Master's Thesis of Science in Agriculture

Farmers' Willingness to Adopt the Drought-tolerant Rice Varieties - the Role of Farmer Field Schools and Farm Labor Force in Pangasinan, the Philippines -

필리핀 팡가시난 농가의 가뭄 저항성 벼 채택 의향 요인
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Farmers' Willingness to Adopt the Drought-tolerant Rice Varieties -the Role of Farmer Field Schools and Farm Labor Force in Pangasinan, the Philippines-*

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Abstract

The purpose of this study is to find out factors affecting farmers' willingness to adopt the drought-tolerant rice varieties in the Philippines. This study performed a household survey with a total of randomly selected 151 rice farmers living in the rain-fed areas of Pangasinan, the Philippines.

According to ordered probit and logit estimation, farmers' adoption of the drought-tolerant rice varieties is positively affected by their participation in the Farmer Field Schools, experiences on drought events, and years of residence. On the other hand, village effects, the number of female household members engaging in the agricultural sector, and the distance to

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output markets negatively affect their adoption willingness.

As the impacts of droughts are rising in the survey area, increasing the availability of the drought-tolerant rice varieties needs to be prioritized first of all. For it to do so, it is required to deliver the information on the varieties to farmers through the Farmer Field Schools. Besides, providing female farmers with information on the drought-tolerant rice varieties will be useful. Furthermore, it is recommended to facilitate farmers' access to output markets for selling their farm products and linking it to their income increase. In facilitating farmers' adoption of the drought-tolerant rice varieties, utilizing community organization or agricultural cooperatives could be helpful for encouraging their information exchange on the varieties and increasing their bargaining power in the output markets. Those implications will be effective for supporting potential users of the drought-tolerant rice varieties at the initial stage of the seed adoption in the survey area.

Keyword: Agricultural technology adoption, drought-tolerant rice varieties, Farmer Field Schools, farm labor force, access to output markets, Philippines.

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List of Abbreviations

AFF	Agriculture, Fisheries, and Forestry
ATI	Agricultural Technology Institute
BLB	Bacterial Leaf Blight
CAPI	Computer-assisted Personal Interview
CRI	Climate Risk Index
CRRA	Constant Relative Risk Aversion
CURE	Consortium for Unfavorable Rice Environment
DoA	Department of Agriculture
EUT	Expected Utility Theory
FAO	Food and Agriculture Organization
FFS	Farmer Field Schools
GDP	Gross Domestic Product
GVA	Gross Value Added
HYVs	High Yield Varieties
IFAD	International Fund for Agricultural Development
INDCs	Intended Nationally Determined Contributions
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
LFTs	Local Farmer Technicians
LGU	Local Government Unit
NEDA	National Economic and Development Authority
NSIC	National Seed Industry Council
PDP	Philippines Development Plan
PhilRice	Philippine Rice Research Institute
R&D	Research and Development
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

1.1 Background

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% of the Filipino workforce, accounts for 11% of Philippine's gross domestic product (World Bank, 2014).

However, the contribution of AFF to the country's GDP continued to decline in the past three years, recording an annual average GDP share of 10% from 2013 to 2015 (NEDA, 2016). Especially, crops 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% during the period from 2013 to 2015, compared to 1% increase of AFF. The reason for the low and poor performance in crops subsector was typhoons and *El Niño* that adversely affected rice production as well as the limited adoption of high-yielding varieties of commodities. Even though the decline in GDP of AFF is the result of economic growth and structural transformation, the revitalization of AFF is highly necessary in the face of slow transformation in the Philippines.

Among the critical challenges in the agricultural sector, climate change is a major obstacle for improving agricultural productivity in most of Southeast Asia countries, impacting on their food production and food security. Floods, droughts, and changes in seasonal rainfall patterns are expected to negatively impact on crop yields, food security, and livelihoods in vulnerable areas (Dawe et al., 2009). The Philippines is highly vulnerable to the impacts of climate change and natural hazards. According to its Intended Nationally Determined Contributions (INDCs) communicated to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015, it was ranked fifth on the long-term climate risk index (CRI) for the period of 1994 to 2014, evaluated by Germanwatch. Climate change and natural hazards will progressively impact sectors that are strategically important for the growth of the economy in the Philippines, including agriculture, fisheries, and water resource management. (INDCs of Philippines, 2015).

Especially, farmers who cultivate rice in rain-fed areas are highly vulnerable to the impacts of climate change. In most Southeast Asian countries, higher temperatures will lead to lower rice yields as a result of shorter growing periods (Barros et al., 2014). Regarding the risks of increasing heat stress, there are parts of Asia where current temperatures are already approaching critical levels during the susceptible stages of the rice plant (Change, 2014), and the Philippines is no exception from the impacts. In addition to the increase in temperature, changes in precipitation could affect farmers who depend on rain sources for their rice farming activities. In rain-fed rice environments, precipitation variability is by far the most important factor for variability in crop production and agricultural economic risk (Sumfleth and Haefele, 2012).

Rice production is an important part of food supply and economy of the Philippines. The Philippines is the 8th largest rice producer in the world, accounting for 2.8% of global rice production (FAO, 2011) and also largest rice importer in 2010 (Factbox, 2011). At present, rice is mainly produced in Luzon, the Western Visayas, Southern Mindanao, and Central Mindanao (Wikipedia, 2010). Despite the important role of rice production for the economy of the Philippines, it has been affected by a strong *El Niño*-related dry spell since December 2015, which has hit its food production. *El Niño* peaked between December and February, and the effect of drought was expected to persist in 2015. Since December 2015, more than 670,000 people have been affected by *El Niño*-induced dry spells and drought conditions (ACAPS, 2016). At present, even though the yield on irrigated farms has been increasing, improving agricultural productivity has been an important issue, affecting both farmer's food and income resources in the Philippines.

Therefore, it is required to improve the capacity of the agricultural sector to cope with the increasing impacts of climate change in the Philippines. In particular, the crop production sector, occupying a high proportion of AFF but pulling down the overall growth of AFF in the Philippines, needs to be more productive and sustainable through farmers' adoption of the climate-resilient and improved agricultural technologies.

1.2 Purpose of Study

The purpose of this study is to find out factors affecting farmer's willingness to adopt the drought-tolerant rice varieties introduced by Consortium for Unfavorable Rice Environment (CURE) project in Pangasinan, the Philippines. This study performed a household survey with a total of 151 randomly selected rice farmers in coordination with the International Rice Research Institute (IRRI) and the Philippine Rice Research Institute (PhilRice) in Pangasinan, the Philippines. By using ordered probit and logit model, this paper will try to find out effective ways for facilitating farmers' use of the drought-tolerant rice varieties in the drought-prone areas of the Philippines.

This paper is organized as follows. First, Philippine's climate change policy on agricultural sector and factors affecting agricultural technology adoption will be explained. Second, current climate change issues and socioeconomic characteristics of farm households in Pangasinan will be explained. Also, the main activities of the CURE project and current situation on farmers' adoption of the drought-tolerant rice varieties will be described, focusing on the Farmer Field Schools (FFS). Third, econometric model and estimation results will be discussed. Finally, implications will be suggested to speed up farmers' use of the drought-tolerant rice varieties in the survey area.

2. Review of Literature

2.1 Philippine's Climate Change Policy on Agricultural Sector

As agricultural and fisheries sectors are central to addressing Philippine's employment and poverty problems, the strategies of Philippines Development Plan (PDP) is aiming at increasing productivity in the AFF sector; increasing forward linkage with the industry and services sectors; and improving sector resilience, including climate change (NEDA, 2016). The National Economic and Development Authority (NEDA) is targeting to increase GVA in AFF from the baseline value of 0.1% to within 2.5 to 3.5% in 2017, and maintain that growth rate over the next five years (NEDA, 2016).

According to PDP reported in 2016, increasing the resilience and the productivity of agricultural sector in sustainable ways is an important strategy to cope with climate change. In this regard, increasing the productivity of agricultural and fisheries industry will be directed through investments in research and development (R&D) and extension for developing appropriate technologies for the major commodities. Interventions will be directed towards increasing the productivity of key commodities, such as palay, corn, sugarcane, pineapple, coconut, coffee, banana, mango, livestock and poultry and fisheries, among others.

To shorten the lag from R&D to farmer's adoption of agricultural technology, enhancing existing extension system is aimed through the engagement of a pool of professional extension workers. The prioritized areas for strengthening the extension system in crop production sector include using certified seeds and quality planting materials, especially high-yielding and stress-tolerant rice varieties (e.g., drought and flood). In this regard, the Department of Agriculture (DoA) will actively guide and coordinate extension units, and will also enhance their links to R&D institutions and think tanks. Besides, the coordination and complementation between DoA and Local Government Unit (LGU) will be strengthened to deliver the extension services and feedback on farm-related problems effectively.

Also, to join the international society's efforts in climate change, the government of Philippines submitted its INDCs to UNFCCC for reductions in greenhouse gas emissions in 2015. The planning for the Philippine's INDCs is consistent with the PDP, the National Framework Strategy on Climate Change, the National Climate Change Action Plan, and the National Disaster Risk Reduction and Management Plan. In particular, the implementation of adaptation measure against climate change will be achieved through financial resources, technology transfer, and capacity building. According to the adaptation actions specified in Philippines INDCs, the enhancement of climate and disaster-resilient of key sectors including agriculture, water, and health is considered as an essential implementation support.

2.2 Factors Affecting Agricultural Technology Adoption

Conceptual models employed for explaining the decision of small farmers to adopt new technology can be classified into three groups (Negatu and Parikh, 1999): 1) the innovation-diffusion model; 2) the economic constraints model; and 3) the technology characteristics-user's context model. 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 in potential user-communities depends mainly on the personal characteristics of the potential individual user. This model assumes that the technology is appropriate for use unless hindered by the lack of effective communication (Negatu and Parikh, 1999). However, as the limitation of the innovation diffusion theory, it is argued that the theory does not foster a participatory approach to the adoption of new technology and not take into account an individual's resources or social support to adopt a new behavior.

The economic constraints model, also known as factor endowment model, focuses on the distribution of resource endowments among the potential users and the pattern of adoption of technological innovation. The model emphasizes on well−functioning markets and importance of price policies (Hayami and Ruttan, 1971).

The technology characteristics−user's context model integrates approaches which assume 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 and Scoones, 1994). The model highlights the importance of the involvement of farmers in the technology development process, for generating technologies with appropriate and acceptable characteristics. Also, the model focuses on the importance of institutionalization of research policies and strategies that facilitate the participation of farmers and other relevant stakeholders in the technology development process.

Before reviewing empirical studies on agricultural technology adoption, it is necessary to understand the definition of the agricultural technology adoption. Feder et al. (1985) distinguished adoption between individual (farm−level) adoption and aggregate adoption for rigorous theoretical and empirical analysis. According to the study, final adoption at the level of the individual farmer is defined as the degree of use of new technology in long−run equilibrium when the farmer has full information about the new technology and its potential. The aggregate adoption behavior is defined as the process of spread of new technology within a region.

In this study, factors affecting agricultural technology adoption will be categorized based on the three adoption theories mentioned above. According to the innovation–diffusion model which highlights the research and extension system for expansion of agricultural technology, providing agricultural extension services could facilitate farmers' adoption of agricultural technology. Experience may provide general farming knowledge as well as specific knowledge about his or her particular farm, while education may enable the farmer to better process the information provided by different sources, and may increase both the allocative and technical efficiency of the farmer (Jamison and Lau, 1982). Strauss et al. (1991) studied determinants of the adoption of certain technologies of upland rice and soybean farmers in the center–region of Brazil, by using probit model. The study found that providing farmers with agricultural education positively affects the adoption of the new technology. Uaiene et al. (2009) studied determinants of agricultural technology adoption in rural Mozambique, by using national representative panel data set. The study showed that households with access to agricultural advisory services, those with access to rural credit and members of the agricultural association are more likely to adopt new agricultural technologies. Hoffmann and Muttarak (2017) investigated the determinants of personal disaster preparedness in Thailand and Philippines focusing on the role of education and experience. By handling non−linear nested models to decompose the education effects, the study pointed out that education improves disaster preparedness only for those households who have not affected by a disaster in the past.

