect on the demand for WII for male respondents but a negative effect for female respondents. Female farmers may strongly consider that a large household will need more spending on children's education and other activities, discouraging them from purchasing WII products. Furthermore, male and female respondents have different perspectives on how important their farm area is in their decision to purchase WII. Male farmers with larger farm areas are more likely to purchase WII, while female farmers with the same are less likely to do so. Equivalently, Jin et al. (2015) found a significant effect of farm size on male farmers' willingness to purchase WII but an insignificant effect on female farmers' decisions.

6. Conclusions

This study investigates Cambodian rice and cassava farmers' willingness to participate in a WII scheme. The survey results show that most farmers were in their 50s, had limited education, and had no previous insurance experience. In addition, the concept of WII is still novel in Cambodia, so farmers' understanding is significantly constrained. Despite these constraints, some farmer respondents showed a willingness to purchase WII.

Our regression results demonstrate that the determinant factors that influence male and female farmers to purchase WII products are different. Marital status and off-farm laborers are important for male farmers in making their decisions to purchase WII. In contrast, with a higher level of education, female farmers are more likely to purchase WII to mitigate climatic impacts. This result is consistent with findings in prior studies that, for female farmers, lower education levels and poor financial literacy are barriers to their demand for WII.

Moreover, our study finds that farmers show a low level of confidence and trust in innovative insurance products and insurance companies. This may result from one of the inherent issues of WII: farmers who purchase WII products may not receive full compensation for their actual losses, as provided by an indemnity-based insurance solution. Additionally, the lack of an effective crop insurance model also discourages farmers from considering WII products.

Nevertheless, WII schemes potentially provide Cambodian smallholder farmers with an important risk management option to transfer climate risk. To promote the upscaling and sustainability of WII, governments, policymakers, and financial institutions need to work together to facilitate its implementation.

7. Limitations and Recommendations

This study has shed light on farmers' demand for innovative insurance products in tackling climate risk, but there are several limitations. For each limitation, we provide relevant recommendations. First, due to COVID-19, face-to-face data collection was constrained to a small number of areas. Future research should include more villages across different districts to further facilitate the generalizability of the results.

Second, some questions from the questionnaire could be improved using a more structured approach. For example, the farmers' risk preference (or risk aversion) would be

more accurately measured by a risk experiment design (e.g., Jin et al. 2016), which could help elicit a truthful risk attitude from the participants (Andersen et al. 2006).

Third, with limited insurance knowledge, especially for the innovative WII, farmers might not have been confident in expressing their ideas. To overcome this limitation, seminars or workshops should be available for farmers to improve their understanding of WII products, in collaboration with local communities or through other effective measures. Furthermore, insurance product designs should consider the significant differences between various customer groups and offer more flexibility.

Finally, while WII products are considered a potential risk management tool, the proposed scheme in Cambodia is still in the preliminary stage. Because WII is weather-parameter-based rather than yield-based, even if farmers have purchased the product, they are not eligible to claim their losses. The Cambodian government may need to establish a legal structure and provide relevant post-event support to those farmers. Such a measure could increase farmers' confidence in WII products by reducing their anxiety about significant losses. As a result, this would increase the uptake rate of WII and, ultimately, help farmers improve their resilience to climate change. In short, by pursuing and addressing relevant limitations, future research work can provide a more comprehensive understanding of farmers' demand for WII.

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Notes

1 https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=KH, (accessed on 18 May 2023).

2 https://databank.worldbank.org/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd=y&inf=n&zm=n&country=KHM, (accessed on 29 June 2023).

3 https://ncsd.moe.gov.kh/dcc/climate-finance, (accessed on 29 June 2023).

4 https://unfccc.int/sites/default/files/NDC/2022-06/20201231_NDC_Update_Cambodia.pdf, (accessed on 29 June 2023).

5 https://policy.asiapacificenergy.org/sites/default/files/Cambodia%20Industrial%20Development%20Policy%202015%20%E2%80%93%202025%20%28EN%29.pdf, (accessed on 29 June 2023).

6 Basis risk is one kind of inherent issue of index insurance, arising when the index-related payout is imperfectly correlated with an insurance policyholder's actual losses (Dalhaus and Finger 2016).

7 Please note that the following source is in Khmer. The relevant information has been confirmed by our co-authors from Cambodia. https://server2.maff.gov.kh/parse/files/myAppId5hD7ypUYw61sTqML/24c7201c21b7eaee15ca8d11407a4a94_1503050715.pdf, (accessed on 29 June 2023).

8 Please note that the following source is in Khmer. The relevant information has been confirmed by our co-authors from Cambodia. https://docs.google.com/spreadsheets/d/1FMC2IKGrKSrcJwS0XytfeJ8N5YQdeNMc/edit?usp=drive_link&ouid=109516025988257489913&rtpof=true&sd=true, (accessed on 29 June 2023).

[9] In general, there are two ways to elicit the demand for WII. One way is directly asking farmers whether they are willing to purchase WII products or participate in the WII program. The binary logistic model is appropriate. The other way goes further: after farmers provide a certain answer regarding their willingness to purchase WII products, then the double-bounded method is usually used to ask farmers about the amount of premium they would like to pay. Our study uses the first way. It can be considered the first stage of the WII scheme in Cambodia. The double-bounded model will be examined in our future work.

[10] In the logistic regression model, a common problem is the independent variables' multicollinearity. Following the literature (Menard 2002; Jin et al. 2016; Maganga et al. 2021), we check this problem based on the variance inflation factor (VIF). Our results showed a maximum VIF value of 3, indicating no severe multicollinearity.

[11] Information about household heads' partners might be important in the WII scheme and should be collected in future work.

[12] In the survey process, a farmer respondent's risk attitude is ranked by his/her risk-taking capability (risk preference). The interview question asked farmer participants to rank their risk-taking from a score of 1 to 10. A lower number indicates a low level of risk-taking, i.e., more risk-averse. To easily interpret the results from the regression model, we measure risk aversion (i.e., *RiskAverse* variable) by using 10 minus the risk-taking rank, with a higher level of risk aversion having a higher number.

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