Master's Thesis of Science in Agriculture

Effect of Information Usage on Rice Production in Thailand

- Comparison of Conventional and Good Agricultural Practices Farms –

정보활용이 태국 쌀 농업 생산에 미치는 영향: 관행 및 GAP 농가 비교를 중심으로

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Abstract

Thailand is one of the major countries in exporting rice, but the production does not reach to high level because of the large prevalence accounting for more than 60% of lowland rainfed rice. Therefore, Thailand has largely focused on increasing higher productivity by applying chemical fertilizers and pesticides. In order to ensure foods safety, Good Agricultural Practices (GAP) was introduced in the early 2000s in Thailand. This study aims to identify the effect of production-related seed and input (fertilizer, pesticide and herbicide) information on rice production in Conventional Agriculture (CA) and GAP farms. This study was conducted in 9 provinces in the Central and Northeast Plains that produce nearly 70% of rice in Thailand. A total of 642 farms were surveyed in 2022, consisting of 338 CA and 304 GAP farms. In addition, it studies a causal relationship using the source of information as an instrumental variable to solve endogeneity in which information usage might be increased due to high rice production, vice versa. The results show that most farmers gain information from community leaders by 43% to 45%, farm group leaders by 21% to 31%, and members in farm groups by 8% to 12% both within and beyond the village. Based on the farm-level production function, when agricultural land size, labor, and input cost increase by 1%, rice production increases by 0.87%, 0.03%, and 0.01% for CA farms, respectively. For GAP farms, when agricultural land size, labor, and machine cost increase by 1%, rice production increases by 0.84%, 0.08%, and 0.06%, respectively. When farmers use the input and seed information, it increases rice production by 0.06% for GAP farms on average. However, seed information doesn't affect CA farms, and only input information does have an impact on rice production by 0.07%. This means that GAP farmers are more willing to reflect seed and input information in their production than CA farmers. Therefore, CA should be provided with incentives to increase attendance in rice training and even designate leading farms next to CA farms

in order to promote the utilization of agricultural information that can lead to an increase in rice production. However, when referring to farm inputs and production-related information, it resulted to have a similar impact in increasing rice production in Thailand. Therefore, information will be as effective as the cost of labor.

Keywords: Thailand, rice production, information usage, Conventional Agriculture (CA), Good Agricultural Practices (GAP), Instrument variables, Two stage least squares

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List of Abbreviations

ACFS	National Bureau of Agricultural Commodity and Food Standards
CA	Conventional Agricultural practice
GAP	Good Agricultural Practices
GHG	Greenhouse Gas
IRRI	International Rice Research Institute
NAMA	Nationally Appropriate Mitigation Actions
NESDC	Office of the National Economic and Social Development Council
NSP	NAMA Support Project
OAE	Office of Agricultural Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
SRP	Sustainable Rice Platform
ICTs	Information and Communication Technologies
IVR	Interactive Voice Response
SMS	Short Message Services
T&V	Training and Visit

Chapter 1. Introduction

Sustainable development is an integrated approach that takes into account all three dimensions of environmental, social, and economic pillars. However, over the past years, Thailand's rice cultivation has been focusing on higher productivy, through the use of high-level of chemical fertilizers, which have caused negative impact on human health and adverse environmental impacts. Also, rice cultivation is the main Green House Gas (GHG) contributor in Thailand's agricultural sector at 50.58% (ONEP, 2022). Also, from the cultivation, it causes high water consumption which may lead to scarcity of water (Mungkung et al., 2022; Thanawong et al., 2014).

Thailand is the world's 6th largest rice producer and second-largest exporter in the world, producing about 33 million ton in 2021 (FAO, 2022). The Northeast and Central Plains produces more than 68% of rice in Thailand, where rice ecosystem is classified into rainfed lowland rice and irrigated rice, respectively (Suwanmontri et al., 2021; Titapiwatanakun, 2012). Therefore, not only the climatic condition but also the social condition that rice farmers are situated differs by region. Rainfed lowland rice is grown mostly in flat, bundled filed that are drought-and flood-prone in areas of North and Northeast Thailand (Suwanmontri et al., 2021; IRRI, 1996). Farmers in the area often lack irrigation system, therefore, rice cultivation is primarily for consumption and sells the surplus. The rice farmers tend to have the lowest agricultural income compared to other parts of the region.