When it comes to the economic constraints model focusing on the distribution of resource endowments among potential users, land, human, and asset resources are considered factors affecting agricultural technology adoption. Farm size can have different effects on the rate of adoption depending on the characteristics of the technology and institutional setting (Feder et al., 1985). Many empirical studies suggest that the use of high yield varieties (HYVs) and some modern variable inputs initially tends to lag behind on smaller farms, implying that the incidence of adoption of HYVs is positively related to farm size (Weil, 1970, Binswanger, 1978). 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) found that small and medium−size farms in India adopted HYVs on a larger proportion of acreage than large farms.

Access to input and output market could affect farmer's adoption of agricultural technology. Poorly functioning input and output markets reduce the profitability of technology to farmers. An important factor in explaining adoption patterns is the availability of complementary inputs. Regarding the adoption of the improved seeds, HYVs will not be adopted by most farmers unless both seeds and some fertilizers are available (Feder et al., 1985). With regard to 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). In this regard, better transportation is associated with diffusion of technology, better use of inputs and better prices (Ahmed and Hossain, 1990). Zeller et al. (1998) studied the determinants of adoption of agricultural technology on the cultivation of hybrid maize and tobacco in Malawi and showed the differences in the household's access to financial and commodity markets significantly influence cropping shares and the hybrid maize farm income. The study supported that the access to agricultural markets and related improvements in rural infrastructure and marketing institutions are essential to support small farmers' adoption of agricultural technology.

The technology characteristics-user's context model assumes that characteristics of a technology underlying user's agro-ecological, socioeconomic and institutional contexts as factors affecting agricultural technology adoption. Tenure status of farm household could affect their adoption of the agricultural technology. A lack of formal title often means farmers 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 expected 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 and Wehrwein, 1940). Therefore, 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 et al., 2014).

Many empirical and descriptive studies have considered the effects of tenure arrangements and the proportion of farms rented on the adoption of HYVs technology (Feder et al., 1985). Soule et al. (2000) distinguished renters according to lease type as well as practices according to the timing of costs and returns for studying the influence of tenure status on the adoption conservation practices of United States corn producers. The study found that cash-renters are less likely to use conservation tillage than owners, but share-renters are not. Newman et al. (2015) explored the effect of land titling on agricultural productivity in Vietnam and showed that obtaining a land title is associated with higher yields, both individually and jointly titled situation. However, several studies found no significant relationship between tenure and adoption of the agricultural technology (Norris and Batie, 1987, Rahm and Huffman, 1984).

Access to credit is one of the important factors affecting agricultural technology adoption. 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). Croppenstedt et al. (2003) studied factors influencing demand and access to fertilizer in Ethiopia and highlighted the role of credit and subsidies, by using double-hurdle model. Hassan and Nhemachena (2008) showed that mono-cropping is the most vulnerable to climate change in Africa and suggested the importance of access to markets, extension and credit services, technology and farmer assets, by using multinomial choice model. Deressa et al. (2009) specified adaptation strategies of farmers by using discrete choice model including the use of different crop varieties, tree planting, soil conversion, early and late planting, and argued the lack of information on adaptation methods and financial constraints are the main barriers in the Nile Basin of Ethiopia.

Farmer's social learning process and network effects are also considered factors affecting technology adoption. The basic 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 realized, the farmer then updates his priors concerning the technology which may increase his probability of adopting the new technology in the subsequent year (Uaiene et al., 2009). Also, farmers within a group learn from each other how to grow new crop varieties (Conley and Udry, 2000). Foster and Rosenzweig (1995) studied adoption and profitability of high-yielding seed varieties of rural Indian households, incorporating learning by doing and learning from others in a modified target-input model of new technology. They found that farmers with experienced neighbors are significantly more profitable than those with inexperienced neighbors, showing that providing some support for public efforts could be useful to increase the adoption through subsidies to early adopters. Takahashi et al. (2015) examined the effects of the participatory approach to the adoption of new crop varieties and agricultural practices in rural Ethiopia. By focusing on the social network structure, the study indicated that the probability of adopting a new maize variety increased if farmers knew and trusted fellow participants.

However, Bandiera and Rasul (2006) showed that giving incentives to adopt early to too many farmers could reduce the incentives to adopt for other farmers around them, resulting in inefficiencies resulted from informational externalities. By studying the relationship between farmer's adoption choices of new crops and their network of family and friends in Mozambique, the study found an inverse-U shaped relationship, suggesting the social effects are positive when there are few adopters in their network while negative when there are many.

A heterogeneity effect of agricultural technology affects farmer's decision to continue to adopt the technology. That is, benefits and costs of new technology are heterogeneous, which leads to different rates of the technology adoption among farm households. Zeitlin (2011) studied a relationship between cocoa farmer's experiences with a new technology and their continuity of using it in Ghana and showed that low experienced returns among adopters are associated with low program retention rates. The study provided evidence that a learning mechanism drives the relationship between realized returns and subsequent adoption decisions. Suri (2011) studied the role of treatment effect heterogeneity in explaining low adoption rate in African agriculture, by showing a non-monotonic relationship between farmers' adoption rates and expected returns.

Farmers' perception about the impacts of climate change could influence their adoption of agricultural technology. As they experience climate phenomenon, they are more likely to be aware of the climate attributes, such as changes in precipitation or temperature. More experienced farmers would be better at distinguishing climate change from merely inter-annual variation (Maddison, 2007). In this regard, adaptation to climate change requires that farmers using traditional techniques of agricultural production first notice that the climate has altered. Farmers then need to identify potentially useful adaptations and implement them (Maddison, 2007). Ndambiri et al. (2013) studied how Kenyan farmers have perceived and adapted to climate change, by using heckman probit model. The study revealed that farmers perceiving the impacts of climate change adopted adaptation measures, including diversifying crops, switching to other different agricultural sector, increasing use of irrigation and fertilizer, and conserving soil.

Several studies tried to explain factors affecting agricultural technology adoption by focusing on farmers' risk attitudes. There have been efforts to measure the risk preferences of farmers, assuming expected utility theory (EUT) approach developed by Von Neumann and Morgenstern (1947). Binswanger (1980) used experimental gambling approach with real payoffs to measure households' risk attitude in rural India and showed that individuals are moderately risk-averse with little variation according to personal characteristics at higher payoff levels. Feder (1980) suggested a theoretical model of crop decision model, by explaining the role of risk aversion and credit constraints in the production decisions of farmers who grow both modern and traditional crops.

However, Just and Zilberman (1983) pointed out that the study of Feder (1980) assumed random yield only for a new technology and did not consider additional implications of fixed costs of adoption, which could lead to significant interaction with stochastic structure in determining the relationship between farm size and adoption. By focusing on a relationship between farm size and technology adoption of farmers, they developed a model that explains land–use allocation and technology adoption taking into account the inter–firm variation of landholdings and the role of landholdings in determining risk preferences. Knight et al. (2003) studied the role of education in reducing the risk–aversion of farmers in Ethiopia, based on the production choices for utility maximization under conditions of risk. By assessing farmer's subjective attitudes toward risk through the hypothetical question, the study showed that educated farmers were significantly less risk–averse than those without education and risk–aversion reduces the probability of adoption.

De Brauw and Eozenou (2014) tested whether Mozambican farmer's risk attitude follows constant relative risk aversion (CRRA) utility function, by eliciting their risk preferences related to sweet potato production through field experiment. By studying whether their preferences follow expected utility function or rank–dependent utility theory, the study strongly rejected the hypothesis that farmers follow CRRA preferences and EUT. Also, the study showed that assuming CRRA preferences describe the risk preferences of more risk–averse farmers well, but poorly describe the risk of preferences of less risk–averse farmers.

However, several studies pointed out the limitations of the EUT approach and incorporated farmer's risk references to answer the question through behavioral economics. Several studies tried to measure their risk preferences based on prospect theory suggested by Kahneman and Tversky (1979). The prospect theory focuses on the differing valuation of gains and losses. The key features of prospect theory are the reference point that distinguishes gains from losses, the degree of loss aversion, and the weighing function. Tanaka et al. (2016) expanded measurement of risk and time preferences beyond one-parameter expected utility model with the prospect theory in Vietnamese villages. The study showed that villages with higher mean income, people are less loss-averse and more patient. Liu (2013) examined the role of individual risk attitudes in the decision to adopt a new form of agricultural biotechnology in China and found that farmers who are more risk or more loss averse adopted Bt cotton later. Shimamoto et al. (2014) investigated the different effects of risk preferences on the adoption of a moisture meter and modern rice variety in the rural area of Cambodia. The study indicated that farmers overweighed a small probability and risk averse farmers adopted a moisture meter and farmers' risk did not affect the adoption. 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).

Most of the previous studies on farmer's technology adoption have been focusing on the final adoption at the level of the final adoption. The final adoption is defined as a situation when the farmer has full information about the new technology and its potential defined by Feder (1985). On the contrary, this study aims at drawing implications for facilitating farmer's adoption of the newly developed rice varieties at the early stage adoption. Additionally, studies on farmers' agricultural technology adoption in Pangasinan are rare, even though the region substantially contributes to agricultural production in the Philippines. In this regard, we incorporated farmers who are willing to adopt the drought-tolerant rice varieties, who could be defined as potential adopter in the ordered probit and logit model.

Also, this study is distinctive in that it reflects the effect of farmers' participation in the Farmers Field Schools (FFS) as a measurement of their access to agricultural extension services. The FFS, which is a group-based learning process, has been used for educating farmers for their farming activities in most of developing countries. In particular, the lack of farmers' access to agricultural information and extension works have been main issues in our survey area, highlighting the role of FFS. Therefore, considering farmers' participation into the FFS allows us to examine whether it has been operating as an effective extension tool in the survey area.

Furthermore, studies focusing on farmers' perception and experiences on climate change and weather events are rare up to know. However, as the impacts of changes in weather phenomena on farmers' agricultural activities are increasing, it is required to reflect farmers' perception and experiences of weather events in the agricultural technology adoption model. In this regard, this study investigated the effect of farmers' experiences on drought events on their willingness to adopt the drought−tolerant rice varieties.

3. CURE Project in Pangasinan, the Philippines

3.1 Study Area

Pangasinan is located in the west central area of the island of Luzon in the Philippines (Figure 1). With a population of about 2.9 million in 2015, it is subdivided into 44 municipalities, four cities, and 1,364 villages. Agriculture is a major sector in the region, and its principal crops include rice, mangoes, corn, and sugar cane. With a land area of about 537,000 hectares, about 44% of total area of the region is used for agricultural production.

Figure 1. Map of Pangasinan in the Philippines

Source: Wikipedia (2017.06.11)

Table 1 shows the socioeconomic information of the survey area (Manaoag, Mapandan, and Malasiqui) and interviewed farmers. Being located in the rain-fed lowland area, rice is mainly cultivated in the wet season and corn is grown in the dry season in the region. Of the total of 151 farmers interviewed in this study, over 91% of household head is primarily working on agricultural farms. Their average age is 51 years, and about 83% of household head is male. About 88% of them are married or living together with their spouse. They have been engaged in farming activities 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 the household member engaged in agriculture is higher than that of non-agricultural sector. The non-agricultural sectors include working for: salary and wages from a government or private company; wholesale and retail trade; transportation, storage; and communication service; and construction. Also, male household members are more involved in the agricultural sector than women.

Regarding farmer's perception on drought, about 93% of them replied that they experienced drought events over the last five years. Especially, about 91% of them responded that the drought events negatively impacted on their farming activities. Also, we investigated which month they experienced drought events most severely. On average, they experienced droughts over two months, most severely between March and April, following between July and August.

The information on the adoption of the drought-tolerant rice varieties introduced by the CURE project is as follows. About 38% of farmers have heard about the drought-tolerant rice varieties. Besides, 7% of them 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. About 77% of them have never received or purchased the drought-tolerant rice varieties, but they are interested in planting the varieties on their farm. In contrast, 15% of them never received or purchased the drought-tolerant rice varieties and do not need them on their farm.

Regarding farm and household asset information, we collected the information about household durables and farm implements/machineries currently owned or sold during the last 12 months, by asking the number of the items and their current value in peso. The average value of household durables is about 521,000 peso, and that of farm implements/machineries is about 430,000 peso. In the survey area, farmers' main assets are residential lot and house as well as farmland, which are mostly inherited from parents in general in the Philippine society.

