Does the Farmer Field Schools Program Improve Farmers' Behavior to Adopt the Drought-tolerant Rice Varieties in Pangasinan, the Philippines?*

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Keywords

The Farmer Field Schools program, Adoption of Drought-tolerant Rice Varieties, Ordered Probit, Propensity Score Matching, Average Treatment Effect on the Treated, the Philippines

Abstract

This study finds out factors affecting farmers' adoption of the drought-tolerant rice varieties in Pangasinan, the Philippines, and measures the effects of the Farmer Field Schools (FFS) program on the adoption through the propensity score matching method. The results show that participants of FFS are more likely to adopt the drought-tolerant rice varieties by 9.9% compared to the non-participants from ordered probit models, and the average treatment effect on the treated is 19.0% through the propensity score matching. It also demonstrates that the FFS with the Local Farmer Technician system is effective in improving farmers' adoption of the newly introduced varieties in the survey area.

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1. Introduction

In the Philippines, the agriculture, fisheries, and forestry (AFF) sectors are pivotal in generating employment for about a third of the country's labor force, thereby reducing poverty and inequality for three-fourths of the poor who are in the rural areas (NEDA 2016). The agricultural sector, employing about 30 percent of the Filipino workforce, accounts for 11 percent of the gross domestic product in the Philippines (World Bank 2014). However, the contribution of AFF to the country's gross domestic product continued to decline in the past three years, showing an annual average GDP share of 10 percent from 2013 to 2015 (NEDA 2016).

In particular, crop subsector is pulling down the overall growth of the AFF sector in the Philippines; Its annual average gross value added (GVA) grew only by 0.2 percent from 2013 to 2015, compared to a one percent increase of AFF (NEDA 2016). The reason for the low and poor performance in crop subsector was typhoons and El Niño that adversely affected rice production as well as farmers' limited adoption of high-yielding varieties of commodities (NEDA 2016). In this regard, it is required to improve the agricultural productivity of the Philippines to cope with the increasing impacts of climate change and to drive overall economic development in the country. The crop production sector needs to be more productive and sustainable through farmers' adoption of climate-resilient and improved agricultural technologies.

The government of the Philippines has been making efforts to enhance the existing extension system through the engagement of a pool of professional extension workers, aiming for shortening the lag from the research and development (R&D) to farmers' adoption of agricultural technology. As prioritized areas for strengthening the extension system in the crop production sector, the government targets using certified seeds and quality planting materials, especially high-yielding and stress-tolerant rice varieties to drought and flood events (Cho 2017).

As part of the efforts for enhancing farmers' access to agricultural technology and education, the Department of Agriculture (DoA) has been operating Farmer Field Schools (FFS) in the rural areas of the Philippines, in cooperation with the Philippine Rice Research Institute (PhilRice) and local governmental units. Developed by the Food and Agriculture Organization (FAO) of the United Nations, FFS is a group-based learning process that has been used by several governments, NGOs, and international agencies, aiming at disseminating improved farming methods to farmers in developing countries (Cho 2017). FFS training is based on experimental learning: farmers learn agricultural practices in demonstration farms, visiting other farmers, and experimenting with their plots (Masset & Haddad 2015). By taking into account that a substantial number of small farmers have limited access to agricultural information and extension services in the Philippines, it is crucial to design and establish a suitable type of extension system. Also, it is essential to measure the effects of FFS on farmers' adoption of agricultural technology.

The FFS should, however, be closely linked with the efficient monitoring and evaluation systems for enhancing accountability as well as the likelihood of timely and adequate service delivery (Masset & Haddad 2015). By considering the importance of monitoring the effects of FFS, this paper tries to identify factors affecting farmers' willingness to adopt the drought-tolerant rice varieties introduced by the Consortium for Unfavorable Rice Environment (CURE) project in Pangasinan, the Philippines, by using ordered probit model (Cho 2017). Also, this study tries to measure the impact of FFS on the adoption to identify whether it has been operating as a proper extension tool in the region by using a propensity score matching method. This paper consists of the following four sections. First, farmers' agricultural technology adoption will be discussed. Second, the project activities of CURE project and the agricultural extension services in the survey area will be explained. Third, the econometric model, as well as data collection and sampling method, will be specified. Lastly, this paper will show estimation results and draw implications for activating farmers' use of drought-tolerant rice varieties and providing agricultural extension services to the farmers in the survey area in an effective way.

2. Farmers' Technology Adoption in Agriculture

Farmers' adoption of agricultural technology has been a critical issue in many developing countries. Despite the advantages of the adoption, why has the adoption rate been low? Conceptual models employed for explaining the decision of small farmers to adopt new technology are classified into three groups: 1) the innovation-diffusion model; 2) the economic constraints model, and; 3) the technology characteristics-user's context model (Negatu & Parikh 1999). According to the innovation-diffusion model used by Rogers (2010), technology is transferred from its research system to final users through extension system, and its diffusion mostly on the individual characteristics of the potential users (Negatu & Parikh 1999). The economic constraints model, also known as factor endowment model, explains the distribution of resource endowments among the potential users and the pattern of adoption of technological innovation, by emphasizing well-functioning markets and the importance of price policies (Hayami & Ruttan 1971). The technology characteristics-user's context model assumes that characteristics of a technology underlying user's agro-ecological, socioeconomic and institutional contexts play the central role in the adoption decisions and diffusion process (Biggs 1990; Thompson & Scoones 1994).

The innovation-diffusion model highlights the research and extension system for the expansion of agricultural technology, pointing out that agricultural extension services facilitate farmers' adoption of agricultural technology. Experience may enhance farming knowledge about his or her particular farm. At the same time, education may make farmers cope with the information provided by different sources more efficiently, and may enhance both the allocative and technical efficiency (Jamison & Lau 1982). Moreover, farmers within a group learn from each other how to grow new crop varieties (Conley & Udry 2000). The underlying motivation behind the effect of social learning on adoption decision is that a farmer in a village observes the behavior of neighboring farmers, including their experiment with new technology. Once a year's harvest is over, the farmer then updates his priors concerning the technology, which may increase his probability of adopting the new technology in the subsequent year (Uaiene, Arndt, & Masters 2009). For example, farmers with experienced neighbors are significantly more profitable than those with inexperienced neighbors (Foster & Rosenzweig 1995).

When it comes to the economic constraints model, the distribution of resource endowments, including land, human, and asset resources, affects agricultural technology adoption among potential users. For instance, farm size leads to differential impacts on the adoption. Many empirical studies suggest that the use of high yield varieties (HYVs) and some modern variable inputs initially tend to lag on smaller farms. This implies that the incidence of adoption of HYVs is positively related to farm size (Hans P Binswanger 1978; Weil 1970). However, several studies argued that smaller farms that initially lag behind larger ones in adopting HYVs, but eventually catch up the larger ones (Schluter 1971).