The second largest rice cultivating region, the Central Plains, is characterized by irrigated lowland rice. Most of the area is irrigated, meaning that a water control system is available both in dry and wet seasons. Therefore, farmers are able to grow throughout the year (Chaikiattiyos and Yoovatana, 2015). Despite the benefit that rice production can be high from double cropping, the GHGs in the agriculture have been a major source accompanying large amounts of water consumption and pesticide use (ONEP, 2022). With growing environmental concerns and health concerns from rice farming, Thailand have been progressively adopting national sustainable farming practices. Across several standards for food crops, Good Agricultural Practices (GAP) has been adopted to manage and improve quality and safety of food (Premier and Ledger, 2006).

Since 2004, a national version of GAP in Thailand called Q-GAP was initiated by the National Bureau of Agricultural Commodity and Food Standards under the Ministry of Agriculture and Cooperatives (MoAC). Since the launch, rice Q-GAP was advanced tgo GAP+ in 2008, where the government is in charge of setting standards, provinding agricultural advisory, carrying out inspections, and issuing certificates (Sardsud, 2007). Recently in 2022, Thailand amended GAP rice standards, namely GAP++ with the goal of converting conventional farming methods into sustainable GAP. To convert conventional agricultural (CA) farming to GAP, related agricultural techniques are being disseminated through extension services.

Farmers who participate in the extension services seek information with the expectation of increase production through the acquisition of information (Feder and Slade, 1984). However, existing literature lacks in identifying the usage of agricultural information as valuable input to farm production. Therefore, by examining whether agricultural information is an important source of input to farm production between two groups of farms, it will be used as a validating basis for providing information to CA and GAP rice farms.

The purpose of this study is to measure the effect of information usage on rice production in Thailand by Ordinary Least Squares (OLS) using a household survey of CA practicing and GAP rice farmers in 2022. It first estimates the marginal effect of land, inputs, capital with the usage of agricultural information. As GAP farmers have to follow the standards, it is expected that GAP farmers are more likely to use input-related information. Then the endogeneity issue between the information and rice production is considered using instrument variables such as information sources. The rest of this study is organized as follows. First, the factors influencing rice productivity will be explained. Also, how GAP has developed, and the status of GAP in Thailand will be explained. Then, literature reviews on information and agricultural productivity will be followed. The second part of this study presents the theory of production function. Subsequent sections cover data analysis, results, conclusion, and discussion with further research areas.

Chapter 2. Literature Review

2.1. Determinants of Rice Production in Thailand

Since rice is a staple food for more than half of the world, various studies have identified the determinants of rice production. Accordingly, International Rice Research Institute (IRRI), since 1960, has been focusing on rice-based agri-food systems and has identified factors that influence rice production by classifying the growth and development stages of rice (De Datta, 1981 and IRRI, 2015). According to IRRI, **Table 1** summarizes the factors affecting rice production, but considering various conditions encountered in different countries, Thailand's situation could be different.

Thailand has long been one of the major producers and exporters of rice, which accounts for 15% of the agricultural GDP (Pongsrihadulchai, 2019). The major rice producing area in Thailand is the Central and Northeast Plains which accounts for nearly 70% of the country's production. However, when looking at the Central and Northeast Plains during the dry season, the contribution of dry season production for Central Plains consisted of 30% (Suwanmontri et al., 2021). However, Northeast Plains during the dry season contributed to 5% only (Suwanmontri et al., 2021). From this statistical data, we can infer that seasonal and regional difference in Thailand contributes to rice productivity.