Regarding farmers' land ownership situation, we collected parcel information owned or cultivated by the household head or members during the last 12 months. About 94% of the parcels are located in the lowland areas, consisted of sandy loam or clay. Regarding the source of water for farming activities, about 74% of parcels relies on rain and tube well facilities, and about 24% of parcels are irrigated by only rainfall. Most of the farmlands in the survey area were classified into self−own, rented−in or share−crop status. The average size of farmland owned and cultivated is 1.2 ha, slightly higher in Manaoag. The respondent farmers own an average of 0.29 ha of farmland, and 25% of farmlands surveyed in our study are held by the respondent farmers.

We collected farmers' rice production information during 2016 wet season. They produced about 77 sacks on average, which is correspondent to about 77kg in converted value and about 25 peso in farm gate price. The average yield of rice production in all three villages is about 7,100, and the value is the highest in the Malasiqui among the three villages.

The information about farmers' access to credit is as follows. About 60% of them replied that their household members or themselves borrowed money during the last 12 months. The average amount of money borrowed is about 14,800 peso, and it is relatively high in Malasiqui and Mapandan than Manaoag. Furthermore, the way to borrow money was investigated, classified into the formal and non−formal sector. The formal sector includes banks, traders, NGO, government, or credit cooperatives. On the other hand, the informal sector includes relatives, friends, employer or informal credit. About 44% of the respondents borrowed money from the informal sector during the last 12 months, with the average amount of about 11,000 peso.

The information on farmers' access to input and output markets for rice farming activities were collected, by examining the distance from their house or farm to input and output traders. The average closest distance from their house and farm to input trader is about 2.6 km and 2.8 km, respectively. The average distance from their house and farm to output trader is 1.7 km and 1.9 km, respectively.

To collect the information about farmers' access to agricultural extension services, we identified the extent of farmers' participation in the Farmer Field School (FFS) and interaction with Local Farmer Technicians (LFTs). We asked them how many times they attended the FFS and how often they meet LFTs in their current residential villages. According to this, about 78% of the respondents replied that they have access to extension workers for their agricultural activities and 50% of the farmers participated in the FFS for Sustainable Rice Production in Rainfed Areas in 2016. About 49% of them participated in the FFS for one to two times. Also, most of the farmers replied that they have been receiving agricultural extension services from the local government office, focusing on crop production.

Farmers' social networks information was collected, such as years of residence in current living villages and their participation in community organization or union for agricultural activities. On average, farmers have been living in their current residential villages for 39 years. Moreover, about 76% of them have been participating in community organization for their agricultural activities.

Table 1. Mean Statistics of the Full Sample by Villages

Variables	Malasiqui (n=51)	Mapandan (n=59)	Manaoag (n=41)	All (n=151)
Household head information				
Age	51.82	48.49	54.41	51.23
Gender (% of male household head)	0.71	0.85	0.95	0.83
Marital Status (% of HH married or living in)	0.82	0.86	0.98	0.88
Number of years in farming activities	23.51	24.32	29.95	25.58
Years of receiving education (years in school)	9.69	10.12	9.85	9.90
Household labor force				
Total	4.86	5.24	4.88	5.01
Male<18	0.71	1.15	0.80	0.91
Male≥18	1.57	1.47	1.78	1.59
Female<18	0.92	1.27	0.66	0.99
Female≥18	1.67	1.34	1.63	1.53
Engaged in agriculture	1.80	1.59	2.02	1.78
Engaged in non-agriculture	1.16	1.12	0.98	1.09
Male engaged in agriculture	1.31	1.17	1.41	1.28
Female engaged in agriculture	0.49	0.42	0.61	0.50
Male engaged in non-agriculture	0.51	0.68	0.61	0.60
Female engaged in non-agriculture	0.65	0.44	0.37	0.49
Perception on drought				
Experience of drought (%)	0.98	0.90	0.90	0.93
Impact of drought on farming activities (%)	0.96	0.88	0.90	0.91
Number of months experienced drought	1.98	1.90	1.51	1.82
Adoption of the drought-tolerant rice varieties				
Heard about the drought-tolerant rice varieties (%)	0.37	0.34	0.46	0.38
Adoption (%)	0.04	0.07	0.12	0.07
Willing to adopt (%)	0.75	0.81	0.76	0.77
Non-adoption (%)	0.22	0.12	0.12	0.15
Farm and household asset (Unit: 1,000 peso)				
Value of household durables	567	439	579	521
Value of farm implements/machineries	659	393	203	431

Landholdings type				
(NN of parcel included in each type among total parcels)				
Lowland (%)	0.97	0.86	0.98	0.94
Medium (%)	0.03	0.12	0.03	0.06
Upland (%)	0.00	0.03	0.02	0.01
Soil type				
Clay (%)	0.23	0.24	0.30	0.25
Loam (%)	0.23	0.10	0.11	0.17
Sandy (%)	0.10	0.17	0.21	0.15
Clay loam (%)	0.07	0.09	0.03	0.07
Clay sandy (%)	0.01	0.08	0.05	0.04
Sandy loam (%)	0.34	0.31	0.31	0.32
Source of water				
Rain (%)	0.38	0.08	0.16	0.24
Rain and tube well (%)	0.62	0.88	0.79	0.74
Irrigated (%)	0.00	0.04	0.05	0.02
Tenure status				
Farm size (ha)	1.24	1.00	1.42	1.20
Area of farmland owned	0.28	0.28	0.32	0.29
Proportion of farmland owned (%)	0.30	0.32	0.09	0.25
Rice production (during 2016 wet season)				
Plantation of rice during 2016 wet season (%)	1.00	1.00	0.95	0.99
Total production of rice (sacks)	77.31	83.85	67.61	77.23
Total value of rice (kg)	105.37	69.63	54.93	77.71
Total value of farm gate price (peso)	26.11	30.73	16.43	25.29
Total yield of rice production	10,250	6,076	4,655	7,100
Access to credit (during last 12 months)				
Borrowed money (%)	0.65	0.61	0.51	0.60
Total amount of money borrowed (peso)	16,647	17,702	8,383	14,815
Borrowed money from informal sector (%)	0.53	0.41	0.39	0.44
Total amount of money borrowed from informal sector (peso)	15,176	10,726	6,280	11,022
Access to input and output markets for rice farming activities (km)				
Closest distance from house to input trader	2.61	2.64	2.58	2.62
Closest distance from farm to input trader	2.98	2.75	2.60	2.79
Closest distance from house to output trader	1.18	1.61	2.33	1.66
Closest distance from farm to output trader	1.43	1.65	2.78	1.88

Access to agricultural extension services				
Access to agricultural extension services (%)	0.78	0.83	0.71	0.78
FFS Participation (%)	0.49	0.58	0.39	0.50
Frequency of FFS participation (%)				
Never	0.45	0.34	0.29	0.36
1-2 times	0.43	0.47	0.59	0.49
3-4 times	0.02	0.10	0.02	0.05
More than five times	0.10	0.08	0.10	0.09
Frequency of meeting LFT (%)				
Never	0.22	0.17	0.29	0.22
At least once a week	0.41	0.34	0.49	0.40
At least monthly	0.04	0.14	0.05	0.08
Occasionally	0.33	0.36	0.17	0.30
Farmer's social networks				
Years of residence	41.67	36.49	41.88	39.70
Participation in community organization (%)	0.73	0.80	0.76	0.76
Number of participating community organizations	1.35	1.28	1.10	1.25

3.2 CURE Project and Farmer Field Schools

Funded by the International Fund for Agricultural Development (IFAD), a special agency of the United Nations, CURE project has been supporting the development of stress-tolerant rice varieties and best crop management techniques in Cambodia, Lao PDR, Indonesia, the Philippines, Thailand, Vietnam, and Myanmar. The project was performed in two phased projects with CURE I(2009-2013) and CURE II(2013-2018). In CURE I activities, the project targeted releasing new stress-tolerant rice varieties through on-farm trials at various stages of dissemination and adoption in drought, submergence, salinity, upland ecosystems.

In CURE II activities, the project developed and evaluated gender-sensitive combinations of rice germplasm and management practices, identifying uptake and communication pathways for fast-track technology dissemination.

In the Philippines, one of the main issues in implementing the project activities was farmer's limited access to agricultural information and extension services. 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. It was reported that a weak link to adoption is the lack of local agricultural extension staffs to disseminate and continuously monitor farmers' adoption of the drought-tolerant rice varieties. In this regard, the necessity of sustainable learning and the importance of a support system were raised that could help farmers adopt the practices learned from the FFS.

The Farmer Field Schools (FFS) is a group-based learning process that has been used by a number of governments, NGOs, and international agencies, aiming at disseminating improved farming methods to farmers in developing countries. Developed by the Food and Agriculture Organization (FAO) of the United Nations in 1989 in Indonesia for the first time, more than two million farmers across Asia have participated in this type of learning.

In the Philippines, the DoA and PhilRice are in charge of implementing the FFS in rural areas. Through the FFS, the DoA 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). In Pangasinan, the FFS is implemented twice a year during the wet and dry season. Farmer's participation in the FFS is voluntary.

Recently, the DoA has been managing LFT system, aiming at solving farmers' low access to agricultural extension services and lack of extension workers in the rural areas. Consisted with farmers who had graduated from FFS, the LFTs receive agricultural technology education from the Agricultural Technology Institute (ATI), under the DoA. Moreover, they deliver what they learned from the ATI to local farmers during the period of the FFS.

Also, the LFTs have been managing demonstration plots in the rural villages, by receiving newly developed rice varieties from the DoA free of charge. The purpose of operating the demonstration plot is to disseminate newly developed crop varieties to local farmers and reduce their risk attitudes on the varieties. Particularly, they are engaged in showcasing the potential of cultivating the newly developed varieties. If the local farmers are willing to plant the varieties, they could exchange or purchase the varieties with the LFTs. In our survey area, the

LFTs system started from 2014 and two of LFTs are working in each village.

The PhilRice, in charge of R&D activities under the DoA, is engaged in developing high-yielding and cost-reducing technologies as well as transferring the technologies to farmers effectively. The PhilRice has been monitoring and collecting farmers' rice production data through palay check system, which is a dynamic rice crop management system that presents the best key technology and management practices. The system enables farmers to compare their farming practices with the best practices and to learn through farmers' discussion group for improving productivity, profitability, and environmental safety of their farming activities.

3.3 Dissemination of Drought-tolerant Rice Varieties

According to the baseline survey of the CURE project performed by IRRI in Pangasinan in 2013, drought was one of the major problems in rice farming, and it occurs in certain months of the year. A majority of farmers in the province responded that they experienced drought mostly from February to April. About half of the farmers have been depending on rainfall as the source of irrigation water and planting rice only during the wet season when rainfall is available.

Regarding farmers' adaptation strategies to climate change, it was shown that a majority of farmers employed several adaptation strategies after drought occurred, implying that most farmers have been responding to risks only when drought occurred. Furthermore, their adaptation strategies are limited to temporary management such as selling livestock, borrowing money or goods from their relatives, friends, or an institution and depending on non-agricultural practices. However, in some cases, it was identified that their borrowing activities worsened their asset status.

In this regard, our survey area was targeted as dissemination site of the drought-tolerant rice varieties by the PhilRice. Developed by the PhilRice and IRRI, four types of the drought-tolerant rice varieties were distributed to the survey area. The name of each variety is following: National Seed Industry Council (NSIC) 280; NSIC Rc 282; NSIC Rc 346; and NSIC Rc 348. The PhilRice distributed the drought-tolerant rice varieties to the LFTs in each village during the FFS on Sustainable Rice Production in Rain-fed Areas in the 2016 wet season. The PhilRice and DoA encouraged LFTs to transfer the varieties to local farmers by operating demonstration plots. Currently, it is in the dissemination stage, and several farmers have exchanged or purchased the drought-tolerant rice varieties with the LFTs.

