An Analysis on Perception to Climate Change of Rice Farmers in Haenam district, Korea

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Abstract

This study analyzes perception to climate change of rice farmers in Haenam district, Korea. A logit model and a probit model are used to examine the determinants of perception to climate change. The results indicate that rice farmers' perception of climate change appear to be high (83.6 percent). The findings indicate that age, education and access to climate information have a significant impact on perception to climate change. This study provides some appropriate policy program of information on climate change, education and training.

Key words：Climate Change, Perception, Rice Farmers, Logit Model, Probit Model

韓国ヘナム郡の米作農家における気候変動の認識に関する分析

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抄録

本研究では韓国ヘナム郡の米作農家における気候変動の認識に関して分析した。ロジットモデルとプロビットモデルを用いて、気候変動の認識の決定要素を検定した。結果として、米作農家の気候変動の認識は高いこと（83.6%）が示された。年齢については負の値であり、高齢者であるほど認識が少ない。つまり若年層が強く気候変動を認識していた。教育については正の値であり、高学歴であるほど強く気候変動を認識していた。そして気候情報の入手については正の値であり、情報アクセスを改善することによって、強く気候変動を認識させることができると分かった。本研究から気候変動情報、教育、訓練における適切な政策プログラムが提供される。

キーワード：気候変動、認識、米作農家、ロジットモデル、プロビットモデル

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Ⅰ. Introduction

Climate change is now widely recognized as the major environmental problem facing the globe. The average temperature in Korea has increased by 1.5℃ over the last 100 years because of global warming (National Institute of Meteorological Research, 2007).

Agriculture is extremely vulnerable to climate change. Climate change is expected to negatively affect agricultural production. Actually, the agricultural cultivation area has been extended northward, and the damage by blight and harmful insects during the winter has increased, resulting in the decrease in agricultural productivity (Kim et al., 2008).

In particular, rice is a main staple food and the most important product in Korean agriculture. Rice farm households account for 69.2 percent of Korean farm households in 2009 (Ministry for Food, Agriculture, Forestry and Fisheries, 2010). Rice also is affected by climate change (Yoo et al., 2007; Kwon et al., 2008; Kim et al., 2009).

It is necessary to examine farmers' perception to climate change in order to cope with climate change in farm-level. Also, it is necessary to analyze the determinants of perception to climate change. Farmers' perception to climate change is affected by many socioeconomic and environmental factors. The knowledge of these socioeconomic and environmental factors assists policy to strengthen countermeasures for climate change through investing on these factors (Temesgen T. Deressa et al., 2009).

Recent literature on the analysis of farmers' perception to climate change include Glwadys Aymone Gbetibouo (2009), Temesgen Tadesse Deressa et al. (2009), David Maddison (2007), Charles Nhemachena et al. (2007), Elizabeth Bryan et al. (2009), Rashid Hassan et al. (2008), Kim et al. (2008), and Kim et al. (2009). Glwadys Aymone Gbetibouo (2009) finds that farmers in the Limpopo river basin of South Africa are able to recognize that temperatures have increased and there has been a reduction in the volume of rainfall. Farmers with access to extension services are likely to perceive changes in the climate. Having access to water for irrigation increases the resilience of farmers to climate variability. With more experience, farmers are more likely to perceive change in temperature.

In Korean Studies, Kim et al. (2008) indicate that the farmers have generally recognized climate change for 5 years and have seriously worried about its negative impacts. Also, Kim et al. (2009) find that farmers' awareness of climate change appeared to be high (about 75.4 percent). These studies in Korea present an important limitation since there are no studies on determinants of perception to climate change of farmers in Korea.

Therefore, the purpose of this study is to analyze the determinants affecting perception to climate change of rice farmers in Haenam district, Korea. A logit model and a probit model are used to examine the determinants of perception to climate change.

The remainder of the paper is structured as follows. Section 2 discusses how data was collected from rice farmers in Haenam district, Korea. Section 3 presents the model setup and describes dependent variable and explanatory variables. Section 4 presents the empirical results. Section 5 concludes with a summary of results and policy implications.