Poorly functioning input and output markets reduce the profitability of technology (Cho 2017). The availability of complementary inputs is an essential factor in explaining adoption patterns. For example, HYVs will not be adopted by most farmers unless both seeds and some fertilizers are available (Feder, Just, & Zilberman 1985). Regarding access to output markets, problems with infrastructure and with supply chains, compounded by weak contracting environments, make it more costly for farmers to access input and output markets and access the benefits from technology adoption (Jack 2013).

The technology characteristics-user's context model assumes that characteristics of the technology underlying user's agro-ecological, socioeconomic, and institutional contexts influence their agricultural technology adoption (Cho 2017). The lack of tenure security, which may or may not requires formal titling arrangements, undermines incentives for long-term investment, including irrigation, fallowing, and planting tree crops (Ali, Deininger & Goldstein 2014). If a farmer lacks formal title, it means that he or she cannot use land as collateral to borrow, and cannot sell land to raise financing for investment in technologies (Jack 2013). According to the conventional wisdom, renters would be likely to be concerned about the short-term profitability of the land they rent, but less so about its long-term value. By contrast, owners-operators would be expected to care about both short-term profitability and the long-term value of their land (Ely & Wehrwein 1940).

Also, the need to undertake fixed investments may prevent small farms from adopting innovation quickly, resulting in differential rates of adoption between farmers (Feder et al., 1985). A study on the demand and access to fertilizer in Ethiopia based on the double-hurdle model highlighted the role of credit and subsidies (Croppenstedt, Demeke & Meschi 2003). Additionally, Deressa et al. (2009) showed that financial constraints are the main barriers to agricultural adaptation strategies in the Nile Basin of Ethiopia.

In other respects, several studies tried to focus on farmers' risk attitudes in explaining agricultural technology adoption. Efforts have been made to measure the risk preferences of farmers, assuming the expected utility theory (EUT) approach developed by Von Neumann and Morgenstern (1947). H. P. Binswanger (1980) used an experimental gambling approach with real payoffs to measure households' risk attitudes in rural India. And Feder (1980) provided crop decision models and explained the role of risk aversion and credit constraints in the production decisions of farmers who grow both modern and traditional crops.

On the contrary, several studies pointed out the limitations of the EUT approach and incorporated farmers' risk references, by suggesting the prospect theory developed by Kahneman and Tversky (1979). Tanaka, Camerer, and Nguyen (2016) expanded the measurement of risk and time preferences beyond the one-parameter expected utility model with the prospect theory. In most cases, however, adoption behavior differs across socioeconomic groups over time, and most of the empirical works on the role of subjective risk is not yet rigorous enough to allow validation or refutation of available theoretical work (Feder et al. 1985).

This study is distinctive on the following grounds. A substantial number of previous studies on farmers' agricultural technology adoption have been focusing on the final level of adoption, which is defined as a situation when the farmer has full information about the new technology and its potential (Feder et al. 1985). On the contrary, considering the fact that the drought-tolerant rice varieties explained in this paper are recently introduced in the survey area and that the farmers are not fully aware of the varietal function of the varieties, this study tries to suggest implications for facilitating farmers' technology adoption at the early stage of adoption. For this purpose, this study incorporated farmers who are willing to adopt the drought-tolerant rice varieties, by indicating them as potential adopters (Cho 2017). Also, measuring the impact of FFS with the propensity score matching method enables us to rigorously measure the effects of farmers' access to agricultural extension services by supplementing the issue of non-randomization in the sampling process on the participants of FFS and the non-participants of FFS.

3. CURE Project in Pangasinan, the Philippines

As a rain-fed low land area, Pangasinan is located in the west-central area of the island of Luzon in the Philippines (Figure 1).

Figure 1. Location of Pangasinan in the Philippines

Source: Statemaster Website (June 16, 2019)

With a population of about 2.9 million in 2015, Pangasinan consists of 44 municipalities, four cities, and 1,364 villages. Also, with a land area of about 537,000 hectares, about 44 percent of the total area of the region is used for agricultural production. Its principal crops include rice, mangoes, corn, and sugarcane. Rice is mainly cultivated in the wet season, and corn in the dry season in the region (PSA 2017).

Funded by the International Fund for Agricultural Development (IFAD), the CURE project supported the development of stress-tolerant rice varieties and best crop management techniques to cope with the increasing impacts of climate change in the following countries: Cambodia, Lao PDR, Indonesia, the Philippines, Thailand, Vietnam, and Myanmar. Between 2009 and 2013, the principal activity of the project in the first stage was to release new stress-tolerant rice varieties through on-farm trials at various stages of dissemination and adoption in drought, submergence, salinity, and upland ecosystem. (Cho 2017). At the second stage of the project between 2013 and 2018, the project mainly focused on identifying uptake and communication pathways for fast-track technology dissemination (IRRI 2015).

The baseline survey of the CURE project performed by the International Rice Research Institute (IRRI) in 2013 showed that drought was one of the major problems in rice farming, and it occurred in certain months of the year in the area. A majority of farmers in the province experienced drought mostly from February to April. Moreover, about half of the farmers depend on rainfall as a source of irrigation water and planting rice only during the wet season when rainfall is available. However, a majority of farmers employed several adaptation strategies after drought occurred, implying that most farmers have been responding to risks only when drought occurred. Also, farmers' limited access to agricultural information and extension services was one of the main issues raised during the project in the Philippines. Because farmers in drought-prone environments live far away from agricultural offices and markets, their access to information, new technologies, and key inputs, such as new rice varieties were much more limited than for those who live nearby (IRRI 2015).

Through the FFS, the Department of Agriculture (DoA) in the Philippines has been providing farmers with agricultural technology information including seedling rate, timing and the right amount of fertilizer, basics of rice production, use of organic and inorganic fertilizer, and integrated pest management (IPM). Recently, the DoA has been managing the Local Farmer Technician (LFT) system to solve the lack of extension workers. Consisted of farmers who had graduated from FFS, the LFTs receive agricultural technology education from the Agricultural Technology Institute (ATI) and provide the agricultural information to local farmers during the FFS. Furthermore, the DoA has been managing demonstration plots in cooperation with the LFT. The purpose of operating the demonstration plots is to disseminate newly developed crop varieties to local farmers, by reducing their risk attitudes on the varieties. The LFTs have been managing demonstration plots in the rural villages and receiving newly developed rice varieties from the DoA free of charge. The local farmers exchange or purchase the varieties with the LFTs if they are willing to plant the varieties. In our survey area, the LFTs system started in 2014, and two of the LFTs are working in each village at the time of the survey (Cho 2017).