The reason why Central Plains could maintain rice production even during the dry season is due to the irrigation system, while in Northeast Plains, the rainfed lowland ecosystem is representative. Therefore, this results in differences in a production system that two or three cropping is possible with the higher production level and tends to cultivate for the market sales. Compared to Central, in the area of the Northeast Plains, the total occupying land for rice is more than 80%. But despite the fact that there is a large area for cultivating rice in the Northeast, the low production is characterized because it relies on climatic conditions, such as floods (Suwanmontri et al., 2021). Therefore, Northeast rice farmers grow rice primarily for home consumption and sell the surplus (Saisema & Pagdee, 2015).

The production costs that are related to rice farming are the use of fertilizer, labor, and machines. The study in Northeast Thailand conducted by Watanabe (2017) found that adopting chemical fertilizer had a positive influence on rice production. Fukai and Ouk (2012) described fertilizer management in Northeast Thailand, where farmers tend to put lower Nitrogen (kg/ha) compared to the recommended rate while applying more Phosphorus (kg/ha) and Potassium (kg/ha) than the recommended rate. Haefele et al. (2006) found that yield reductions due to water stress were affected by the level of nutrient supply, with the differences in yield between different fertilizer treatments decreasing as water stress increased.

Considering that rice production is labor-intensive agriculture, Sachchamarga and Williams (2004) found labor shortages can impose constraints on the efficiency of rice growing. Attavanich et al. (2019) found that an increase in labor and capital inputs can raise 0.12% and 0.10% of the output, respectively, but Faysse et al. (2020) found out that almost all the rice farmers do not have the necessary machines to cultivate rice because they rent machinery and other family members help them to produce. To be more specific, in the Central Plains study by Faysse et al. (2020), in terms of usage of labor, almost all rice farmers outsourced part of farm operations. According to the study, rice farmers who had invested in agricultural machinery did not express any intention to increase their rice cultivation area (Faysse et al., 2020). Suggesting that machine usage may not be a factor that improves rice production in the case of Thailand.

Lastly, in terms of planting method, whether direct seeding or transplanting is used, the seed rate is different. The study conducted by Suwanmontri et al. (2021) found that increasing the amount of seed used in direct seeding methods led to higher production in both the Central and Northeast regions of Thailand, despite the higher seed rate used in the Central region. In addition, Tomita et al. (2003) conducted surveys every three weeks and found that direct seedlings compared to transplanting, had a significantly lower average production, but this result only applies to resource-medium and–poor conditions. This suggests that increasing seed rates can be an effective way to improve rice production in these regions.

Table 1 Factors of Rice Production in Thailand Studies

Type of Factors	Factors	Thailand Studies
Climatic Environment	Rainfall	(Sachchamarga and Williams, 2004)
	Solar radiation	(Kawasaki and Herath, 2011)
	Day length	(Sawano et al., 2008)
	Temperature	(Reda et al., 2015)
	Relative humidity	(Taweerattanapanish et al., 1999)
	Wind	
Landscape	Upland (dryland preparation)	(Suwanmontri et al., 2021)
	Lowland (wetland preparation)	(Haefele et al., 2006) (Thanawong et la., 2014)
Water management	Rainfed	(Haefele et al., 2006) (Wade et al., 1999)
	Irrigated	(Suwanmontri et al., 2021) (Thanawong et la., 2014)
Production costs	Land size	(Attavanich et al., 2019) (Rahman et al., 2009) (Sachchamarga and Williams, 2004)
	Labor	(Attavanich et al., 2019) (Sachchamarga and Williams, 2004)
	Rent (machine, labor, land)	(Pochanasomboon et al., 2020) (Srisompun et al., 2019) (Fakkhong et al., 2015)
	Fertilizer (N, P, K)	(Fukai and Ouk, 2012) (Haefele et al., 2006) (Watanabe, 2017)
	Pesticide & Herbicide (Pest/Diseases & Weed)	(Praneetvatakul et al.) (Wanger et al., 2014)
	Seed	(Haefele et al., 2006)

2.2. Status of Good Agricultural Practices in Thailand

From the 1990s, government policy continued persuading farmers to shift from conventional to sustainable agriculture, and a number of projects and police have been implemented (Cramb et al., 2020). Thailand GAP (Q-GAP) has been operating since 2004 to promote sustainable practices and improve rice quality, particularly in light of the intense usage of chemical inputs and concerns about food safety. Since the launch, rice Q-GAP was advanced to GAP+ in 2008, which has been fully managed by the ACFS under MoAC. The Thai government is in charge of setting standards, providing agricultural advisory, carrying out inspections, and issuing certificates (Sardsud, 2007).