The production information about the drought-tolerant rice varieties identified from the interview with the LFTs and local farmers in each village is as follow. In Malasiqui (Pasima), the

NSIC Rc 348 showed low height and medium sized and required about 105 days for maturity. For NSIC 280, it showed high height and flat shaped characteristics and required about 123 days for maturity. The NSIC Rc 282 showed high height, but the cooking quality was low. The NSIC Rc 346 was prone to bacterial leaf blight (BLB) and required about 105 days for maturity. Overall, the LFTs were satisfied with the NSIC Rc 348, which is characterized by short maturity days and resistant to BLB.

In Mapandan (Luyen), the NSIC Rc 280 showed high yielding characteristics in the demonstration plots of LFTs. At present, farmers prefer NSIC Rc 222 and NSIC Rc 160 because of their high yielding features and superior marketability. However, the LFTs replied that the NSIC Rc 280 is competitive compared to the two popular rice varieties in Luyen. Also, according to the Palay Check System from the PhilRice, it was identified that the NSIC Rc 280 showed the highest yield among the distributed drought-tolerant rice varieties. The LFTs replied that farmers could cultivate the NSIC Rc 280 in last October 2016 when a typhoon hit Mapandan, even though they could not cultivate NSIC Rc 346 and NSIC Rc 348. Up to now, eight farmers exchanged the NSIC Rc 280 with LFTs, and they are waiting for harvesting. Moreover, our survey team visited one farmer's field, which was planted with one of the drought-tolerant rice varieties. The female farmer was testing whether the varieties could grow well in this dry season and satisfied with its growth up to now. Most of the farmers who have been cultivating the drought-tolerant rice varieties are consuming by themselves because the number of seeds they received from the PhilRice is low and it is not enough to sell them in markets.

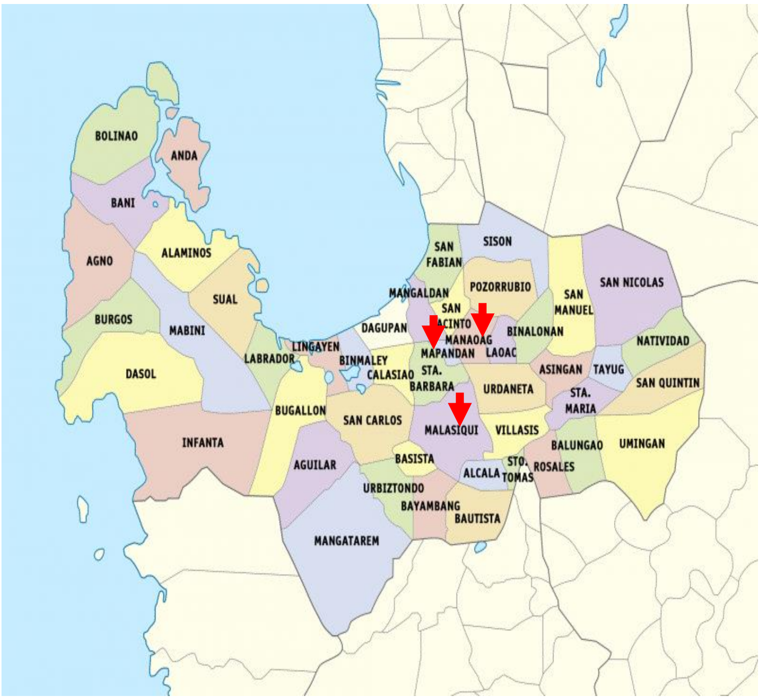
According to the interview from the LFTs in Nalsian, their satisfaction with NSIC Rc 346 and NSIC Rc 348 was high because of their high yielding. However, the yield of NSIC Rc 280 and NSIC Rc 282 was low because those were negatively impacted by the typhoon in 2016.

4. Data and Procedure

4.1 Data Collection and Sampling Method

This study performed a household survey with rice farmers in the three municipalities located in Pangasinan of the Philippines following: Manaoag; Mapandan; and Malasiqui (Figure 2). The respondent farmers were classified into farmers who participated in the FFS on Sustainable Rice Production in Rain-fed Areas in 2016 wet season and who did not. The participants of FFS are defined as farmers who graduated from the FFS in 2016 and have been cultivating rice in Manaoag (Nalsian), Mapandan (Luyan), or Malasiqui (Pasima). On the other hand, the non-participants of FFS are defined as farmers who did not attend the FFS or did not graduated from it yet, but cultivate rice in one of the three villages.

Figure 2. Map of the Survey Area in Pangasinan



Source: Wikipedia (2017.06.11), marked by authors.

For sampling, lists of participants and non-participants of the FFS were produced and validated, through the coordination from DoA. Before the survey, respondent farmers who would be interviewed in this study were randomly selected from the participant of FFS and non-participant of FFS groups in each village. A total 151 farmers engaging in rice farming activities in Manaoag (Nalsian), Mapandan (Luyan), or Malasiqui (Pasima) were interviewed. Among them, 76 farmers were participants of the FFS and 75 farmers where non-participants of the FFS (Table 2).

Table 2. 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

Surveybe, a computer-assisted personal interview (CAPI) software, was used to conduct the survey of this study. Four enumerators conducted the personal interviews, and they received the hands-on training on Surveybe before the survey to be familiar with the questionnaire and the Surveybe software.

4.2 Variables and Descriptive Statistics

The dependent variable used in our study is the status of farmers' willingness to adopt the drought tolerant rice varieties. We classified it into three categories following: 1) adoption; 2) willing to adopt; and 3) non-adoption. The adopters are defined as farmers who have planted the drought-tolerant rice varieties on their farm or farmers who have received or purchased them but did not plant them on their farm yet. Regarding farmers who have never received or purchased the drought-tolerant rice varieties but interested in planting them on their farm, we defined them as who are willing to adopt the varieties. Regarding the non-adoption status, farmers who never received or purchased the drought–tolerant rice varieties and do not need them on their field are classified into this status.

We selected independent variables based on previous studies as well as our hypothesis on farmers' adoption of the drought–tolerant rice varieties. We reflected village dummy to see regional differences in farmers' willingness to adopt the drought–tolerant rice varieties. Age of household head was reflected as an independent variable. In general, it is believed that with age, farmers accumulate more personal capital and thus, show a greater likelihood of investing in innovations (Nkamleu et al., 1998). However, it is also likely that farmers become less active in adopting new agricultural technology as they become old, while young farmers are more flexible and active for adopting the new technologies. In this regard, the expected sign of the coefficient on age is indeterminate.

In the Philippines, agricultural operators had a median age of 46 years (CAF, 2002). Agricultural operators are defined as a person who takes the technical and administrative responsibility of managing a holding. He or she is responsible for making and operating the holding, including the management and supervision of hired labor. The median age of male agricultural operators was 45 years old while among female operators was 56 years old, implying that female agriculture operators were older than their male counterpart (PSA, 2009). In Ilocos region, where Pangasinan is located, the majority of the operators, totaling 139.3 thousand, belonged to the 35 to 43 years old age group (PSA, 2004).

Gender of household head was reflected as a dummy variable (male=0, 1=female) in our study. It has been argued that female household heads lag behind in adopting agricultural technology because of their limited access to inputs and information. In this regard, the expected sign of the coefficient on the female household head is negative. In the Philippines, male operators have been dominating agriculture sector. Of the 4.8 million agricultural operators, 80% were males (CAF, 2002). In Ilocos Region, more male operators were engaged in agriculture than their female counterparts (CAF, 2004). Male operators accounted for 90.6% of the total agricultural operators in the region (CAF, 2002).

We included the marital status of the household head as a dummy variable (single, divorced, widow=0, married, living in=1). The relationship between marital status and technology adoption is hard to assume. In general, becoming a member of a family could operate as a social safety net. In this regard, we considered marrying could reduce farmers' subjective uncertainty on technology adoption since farmers could feel secure socially as they become a member of a family.

We included the number of years in farming for household head to reflect the effect of farming experience on their adoption the drought-tolerant rice varieties. It is expected that farmers become more favorable in receiving new agricultural information as they engage in agriculture longer. Adesina and Zinnah (1993) studied the effect of mangrove swamp rice farmers' perception of technology-specific characteristics on their decisions in Sierra Leone. By using tobit model, the study reflected years of experience in mangrove rice farming, expecting that it would be related to the ability of the farmer to obtain, process, and use information relevant to cultivation. As in this study, a positive relationship is hypothesized between the farming experience of household head and their agricultural technology adoption.

As a measurement of labor availability within a family, the number of household members was included by the gender of household members as well as their engagement sectors. The labor availability could affect farmers' decision for adopting new agricultural practices, depending on the characteristics of the new technologies. 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 adoption. Moreover, new technologies may increase the seasonal demand for labor, so that adoption is less attractive for those with limited family labor or those operating in areas with less access to labor markets (Feder et al., 1985). On the other hand, it is also expected that farmers become more positive in adopting the new agricultural technology if more household members can do farming activities or have enough access to agricultural information. In this regard, the expected sign of the coefficient on the number of household members is indeterminate. In the Philippines, the average household size (AHS) per household was 4.4 persons in 2015. Overall, the number of AHS decreased from 5.0 persons in 2000 and 4.6 persons in 2010 (PSA, 2015). Also, male operators dominated agricultural sector. Of the 4.8 million agricultural operators, 89% are male while only 11% are female (PSA, 2009). From 1999 to 2003, women's participation was significant in planting/transplanting, manual weeding, care of crops and harvesting. However, women's actual contribution to food production and the rural economy remains undervalued and invisible in the Philippines (FAO).

Years of receiving school education were included to reflect the education level of the household head. In general, education gives farmers the ability to perceive, interpret and respond to new information much faster than their counterparts without education (Feder et al., 1985). In this regard, a positive relationship is hypothesized between the education level of household and the probability of adopting the new technology. In the Philippines, about 56% of agricultural operators have an elementary education (CAF, 2002).

Farmers' perception and experience of weather events could affect their decision behavior. Although natural disaster imparts no new information, natural disasters affect behavior through their impact on estimates of background risk (Cameron and Shah, 2015). Ding et al. (2009) hypothesized that farmers' experience during past drought would change their expectations of future weather risk and water availability, and thus affect their investment decision in conservation tillage practices. The study showed that farmers' experience on dry conditions increases the adoption of both no-till and other conservation tillage practices. In this study, we asked farmers which month they experienced drought most severely during the last five years. To measure the effect of farmers' experience of drought events on their willingness to adopt the drought-tolerant rice varieties, we reflected the number of months experienced drought events. Given the rice production in the survey area has been impacted by *El Niño* steadily, we hypothesized the number of months when farmers experienced drought value would affect farmers' willingness to adopt the drought-tolerant rice varieties.

To investigate farmers' asset information, we collected the information on farm implements and machineries as well as household durables currently owned or sold during the last 12 months. 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). The lack of sufficient accumulated savings by farmers could prevent them from investing capital in new technologies. In this regard, the expected sign of the coefficient on the farm and household asset information is positive. Particularly, in the Philippines, the main cause of poverty is from high and persistent levels of inequality in incomes and assets, which dampen the positive impacts of economic expansion (Aldaba, 2009). Most vulnerable households engaged in the agricultural sector have few assets and have limited access to insurance and credit that would buffer them against income shocks resulting from bad harvests or inclement weather in the Philippines (Tabunda, 2000). To solve this problem, the government of the Philippines has been implementing several asset reform programs such as the Comprehensive Agrarian Reform Program for farmers; the Community Mortgage Program for informal settlers and the urban poor; and the Indigenous People's Rights Act. However, challenges are remaining to reduce the vulnerability of poor people by improving their human, physical, natural, financial, and social capital (Aldaba, 2009).

Farm size was reflected as an independent variable on the assumption that it would have a positive impact on farmers' agricultural technology adoption. In the Philippines, 5.56 million farms/holdings covering 7.19 million hectares, which translated to an average area of 1.29 ha per farm/holdings increased from 1980 to 2012 by 62.6%, as the mean area of farm/holdings decreased from 2.84% per farm/holding in 1980 to 1.29 hectare per farm/holding in 2012 (PSA, 2012). This trend could be accounted to the partitioning of farmers/holdings from one generation of agricultural holders/operators to their succeeding generation in the Philippines. Also, Philippines has a skewed distribution of landholdings, and its land inequality has spawned a continuing rural insurgency, which adds to investment uncertainties in rural areas (Aldaba, 2009).