Manaoag (Nalsian), Mapandan (Luyan), and Malasiqui (Pasima), which is the survey area of this study, were targeted as dissemination sites of the drought-tolerant rice varieties by the Philippine Rice Research Institute. Developed by the PhilRice and International Rice Research Institute (IRRI) for the CURE project, four types of the drought-tolerant rice varieties were distributed in the area as follows: National Seed Industry Council (NSIC) 280; NSIC Rc 282; NSIC Rc 346, and; NSIC Rc 348. In particular, the PhilRice distributed the drought-tolerant rice varieties to the LFTs in each village at the period of the FFS on Sustainable Rice Production in Rain-fed Areas in the wet season of 2016. At the time of the survey, the project was in the stage of dissemination and several farmers have exchanged or purchased the drought-tolerant rice varieties from the LFTs (Cho 2017).

4. Model

The ordered probit model is a generalization of the probit in the case of more than two ranked outcomes of an ordinal dependent variable. McKelvey and Zavoina (1975) used this model to identify ranked dependent variables. The maximum likelihood method enables us to get an asymptotically efficient estimator. The model begins as

$$y^* = \boldsymbol{X}'\boldsymbol{\beta} + \epsilon \tag{1}$$

y^* is unobserved. what we can observe is, y, and it can be written as

$$\begin{aligned} y &= 0 \text{ if } \quad y^* \le 0, \\ &= 1 \text{ if } 0 < y^* \le \mu_1, \\ &= 2 \text{ if } \mu_1 < y^* \le \mu_2, \\ &\cdots \\ &= J \text{ if } \mu_{J-1} < y^*. \end{aligned} \tag{2}$$

Farmers' willingness to adopt the drought-tolerant rice varieties (y) is determined by certain measurable factors ($\boldsymbol{X}$), including unobservable factors (ϵ) that is assumed to be generally distributed across observations and the mean and variance of are normalized to zero and one. The following probabilities are induced:

$$\begin{aligned} \Pr(y=0\,|\,X) &= \Phi(-\boldsymbol{X}'\boldsymbol{\beta}), \\ \Pr(y=1\,|\,X) &= \Phi(\mu_1 - \boldsymbol{X}'\boldsymbol{\beta}) - \Phi(-\boldsymbol{X}'\boldsymbol{\beta}), \\ \Pr(y=2\,|\,X) &= \Phi(\mu_2 - \boldsymbol{X}'\boldsymbol{\beta}) - \Phi(\mu_1 - \boldsymbol{X}'\boldsymbol{\beta}), \\ &\cdots \\ \Pr(y=J|X) &= 1 - \Phi(\mu_{J-1} - \boldsymbol{X}'\boldsymbol{\beta}). \end{aligned} \tag{3}$$

Φ is the cumulative normal distribution function. In the probit model, the sign of parameters β shows whether the latent variable (y^*) increases or decreases with the regressors ($\boldsymbol{X}$). The marginal effects can be explained as each unit increase in the independent variable increases or decreases the probability of selecting alternative J and is expressed as a percentage. (Greene 2018).

On the other hand, based on Caliendo and Kopeinig (2008), the treatment effect (τ_i) for each individual i, can be defined as

$$\tau_i = Y_i(D_i = 1) - Y_i(D_i = 0) = Y(1) - Y(0) \tag{4}$$

where $Y_i(D_i = 1)$ is a potential outcome when individual i is treated($D_i = 1$) and $Y_i(D_i = 0)$ is a potential outcome when individual i is not treated($D_i = 0$). Then, average treatment effect(τ_{ATE}) can be written as

$$\tau_{ATE} = E[\tau] = E[Y(1) - Y(0)] = E[Y(1)] - E[Y(0)]. \tag{5}$$

Average treatment effect on the treated(τ_{ATET}) which is regarded as the average causal effect can be expressed by

$$\tau_{ATET} = E[\tau | D = 1] = E[Y(1) - Y(0) | D = 1] = E[Y(1) | D = 1] - E[Y(0) | D = 1] \tag{6}$$

The second term, $E[Y(0) | D = 1]$ is called the counterfactual mean for those being treated and is not observed.

By considering Angrist and Pischke (2009), the comparison of (observed) average treatment effect (τ_{ATE}) is formally linked to the average casual effect (τ_{ATET}) such as

$$\underbrace{E[Y_i|D=1] - E[Y_i|D=0]}_{\tau_{ATE}} = \underbrace{E[Y(1)|D=1] - E[Y(0)|D=1]}_{\tau_{ATET}} \tag{7}$$

$$+ \underbrace{E[Y(0)|D=1] - E[Y(0)|D=0]}_{selection\, bias}.$$

If selection bias becomes zero or if the treatment is random regardless of its baseline status in an experimental study, then its (observed) average treatment effect becomes an average casual effect (average treatment on the treated).

For this study, however, the propensity score matching method is used to overcome the issue raised from random-sampling in the data. It is plausible that farmers' participation in the FFS (treatment) is not random, which could result in a biased estimator in the ordered probit model. Developed by Paul Rosenbaum and Donald Rubin in 1983, the propensity score is the probability of being treated conditional on observed baseline characteristics. The propensity score allows one to design and analyze an observational (non-randomized) study so that it mimics some of the particular characteristics of a randomized controlled trial (Austin 2011).

That is, PSM reduces selection bias by only comparing groups of participants of FFS and non-participants of FFS ('treated' and 'untreated' subjects in the terminology of the impact evaluation literature) that are sufficiently similar based on observable characteristics (Wainaina, Tongruksawattana & Qaim 2017).

5. Sampling and Data Summary

The respondents are classified into two groups; 1) farmers who participated in the FFS and as well graduated from the educational program of Sustainable Rice Production in Rain-fed Areas (SRPRA), which took place in the wet season of 2016 and 2) those who did not. The participants of FFS are farmers who graduated from the FFS by completing the SRPRA program in 2016 and have been cultivating rice in Manaoag (Nalsian), Mapandan (Luyan), or Malasiqui (Pasima). The non-participants of FFS are farmers who did not join the FFS or did not attend the SRPRA program yet, but cultivate rice in one of the three villages. For sampling, in coordination with the DoA, this study produced and validated the lists of participants and non-participants of the FFS. Before the survey, this study randomly selected respondents who would be interviewed in this study from the participants of FFS and the non-participants of FFS groups in each village. A total of 151 farmers engaging in rice farming activities in Manaoag (Nalsian), Mapandan (Luyan), or Malasiqui (Pasima) were interviewed from 9th to 15th February 2017. Among them, 76 farmers were participants and 75 farmers were non-participants of the FFS (Table 1). The Surveybe, a computer-assisted personal interview (CAPI) software, was used to conduct the survey (Cho 2017).

