Risk mitigation of climate change impacts on rice farming through crop insurance: an analysis of farmer's willingness to participate (a case study in Karawang Regency, Indonesia)

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Abstract. Rice farming is still dominant in supplying food needs in Indonesia, so drought or flood will impact on food security. Rice farmers as the main actors are heavily impacted by climate change risks through the increasing difficulties of farming development. Therefore, there should be a protection program for farmers from the negative impacts of climate change. Agricultural insurance is one form of adaptation to the impact of climate change that is potentially developed in Indonesia and began to be initiated since 2015 by the Indonesian government through the policy, called Asuransi Usaha Tani Padi (AUTP) in Indonesian. This study aims to determine the factors that affect farmers' participation in the insurance program, by analyzing the farmer's willingness to pay (WTP) using logistic regression. Data were collected from Karawang Regency, West Java which contributes to the national rice demand of 865,000 tons per year. This study found that significant factors influencing farmer's decision to participate in the crop insurance program were farm size, land status, farmer's income, and expenditure, also the value of WTP Bid.

1. Introduction

The climate of the world is changing and has already disrupted in economic activities including in agricultural systems. Climate change such as extreme weather, unexpected temperature, and rainfall fluctuations force a number of significant risks to the agro-economy [1]. Farmers throughout history have been required to make decisions under uncertainty and different coping strategies for survival. Farmers do not have control over weather calamities, but there is a need to adapt and find ways to mitigate the damage caused by climatic change and other uncertainty in production to sustain agricultural productivity and attain food security in general. In this regard, crop insurance is one of the most important tool from a financial management perspective [2]. Kwadzo et al. [3] state that crop insurance is the most effective tool for farmer management that can be used in the current agricultural industry where the level of uncertainty is very high. Similarly, Hess [4] suggests that crop insurance can serve as an important alternative tool in risk management for rural farmers.

Agricultural insurance has widely applied in many countries in favor of the farmers and the poor people. Over half of the world's countries have implemented some form of agricultural insurance. For instance, the United States and Japan have been carrying out crop insurance since 1938, with the United

States applying agricultural insurance reforms in 1994. South Korea began to administer crop insurance from 2001. China restored agricultural insurance in the 1980s and a made strong efforts to push agricultural insurance schemes and create pilot insurances in 2004 [5].

Risks in rice farming perpetuate poverty and insecurity. Risks faced by rice farmers in Indonesia are both natural as well as due to human activity. Harvest failure due to flood, drought, and pests and diseases infestations are common in several parts of Indonesia. The increasing frequency of harvest failures and yield loses in important rice-producing areas urgently need rice policy response. In this context, crop insurance would be a strategic policy response to the current food production scenario. This is one of the financial instrument to transfer farmer's production risks, associated with farming, to a third party (a private company or government institution) through a certain amount of premium payment. It is very important to help small farmers to avoid crop loss and ensure their minimum working capital for the next planting season [6].

In Indonesia, the issuance of the law number 19/2013 on Farmer's Protection and Empowerment should allow the implementation of agricultural insurance with all related activities. In particular, article 37 of the law clearly mentioned the obligation of central and local government to protect farmers against harvest failure in the form of agriculture insurance. This obligation should specifically facilitate (a) registration to participate in the insurance program; (b) access to the insurance company; (c) socialization on insurance program; and (d) premiums payment. The law stated that all aspect related to the execution of the agriculture insurance scheme should be incorporated into a minister of agriculture decrees and regulations. Following this law, the rice crop insurance program has been prepared and conducted in 2015 planting season nationally. This scheme was implemented with the support of the ministry of agriculture budget, provide 80% of the premium rate.