Also, since 2015, ASEAN member countries have been required to meet the same standards for agricultural produce, and among member countries, Thailand is the largest number of farmers that are certified (Amekawa et al., 2022; Srisopaporn et al., 2015). Additionally, GAP is a standard that complies with international trade requirements for exporting food crops (including rice, mango, and coffee) to other continents (Amekawa, 2013a). Then recently, the Rice Department of MoAC amended the current existing GAP standard.

Consistent with the Sustainable Rice Platform (SRP) Standard, which is currently supported under the Thai Rice NAMA Support Project (NSP)[1], the current GAP is referred to as GAP++ to demonstrate that it is built on existing approaches (Mitigation Action Facility, 2022). The involved stakeholders of the NSP include the Thai government, private, civil society and an international donor agency, and international organizations. Therefore, Rice Q-GAP is a critical standard both within a national, subregional, and international level.

To participate in the Rice Q-GAP, registration is based on the plot level. Thus, some farmers may have multiple plots while having both GAP and conventional agricultural (CA) rice farms, respectively. Since the beginning year, GAP has been highly focused on pesticide residues (Schreinemachers et al., 2012). To ensure

[1] Thai Rice NAMA Support Project (NSP) was implemented from April 2018 until March 2023.

quality, GAP-certified farms have been receiving training on Q-GAP standards to manage rice production according to the best-known practices (Srisopaporn et al., 2015; Cramb et al., 2012).

The Q-GAP requirement deals with four major areas, including (1) food safety, (2) quality produce, (3) farmers' health and safety, and (4) environmental management. The rice GAP+ standard is used to accommodate eight areas of regulation, while the rice GAP++ has ten areas of regulation (National Bureau of Agricultural Commodity and Food Standards, 2022). With the expectation to transition to GAP, the number of farms that Thailand is registered as GAP is estimated to be more than 146,000 (Amekawa et al., 2021). Also, preparation before planting and processing rice for sustainable rice products is specified in new requirements. To promote GAP++, capacity building and training on sustainable practices have been given to advanced farmers, and so-called “smart farmers” are acting as trainers of trainers (Mitigation Action Facility, 2022).

In light of GAP expansion, academic research on national GAP standards has been studied in many Southeast Asian countries. Also, many of GAP studies have emphasized the role of utilization of information in terms of farmers’ adoption and continued participation in GAP. According to Sirsopaporn et al. (2015), the adoption of Rice Q-GAP has been studied in terms of first-time adopters and continued participation and the factor positively contributing both to first-time adopters and continued participation was the contact with informants, especially with the government. According to Srisopaporn et al., (2015), the higher the rice training attendance, the GAP farmer tend to continue their farming practice, and the fact that rice farmers receive agricultural information through "smart farmers" in order to transition from CA to GAP indicate that Thai GAP farmers receive agricultural information.

Related to knowledge diffusion mechanism in the process of introducing Sustainable Rice Platform (SRP) which became basis for current GAP standards in Thailand, relatives, government officials, agricultural extension officers, and experts in university were found to be sources of information. However, there was a response

that the government's projects lost confidence in government activities because they did not have sustainable output (Sae-Heng et al., 2021). In addition, subsidies initially existed but were not continued after switching to new farming method and the level of farm education when new agricultural information is learned came to be the biggest barrier for Thai farmers. (Sa-Heng et al., 2021).