Regarding the tenure status of farm household, some empirical studies found that farmer's tenure status could affect their technology adoption positively, conceptualizing the tenure status in different ways. Lee (1980) classified the tenure status into full-owner operators, part-owner operators, and non-operator landlords. Lynne et al. (1988) used dummy variables to distinguish operators as full-owners, owner renters or full-renters. Several studies sampled farm operators, using the proportion of farm acres that are rented to indicate tenure status (Rahm and Huffman, 1984, Belknap and Saupe, 1988). In our study, as a variable which represents farmer's tenure status, we reflected the proportion of farm land owned by the household member of the total farm lands 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.

To measure farmers' access to credit, we investigated whether they borrowed money from formal and informal sector during the last 12 months as well as the amount of money they borrowed. A majority of small farms reported the shortage of funds as a major constraint on adoption of the divisible technology such as fertilizer use (Wills, 1972, Khan, 1975, Frankel, 2015). Therefore, an improvement of access to formal credit could provide farmers with opportunities for adopting the new agricultural technology. In this study, a negative relationship was hypothesized between the total amount of money borrowed from informal sector and farmers' adoption of the drought-tolerant rice varieties.

Access to market is also one of important factors affecting agricultural technology adoption. The hypothesis is that the further away a farm or household is from input and output markets, the smaller is the likelihood that they will adopt new technology. 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). In our study, farmers' access to input and output markets for rice farming activities were measured with the closest distance from their house to input markets and output markets. We hypothesized a negative relationship between the distance from farmer's house to input and output traders and their adoption of the drought-tolerant rice varieties.

Farmer's exposure to agricultural information could affect their technology adoption. More exposure to appropriate information through various communication channels reduces their subjective uncertainty on technology adoption. A common proxy variable for measuring the extent of farmers' access to information was whether the farmer was visited by extension agents (Gerhart, 1975) or whether he attended demonstrations organized by the extension service or other agencies (Demir, 1976). In our study, we reflected the extent of farmers' participating into the FFS as ranked variables following: never; 1–2 times; 3–4 times; and more than five times.

Lastly, we reflected farmers' social networks information by using a proxy variable which represents years of residence in current villages. A social network is defined by individual members (nodes) and the links among them through which information, money, goods or services flow (Maertens and Barrett, 2012). Farmers' network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other (Foster and Rosenzweig, 1995). Sharing information about farming activities could reduce their risks on the adoption of new agricultural technology. In this regard, the expected sign on the coefficient on the years of residence on the current village is positive. Table 3 summarizes the measurement unit and expected sign of the coefficients on factors affecting farmers' adoption of the drought–tolerant rice varieties.

Table 3. 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 receiving education	Years	Positive
Farmer's perception and experience of weather events	Number of months experienced drought	Number	Positive
Farmers' asset	Total value of farm asset 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 sector	PESO	Negative
Access to market	Closest distance from house to input trader	Km	Negative
	Closest distance from house to output trader	Km	Negative
Access to agricultural extension service	Frequency of attending FFS ('0' =never, '1' =1-2 times, '2' =3-4 times, '3' =more than five times)	Ranked	Positive
Farmers' social networks	Years of residence in current villages	Years	Positive

Table 4 shows descriptive statistics of the dependent variable and independent variables used in this study. General household socioeconomic characteristics are already discussed in section 3. The proportion of land owned by household is 25%, implying that farmer's tenure status is weak in the survey area. Regarding access to input and output markets, the average distance from farmer's house to input traders is longer than the output traders. It is because several farmers in the survey area sell their outputs through direct visiting from output traders to their farmland. They prefer this way of selling because they could reduce time and costs for going to the output markets.

Table 4. Descriptive Statistics

Variables	Obs	Mean	Std.Dev.	Min	Max
Adoption status	151	1.92	0.47	1.00	3.00
Pasima	151	0.34	0.47	0.00	1.00
Luyan	151	0.39	0.49	0.00	1.00
Nalsian	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
NN of male engaged in agricultural sector	151	1.28	0.74	0.00	5.00
NN of female engaged in agricultural sector	151	0.50	0.55	0.00	2.00
NN of male engaged in non-agricultural sector	151	0.60	0.79	0.00	4.00
NN of female engaged in non-agricultural sector	151	0.49	0.82	0.00	5.00
Years of receiving education	151	9.90	2.94	3.00	21.00
Number of months experienced drought	151	1.82	1.25	0.00	6.00
Log(total value of farm asset and household durables)	151	12.54	2.12	0.00	16.62
Total farm size(including own and tenant status)	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	151	2.62	2.18	0.00	11.00
Distance from house to output trader	151	1.66	2.51	0.00	20.00
Frequency of attending FFS (‘0’=never, ‘1’=1-2 times, ‘2’=3-4 times, ‘3’=more than 5 time)	151	0.87	0.88	0.00	3.00
Years of residence	151	39.70	21.11	1.00	82.00

4.3 Random Utility Model with Ordered Data

As independent variables in this study, we reflected factors affecting agricultural technology adoption in the innovation-diffusion model, the economic constraints model, and technology characteristics-user's context model. In general, decisions of a farmer in a given period are assumed to be derived from the maximization of expected utility (or expected profit) subject to land availability, credit, and other constraints (Feder et al., 1985).

Following the random utility model developed by McFadden (1974), assume that individual i derives from staying in j status of adopting the drought-tolerant rice varieties. The utility function of individuals is postulated to have a systematic component (V_{ij}) and a random component (e_{ij}), according to their adoption status. Individuals make the choice that provides the highest utility:

$$U_{ij} = V_{ij} + e_{ij}; \quad V_{ij} = \mathbf{x}_{ij}\boldsymbol{\beta} \tag{1}$$

The systematic component V_{ij} is a function of observable characteristics (x_{ij}) of farm household that could affect farmers' willingness to adopt the drought-tolerant rice varieties. The adoption status is classified into three categories: non-adoption ($j = 1$); willing to adopt ($j = 2$); and adoption ($j = 3$). We only observe the adoption choices of the farm households, rather than observing their utility. As the utility is random, the i th household will select the alternative 'adoption' if and only if $U_{i3} > U_{i2}$ and 'willing to adopt' if and only if $U_{i2} > U_{i1}$.

We used an ordered probit and logit model as an estimation method. The ordered probit model is a generalization of the popular probit analysis in the case of more than two outcomes of an ordinal dependent variable. McKelvey and Zavoina (1975) used this model for identifying ranked dependent variables. It is usually estimated by the maximum likelihood method, which provides a means of choosing an asymptotically efficient estimator for a parameter or a set of parameters. The model begins as:

$$y^* = \mathbf{x}'\boldsymbol{\beta} + \varepsilon \tag{2}$$

In general, y^* is unobserved and what we can observe is:

$$\begin{aligned} y &= 0 \ \text{ if } \ y^* \leq 0, \\ &= 1 \ \text{ if } \ 0 < y^* \leq \mu_1 \\ &= 2 \ \text{ if } \ \mu_1 < y^* < \mu_2, \\ &\ \ \vdots \\ &= J \ \text{ if } \ \mu_{J-1} < y^*, \end{aligned} \tag{3}$$

The above equation is a form of censoring. The μ is defined as unknown parameters to be estimated with $\boldsymbol{\beta}$. The determinants of farmers' willingness to adopt the drought-tolerant rice varieties depend on certain measurable factors $\mathbf{x}$ and certain unobservable factors ε. Here, ε is assumed to be normally distributed across observations, and the mean and variance of ε are normalized to zero and one. The following probabilities are induced.

$$
\begin{aligned}
&\text{Prob}(y = 0|\mathbf{x}) = \Phi(-\mathbf{x}'\boldsymbol{\beta}),\\
&\text{Prob}(y = 1|\mathbf{x}) = \Phi(\mu_1 - \mathbf{x}'\boldsymbol{\beta}) - \Phi(-\mathbf{x}'\boldsymbol{\beta}),\\
&\text{Prob}(y = 2|\mathbf{x}) = \Phi(\mu_2 - \mathbf{x}'\boldsymbol{\beta}) - \Phi(\mu_1 - \mathbf{x}'\boldsymbol{\beta}),\\
&\quad\vdots\\
&\text{Prob}(y = J|\mathbf{x}) = 1 - \Phi\left(\mu_{J-1} - \mathbf{x}'\boldsymbol{\beta}\right). \qquad (4)
\end{aligned}
$$

Φ is the cumulative distribution function of the standard normal distribution. The parameters $\boldsymbol{\beta}$ are estimated by maximum likelihood and $\mathbf{x}'$ is a vector of exogenous variables which explains farmers' adoption of the drought-tolerant rice varieties. The following condition is required for all of the probabilities to be positive.

$$0 < \mu_1 < \mu_2 < \cdots < \mu_{J-1}. \qquad (5)$$

Probit and logit models are basically the same, but the difference is in the distribution. In the logit model, ε is assumed to be logistically distributed across observations, thus the probability follows cumulative standard logistic distribution following:

$$\begin{aligned}
\text{Prob}(y=0) &= \frac{1}{1+\exp(-\mathbf{x}'\boldsymbol{\beta})}, \\
\text{Prob}(y=1) &= \frac{1}{1+\exp(\mu_1-\mathbf{x}'\boldsymbol{\beta})} - \frac{1}{1+\exp(-\mathbf{x}'\boldsymbol{\beta})}, \\
\text{Prob}(y=2) &= \frac{1}{1+\exp(\mu_2-\mathbf{x}'\boldsymbol{\beta})} - \frac{1}{1+\exp(\mu_1-\mathbf{x}'\boldsymbol{\beta})}, \\
&\vdots \\
\text{Prob}(y=J) &= 1 - \frac{1}{1+\exp(\mu_{J-1}-\mathbf{x}'\boldsymbol{\beta})}.
\end{aligned} \tag{6}$$

In both probit and logit model, The sign of parameters $\boldsymbol{\beta}$ shows whether the latent variable y^* increases or decreases with the regressors $\mathbf{x}$. The marginal effects can be explained as each unit increase in the independent variable increases or decreases the probability of selecting alternative j by the marginal and is expressed as a percentage. The probit and logistic distribution is similar, but the logistic distribution has fatter tails. However, the difference in the distribution hardly has meaningful impact on marginal effects.

5. Results

5.1 Maximum Likelihood Estimation Results

Table 5 provides the estimation results. Make sure that 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. Overall, farmers' adoption of the drought tolerant rice varieties is positively affected by the following factors: experience on drought events; household and farm assets; borrowing money from informal sector; distance from the house to input trader; participation in the FFS; and years of residence. The sign of parameters is same in both ordered probit and logit estimation.

Farmer's perception and experience of drought events are positively related to their adoption willingness, meaning that they are more likely to adopt the drought tolerant rice varieties as the number of months affected by drought increases. As farmers are exposed to adverse impacts of drought events, they realize the necessity of planting the drought-tolerant rice varieties. This experience could improve their understanding of drought phenomenon and perception on the function of the drought-tolerant rice varieties. Thus, it could increase farmers' willingness to plant the drought-tolerant rice varieties, thereby contributing to reducing their uncertainty on the varieties. In this regard, as expected, the severity of experiencing drought events positively affects farmers' willingness to adopt the 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 household durables and farm assets increases. Their accumulation of savings could contribute to investing capital in new technologies. Therefore, the positive relationship between farm and household assets and the adoption status is consistent with our expectation results.

Access to credit also affects farmers' adoption status of drought tolerant rice varieties, but the sign of the coefficient is different from our expectation 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. As the frequency of attending the FFS increases, they are more likely to adopt the drought tolerant rice varieties. In general, through FFS, farmers attain information related to agricultural technology such as seedling rate, the amount of fertilizer, and IPM. Morevoer, newly developed crop varieties are introduced during the implementation period of the FFS. It provides opportunities to farmers for learning knowledge on the function of the newly developed crop varieties, by reducing their risk attitudes for the varieties.

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

On the other hand, farmers' willingness to adopt the drought-tolerant rice varieties is negatively affected by following variables: residing in Pasima or Luyan; the number of female household members engaged in the agricultural sector; and distance from the house to output trader.