Table 1. Sampled Households in Pangasinan

Municipality	Village	Type of respondent		Total
		Participant of FFS	Non-Participant of FFS	
Mapandan	Luyan	25	34	59
Manaoag	Nalsian	25	16	41
Malasiqui	Pasima	26	25	51
Total		76	75	151

1) As of 2015, from the Philippines statistics, the population from Mapandan, Manaoag and Malasiquia are 37,059, 69,497, and 123,566, respectively.

Table 2 summarizes the measurement unit and the expected sign of the coefficients on the variables above. As a dependent variable, farmers' willingness to adopt the drought-tolerant rice varieties is classified into the following three categories: adoption, willingness to adopt, and non-adoption. The adopters are farmers who planted the drought-tolerant rice varieties or those who received or purchased them but did not plant yet. Those who have never received or purchased the drought-tolerant rice varieties but interested in planting them on their farm are defined as farmers who are willing to adopt the varieties. Lastly, the non-adopters are farmers who never received or purchased the drought-tolerant rice varieties and do not need them on their field (Cho 2017).

Independent variables are selected based on previous studies and our hypothesis on farmers' adoption of the varieties in the area. Dummy variables on the villages and the gender of the household head were reflected. By taking into account that female household heads lag in adopting agricultural technology because of their limited access to inputs and information, the expected sign of the coefficient on the female household head is negative (Quisumbing 1995). Also, farmers are more favorable in receiving new agricultural information as they engage in farming activities longer. Therefore, a positive relationship is hypothesized between the farming experience of household heads and their adoption of agricultural technology (Cho 2017).

As a measurement of labor availability, this study included the number of household members by the gender of household members and their engagement sectors. The expected sign of the coefficient on the number of household members is indeterminate since labor availability could affect farmers' decisions for adopting new agricultural practices, depending on the characteristics of the new technologies (Cho 2017). In some cases, new technologies are relatively labor-saving, while others are labor-using. HYVs technology requires more labor inputs and labor shortages may prevent its technological adoption (Feder et al. 1985).

In general, education enables farmers to increase the ability to perceive, interpret, and respond to new information much faster than their counterparts without education (Feder et al. 1985). Therefore, this study hypothesized a positive relationship between the educational level of the household and the probability of adopting the new technology. Farmers' perception and experience of weather events may affect their decision behavior by changing their risk attitude. Cameron and Shah (2015), for example, demonstrate that although natural disaster imparts no new information, it could affect farmers' behavior and agricultural practices through the impact on estimates of background risk. Given the rice production in the survey area has been impacted by El Niño steadily, this study hypothesized the number of months farmers experienced drought events affect farmers' willingness to adopt the drought-tolerant rice varieties (Cho 2017).

Capital, in the form of either accumulated savings or access to capital markets, is required to finance many new agricultural technologies (Feder et al. 1985). For the examination of farmers' asset information, this study collected the information on farm implements and machinery as well as household durables currently owned or sold during the last 12 months. The expected sign of the coefficient on the asset variable is positive.

Farm size was reflected as an independent variable, being assumed to have a positive impact on farmers' agricultural technology adoption. In the Philippines, 5.56 million farms/holdings covering 7.19 million hectares, which is translated to an average area of 1.29 hectares per farm/holdings increased from 1980 to 2012 by 62.6 percent, as the mean area of farm/holdings decreased from 2.84 hectares per farm/holding in 1980 to 1.29 hectare per farm/holding in 2012 (PSA 2012). This trend accounts for the partitioning of farmers/holdings from one generation of agricultural holders/operators to their succeeding generation in the Philippines. For representing farmers' tenure status, this study reflected the proportion of farmland owned by the household member of the total farmlands owned or cultivated by the household head during the last 12 months. A positive relationship is hypothesized between the proportion of farmland owned by household head and their adoption of the drought-tolerant rice varieties. The reason is that empirical studies find that farmers' tenure status could affect their technology adoption positively, conceptualizing the tenure status in different ways (Belknap & Saupe 1988; Rahm & Huffman 1984).

The constrained access to credit figures prominently among the reasons often cited for why technology fails to diffuse (Feder et al. 1985). Therefore, improving farmers' access to credit could provide them with opportunities for adopting the new agricultural technology. This study investigates farm households' borrowed money from the formal and informal sector during the last 12 months as well as the amount of money they borrowed. This study hypothesized a negative relationship between the total amount of money borrowed from the informal sector and their adoption (Cho 2017).

In examining the access to markets for inputs and outputs, some of the information needs to be at the level of individual farmers-such as how far they have to go to the nearest local market, measured in miles, kilometers, time, or cost (Doss 2006). This study measured farmers' access to input and output markets for rice farming activities by using the closest distance from their house to input markets and output markets, respectively. In general, the further away a farm or household is from input and output markets, the smaller is the likelihood that they will adopt new technology (Cho 2017).

Farmers' access to agricultural extension services is examined by asking whether they attended FFS on SRPRA in the 2016 wet season. The network effects are essential for farmers' decisions in making agricultural innovations, sharing information, and learning from each other (Foster & Rosenzweig 1995). Therefore, the coefficient of the years of residence in the current village, which was used as a proxy variable for representing the degree of farmers' social networks, is expected to be positive.

Table 2. Expected Sign of the Coefficients

Category	Variable	Measurement	Expected sign
Village dummy	Village dummy	Dummy	Indeterminate
Household head	Age of household head	Years	Indeterminate
Household head	Gender of household head (0=male/ 1=female)	Dummy	Negative
Household head	Marital status of the household head (0=single, divorced, widow/ 1=married, living in)	Dummy	Positive
Farming experience	Years of farming	Years	Positive
Household labor availability	Number of household members (by gender/engagement sector)	Number	Indeterminate
Household head	Years of education received	Years	Positive
Farmers' perception and experience of weather events	Number of months experiencing drought	Number	Positive
Farmers' asset	Total value of farm assets and household durables	PESO	Positive
Farm size	Total farm size (including own and tenant status)	ha	Positive
Tenure status	Proportion of land owned	Number	Positive
Access to credit	Total amount of money borrowed from informal sectors	PESO	Negative
Access to input market	Closest distance from house to input trader	km	Negative
Access to output market	Closest distance from house to output trader	km	Negative
Access to agricultural extension service	Participation in FFS (0=No/1=Yes)	Dummy	Positive
Farmers' social networks	Years of residence in current villages	Years	Positive

This study divides farmers into three categories; 1 for non-adopters, 2 for willing to adopt, and 3 for adopters. Since the drought-tolerance rice varieties from the CURE project is recently introduced to the public, it takes a while for farmers to get it. Therefore, "willing to adopt" is added to distinguish the non-adopters from the farmers with the willingness to buy it. In the Table 3, which shows the descriptive statistics, 15% of them never received or purchased the drought-tolerant rice varieties and do not need them on their farm. About 77% of them has never received or purchased the drought-tolerant rice varieties, but they are interested in planting the varieties on their farm. Only about 8% of the respondents have planted the drought-tolerant rice varieties on their farm or have received or purchased them but did not plant them on their farm yet.