Ⅱ. Data

A questionnaire developed in this study is based on the review of studies on farmers' perception to climate change (Glwadys Aymone Gbetibouo, 2009; Temesgen Tadesse Deressa et al., 2009; Kim et al., 2008; Kim et al., 2009). The questionnaire includes questions on farmers' perception to climate change and farmers' socioeconomic characteristics.

The data for this study was collected from rice farmers in Haenam district, Korea. The survey was carried out with collaboration from the Korea Rice Pro-farmer Federation. Farm-level data was collected from 202 farm households in Haenam district for about two months between October and December 2010. Any incomplete questionnaires were discarded. Out of 202 samples, a total of 189 questionnaires were usable.

The study area, Haenam district has two characteristics. First, Haenam district is one of the largest cultivated areas of paddy rice in Korea. According to the Statistics Korea (2010), Gimje district has the largest cultivated area of paddy rice in Korea, next to Haenam district. Also, the cultivated area of paddy rice in Haenam district in 2010 increased by 8.2 percent compared to 2009. In other words, Haenam district has the highest rate of increase among cultivated areas of paddy rice in Korea. Thus, Haenam district is a typical rice farming region.

Second, there is a flux tower in Haenam district, enrolled in KoFlux. It is located in the middle of farmland (34° 33'N, 126° 34'E). And it has observed the concentration of carbon dioxide in the atmosphere.

Summary statistics of rice farmers' socioeconomic characteristics are given in Table 2. The average age of respondents is 55.5 years. Out of 189 respondents, 9.0 percent are elementary graduates and lower, 41.3 percent are middle school graduates, 39.7 percent are high school graduates and 10.1 percent are college graduates and higher. The average cultivated area of paddy rice is 5.2 hectares. Most of the respondents (77.8 percent) don't have farming successors and 22.2 percent have farming successors. With regard to yearly farm household income, 8.5 percent are under 9.99 million won, 20.6 percent are 10 million won ～ 19.99 million won, 21.7 percent are 20 million won ～ 29.99 million won, 18.5 percent are 30 million won ～ 39.99 million won, 14.8 percent are 40 million won ～ 49.99 million won and 15.9 percent are above 50 million won. The average number of

Table 1. Cultivated area of paddy rice in Korea (2010)

(Unit : Hectare, Percent)

	2009 (A)	2010 (B)	Variation (B－A)	Variation (%)
Gimje district	22,811	22,421	－390	－1.7
Haenam district	20,547	22,223	1,676	8.2
Seosan district	21,012	20,899	－113	－0.5
Dangjin district	21,294	20,883	－411	－1.9
Iksan district	19,299	18,303	－996	－5.2

Source : Statistics Korea (2010)

Table 2. Summary statistics of rice farmers' socioeconomic characteristics

Variables	Minimum Value	Maximum Value	Mean	Standard Deviation
Age (Year)	30	75	55.5	8.9
Education*	1	4	2.5	0.8
Area (hectare)	0.3	29.8	5.2	5.0
Existence of farming successors (No=0, Yes=1)	0	1	0.2	0.4
Farm household income**	1	6	3.6	1.6
Number of farmer organizations (number)	0	10	2.1	1.4
Access to climate information (low=1, medium=2, high=3)	1	3	2.0	0.6

* Elementary grad. and lower =1, Middle school grad.=2, High school grad.=3, College grad. and higher =4
** Under 9.99 mil.won = 1; 10 mil.won～19.99 mil.won = 2;
20 mil.won～29.99 mil.won = 3; 30 mil.won～39.99 mil.won = 4;
40 mil.won～49.99 mil.won = 5; Above 50 mi1.won＝6

Table 3. Farmers' perception of climate change

(Unit: Persons, Percent)

	Number of respondents	Percent of respondents
Yes	158	83.6
No	31	16.4
Total	189	100.0

farmer organizations are 2.1 number. With regard to access to climate information through television, 16.9 percent are high, 63.5 percent are medium, 19.6 percent are low.