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

Regarding the household labor force information, farmers are less likely to adopt the drought-tolerant rice varieties as the number of female household members engaged in agricultural sector increases within their family. It implies that households who have a large number of women members involved in the agricultural sector are reluctant to adopt drought-tolerant rice varieties. This result is related to the fact that the labor force structure according to gender within the household affects farmers' adoption of the drought-tolerant rice varieties. It is speculated that female farmers lack information on the drought-tolerant rice varieties relatively, which affects their negative or unfamiliar attitude on the drought-tolerant rice varieties.

Access to output market for rice farming activities 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 increase. It shows that farmers consider their access to output market importantly in adopting new varieties for selling them in markets.

The thresholds, or cut points, reflect the predicted cumulative probabilities at covariate of zero. Those coefficients on cut1 and cut2 are the estimates of the cut points μ_1 and μ_2 by maximum likelihood procedure. We tested for the equality of theses cut points to identify whether they are different from each other. The estimated value of chi-square (χ^2) is 68.87 and 55.92 in ordered probit and logit estimation, respectively. In this regard, the null hypothesis assuming the equality of the cut points were rejected in both models.

Regarding the significance of the cut points, the coefficient on the cut point μ_2 was statistically significant, while that of the cut−point μ_1 was insignificant. This is because we could identify a small number of adopters of the drought−tolerant rice varieties in the survey area.

Table 5. Determinants of Farmers' Adoption of the Drought-tolerant Rice Varieties in Pangasinan, the Philippines

Dependent variable: adoption status	Ordered probit model	Ordered logit model
Pasima	−1.612***	−2.783***
	(0.472)	(0.869)
Luyan	−0.832**	−1.370*
	(0.412)	(0.780)
Age of household head	−0.0121	−0.0198
	(0.0203)	(0.0367)
Gender of household head	0.462	0.815
	(0.514)	(0.903)
Marital status of household head	−0.706	−1.305
	(0.619)	(1.135)
Farming experience	−0.0113	−0.0198
	(0.0155)	(0.0282)
Number of male engaged in agricultural sector	0.219	0.371
	(0.214)	(0.426)
Number of female engaged in agricultural sector	−0.729**	−1.208**
	(0.306)	(0.552)
Number of male engaged in non-agricultural sector	−0.107	−0.165
	(0.208)	(0.388)
Number of female engaged in non-agricultural sector	0.199	0.328
	(0.204)	(0.363)
Education of household head	0.0356	0.0831
	(0.0520)	(0.0952)
Number of months experienced droughts	0.282**	0.526**
	(0.138)	(0.258)
Log of household durables and farm asset	0.157**	0.255*
	(0.0710)	(0.145)
Total farm size	−0.0514	−0.0974
	(0.147)	(0.271)
Proportion of farmland owned	−0.537	−1.017
	(0.394)	(0.751)
Log of amount of money borrowed from informal sector	0.0999***	0.187***
	(0.0373)	(0.0704)
Distance from house to input trader	0.149**	0.246*
	(0.0729)	(0.136)
Distance from house to output trader	−0.213***	−0.391***
	(0.0823)	(0.148)
Frequency of attending FFS	0.815***	1.511***
	(0.209)	(0.385)
Years of residence	0.0308***	0.0556***
	(0.0103)	(0.0197)
Constant cut1	0.929	1.700
	(1.361)	(2.533)
Constant cut2	5.474***	9.892***
	(1.503)	(2.844)
Observations	151	151
Log likelihood	−55.9127	−56.4444
Log likelihood ratio $\chi^2(20)$	92.06	90.99
Prob>χ^2	0.0000	0.0000
Pseudo R^2	0.4515	0.4463

Note: Standard errors in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

NN of adoptor=11, NN of partial-adoptor=117, NN of non-adoptor=23

5.2 Marginal Effects

Defined as each unit increases or decreases the probability of selecting alternative adoption status y expressed as a percentage, the marginal effects of each variable can be calculated from the estimated coefficients. Table 6 shows the marginal effects in each adoption status, respectively. The marginal effects are explained focusing on the level of adoption status $(y_i = 3)$ in ordered probit estimation.

The probability of household adopting the drought-tolerant rice varieties reduces (12.4%) if farmers live in Pasima village compared to residing in Nalsian village. Besides, the probability of household who does not adopt the drought-tolerant rice varieties increases (10.3%) when farmers reside in Luyan village compared to living in Nalsian village. It implies that farmers living in Nalsian village are more likely to adopt the drought-tolerant rice varieties, compared to farmers residing in Pasima and Luyan village. The reason for this could be ascribed to the fact that LFTs in Pasima village are managing their demonstration plots, but they do not live in the village. It could affect the interaction between the LFTs and local farmers to be less active.

The probability of household adopting the drought tolerant rice varieties is reduced (5.6%) as the number of the female households engaged in agricultural sector increases, given that the rest predictors are set to their mean values. It implies that female household members involved in agricultural sector lack information on the drought-tolerant rice varieties. At present, in the survey area, it is early in the adoption of the drought-tolerant rice varieties, because the PhilRice distributed a small amount of the varieties to LFTs through the FFS during the wet season of 2016. Considering that most of the participants of FFS are male household in the survey area, it is expected that the female household members do not receive enough information on the drought-tolerant rice varieties, which affects their uncertainty on the newly developed varieties.

An increase of the number of months experienced drought events is associated with more likely to adopt the drought-tolerant rice varieties (2.2%). It is speculated that farmers become more aware of the necessity of the drought-tolerant varieties, as they are more exposed to the adverse effects of drought events. According to our survey, 93% of respondent farmers replied that they experienced drought events and 91% of them responded that the drought events negatively affected their farming activities during the last five years.

Household asset and access to credit also affect farmer's adoption of the drought-tolerant rice varieties. Each variable was reflected as a log-transformed value, which measures the total value of household durables and farm assets and the proportion of money borrowed from the informal sector, respectively. The marginal effects could be explained as following. The probability that a farmer adopt the drought-tolerant rice varieties increases by 0.012 on a [0,1] scale for a 1% increase in the household durables and farm asset. Also, the probability increases by 0.008 for a 1% increase in the amount of money borrowed from the informal sector, also on a [0,1] scale. It implies that farmers are more likely to adopt the drought-tolerant rice varieties as the value of their household durables and farm assets increases. It is expected that farmers tend to take the initiative in planting the newly developed rice varieties when they feel secure from their accumulated assets. It is because the abundance of household and farm assets could reduce their risk attitudes, which operates as an offset for the loss of agricultural production resulted by planting the newly crop varieties.

Regarding the access to credit, farmers are more likely to adopt the drought-tolerant rice varieties as the amount of money borrowed from informal sector increases. The estimation result is opposite to our expectation, which assumes the expected sign on the coefficient on the access to formal credit is positive. It implies that farmers are willing to adopt the drought-tolerant rice varieties even though they borrow money from the informal sector. It is speculated that farmers' access to formal sector does not substantially affect their adoption of the drought tolerant rice varieties. Moreover, by comparing the size of the marginal effects on the household and farm asset and access to credit, it appears that farmers' asset is more influential factors than their access to credit.

An increase of the distance from the house to closest output trader is associated with less likely to adopt the drought tolerant rice varieties (1.6%) and more likely to not to adopt the varieties (2.6%), respectively. It appears that farmers consider selling their farm products importantly than purchasing input materials for their farming activities. They tend to be more actively adopt the drought tolerant rice varieties if they have access to output markets securely.

Access to agricultural extension services also affects farmers' adoption of the drought-tolerant rice varieties. An increase of the frequency of attending the FFS is associated with more likely to adopt the drought tolerant rice varieties (6.3%). It implies that the implementation of the FFS could be a useful method for providing farmers with new agricultural information. Since the information on the drought-tolerant rice varieties has been delivered through the FFS and demonstration plots managed by the LFTs, it appears that the FFS has been playing its role as extension services in the survey area.

Lastly, an increase of the years of residing in current area is associated with more likely to adopt the drought tolerant rice varieties (0.2%), showing that farmers' social interaction could affect their perception and acceptance of the newly developed rice varieties.

The marginal effects estimated from the ordered logit model are similar with those estimated from ordered probit model. However, the marginal effects of household durables and farm asset are insignificant in the ordered logit estimation results (Table 7).

Table 6. Marginal Effects in Ordered Probit Model

Dependent variable: adoption status	Non-adoption (Y=1)	Willing to adopt (Y=2)	Adoption (Y=3)
Pasima	0.201***	−0.076*	−0.124**
	(3.81)	(−2.04)	(−2.98)
Luyan	0.103*	−0.039	−0.064
	(2.08)	(−1.54)	(−1.95)
Age of household head	0.002	−0.001	−0.001
	(0.60)	(−0.59)	(−0.59)
Gender of household head	−0.058	0.022	0.036
	(−0.91)	(0.87)	(0.88)
Marital status of household head	0.088	−0.033	−0.054
	(1.14)	(−1.00)	(−1.14)
Farming experience	0.001	−0.001	−0.001
	(0.73)	(−0.69)	(−0.72)
Number of male engaged in agricultural sector	−0.027	0.010	0.017
	(−1.03)	(0.93)	(1.02)
Number of female engaged in agricultural sector	0.091*	−0.034	−0.056*
	(2.44)	(−1.62)	(−2.33)
Number of male engaged in non-agricultural sector	0.013	−0.005	−0.008
	(0.51)	(−0.50)	(−0.51)
Number of female engaged in non-agricultural sector	−0.025	0.009	0.015
	(−0.97)	(0.86)	(0.99)
Education of household head	−0.004	0.002	0.003
	(−0.68)	(0.64)	(0.68)
Number of months experienced droughts	−0.035*	0.013	0.022*
	(−2.07)	(1.52)	(1.98)
Log of household durables and farm asset	−0.020*	0.007	0.012*
	(−2.30)	(1.62)	(2.13)
Total farm size	0.006	−0.002	−0.004
	(0.35)	(−0.34)	(−0.35)
Proportion of farmland owned	0.067	−0.025	−0.041
	(1.37)	(−1.17)	(−1.34)
Log of amount of money borrowed from informal sector	−0.012**	0.005	0.008*
	(−2.73)	(1.73)	(2.50)
Distance from house to input trader	−0.019*	0.007	0.011
	(−2.18)	(1.69)	(1.91)
Distance from house to output trader	0.026**	−0.010	−0.016*
	(2.70)	(−1.79)	(−2.36)
Frequency of attending FFS	−0.101***	0.039	0.063***
	(−3.85)	(1.82)	(3.72)
Years of residence	−0.004***	0.001*	0.002*
	(−3.35)	(2.09)	(2.57)
Observations		151	

Note: t statistics in parenthesis
*** p<0.01, ** p<0.05, * p<0.1
NN of adoptor=11, NN of partial-adoptor=117, NN of non-adoptor=23

Table 7. Marginal Effects in Ordered Logit Model

Dependent variable: adoption status	Non-adoption (Y=1)	Willing to adopt (Y=2)	Adoption (Y=3)
Pasima	0.193***	−0.077*	−0.117**
	(3.57)	(−2.08)	(−2.74)
Luyan	0.095	−0.038	−0.058
	(1.79)	(−1.43)	(−1.68)
Age of household head	0.001	−0.001	−0.001
	(0.54)	(−0.53)	(−0.54)
Gender of household head	−0.057	0.022	0.034
	(−0.91)	(0.87)	(0.88)
Marital status of household head	0.091	−0.036	−0.055
	(1.15)	(−1.00)	(−1.15)
Farming experience	0.001	−0.001	−0.001
	(0.70)	(−0.67)	(−0.70)
Number of male engaged in agricultural sector	−0.026	0.010	0.016
	(−0.87)	(0.81)	(0.87)
Number of female engaged in agricultural sector	0.084*	−0.033	−0.051*
	(2.20)	(−1.55)	(−2.12)
Number of male engaged in non-agricultural sector	0.012	−0.005	−0.007
	(0.43)	(−0.42)	(−0.42)
Number of female engaged in non-agricultural sector	−0.023	0.009	0.014
	(−0.90)	(0.82)	(0.90)
Education of household head	−0.006	0.002	0.003
	(−0.88)	(0.81)	(0.87)
Number of months experienced droughts	−0.037*	0.015	0.022*
	(−2.08)	(1.53)	(1.97)
Log of household durables and farm asset	−0.018	0.007	0.011
	(−1.78)	(1.41)	(1.70)
Total farm size	0.007	−0.003	−0.004
	(0.36)	(−0.35)	(−0.36)
Proportion of farmland owned	0.071	−0.028	−0.043
	(1.37)	(−1.16)	(−1.35)
Log of amount of money borrowed from informal sector	−0.013**	0.005	0.008*
	(−2.72)	(1.78)	(2.41)
Distance from house to input trader	−0.017	0.007	0.010
	(−1.93)	(1.59)	(1.71)
Distance from house to output trader	0.027**	−0.011	−0.016*
	(2.77)	(−1.83)	(−2.39)
Frequency of attending FFS	−0.105***	0.042	0.063***
	(−3.87)	(1.83)	(3.76)
Years of residence	−0.004**	0.002*	0.002*
	(−3.16)	(2.09)	(2.42)
Observations		151	