One of the indicators used by the government to measure the success of this program is that farmers pay 20 percent of self-insurance premium so that farmers are expected to get insurance protection if they fail to harvest and get compensation as the next working capital of rice farming. In the implementation, the insurance program has not run optimally. This is reflected in the achievements of the existing program. From the target area of 1 million hectares in 2015, until December, the realization of insured rice fields in the AUTP program only reached ± 23% or 233,499.55 ha. Likewise in 2016, with the same target, until the end of December, the achievement of the program only covers the rice fields 499,961, 95 ha or 49.9%. The lack of the program realization is claimed due to the low interest of farmers to pay the self-supporting premium because the socialization is not optimal. With these conditions then this paper aims to analyze the factors that affect the participation of farmers to follow the crop insurance program.

2. Methodology

This research is descriptive research method with a quantitative approach. The research was conducted in a cross-sectional design because, in terms of time, this study was observed only once at a certain time. While research technique used is the survey method, which takes a sample from a population by using the questionnaire as a tool to collect data [7]. The research was conducted to identify the factors affecting the farmer's willingness to pay of premium crop insurance. Determining the location of the study was done purposively, namely at Karawang regency, West Java. Selection of this location based on the consideration that Karawang regency is a rice barn area of West Java and one of the regions that contribute to the national rice needs.

2.1 Sample

Sampling was done by multistage random sampling method. The first stage with stratified random sampling on captured 30 subdistricts was chosen two subdistricts namely Tempuran and Ciampel with the consideration that they had the largest and the lowest rice fields. The second phase is selecting the subdistrict villages, Kutapohaci village at Ciampel Subdistrict was selected because it has the largest rice field among other villages, about 288 ha or 80% of the total rice field. Lemah Karya at Tempuran

has selected for the simple reason that the village experienced a crop failure in 2017 due to a pest attack. Using Slovin formula, samples that will be taken in this research as much as 100 farmer households.

2.2 Data analysis

In this study, the choice is dichotomous related to whether the respondent is willing to pay for crop insurance or not. The decision problem was modeled using a Logit discrete binary regression model. The model specifies binary response function in which the dependent variable is a dummy variable being dichotomous in nature. According to Schmidt in Firdaus [8], logistic regression analysis or known as logit is part of regression analysis. This analysis examines the relationship of the explanatory variables (x) of the response variable (y) through certain mathematical equation models. If the response variable is a variable with numerical data, it can be analyzed with an ordinary least squares method, but in some circumstances, the response variable may be a categorical variable or dichotomous. If the Y variable is a categorical variable then it can be analyzed with logistic regression analysis. Logistic regression does not assume the relationship between independent and dependent variables linearly but non-linearly, so it does not require classical assumptions as in the linear regression. Independent variables include gender, marital status, age, education level, income, land area, while the dependent variable is the willingness to pay or not. The regression equation is expressed in the form:

$$Log(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots\ldots\beta_3 Xk + \mu i \quad (1)$$

Where

Log (Y) : respondent's willingness opportunity to pay the insurance premi (worth 1 if 'yes' and 0 if 'no')
β0 : intersep
β1 ..... βk : Regression coefficient
X1 ..... Xk : Variable observed
μ : variable not observed
i : respondent i (i = 1,2, ..., n)

A positive estimated coefficient implies an increase in the likelihood that a respondent will be an adopter of or willing to pay for crop insurance with a unit increase in the concerned explanatory variable. The detailed specifications of explanatory variables included in the model are presented in Table 1.

Table 1. Variables considered in the study

Variables	Description	Measurement
Age	Age of household head	Number of years
Gender	gender of household head	Male
		Female
Marital status	Marital status of household head	Single
		Married
		Widow/widower
		Not attending school
Edu	The education level of household head	Primary
		Middle
		High school
		Graduation and above
Dependt	Number of dependents in household	Numbers
Land size	Size of landholding of household	Hectares (ha)
Land status	Status of landholding of household	Owner
		Rent
Farmexp	farming experience	Number of years
Inscouns	Participation in insurance counseling	No
		Yes

Grfaminc	Gross monthly family income	Rp
Bidwtp	Nominal WTP	Numbers
Grfamexp	Gross monthly family expenditure	Rp
Finsource	Source of farming financing	Borrow Not borrow

3. Result and discussion

The findings of this study are presented below. Socio-economic characteristics of respondents Table 2 shows that the highest proportion of farmers belonged to the middle age group and the mean age was 49.88 years. Majority of the farmers are male. The main marital status of the vast majority of the respondents was married. The educational level among farmers showed nearly an equal number of respondents were middle school and high school level of education. Most of the farmers had marginal land below 5000-meter squares, only 6 % of respondents' had land holding above 5000-meter squares. The mean land holding was 1.360 meters squares. The average farming experience was 26,34 years.