In general, GAP is a farming method that reduces productivity because it applies low amounts of inputs. However, depending on which type of crops is grown in different country, GAP compared to CA were empirically shown to be high in productivity. According to GAP in Turkey when comparing GAP and CA for various crops, GAP productivity varied from 3.3% to 20.6% depending on the type of crop. Among them, when comparing the productivity of GAP and CA for paddy, GAP productivity was 1,100 kg/ha lower (Kılıç et al., 2020). However, in Thailand, the study found that the productivity of Thai rice GAP was rather high (Suwanmaneepong et al., 2022). From this, we can infer that productivity of CA is always higher compared to GAP.

2.3. Role of Information on Farm Production

The factors that affect a farmer's information search behavior include situational characteristics (farmers' interests based on their type of business), psychological characteristics (farmers' attitudes toward information search), and demographic and socioeconomic characteristics, which may affect the ease of accessing alternative sources (Diekmann et al., 2009). Therefore, depending on what kind of crop farmers produce and depending on the economic status of a farmer (e.g., high income) will affect information-seeking behavior.

When it comes to famer's ability to increase efficiency, it is largely depending on the ability of its own including ability to process information. Then production difference among farmers was pointed out by Anderson and Feder (2003) as there exists gap between technology gap and management gap. Therefore, governments have employed agricultural extension and subsidies to reduce the gap and even facilitate the diffusion of technology (Anderson and Feder, 2003; Stoneman and David, 1986).

In the last decade, traditional provision policies through agricultural extension schemes employed a linear knowledge diffusion model (Rockenbauch et al., 2019; Black, 2000). The traditional advisory system was basically top-down method which considered new agricultural technology and knowledge is developed merely by researchers and extension agencies promote new innovations to farmers in order to increase production (Black, 2000; Rogers, 1983). In recognition of multiple roles, the extension services have changed into pluralistic agricultural advisory services which started to include private sector, civil society, and farmer organizations (Lin et al., 2021; Chowa et al., 2013; Birner et al., 2009). This perspective emphasizes the importance of social networks in facilitating the adoption of improved agricultural crops and practices.

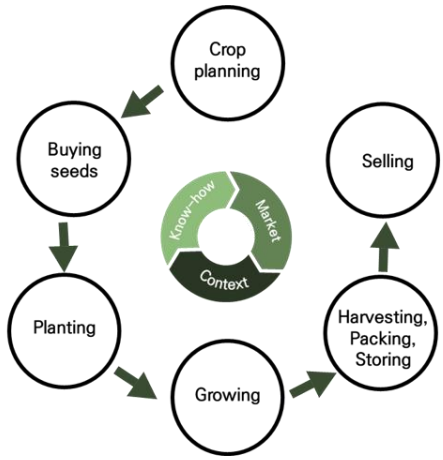
With the development of information and communication technologies (ICTs), farmers could receive information through existing and modern sources. Mittal and Mehar (2016) analyzed factors that affect the adoption of different agriculture-related information sources by potato farmers in India through multivariate probit

model. They defined four possible sources of information combination among face-to-face, other farmers, traditional media and modern media. They found out that famers do not use single source to obtain information.

In the similar manner, agricultural extension methods in Thailand have changed from the training and visit (T&V) system to the participatory method, which aims to make farmers more self-reliant. The yield increase rate under the T&V system was higher than under the participatory method, but the latter approach emphasizes farmer empowerment and self-sufficiency (Suwanmontri, 2021). However, Thailand's agricultural extension system has varying degrees of information accessibility (Aonngernthayakorn and Pongquan, 2017; Kasem and Thapa, 2011). For instance, Kasem and Thapa (2011) found out that rice mono-croppers have at tend to attend fewer training sessions and fewer contacts with extension agents. In regard to rice farmer in Central Plains, Aonngernthayakorn and Pongquan (2017) found that medium or large farmers tend to use extension service than small farmers subject to acquisition of information. From previous studies, diversified farmers who have large farms have high access to agricultural information services.