Of the total 151 farmers interviewed in this study, over 91% of the household head is primarily working on agricultural farms. Their average age is 51 years, and about 83% of household heads are male. About 88% of the total farmers are married or living together with their spouses. They have been engaging in farming activities for an average of 26 years and received an average of 10 years of education. The average number of household members is five, and the number of household members engaged in agricultural activities is higher than that of the non-agricultural sector in both male and female-headed household groups.

About 93% of the farm households replied that they experienced drought events over the last five years. Notably, about 91% of them responded that the drought events negatively impacted on their farming activities. On average, they experienced droughts over two months, most severely between March and April, following between July and August.

The average value of household durables is about 521,000 peso, and that of farm implements/machinery is about 430,000 peso. The most critical assets in the survey area were residential lot and house as well as farmland, which are mostly inherited from parents in the Philippine society. The average size of farmland owned and cultivated is 1.2 ha, slightly higher in Manaoag.

Regarding the tenure status of the farm households, farmlands in the survey area are classified into self-own, rented-in, or share-crop status. About 25% of farmlands surveyed in our study are owned by the farmers. Furthermore, the way to borrow money was classified into the formal and non-formal sectors. The former includes banks, traders, NGOs, government, or credit cooperatives. The latter consists of relatives, friends, employers, or informal credit. About 44% of the respondents borrowed money from the informal sector during the last 12 months, with an average amount of about 11,000 pesos.

The average closest distance from their house to input trader and output trader is about 2.62km and 1.66km, respectively. The average distance from farmer's house to input traders is longer than the average distance from their house to output traders in the survey area. Several farmers in the survey area sell their outputs to the traders who visit directly to their farmland. They prefer this way of trade because it could reduce the time and costs of going to the output markets. Regarding farmers' access to agricultural extension services, about 49% of them participated in the FFS for one to two times. On average, farmers have been living in their current residential villages for 40 years.

Table 3. Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
Adoption status 1 = 23 obs (15%) 2 = 117 obs (77%) 3 = 11 obs (8%)	151	1.92	0.47	1.00	3.00
Pasima household	151	0.34	0.47	0.00	1.00
Luyan household	151	0.39	0.49	0.00	1.00
Nalsian household	151	0.27	0.45	0.00	1.00
Age of household head	151	51.23	13.77	22.00	82.00
Gender of household head (0=male/1=female)	151	0.17	0.38	0.00	1.00
Marital status of household head (0=single, divorced, widow/ 1=married, living in)	151	0.88	0.33	0.00	1.00
Years of farming	151	25.58	14.50	2.00	60.00
Number of males engaged in agricultural sector	151	1.28	0.74	0.00	5.00
Number of females engaged in agricultural sector	151	0.50	0.55	0.00	2.00
Number of males engaged in non-agricultural sector	151	0.60	0.79	0.00	4.00
Number of females engaged in non-agricultural sector	151	0.49	0.82	0.00	5.00
Years of education received	151	9.90	2.94	3.00	21.00
Number of months experiencing drought	151	1.82	1.25	0.00	6.00
Log (total value of farm assets and household durables, peso)	151	12.54	2.12	0.00	16.62
Total farm size (including own and tenant status, ha)	151	1.2	1.24	0.05	9.00
Proportion of land owned	151	0.25	0.41	0.00	1.00
Log (total amount of money borrowed from informal sector)	151	5.74	4.81	0.00	11.92
Distance from house to input trader (km)	151	2.62	2.18	0.00	11.00
Distance from house to output trader (km)	151	1.66	2.51	0.00	20.00
Participation in FSF (0=No/1=Yes)	151	0.50	0.50	0.00	1.00
Years of residence	151	39.70	21.11	1.00	82.00

6. Ordered Probit and Propensity Score Matching

Table 4 provides the estimation results where the dependent variable is ranked from one (non-adoption) to two (willing to adopt) and three (adoption) so that positive coefficients mean a positive relationship with farmers' willingness to adopt the drought-tolerant rice varieties. The chi-square ($\chi 2$) test for the parallel line assumption is 22.9702 with 20 degrees of freedom (P-value is 0.2903), so that it fails to reject the null hypothesis of the parallel line assumption, which means that this results of one set of coefficients with two intercepts would be sufficient.

Farmer's perception and experience of drought events are positively related to their adoption willingness, implying that they are more likely to adopt the drought-tolerant rice varieties as the number of months affected by drought increases. Farmers realize the necessity of planting the drought-tolerant rice varieties as they are exposed to adverse impacts of drought events. This experience improves their understanding of drought phenomenon and the function of the drought-tolerant rice varieties. In this regard, as expected, the severity of experiencing drought events positively affects farmers' willingness to adopt drought-tolerant rice varieties.

Farmers' assets are positively related to their adoption status, showing that they are more likely to adopt the drought-tolerant rice varieties as the value of their household durables and farm assets increases. The accumulation of savings led to farmers' invest in capital in new technologies. Therefore, the positive relationship between farm and household assets and the adoption status is consistent with our expected results.

Access to credit affects farmers' adoption status of drought-tolerant rice varieties, but the sign of the coefficient is different from our expected results. As the amount of money borrowed from informal sector increases, they are more likely to adopt the drought-tolerant rice varieties.

Access to input markets for rice farming activities affects farmers' adoption status. As the distance from the house to input trader increases, they are more likely to adopt the drought tolerant rice varieties.

Farmers' participation in the FFS positively affects their adoption status as expected. The farmers attain information about agricultural technology such as seedling rate, the amount of fertilizer, and IPM through FFS. Moreover, newly developed crop varieties are introduced during the implementation period of the FFS. It provides the farmers with opportunities to learn knowledge about the function of the newly developed crop varieties, by reducing their risk attitudes on the varieties.

The longer farmers live in their current residential village, the higher the likelihood of adopting drought-tolerant rice varieties. In this study, the years of residence were used as a proxy variable, which represents farmers' social networks. It was expected that the farmers would communicate or interact with their neighbors more actively as their residential years' increases. It could facilitate the exchange of information about farming activities among neighboring farmers.