Table 2. Characteristics of the farmers

No.	Characteristics	Categories	Number of respondents (100)
1.	Age (years)	21-40	16 (16)
		41–56	67 (67)
		>56	17 (17)
		Average score	49.88
2.	Marital status	Single	7 (7)
		Married	80 (80)
		Widow/widower	13(13)
3.	Gender	Male	73 (73)
		Female	27 (27)
4.	Education	Not school;	3 (3)
		Primary	40 (40)
		Middle	26 (26)
		High school	23 (23)
		Graduate and above above	8 (8)
5.	Number of dependents	0-2	10 (10)
		3-5	82 (82)
		6-8	8 (8)
6.	Land size (hectares)	marginal (< 0.25)	70 (370)
		small (0.25 – 0.49)	24 (24)
		medium (0.5–0.99)	6 (6)
7.	Farming experience (years)	0-20	29 (29)
		21–40	61 (61)
		41–60	10 (10)

Figures in parentheses indicate the percentage

Forty-four percent of respondents were willing to pay the premium in this scheme, whereas, 56 % of respondents were not willing to purchase the insurance due to different reasons. Table 3 elicits the distribution of respondents according to their willingness to participate in the insurance scheme.

Table 3. Response to a willingness to pay the insurance premi

Pay the insurance premi	No of the respondent(%)
Yes	44
No	56
Total	100

The farmers who were not willing to participate in the scheme were asked about the possible reasons for not doing so. The reason elicited by the highest proportion of respondents was "not know about insurance program" (57 %), followed by "no need of insurance" (20 %), "the insurance scheme being too costly" (16 %; Table 4). Four percent of farmers said they had a problem in the claims settlement for their unwillingness.

Table 4. Reason for unwillingness to pay

Reason for unwillingness	No. of respondent	(%)
Not know about the insurances	32	57
No need of insurance	11	20
The insurance scheme is too costly	8	14
The problem in the claim settlement	3	5
Don't have enough money	2	3

The results of the Logit model fitted to identify the factors significantly influencing farmers' likelihood of willingness to pay for crop insurance are presented in Table 5. Five variables (land size, land status, gross income, gross expenditure, and nominal WTP) significantly affected the probability of willingness to pay. The estimated coefficients of significant variables were positive for land size, land status, gross income, and nominal WTP, implying that as these variables increase, the probability of willingness to pay also increases.

Table 5. Willingness to pay model results

Independent Variables	Coefficient (β)	Standard Error	Sig.	Exp(β)
Age	.398	.268	.137	1.490
Gender	-1.707	1.009	.091	.181
Marital status	-2.255	1.484	.129	.105
Edu	.264	.522	.613	1.302
Dependt	-.284	.436	.515	.753
Landsize	1.004	1.154	.038	.366
Landstatus	1.190	1.353	.038	3.288
Farmexp	.287	.279	.303	.750
Inscouns	27.646	4450.139	.995	1.015
Grfaminc	7.344	2.242	.007	1.000
Bid wtp	1.130	4.325	.009	1.000
Grfamexp	-1.523	2.126	.047	1.000
Finsource	-.850	1.018	.404	.427
Constant	-35.441	4450.145	.994	.000

Chi Square test = 90.611 (P=0.000); Cox & Snell R = 0.596; Nagelkerke R^2 = 0.798; Hosmer&lomeshow = 6.895; -2LL (α) = 137.186; -LL (all variables) = 46.575

In order to test the significance of OLS models using the F test, whereas at regression logistic uses the value of the Chi-Square. On SPSS output value of Chi-Square existed on the Omnibus test showed

the significance test model. the ability of the independent variable to explain the dependent variables simultaneously or simultaneous. If the sig value on the Omnibus test is less than adequate for the trust, then it can be said that independent variable can give real influence against the model. Based on the SPSS output the sig value obtained is 0.000. So it can be concluded that the model is significant at 5 percent confidence level.