In addition, in terms of seeking agricultural advice, farmers may seek agriculutral advice from sources outside the village. According to Van Den Broeck and Dercon (2011), larger kinship network and those who live closer to other farmers in the village are less likely to seek agricultural advices from outside village. Meaning that those who are smallholders may be reliant on outside sources, such as relatives. For instance, Aonngernthayakorn and Pongquan (2017) investigated uilization of agricultural information among rice farmers in central Thailand and found out that those who have small size of land, known as smallholders, relied upon relatives. However, this research was in lack of differentiating the sources of information from outside and inside village. From this, both the outside and inside social network system that farmer utilize can be complementary relationship as small holder is likely to relate to where they are located while most farmers are likely to both outside and inside sources.

Figure 1. Type of Information Needs by Farmers



Notes: Figure reproduced from Aker (2011).

Accordingly, farmers have varying value depending on the type of information. For instance, managerial value has an enduring value that improves over time and experience, while information on market price has a short-lived value (Anderson and Feder, 2003). From Anderson and Feder (2003) study on information provided to farmers, we can infer that the value depends on the type of practices and the nature of information. Moreover, type of information needs by farmers can also be divided into production stages and functions (Figure 1), because farmers have different Therefore, a number of studies has utilized various type of information as intervention to measure the productivity of farmers (Table 3).

Effect of information through various means and sources have been widely studied concerning (1) strengthen a famer's decision making process and (2) increase productivity and farm income. The role of information in changing one's behavior, in terms of adopting new practices, has been studied with the development of new technologies. Especially with the rise of environmental concerns, many studies have started to look for factors influencing choice of sustainable agricultural practice (Suwanmaneepong et al., 2023; Salaisook, et al., 2020; Khataza et al., 2018; Feder and Savastano, 2006; Feder and Slade, 1984).

To measure impact of information provision on productivity, earlier studies focused more on various extension models rather than focusing on specific type of

information given to farmers. For instance, in the early studies, the most common approaches are T&V and Farmer Field Schools (FFS). In the T&V approach, the impact on farm productivity had varying result. While some studies found that these programs had a significant positive effect on crop production and economic returns, others found only small impacts or no significant effects (Maffoli et al., 2011; Feder et al., 1987, Bindlish and Evenson, 1997). One reason for this inconsistency is that there may be other factors besides extension programs that are correlated with increased economic returns in agriculture (Aker, 2011). Other earlier studies in regard to Farmer Field Schools (FFS) in Indonesia which primarily focuses on giving integrated pest management technology among rice growers, and examined the effectiveness of FFS on yield and pesticide use. but finds that the program did not have significant impacts on both (Feder et al, 2004). One possible reasons for this outcome pointed out by the Feder et al. (2004) was that informal communication among farmers hindered diffusion of information related to FFS initiatives which undermined their economic viability even further.

With recognition of various role in farm, impact of farmer-to-farmer level diffusion of information on production efficiency were studied by Alene and Manyong (2006). The study explored the reasons for yield differences among farmers who adopted improved cowpea varieties in northern Nigeria through farmer-to-farmer diffusion. The study finds that lead farmers, who have contact with breeders, are more efficient than follower farmers, who get technology and information from the lead farmers. Differential adoption of a package of seed, insecticide, fertilizer and recommended cropping pattern explains much of the yield variation among adopters. From this depending on what technology and information is adopted by farmers, variations among farmer's productivity could be explained.

With development of technology and as a means to reduce information asymmetry, growing literatures considered on ICTs to measure the impact on productivity. Studies investigated whether information access through modern technologies has an impact on farm productivity. Ogutu et al. (2014) show that ICT-based market information services increased farm productivity and use of other productivity related inputs. In case of Cambodia, with increased access to market information

through mobile phone use, farmers can obtain better prices for their agricultural goods by selling them in other markets where they fetch higher prices (Shimamoto et al., 2015). Likewise, Zheng and Ma (2023) looked at the potential information pathways that considered both on input and marketing information and found out positive result on crop yields. Van Campenhout et al., 2020 reported that ICT-based video messages that deliver agricultural information increased maize yields in Uganda. But little evidence of IVR or SMS service on yields, thus, depending on which source of information is used, the impact on yield varies.