Rice farmers' perception of climate change is presented in Table 3. Most of the respondents (83.6 percent) have perceived climate change and 16.4 percent have not perceived climate change. Therefore, rice farmers' perception of climate change appears to be high.

Ⅲ. Model

1. Model setup

To analyze the determinants affecting perception to climate change of rice farmers, we set up the model as follows:

$$y_i^* = x_i \beta + \varepsilon_i \quad \text{Equation (1)}$$

Where y_i^* is the latent variable indicating whether or not a rice farmer perceives climate change, x_i denotes the set of explanatory variables indicating the factors which affect perception to climate change of the rice farmer, ε_i is the error term.

we can denote equation (1) as follows using the observed dummy variable, y_i^*. Equation (2) defines the binary outcome. The dependent variable is a dummy variable equal to 1 if the rice farmer perceives climate change and 0 otherwise.

$y_i = 1$ (perceived) if $y_i^* > 0$
$y_i = 0$ (didn't perceive) if $y_i^* \leq 0$ Equation (2)

Analysis of this dependent variable requires a binary response model. Two options for this analysis are the logit and probit models. The main difference between the logit and probit models lies in the assumption of the distribution of the error term, ε_i. The error term is assumed to have the standard logistic distribution in the case of the logit model, and the standard normal distribution in the case of

Table 4. Description on model variables

Variables		Description
Dependent variable	Perception to climate change of rice farmers	Perceived: y_i=1 Did not perceive: y_i=0
Explanatory variables	Age	Age of respondent (year)
	Education	Education level (Elementary grad. and lower =1, Middle school grad.=2, High school grad.=3 College grad. and higher=4)
	Area	Cultivated area of paddy rice (hectare)
	Existence of farming successors	Question about whether or not rice farmer has farming successors in farming family (No=0, Yes=1)
	Farm household income	Yearly farm household income (Under 9.99 mil.won=1; 10 mil.won～19.99 mil.won=2; 20 mil.won～29.99 mil.won=3; 30 mil.won～39.99 mil.won=4; 40 mil.won～49.99 mil.won=5; Above 50 mil.won=6)
	Number of farmer organizations	Number of farmer organizations that rice farmer joined as a member (number)
	Access to climate information	Access to climate information through television (low=1, medium=2, high=3)

the probit model. Therefore, we adopt the logit and probit models. Appendix A provides detailed explanations about the logit and probit models.

2. Description on model variables

Description on dependent variable and explanatory variables are presented in Table 4.

The dependent variable for this study is binary, indicating whether or not a rice farmer perceives climate change (discussed above).

The explanatory variables for this study include: age, education, area, existence of farming successors, farm household income, number of farmer organizations, and access to climate information. Existence of farming successors is whether or not rice farmer has farming successors in farming family. Access to climate information is the question that rice farmer gets more climate information from television, compared to radio, newspaper, and others. "High" means that rice farmer gets more information from television than radio, newspaper, and others. If the proportion of television to radio, newspaper, and others equals, rice farmer answers "Medium". "Low" means that rice farmer gets less information from television than radio, newspaper, and others.

Ⅳ. Results

In this section, we present the empirical results. Results from the logit and probit models of determinants of perception to climate change are presented in Table 5.

The coefficient on age is significant and negatively related to perception to climate change in the logit and probit models. The age of the rice farmer has a negative and significant impact on their perception to climate change. This result implies that the younger farmers are more likely to perceive climate change.

The coefficient on education is significant and positively related to perception to climate change in the logit and probit models. Education of rice farmer has a positive and significant impact on perception to climate change. This result implies that the more educated farmers are more likely to perceive climate change.

The coefficient on access to climate information is significant and positively related to perception to climate change in the logit and probit models. Access to climate information of rice farmer has a positive and significant impact on perception to climate change. This result implies that rice farmers who have access to climate information through television have better chances to perceive change in climatic conditions. Therefore, improving access to climate information for rice farmers has the potential to significantly increase farmers' perception of changing climatic conditions.

In other words, the results indicate that age, education and access to climate information have a significant impact on perception to climate change.