Note: t statistics in parenthesis

*** p<0.01, ** p<0.05, * p<0.1

NN of adoptor=11, NN of partial-adoptor=117, NN of non-adoptor=23

6. Conclusion

Comparing the size of the marginal effects allows us to prioritize which support could be useful for facilitating farmers' adoption of the drought-tolerant rice varieties in Pangasinan, the Philippines. First of all, it is required to reduce the difference in adoption of the drought-tolerant rice varieties by villages. Farmers in Pasima and Luyan are less likely to adopt the drought-tolerant rice varieties compared to the farmers living in Nalsian. The LFTs in Nalsian have been not only managing their demonstration plots but also living in the village, which could contribute to more active communication or interaction between them and local farmers compared to the other two villages. Given that the percentage of farmers affected by drought is the highest in Pasima, it is recommended to facilitate farmers' adoption of the drought tolerant rice varieties in the village by disseminating the information on the drought-tolerant rice varieties to local farmers more actively.

For it to do so, the PhilRice needs to increase the availability of the newly developed rice varieties, and the DoA needs to provide farmers with the information on the varieties through FFS. At present, the most significant obstacle for facilitating farmers' adoption of the drought-tolerant rice varieties is the availability of the seeds, according to the interviews with municipal agriculturists in the survey area. Moreover, the role of LFTs needs to be enhanced in showcasing the potential of cultivating the varieties to local farmers. By utilizing the demonstration plots in each village, the LFTs needs to reduce farmers' risk attitudes on the drought-tolerant rice varieties and more actively exchange the seeds with the farmers.

Second, the estimation results showed that participating in the FFS positively affects farmers' willingness to adopt the drought-tolerant rice varieties. The FFS, which is an agricultural extension service, has been an effective method for improving farmers' perception on the drought-tolerant rice varieties. In this regard, it is recommended to actively deliver the information on the drought-tolerant rice varieties and cultivation methods to farmers through FFS. Furthermore, encouraging non-participants of FFS to participate in the FFS could be useful.

Third, it is recommended to provide female farmers with enough information on the drought-tolerant rice varieties. It appears that female farmers have limited availability and information on the drought-tolerant rice varieties. It is because most of the participants of the FFS have been male households and farmers have mainly attained the information on the drought-tolerant rice varieties through the FFS in the survey area.

Fourth, increasing the availability of seeds among farmers who experienced the negative impacts of drought events could be useful for facilitating farmers' adoption of the drought-tolerant rice varieties. Since over 90% of farmers in the three villages replied that they have been affected by droughts during the last five years, cultivating the drought-tolerant rice varieties could contribute to increasing their capacity to cope with climate change and natural disasters.

Fifth, it is required to facilitate farmer's access to output markets for their rice farming activities. It was found that the access to output market is more influential factors affecting their adoption status. In this regard, it is required to secure their access to output markets, by creating sale channels for selling their farm products. At present, most of the farmers who have been cultivating the drought-tolerant rice varieties are consuming them by themselves, because the amount of seeds provided from the PhilRice is insufficient for them to produce enough rice to sell to the markets. In this regard, creating linkages between farmers' adoption of the varieties and their income increase could encourage them to adopt the varieties. It is likely that farmers have a strong willingness to sustain agricultural technologies if they realize that the technologies could contribute to their income increase and livelihoods improvement.

Lastly, utilizing farmers' social networks could be useful for disseminating the information on the drought-tolerant rice varieties among them. Farmers are more likely adopt the varieties as they live in the current village longer. In this regard, farmers' interaction and communication play a role in improving their perception on new crop varieties and sharing of agricultural information between them. Therefore, increasing the availability of the drought-tolerant rice varieties through community organization or agricultural cooperatives could be helpful.

Furthermore, it appears that the abundance of their assets influences their willingness to adopt the newly developed varieties, allowing them to become more favorable to them. Considering that difference in household assets is high among the surveyed farmers, it is recommended to make efforts for reducing the asset inequality in the survey area. In the Philippines, to reduce the inequality of asset and distribute land in the rural areas, the government has been implementing the Comprehensive Agrarian Reform Program. However, there have been delays in the full implementation of the program. In Phase I of land distribution, about one million hectares including rice and corn lands, idle lands, and certain agricultural lands held by the government were transferred to private owners. Phase II implemented only 23% of the targeted 7.66 ha, including other public agricultural lands and all private agricultural holdings more than 50 ha. The third and final phase of the program is yet to be fully implemented, but the possible extension of the program has been stalled in Congress (Aldaba, 2009). In this regard, more active efforts are required to reduce the asset inequality in the

Philippines.

This study has limitations in that it could not identify enough number of adoptors and measure the degree of farmers' adoption willingness specifically because the time of the survey was too early to find final adoptors of the drought-tolerant rice varieties. However, this study could be helpful for understanding farmers' obstacles for using newly developed rice varieties, thus contributing to finding out effective strategies in the early diffusion process of agricultural technology in Pangasinan, the Philippines.

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Appendix 1. Survey Questionnaire

IRB No. 1702/002-015 유효기간: 2018년 2월 12일

Explanation and Consent Form for Participant in a Research Study

Dear Respondent,

This study aims for identifying the factors affecting farmer's adoption on the drought-tolerant rice varieties in Pangasinan, the Philippines. By performing household survey toward farmers who have been or not have been adopting the drought-tolerant rice varieties introduced by CURE project, this research will try to find out effective implications for disseminating the improved rice varieties in Pangasinan. In particular, this study will focus on the network effects among farmers and the role of extension services to find out the effects of those factors on farmers' agricultural technology adoption.

The researcher, Sunmee Cho, is attending master degree in Graduate School of International Agricultural Technology in Seoul National University, Republic of Korea. Her email address is sunmeecho9211@gmail.com. The researcher and Filipino survey team members will explain the purpose and details of the survey to you.

This consent form will offer you enough information about the rationale for this survey. Furthermore, the researcher and Filipino survey team members will explain to you any possible risks of discomforts that you may face while you are participating in the survey. We kindly encourage you to take time to think about your decision whether to participate in the survey or not. If you decide to participate in the survey, the researcher and the Filipino survey team members will ask you to sign the consent form. If you any further questions, please do not hesitate to ask us.

1. Purpose of study: This study aims for finding out factors affecting farmers' adoption on the drought-tolerant rice varieties in Pangasinan, the Philippines.
2. Eligibility of survey participants: This study aims for performing household survey towards 150 farmers in Pangasinan, the Philippines. The survey will be only conducted with each head of household or his or her spouse aged between 18 and 65 years old.
3. Process of participation: The researcher and the Filipino survey team members will kindly ask you to participate in the survey, explaining the purpose and contents of the survey in detail. Once you agree to participate in the survey, we will distribute our prepared questionnaire. You are kindly invited to answer the questions step by step and you can ask any questions during answering if you do not understand the questions. The survey will takes less than 45 minutes to complete. If you feel uncomfortable or do not want to participate in the survey anymore, please kindly let us know so that we can help you to stop your participation in the survey.
4. Risks and benefits from participation: There are no risks existing regardless of your participation in the survey. As a repayment for your valuable participation in the survey, we would like to give you some snacks or souvenir. The long terms benefits are not known at present.
5. Protection of your information: The researcher will keep all records, including the all the codes from your data in confidential. Your responses will be kept strictly anonymous. The researcher promises not to provide your personal information such as your name and village name to anyone. Deliberate Council of Life Ethics, Seoul National University may ask the researcher to provide result to verify reliability of survey information due to university regulations. The researcher will continue to keep your personal information confidential even in this case. Your signature on this consent form will indicate that you have been provided with the preceding information and agree to it.

IRB No. 1702/002-015 유효기간: 2018년 2월 12일

Subject Statement of Voluntary Consent

1. I have read this form and discussed the information with the researcher.
2. I have been informed about the risks and benefits of the study, and I am satisfied with the answers that were provided.
3. I agree to participate voluntarily.
4. I agree to the fact that the researcher is going to collect my personal information according the regulations of the Deliberate Council of Life Ethics, Seoul National University.
5. I agree to the process of this research and management of the results. If the Deliberate Council of Life Ethics, Seoul National University inspects the research to verify reliability of survey information, I agree to give them my personal information for this official purpose.
6. I know the fact that I had the opportunity to stop participating in the study. I understand there will be no disadvantage to me even though I decided not participate in this survey.
7. My signature indicates that I have been given a copy of this signed Informed Consent Form and I will keep this copy until research is completed.

Participant Signature:	Print Name:	Date (YY/MM/DD):
Signature of Person Obtaining Consent	Print Name:	Date (YY/MM/DD):
Researcher	Print Name: Sunmee Cho	Date (YY/MM/DD):

IRB No. 1702/002-015 유효기간: 2018년 2월 12일

Survey on Drought-prone Environments
Consortium for Unfavorable Rice Environments
International Rice Research Institute

RESPONDENT NUMBER
For use of office editors only.
Do not fill-out.

Respondent name ______________________
The respondent is the person who answers below survey question.

Province ______________ ☐☐

Municipality ______________ ☐☐

Village ______________ ☐☐

Start time of survey ______________
Record the month, day and year of interview.

Enumerator ______________ ☐☐
Name of interviewer.

Thank you for the opportunity to speak with you. We are a research team from International Rice Research Institute (IRRI). In this survey, we intend to learn about rice farming households in your area.

IRB No. 1702/002-015 유효기간: 2018년 2월 12일

Your household has been selected at random to participate in an interview that includes questions on topics about your agricultural production. This interview will take approximately 45 minutes and your participation is voluntary. Your answers will be confidential.

1. **Characteristics of household**

1) Household information

No.	Questions	Answers
1	Respondent's relationship with the household head	1) Self (household head) 2) Spouse 3) Child 4) Parent 5) Grandchild 6) Relative 7) Sister/brother, include in-law sister/brother 8) Daughter/son in law 9) Other (Please state):
2	Age of the household head (years)	
3	Gender of the household head	1) Male 2) Female
4	Marital status of the household head	1) Single 2) Married/ Living-in 3) Divorced 4) Widow/ widower 5) Separated 6) Other (Please state):
5	Farming experience of the household head (Number of years in farming)	Number of Years:
6	Number of household members As household members, include family and non-family members living in the same house and taking food from the same kitchen during the survey period.	1) Male<15: 2) Male≥ 15: 3) Female<15: 4) Female≥15:

2) Employment and education information

No.	Questions	Answers
1	Education of household head (number of years in school)	Number of Years:
2	Primary occupation of household head (Record the major occupation that takes up most of the time.)	1) working on agricultural farms 2) salary and wages 3) wholesale and retail trade 4) transportation, storage and communication services 5) construction 6) other (please state):
3	Number of household members engaged in agricultural activity (see Income Source Information) As household members, include family and non-family members living in the same house and taking food from the same kitchen during the survey period.	1) Male: 2) Female:
4	Number of household members engaged in non-agricultural activity (see Income Source Information) As household members, include family and non-family members living in the same house and taking food from the same kitchen during the survey period.	1) Male: 2) Female:

INCOME SOURCE INFORMATION

Agriculture agricultural activities included working on agricultural farms including crop farming or livestock field

Non-agriculture include following sectors:

- Salary and wages (of **all Household Members**) from government or private employment
- Wholesale and retail trade including market vending, sidewalk vending and peddling, selling groceries, beverages, snacks, and farm products, etc
- Transportation, storage and communication service such as operation of tricycle, lorries, jeepneys, pedicabs; storage and warehousing activities,

messengerial services, telephone rentals, etc.
- Construction like repair of houses, building or and structure

3) Farm and household asset information

Collect information on all household durables and farm implements/machineries currently owned or sold during the last 12 months by the household.