This paper reflected fixed effects on the residential areas. The estimation results show that farmers living in Pasima village and Luyan village are less likely to adopt drought-tolerant rice varieties, compared to the farmers living in Nalsian village, which was set as a reference variable in the residential areas.

In terms of the household labor force, farmers are less likely to adopt the drought-tolerant rice varieties as the number of female household members engaged in the agricultural sector increases within their family. It implies that households with a large number of women members involved in the agricultural sector are reluctant to adopt the drought-tolerant rice varieties. The structure of the labor force by gender in the household affects farmers' adoption of the drought-tolerant rice varieties. Female farmers might lack information on drought-tolerant rice varieties relatively and it makes them become negative or unfamiliar with drought-tolerant rice varieties.

Access to the output market affects the adoption status as expected. Farmers are less likely to adopt the drought-tolerant rice varieties as the distance from their house to output market increases. It shows that farmers consider their access to output market importantly in adopting new varieties for their sales. On the other hand, the distance to the input market affects positively on the adoption status, which is opposite to our hypothesis. It is interpreted in this way. Farmers in Pangasinan are not used to getting new information on rice varieties due to the distance from the input market so that they are more likely to adopt the new information when they receive it.

Table 4. Determinants of Farmers 'Adoption of the Drought-tolerant Rice Varieties in Pangasinan, the Philippines

Dependent Variable: Non-adoption(Y=1), Willing to adopt (Y=2), Adoption(Y=3)	Estimates
Pasima	-1.476*** (0.441)
Luyan	-0.520 (0.390)
Nalsian	-
Age of household head	-0.0108 (0.0193)
Gender of household head	0.590 (0.489)
Marital status of household head	-0.396 (0.571)
Farming experience	-0.00516 (0.0146)
Number of males engaged in agricultural sector	0.252 (0.209)
Number of females engaged in agricultural sector	-0.587** (0.281)
Number of males engaged in non-agricultural sector	-0.0890 (0.197)
Number of females engaged in non-agricultural sector	0.190 (0.205)
Education of household head	0.0319 (0.0491)
Number of months experiencing droughts	0.325** (0.130)
Log of household durables and farm assets	0.136** (0.0668)
Total farm size	-0.0481 (0.140)
Proportion of farmland owned	-0.784** (0.392)
Log of the amount of money borrowed from the informal sector	0.0810** (0.0347)

(Continued)

Dependent Variable: Non-adoption(Y=1), Willing to adopt (Y=2), Adoption(Y=3)	Estimates
Distance from house to input trader	0.153** (0.0684)
Distance from house to output trader	-0.231*** (0.0811)
Years of residence	0.0265*** (0.00973)
Participation in FFS	1.151*** (0.336)
Constant cut1	1.133 (1.310)
Constant cut2	5.380*** (1.432)
Observations	151
Test for the Equal Slopes Assumption	22.9702

Note 1: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1, NN of adopter=11, NN of partial-adopter=117, NN of non-adoptor=23

Note 2: Chi-Square statistics for the parallel line assumption is 22.9702 with 20 degrees of freedom (P-value is 0.2903) so that it fails to reject the null hypothesis of the parallel line assumption.

Table 5 shows the marginal effects on each adoption status estimated from the ordered-probit model. When it comes to the effects of FFS, the participants of FFS are more likely to adopt the drought-tolerant rice varieties (9.9%), compared to the non-participants of FFS.

Table 5. Marginal Effects in Ordered-Probit Model

Dependent Variable: Adoption Status	Non-adoption (Y=1)	Willing to adopt (Y=2)	Adoption(Y=3)
Participation in FFS	-0.144*** (-3.42)	0.0446 (1.50)	0.0990** (3.08)
Pasima	0.184*** (3.59)	-0.0573 (-1.58)	-0.127** (-2.96)
Luyan	0.0649 (1.34)	-0.0202 (-1.05)	-0.0447 (-1.31)
Age of household head	0.0013 (0.56)	-0.0004 (-0.55)	-0.0009 (-0.55)
Gender of household head	-0.0736 (-1.22)	0.0229 (1.01)	0.0507 (1.18)

(Continued)

Dependent Variable: Adoption Status	Non-adoption (Y=1)	Willing to adopt (Y=2)	Adoption(Y=3)
Marital status of household head	0.0494 (0.69)	-0.0154 (-0.64)	-0.0340 (-0.69)
Farming experience	0.0006 (0.35)	-0.0002 (-0.34)	-0.0004 (-0.35)
Number of males engaged in agricultural sector	-0.0314 (-1.21)	0.0098 (1.00)	0.0217 (1.18)
Number of females engaged in agricultural sector	0.0733* (2.07)	-0.0228 (-1.27)	-0.056* (-2.04)
Number of males engaged in non-agricultural sector	0.0111 (0.45)	-0.00345 (-0.44)	-0.0077 (-0.45)
Number of females engaged in non-agricultural sector	-0.0237 (-0.92)	0.00735 (0.77)	0.0163 (0.94)
Education of household head	-0.004 (-0.65)	0.0012 (0.59)	0.0027 (0.65)
Number of months experiencing droughts	-0.0406* (-2.53)	0.0126 (1.39)	0.0280* (2.40)
Log of household durables and farm assets	-0.0170* (-2.09)	0.00528 (1.35)	0.0117 (1.94)
Total farm size	0.006 (0.34)	-0.0019 (-0.33)	-0.0041 (-0.35)
Proportion of farmland owned	0.0978* (2.04)	-0.0304 (-1.33)	-0.0674 (-1.91)
Log of the amount of money borrowed from the informal sector	-0.0101* (-2.35)	0.0031 (1.36)	0.0070* (2.23)
Distance from house to input trader	-0.0191* (-2.35)	0.0060 (1.46)	0.0132* (2.07)
Distance from house to output trader	0.0288** (2.97)	-0.0090 (-1.51)	-0.0199* (-2.57)
Years of residence	-0.0033** (-3.00)	0.0010 (1.62)	0.0023* (2.41)

Note: Total observations are 151. t-statistics are in parenthesis, *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Developed by Rosenbaum and Rubin in 1983, propensity score matching estimators are widely in evaluation research to estimate average treatment effects to reduce selection bias (Abadie & Imbens, 2016). The observational study lacks randomization so that statistical inferences are usually corrected by considering both observed or unobserved effects of covariates. If a specific case has a higher chance of being selected for a specific treatment, the characteristics for that case can affect statistical results. Hence, this method is used for controlling covariate imbalance that produces the selection bias, and the propensity score is defined as the conditional probability of assignment to a treatment given a vector of covariates (Lee 2016).