Although Pseudo-R^2 is low (0.1470) in the logit and probit models, the results of this study is meaningful such as other studies. Other studies also show similar Pseudo-R^2. For example, Glwadys Aymone Gbetibouo (2009) examined the adaptation to climate change of farmers in Limpopo Basin. Results from the multinomial logit model in his study indicate that Pseudo-R^2 is 0.1320. Temesgen Tadesse Deressa et al. (2009) analyzed that determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. Results from the multinomial logit model in their study indicate that Pseudo-R^2 is 0.26.

The percent of farmers' perception of climate change is high in sample data used for this study. It should be noted that the kind of analytical results may differ slightly according to sampling method and sample size. In the future, we will try to carry out a new study for getting better study results considering these facts.

Ⅴ. Conclusions

It is necessary to examine farmers' perception to climate change in order to cope with climate change in farm-level with analysing the socioeconomic and environmental determinants of perception to climate change. The information and knowledge on these determinants assists policy to strengthen countermeasures for climate change through investing on them.

The purpose of this study is to analyze the determinants affecting perception to climate change of rice farmers in Haenam district, Korea using a logit model and a probit model.

The major findings of this study are summarized as follows. First, rice farmers' perception of climate change appears to be high. The results indicate that most of the rice farmers (83.6 percent) have perceived

Table 5. Results of determinants of perception to climate change

Variables	Logit Model		Probit Model	
	Coefficient	t-value	Coefficient	t-value
Age	−0.06675	−1.99**	−0.035634	−1.93*
Education	0.5510447	1.77*	0.3045489	1.76*
Area	−0.064495	−1.13	−0.034577	−1.08
Existence of farming successors	0.1785963	0.31	0.1521889	0.47
Farm household income	0.2518781	1.30	0.1427314	1.35
Number of farmer organizations	−0.026547	−0.15	−0.01325	−0.14
Access to climate information	0.8315903	2.06**	0.4417632	1.96**
Constant	2.211568	0.89	1.20118	0.86
Number of observations	189		189	
Log likelihood	−70.542525		−70.543731	
Pseudo−R^2	0.1470		0.1470	

Note: ***, **, and * indicate significance at the 1%, 5% and 10% level.

climate change. Second, the farmers' age, education and access to climate information have a significant impact on their perception to climate change.

This study provides several policy implications for countermeasures to climate change in the agricultural sector. First, policies need to emphasize the crucial role of information on climate change. Farmers who have access to climate information will have better chances to perceive change in climatic conditions. Reliable and prompt information on climate will help farmers to perceive climate change. Examples of these policy measures include improved access to climate change through television and climate information forecasting et al. In particular, television is an easily approachable broadcast medium to farmers. Second, proper education and training programs about climate change should be developed for the farmers. Third, cooperation of agencies concerned is necessarily required so as to cope with climate change effectively. The agencies concerned include government, farmers, academic professionals and the press.

Although rice farmers' perception of climate change appears to be high（83.6 percent）in the results, this study has several significance. First, Haenam district we surveyed is one of the largest cultivated areas of paddy rice in Korea. Thus, it is important to know rice farmers' perception of climate change in the area. Second, it is significant to know rice farmers' socioeconomic characteristics greatly affecting perception to climate change. Third, the farmers is usually behind citizens on informationization and the farming population is aging in Korea. But the results show that rice farmers' perception of climate change is higher than we expected.

Future studies concerned will have to analyze responsive adaptation to climate change as well as perception to climate change of farmers at the same time. Perception to climate change of farmers must lead to adaptation to climate change of farmers eventually.

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Appendix A : The logit and probit models

A categorical variable refers to a variable that is binary, ordinal, or nominal. In categorical dependent variable models, dependent variable is neither interval nor ratio, but rather categorical. Binary responses (0 or 1) are modeled with binary logit and probit regressions. Independent variables are interval, ratio, and/or binary (dummy).

Categorical dependent variable models adopt the maximum likelihood estimation method. The maximum likelihood method requires an assumption about probability distribution functions. Logit model uses the standard logistic probability distribution, while probit model assumes the standard normal distribution.