The Negelkerke R-value in Table 4 describes the variable capabilities used by the model to explain the dependent variable. The value of Negelkerke R obtained is 0.798 or 79.8 percent. It shows that the independent variable in the model is able to explain the dependent variable of 79.8 percent. The other 20.2 percent explained by other variables outside the model.

Hosmer and Lemeshow test is a goodness of fit (GOF) test on the model. The test is a test that determines whether the model used is appropriate or not. The model is appropriate if the significance value obtained greater than the level of trust. The significance value obtained is 0.276. So it can be concluded that the model is significant at the 5 percent confidence level.

The results suggest that farm and farmer characteristics are more important determinants of farmers' willingness to participate, rather than institutional variables like insurance counseling and source of farming capital. Only enlarging the farm business scale as a policy variable which significantly influenced farmers' willingness to pay. This suggests that in order to stimulate demand for crop insurance products, it is necessary to: (1) increase the scale of farming, farmers with large land area are more likely to participate in insurance; (2) encourage farmers to have their own land, because farmers who have land are free to take insurance or not.

4. Conclusion

Having a good understanding of the relationship between climate change and agricultural production can help policy makers to better anticipate issues concerning food security. An interesting issue from the policy perspective is to identify and understand the determinants of farmers' adaptation capability, as that knowledge can support the design of effective adaptation policies. To protect rice farmers from losses due to climate change, the Indonesian government issued a crop insurance policy. This paper aims to analyze the factors that affect the participation of farmers to follow the crop insurance program. Logit discrete binary regression model showed that farmers with larger farm size were more willing to participate in the insurance scheme. The estimated coefficients of land holding size and dairy farming experience were positive, implying that the probability of willingness to pay also increases among the paddy farmers. The farm and farmer characteristics are more important determinants of farmers' willingness to pay for crop insurance.

Most modern risk avoidance measures are not readily available in developing countries. Hence, farmers in these regions are obliged to adopt traditional informal mechanisms for coping with risk. Provision of insurance could be an effective strategy for the farmers in the developing world to mitigate risk and reduce their vulnerability to shocks. The crop insurance scheme in Indonesia is applicable only to paddy farmers with maximum land size 2 ha. Also, the subsidy is restricted to 80% of the insurance premium. As such, the poor cannot afford to pay insurance premiums lump sum through the insurance premium is subsidized. At present, the numbers of paddy farmland insured are very low, in spite of a large population of paddy farmland. The reasons observed are several that include lack of awareness, literacy problem, affordability, lack of delivery channels that provide access at the doorsteps, the problem in claims settlements, etc. from the viewpoints of farmers and the high cost of transaction and service from the viewpoints of the insurance industry. The low level of education of many dairy farmers in the study area had negatively influenced the decision to purchase crop insurance.

To increase the farmers' participation in insurance, policymakers and insurers should design a program to educate them about different sources of risk and risk management tools. Such schemes, though have laudable objectives, are not implemented effectively mainly due to lack of awareness among the beneficiaries. It is important that the farmers are made aware of the benefits of such schemes so that the farmers will be inclined to pay the required premium to ensure their farming. In order to make insurance scheme accessible, effective, and attractive to farmers, the existing crop insurance scheme

should be easier to process its claim. Other schemes, such as index base insurance can also be helpful in the Indonesian context. The Indonesian government should intensify its advertising efforts and inform farmers about insurance products, taking into account the farmers' farming level. Private insurance companies may also be encouraged to provide various crop insurance. The efforts made on economic empowerment of farmers might also improve adoption of crop insurance and farmers' WTP.

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