In conducting the propensity score matching method, the test of balancing property of the propensity was conducted. The optimal number of blocks is five, which ensures that the mean propensity score is not different for treated and controls in each block. Also, the balancing property is satisfied. As a matching algorithm, the nearest neighbor (NN) matching was used, and the number of matches per observation was one. In NN matching, the individual from the comparison is chosen as a matching partner for a treated individual that is closest regarding the propensity score (Caliendo & Kopeinig 2008).

It is assumed that the farmers who planted drought-tolerant rice varieties or received or purchased them but did not plant are considered to adopt the new varieties as adoption behavior. Table 6 shows the average treatment effect (ATE) and the average treatment effect on the treated (ATET) estimated from the PSM method. The ATE is the average response to treatment for a random sample from the population. On the other hand, the ATET is the average response to treatment for a sample of individuals for whom the treatment is intended. Both are the same when selection bias is zero and calculated by using STATA command of "teffects psmatch". According to the estimation results, farmers' participation in FFS increases their adoption behavior by 26.5% on average and by 19.7% for those whom the FFS is intended through the SRPRA program. The results enhance the positive effects of FFS on farmers' adoption, in consideration of the issue raised from the possibility of non-randomization in the sampling process.

Table 6. Average Treatment Effect and Average Treatment Effect on the Treated from the Propensity Score Matching

Outcome: adoption_status	ATE	ATET
Participation in FFS	0.265^{***} (0.0445)	0.197^{***} (0.0661)

Note: Total observations are 151. Standard errors are in parentheses, *** p<0.01

7. Conclusion and Policy Implications

Comparing the size of the marginal effects from the ordered probit model allows for prioritizing ways for facilitating farmers' adoption of the drought-tolerant rice varieties in the survey area. First of all, it is necessary to find ways to increase farmers' adoption of the drought-tolerant rice varieties by villages. As shown in the estimation results, farmers in Pasima and Luyan are less likely to adopt the drought-tolerant rice varieties compared to the farmers in Nalsian. Therefore, the PhilRice in charge of providing new rice varieties in the Philippines needs to increase the availability of the newly developed rice varieties among farmers, and the DoA needs to provide the farmers with the information about the varieties through FFS. According to the interviews with municipal agriculturists in the survey area. The availability of the seeds is the most significant obstacle in facilitating farmers' adoption of the drought-tolerant rice varieties (Cho 2017).

Along with the efforts for increasing the supply of seed inputs, the role of LFTs should be enhanced for sharing the advantages of cultivating the drought-tolerant rice varieties in the survey area. The LFTs have been playing an essential role in disseminating agricultural technologies and solving the lack of farmer's access to local agricultural extension services. As the LFTs are local farmers who completed the FFS, they will be likely to interact with farmers more closely and frequently than local government officials do. This could stimulate farmers to learn from their neighbors. In this regard, by utilizing the demonstration plots in each village, the LFTs needs to reduce farmers' risk attitudes on the drought-tolerant rice varieties and exchange the seeds with them more actively.

Second, it is recommended to deliver the information on the varietal information and the cultivation method of the drought-tolerant rice varieties to the farmers through the FFS. In the survey area, the combined efforts of disseminating the varieties and providing agricultural technology education through the FFS are useful for improving farmers' awareness of the varietal function and how to use the seed inputs. In particular, given that female farmers have limited availability on the drought-tolerant rice varieties, it may be useful to provide farm households consisted of a higher number of female farmers with agricultural practices on the varieties. Furthermore, encouraging the non-participants of FFS to join the FFS will be useful for reducing farmers' risk attitudes on the newly developed rice varieties. It is vital to design the effective agricultural extension services that include educating agricultural practices and delivering agricultural inputs, based on the understanding of the local socio-economic and agricultural conditions.

Third, by creating market channels for agricultural products, farmers' access to output markets can be secured. At present, in the survey area, several farmers are using the drought-tolerant rice varieties for their self-consumption because the amount of seeds provided from the PhilRice is insufficient for them to produce enough rice to sell at the markets. If new seeds are not secured in the market, farmers are not likely to cultivate the varieties even though the yield is high. It shows the importance of creating linkages between farmers' adoption of climate-resilient agricultural practices and their increase in income. Moreover, utilizing farmers' social networks might be useful for disseminating information about drought-tolerant rice varieties, encouraging them to learn from their neighbors. Supporting farmer organization or cooperative in charge of producing the rice varieties may useful for achieving the economy of scale of the drought-tolerant rice varieties, thus contributing to increasing farmers' bargaining power at the output markets.

Lastly, considering that the difference in household assets is high among the surveyed farmers, the inequality of assets among farmers should be reduced in the survey area. Those implications will help facilitate farmers' use of the drought-tolerant rice varieties at the initial stage of agricultural technology adoption in Pangasinan, the Philippines. Also, this study can be utilized as baseline information for the CURE project. Further studies are required on the soundness of measuring the effects of farmers' participation in the FFS or adoption of the drought-tolerant rice varieties on the increase in their yield and income (Cho 2017).

References

Journals

Abadie, A., & Imbens, G. W. 2016. Matching on the estimated propensity score. *Econometrica.* vol. 84, no. 2, pp. 781-807. DOI: 10.3386/w15301

Ali, D. A., Deininger, K., & Goldstein, M. 2014. Environmental and gender impacts of land tenure regularization in Africa: Pilot evidence from Rwanda. *Journal of Development Economics.* vol. 110, pp. 262-275. DOI: 10.1016/j.jdeveco.2013.12.009

Angrist, J.D. and J.S. Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion.* Princeton University Press.

Austin, P. C. 2011. "An introduction to propensity score methods for reducing the effects of confounding in observational studies." *Multivariate behavioral research.* vol. 46, no. 3, pp. 399-424. DOI: 10.1080/00273171.2011.568786

Belknap, J. & Saupe, W. E. 1988. "Farm family resources and the adoption of no-plow tillage in Southwestern Wisconsin." *North Central Journal of Agricultural Economics.* vol. 10, no. 1, pp. 13-23. DOI: 10.1093/aepp/10.1.13

Biggs, S. D. 1990. "A Multiple Source of Innovation Model of Agricultural-Research and Technology Promotion." *World development.* vol. 18, no. 11, pp. 1481-1499. DOI: Doi 10.1016/0305-750x(90)90038-Y

Binswanger, H. P. 1978. *The economics of tractors in South Asia.*

Binswanger, H. P. 1980. "Attitudes toward Risk - Experimental-Measurement in Rural India." *American journal of agricultural economics.* vol. 62, no. 3, pp. 395-407. DOI: Doi 10.2307/1240194

Caliendo, M., & Kopeinig, S. 2008. "Some practical guidance for the implementation of propensity score matching." *Journal of economic surveys.* vol. 22, no. 1, pp. 31-72. DOI: 10.1111/j.1467-6419.2007.00527.x

Cameron, L., & Shah, M. 2015. "Risk-Taking Behavior in the Wake of Natural Disasters." *Journal of Human Resources.* vol. 50, no. 2, pp. 484-515. DOI: 10.3368/jhr.50.2.484

Cho, S. 2017. Farmers' Willingness to Adopt the Drought-tolerant Rice Varieties -the Role of Farmer Field Schools and Farm Labor Force in Pangasinan, the Philippines-. A Master's Thesis. Seoul National University.