However, Maffioli et al. (2011) and Lecoutere et al. (2023) studies have shown that impacts of information acquisition/access on farm productivity remain mixed. Maffioli et al. (2011) finds a negative overall impact on yields but a positive effect on the adoption of higher-quality grape varieties which revealed the temporal dimensions play an important role in extension service effectiveness. Lecoutere et al. (2023) started the study from the notion that agricultural advisory services are biased towards men and examined how this bias affects women's ability to make decisions. The experiment showed video on farming technique toward exclusively to female co-heads, male co-heads, and joint co-heads. It was found out that targeting information exclusively to female within households increases their knowledge, role in decision-making, adoption of recommended practices and inputs, and yields on fields they manage, while male co-head's unilateral decision-making is reduced. The experiment featured female role in agriculture and encouraged adoption of recommended practices by women.

From the previous studies, there were mainly two approaches in measuring the effect of diffusion of information on productivity. First, earlier studies were focusing on the type of extension services given to farmers, without specific type of information. Second of all, effectiveness of using ICTs for agricultural extension depends on the type of information being provided. Earlier studies considered mainly two type of information: (1) Production-related and (2) Market-related information. The former, such as weather forecasts and instructions on fertilizer use, helps farmers prepare for agricultural activities and increase productivity. Farming technique information is also important to ensure skillful farming based on scientific

knowledge and experience with each crop. The latter consists of crop sales price and intermediate trader information. Knowing the price of crops before going to market can give farmers an advantage when negotiating with intermediaries, which can lead to sustainable sales revenue and a fair price for their products. Also, to best of my knowledge, no previous studies have investigated the impact information accessibility on farm productivity in rice farmers in Thailand.

Table 2. Studies on the Effect of Information Diffusion on Farm Production

Type of Information	Mechanism	Study	Result	Country
N/A	T&V	Feder et al. (1987)	−	India
N/A	T&V	Bindlish and Evenson (1997)	+	Kenya and Burkina
Input information	Famer Field Schools	Feder et al. (2004)	−	Indonesia
Input & technique	Farmer-to-Farmer	Alene and Manyong (2006)	+	Nigeria
Input & technique	T&V	Maffioli et al. (2011)	−	Argentina
Market information	ICTs	Ogutu et al. (2014)	+	Kenya
Market information	Smartphone	Shimamoto et al. (2015)	+	Cambodia
Input &technique	ICTs, video, SMS, IVR	Van Campenhout et al. (2020)	+	Uganda
Input & market	Smartphone	Zheng and Ma (2023)	+	China
Technique information	Video	Lecoutere et al. (2023)	±	Uganda
Weather information	SMS	Yegbemey et al. (2023)	+	Benin

Chapter 3. Theory

Under the assumption that farmers actively seek out information when they expect it to provide an economic return, the production function theorized by Feder and Slade (1984) assumes that farmer's knowledge level affects the production. This theory further considered the issue of non-adoption of new inputs, which includes improved cultivation practices and the use of a variable input with which the farmers are not familiar.

The model proposed by Feder and Slade (1984) developed from Shchori-Bachrach (1973) that it used multiplicative term which is dependent on knowledge. And the production function by Feder and Slade (1984) further accounts for the possibility that some elements of knowledge may only benefit the farmer if a new input is adopted. Therefore, the farmers can benefit the farmer if the new variable input is not adopted. It is because farmers can acquire knowledge from a single source. For example, visit to community leader can provide the farmer with information on the use of inputs, which can help farmer to accumulate knowledge, leading to increased production.

In the specification of the production function assumed by Feder and Slade (1984) was that there exist general (non-input-specific) impact of knowledge. It is also known to be know-how and the experience that a farmer has gained over time through their farming practices which may not be realted to the specific new input being introduced. Therefore, the production function should explicitly incorporate the level of existing knowledge, including new input-specific knowledge.