The main difference between the logit and probit models lies in the assumption of the distribution of errors (disturbances). In the logit model, errors are assumed to follow the standard logistic distribution with mean 0 and variance $\frac{\pi^2}{3}$, $\lambda(\varepsilon)=\frac{e^{\varepsilon}}{(1+e^{\varepsilon})^2}$. The errors of the probit model are assumed to follow the standard normal distribution, $\Phi(\varepsilon)=\frac{1}{\sqrt{2\pi}}e^{\frac{\varepsilon^2}{2}}$ with variance 1.

The probability density function (PDF) of the standard normal probability distribution has a higher peak and thinner tails than the standard logistic probability distribution (Figure 1). The standard logistic distribution looks as if someone has weighed down the peak of the standard normal distribution and strained its tails. As a result, the cumulative density function (CDF) of the standard normal distribution is steeper in the middle than the CDF of the standard logistic

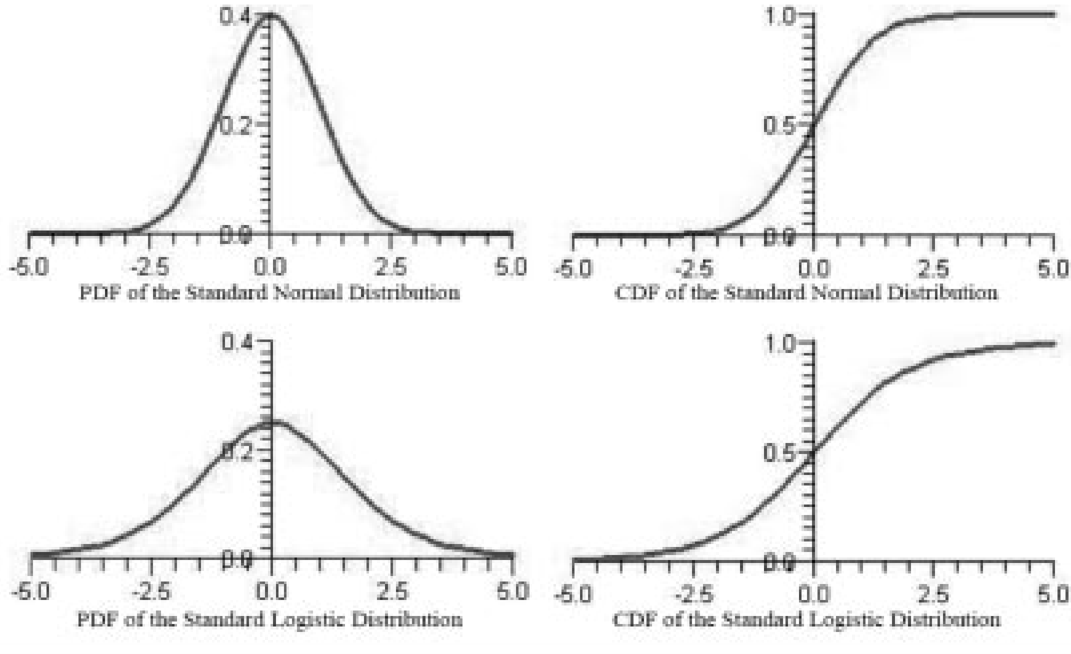

Figure 1. The Standard Normal and Standard Logistic Probability Distributions

Source：Park（2010）

distribution and quickly approaches zero on the left and one on the right.

The two models produce different parameter estimates. In binary response models, the estimates of a logit model are roughly $\pi/\sqrt{3}$ times larger than those of the probit model. These estimators, however, end up with almost the same standardized impacts of independent variables（Long 1997）.

The choice between logit and probit models is more closely related to estimation and familiarity than to theoretical or interpretive aspects. In general, logit models reach convergence fairly well. Although some（multinomial） probit models may take a long time to reach convergence, a probit model works well for bivariate models. As computing power improves and new algorithms are developed, importance of this issue is diminishing（Park, 2010）.