Conley, T. G., & Udry, C. R. 2010. *Learning about a new technology: pineapple growers in Ghana.* Preprint, Northwestern University. DOI: 10.1257/aer.100.1.35

Croppenstedt, A., Demeke, M., & Meschi, M. M. 2003. "Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia." *Review of Development Economics.* vol. 7, no. 1, pp. 58-70. DOI: 10.1111/1467-9361.00175

Doss, C. R. 2006. "Analyzing technology adoption using microstudies: limitations, challenges, and opportunities for improvement." *Agricultural economics.* vol. 34, no. 3, pp. 207-219. DOI: DOI 10.1111/j.1574-0864.2006.00119.x.

Deressa, T. T., Hassan, R. M., Ringler, C., Alemu, T., & Yesuf, M. 2009. "Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia." *Global environmental change.* vol. 19, no. 2, pp. 248-255. DOI: 10.1016/j.gloenvcha.2009.01.002

Ely, R. T., & Wehrwein, G. S. 1940. *Land economics.* Land Economics.

Feder, G. 1980. "Farm Size, Risk-Aversion and the Adoption of New Technology under Uncertainty." *Oxford*

Economic Papers-New Series. vol. 32, no. 2, pp. 263-283. DOI: 10.1093/oxfordjournals.oep.a041479

Feder, G., Just, R. E., & Zilberman, D. 1985. "Adoption of Agricultural Innovations in Developing-Countries - a Survey." *Economic development and cultural change*. vol. 33, no. 2, pp. 255-298. DOI: Doi 10.1086/451461

Foster, A. D., & Rosenzweig, M. R. 1995. "Learning by Doing and Learning from Others - Human-Capital and Technical Change in Agriculture." *Journal of political Economy*. vol. 103, no. 6, pp. 1176-1209. DOI: 10.1086/601447

Greene, W. H. 2018. *Econometric analysis*. Pearson.

Hayami, Y., & Ruttan, V. W. 1971. *Agricultural development: an international perspective: Baltimore*. Md/London: The Johns Hopkins Press.

Jack, B. K. 2013. *Market inefficiencies and the adoption of agricultural technologies in developing countries*.

Jamison, D. T., & Lau, L. J. 1982. *Farmer education and farm efficiency*. Johns Hopkins University Press.

Kahneman, D., & Tversky, A. 1979. "Prospect theory: An analysis of decision under risk." *Econometrica: Journal of the econometric society*. vol. 24, no. 2, pp. 263-291. DOI: 10.2307/1914185

Lee. D. 2016. "An introduction to propensity score matching methods." *Anesthesia and Pain Medicine*. vol. 11, no. 2, pp. 130-148. DOI: 10.17085/apm.2016.11.2.130

Masset, E., & Haddad, L. 2014. "Does beneficiary farmer feedback improve project performance? An impact study of a participatory monitoring intervention in Mindanao, Philippines." *The Journal of Development Studies*. vol. 51, no. 3, pp. 287-304. DOI: 10.1080/00220388.2014.959933

McKelvey, R. D., & Zavoina, W. 1975. "A statistical model for the analysis of ordinal level dependent variables." *Journal of mathematical sociology*. vol. 4, no. 1, pp. 103-120. DOI: 10.1080/0022250x.1975.9989847

Negatu, W., & Parikh, A. 1999. "The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district) of Ethiopia." *Agricultural economics*. vol. 21, no. 2, pp. 205-216. DOI: Doi 10.1016/S0169-5150(99)00020-1.

Quisumbing, A. R. 1995. *Gender differences in agricultural productivity: A survey of empirical evidence*. Food Consumption and Nutrition Division Discussion Paper 5. Washington, DC: International Food Policy Research Institute.

Rahm, M. R., & Huffman, W. E. 1984. "The Adoption of Reduced Tillage - the Role of Human-Capital and Other Variables." *American journal of agricultural economics*. vol. 66, no. 4, pp. 405-413. DOI: Doi 10.2307/1240918

Rogers, E. M. 2010. *Diffusion of innovations: Simon and Schuster*.

Schluter, M. 1971. "Effect of high pressure on the electronic density of states of aluminum." *Physica Status Solidi (b)*. vol. 43, no. 1, pp. 141-145. DOI: 10.1002/pssb.2220430115

Tanaka, T., Camerer, C. F., & Nguyen, Q. 2016. "Risk and time preferences: linking experimental and household survey data from Vietnam." In Behavioral Economics of Preferences, Choices, and Happiness (pp. 3-25): Springer. DOI: 10.1007/978-4-431-55402-8_1

Thompson, J., & Scoones, I. 1994. "Challenging the populist perspective: Rural people's knowledge, agricultural research, and extension practice." *Agriculture and Human Values*. vol. 11, no. 2-3, pp. 58-76. DOI: 10.1007/bf01530446

Uaiene, R. N., Arndt, C., & Masters, W. 2009. "Determinants of agricultural technology adoption in Mozambique." Discussion papers, 67.

Von Neumann, J., & Morgenstern, O. 1947. *Theory of games and economic behavior,* 2nd rev.

Wainaina, P., Tongruksawattana, S., & Qaim, M. 2018. "Synergies between Different Types of Agricultural Technologies in the Kenyan Small Farm Sector." *The Journal of Development Studies*. 1-17. DOI: 10.1080/00220388.2017.1342818

Weil, P. M. 1970. "The introduction of the ox plow in Central Gambia." *African food production systems: cases and theory*. pp. 229-263.

Documents

International Rice Research Institute (IRRI). 2015. Improving Livelihoods and Overcoming Poverty in the Drought-Prone Lowlands in Southeast Asia. Final Report.

National Economic and Development Authority (NEDA). 2016. Philippine Development Plan 2017-2022.

Online

Philippine Statistic Authority (PSA). http://psa.gov.ph/.

Statemaster Website. http://www.statemaster.com/encyclopedia/Pangasinan-province.

World Bank Data. https://data.worldbank.org/indicator/AG.LND.AGRI.ZS.

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