HOUSEHOLD DURABLES	Check the durables currently owned by the household.	Number of units owned by the household	Current value NOTE: If the item was sold, leave blank (Unit: PESO)	Check the durables sold during the last 12 months by the household.	Number of units sold during the last 12 months by the household	If the item was sold, by how much? NOTE: Blank if item was not sold (Unit: PESO)
Residential lot	☐			☐		
Residential house	☐			☐		
Business land	☐			☐		
Business building	☐			☐		
Radio/Component	☐			☐		
Television	☐			☐		
VHS/VCD/DVD	☐			☐		

player						
Electric fan/ Air conditioner	☐			☐		
Refrigerator	☐			☐		
Gas range/ Gas stove	☐			☐		
Washing machine	☐			☐		
Laptop/ computer	☐			☐		
Cell phone	☐			☐		
Bicycle	☐			☐		
Motorcycle	☐			☐		
Car	☐			☐		
Other:	☐			☐		

FARM ASSETS AND MACHINERY	**Check the farm assets and machinery currently owned by the household.**	**Number of units owned by the household**	**Current value** **NOTE: If the item was sold, leave blank** **(Unit: PESO)**	**Check the durables sold during the last 12 months by the household.**	**Number of units sold during the last 12 months by the household**	**If the item was sold, by how much?** **NOTE: Blank if item was not sold** **(Unit: PESO)**
Farm land (Area: ______)	☐			☐		
Combined harvest thresher	☐			☐		
Mechanized reaper	☐			☐		
2-wheel tractor	☐			☐		

Big tractor	☐			☐		
Drum row seeder	☐			☐		
Rotary weeder	☐			☐		
Irrigation pump	☐			☐		
Thresher	☐			☐		
Sprayer	☐			☐		
Plow	☐			☐		
Harrow	☐			☐		
Rice miller/huller	☐			☐		
Corn sheller	☐			☐		
Sugarcane crusher	☐			☐		
Other:	☐			☐		

4) **Landholdings**

Include ALL parcels owned and/or cultivated by the respondent during the last 12 months. A parcel is a contiguous piece of land cultivated by the farmer.

Parcel no.	Area (ha)	Land type	Soil type	Tenure status	Source of water
Assign an arbitrary number. Split parcel into plots if parcel has more than 1 land type or soil type.	**Record the area of parcel/plot whether planted or unplanted.**	**Record land type.** **1) Lowland** **2) Medium** **3) Upland**	**Record the soil type.** **1) Clay** **2) Loam** **3) Sandy** **4) Silt** **5) Others (please state)**	**1) Owned** **2) Rented in** **3) Rented out** **4) Share-crop** **5) Government-owned** **6) Mortgaged**	**Record the major source of water for this plot.** **1) Rain** **2) Spring/ River/ Creek** **3) Irrigation** **4) Shallow tube well** **5) Pond**

					6) Others (please state)

5) **Access to credit**

No.	Questions	Answers
1	Have you or your household members borrowed money during the last 12 months?	1) Yes (go to No.2) 2) No (go to next section)

2	If yes, from whom did you or your household members borrow money most frequently?	1) Banks 2) Traders 3) NGO 4) Government 5) Credit cooperatives	6) Relatives 7) Friends 8) Employer 9) Informal credit 10) Other source (Please state):
3	If yes, how much is the total amount of money borrowed by you or your household members during the last 12 months? (Unit: PESO)		

6) **Access to inputs and output markets for rice farming activities**

No.	Questions	Answers
1	What is the closest distance from your house or farm to input traders?	1) From house to input traders:_______ km 2) From farm to input traders: _______ km
2	What is the closest distance from your house or farm to output traders?	1) From house to output traders: _______ km 2) From farm to output traders: _______ km

7) **Access to agricultural extension services**

No.	Questions	Answers
1	Do you have access to extension worker/s for your agricultural activities? (**Agricultural extension** is the application of scientific research and new knowledge to agricultural practices through **farmer education**.)	1) Yes (go to No.2) 2) No (go to next section)
2	If yes, how often do you see extension worker/s??	1) At least once a week 2) At least monthly 3) Occasionally
3	If yes, who provided the extension service for your agricultural activities most frequently?	1) local government office 2) national government office 3) NGO 4) Universities 5) Others (Please state):
4	If yes, what type of extension services you were most frequently provided? (Record the topic covered by the extension services.)	1) Crop production 2) Livestock production 3) Livelihood industry 4) Demonstration field 5) Others (Please state):

5	Do you think receiving the agricultural extension services is helpful for improving your knowledge on the use of modernized rice varieties and improved farming technologies?	1) Yes (go to next section) 2) No (go to No.6)
6	If no, why do you think receiving the agricultural extension services is not helpful for improving your knowledge on the use of modernized rice varieties and improved farming technologies?	1) Far distance from extension offices 2) Lack of sustainable extension services 3) Inconsistency of the extension services with my requirement 4) Others (please state):

8) Farmers' social networks

No.	Questions	Answers
1	How many years have you resided in your current residence?	Number of Years:
2	How long does it take to walk to the closest neighbourhood's house from your house?	___ hours ___ minutes
3	Have you or your household members participated in community organization or union for agricultural activities (example: cooperative)?	1) Yes (go to No.4) 2) No (go to next section)
4	If yes, how many community organization or union have you or your household members have been participating for your agricultural activities at present?	Number of community organization or union:

9) Household's perception on drought

No.	Questions	Answers			
1	Have you or your household member experienced droughts during the last 5 years?	1) Yes (go to No.2) 2) No (go to next section)			
2	If yes, which month have you or your household members most seriously experience droughts? (Encircle)	1) January 2) February 3) March	4) April 5) May 6) June	7) July 8) August 9) September	10) October 11) November 12) December
3	If yes, did the drought negatively impact on your farming activities during the last 5 years?	1) Yes 2) No			

10) Adoption on the drought-tolerant rice varieties

No.	Questions	Answers

y

1	Have you heard about drought-tolerant rice varieties introduced by CURE project?	1) Yes (go to No.2) 2) No (skip to next section)
2	If yes, from whom did you hear about drought-tolerant rice varieties most frequently?	1) Family or relatives living in same village 2) Family or relatives living in different village 3) Neighbours/friends living in same village 4) Neighbours/friends living in different village 5) Local extension staffs from IRRI or Philirice 6) Seed traders from input markets 7) Others (please state):
3	Please select your current status of adoption on the drought-tolerant rice varieties	1) I have planted the drought-tolerant rice varieties on my farm (Please go to No.5) 2) I have received or purchased the drought-tolerant rice varieties but did not plant them on my farm yet. 3) I have never received or purchased the drought-tolerant rice varieties, but I am interested in planting the varieties on my farm. 4) I have never received or purchased the drought-tolerant rice varieties and do not need them on my farm.
4	If you have planted, received, or purchased the drought tolerant rice varieties on your farm, which varieties? This can be multiple answers.	1) NSIC RC280 (Sahod ulan 6) 2) NSIC RC282 (Sahod ulan 7) 3) NSIC RC346 (Sahod ulan 11) 4) NSIC RC348 (Sahod ulan 12) 5) Others (please state):
5	Where did you get the drought-tolerant rice varieties most frequently?	1) Family or relatives living in same village 2) Family or relatives living in different village 3) Neighbours/friends living in same village 4) Neighbours/friends living in different village 5) Local extension staffs from IRRI or Philirice 6) Purchase from input markets 7) Others (please state):
6	Have you transferred the drought-tolerant rice varieties to others?	1) Yes (go to No.7) 2) No (go to next section)
7	If yes, how many others have you transferred the drought-tolerant rice varieties to others?	Number of farmers:
8	Do you know any people who have been planting the drought-tolerant rice varieties on their farm in the following communities – family, relatives, neighbours, and friends living in within or outside villages?	1) Yes (go to No.9) 2) No (finish survey)
9	If yes, how many people do you know who have been planting the drought-tolerant rice varieties in the following categories?	1) Family or relatives living in same villages (Number of people:) 2) Family or relatives living in different villages (Number:)

		3) Neighbours or friends living in same village (Number:) 4) Neighbours or friends living in different village (Number:) 5) Others (please sate): (Number:)

Enumerator: Please state the following note to the respondent: "Thank you very much for participating in our survey. We will use your information to draw policy recommendations that, we hope, will make lives of people in Pangasinan better. We hope that you will also help us in the future. Thank you

Appendix 2. Approval from IRB

심의결과 통보서

수신

책임연구자	**이름:** 조선미	**소속:** 서울대학교 국제농업기술대학원 국제농업기술학과	**직위:** 석사과정
지원기관	기타(한국동남아학회)		

과제정보

연구과제명	필리핀 팡가시난 지역 농가의 가뭄저항성 벼 품종 채택 요인 분석
연구종류	설문조사
심의종류	신속심의
심의일자	2017-05-08
심의결과	승인

2017년 05월 08일

서울대학교 생명윤리위원회 위원장

Abstract (Korean)

국 문 초 록

필리핀 팡가시난 농가의 가뭄 저항성 벼 채택 의향 요인 -농가현장학교와 농가 내 노동력을중심으로-

서울대학교 국제농업기술대학원
국제농업기술전공
조선미

농업은 필리핀 국내총생산의 약 11%를 차지하며 전체 노동력의 약 30%를 고용한다 (2014년 기준, 세계은행). 그러나 필리핀 국가경제개발위원회는 농업 부문의 부가가치가 지속적으로 감소하고 있으며, 그 원인으로 자연 재해의 영향과 농가의 신품종 채택률이 낮은 점을 지적하였다. 따라서 증가하는 기후변화의 영향에 대응하기 위하여 필리핀의 농업 생산성을 지속 가능한 방법으로 높일 필요가 있다. 본 연구의 목적은 필리핀 팡가시난 농가의 가뭄 저항성 벼 채택 의향에 미치는 요인을 조사하는 것이다.

현재 초기의 종자 보급 단계에서 우선적으로 가뭄 저항성 벼의 보급량을 높일 필요가 있다. 농가의 가뭄 저항성 벼에 대한 수요가 증가하고 있으나, 2016년 우기에 소수의 농민 기술자(Local Farmer Technicians)를 대상으로 소량의 종자가 보급되어 공급이 부족한 상황이다. 또한 농민 기술자의 역할이 강화될 필요가 있는데, 시범 농장을 통하여 농민들의 신품종에 대한 위험 인식을 낮춰줄 필요가 있다.

무작위 표본추출을 통해 선정된 총 151명의 농가를 대상으로 설

문조사를 진행하였으며, 순위 프로빗 및 로짓 모형을 이용하여 수집된 자료를 분석하였다. 이를 토대로 도출된 필리핀 농가의 가뭄 저항성 벼 채택률을 높이기 위한 시사점은 다음과 같다. 첫째, 농가현장학교를 통하여 농가를 대상으로 가뭄 저항성 벼의 기능 및 재배 정보를 제공할 필요가 있다. 둘째, 여성 농민을 대상으로 가뭄 저항성 벼에 대한 정보 제공과 교육이 필요하다. 셋째, 수확한 쌀을 판매할 수 있는 시장 환경을 조성하고, 이것이 농가의 소득증대에 기여할 수 있음을 보여줄 필요가 있다. 특히 농가 간 가뭄 저항성 벼의 정보 및 종자 교환을 장려하기 위해서는 마을 내 농업협동조합과 같은 공동체 조직을 이용하는 것이 유용할 수 있다. 마지막으로 농촌 사회 내 자산 불평등을 완화하기 위한 정부의 제도적 및 정책적 지원이 필요할 것으로 사료된다.

주요어: 농업 기술 채택, 가뭄 저항성 벼, 농가현장학교, 농가 내 노동력, 산출물시장으로의 접근성, 필리핀.

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