In this paper, extended from Feder and Slade (1984) that depending on the crops that farmers grow general knowledge could be constant. In case of rice farming in Thailand which have been produced over decades, the know-how that farmers occupy may not be changing factor to the output, while as an introduction of new farming standards, such as GAP, farmers will recognize new knowledge and information in order to maintain compliance to the standards and the quality in the long run. Therefore, in this paper, the production function only incorporates the input-specific knowledge in the Eq (1):

$$Y = F[L, h(K) \cdot N] \qquad (1)$$

Y is output, L is the amount of land owned by farmer, N is the level of the input utilized, and h(K) describes the input-specific impact of knowledge. The functions $F(\cdot,\cdot)$ and $h(\cdot)$ are concave.

When N=0, the potential benefits of knowledge regarding the application of the variable input cannot be realized. This means that if farmers are not using the variable input, their knowledge about how to use it effectively will not be useful or beneficial. The farmer needs to actually use and apply knowledge and information in order to have any impact on improving cultivation practices.

Production technology uses factors of production (input) to generate output. In terms of production technology, GAP and CA is different, because GAP produces crops through reduced input farming method compared to CA. Eventually, depending on the nature of the production technology, the degree to which substitution between the factors of production can be easily achieved will vary, and the shape of the isoquant curve will also vary. However, CA and GAP have similar characteristics in almost all other production factors except cost of input, and the elasticity of production factors of labor and land is the same, so the elasticity of output of each production factor will be constant.

The marginal product of input N can be calculated by taking the partial derivative of the production function with respect to N. From the equation below, when the input N increases, the marginal product of N is positive (assuming h(K) exist and positive), which means that output increases as well.

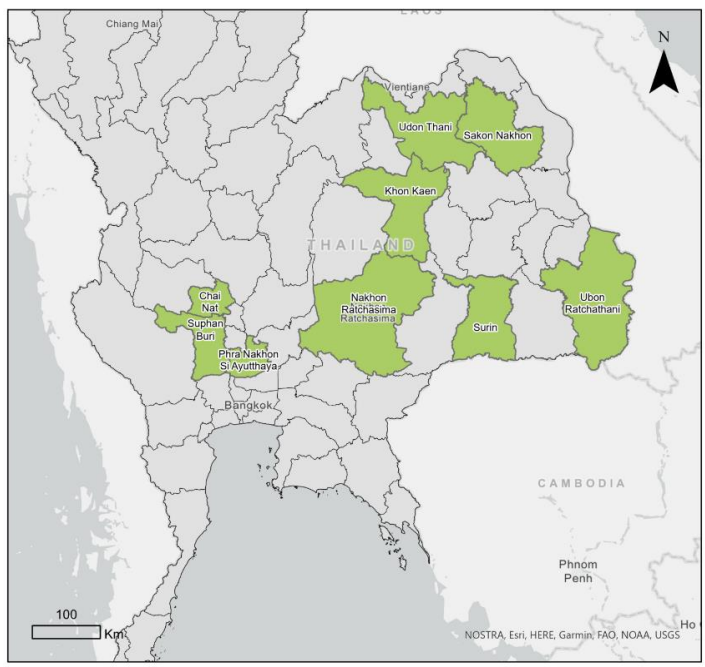
$$\frac{\partial Y}{\partial N} = h(K) * \frac{\partial F[L,h(K)\cdot N]}{\partial N}$$

Chapter 4. Data and Procedure

4.1. Study Area

This research was carried out in the three provinces in Central region (Ayutthaya, Chai Nat, Suphan Buri) and in Northeast region of Thailand consisting of six provinces (Khon Kane, Nakhon Ratchasima, Sakon Nakhon, Surin, Ubon Ratchanthani, Udon Thani). Rice production has a significant role in the economy of both Central provinces and Northeast provinces producing 5502.56 kg on average. In Thailand, there are total 17 provinces in Central region and 19 provinces total in Northeast region. Amongst them nine provinces were chosen in terms of either they participate in NSP or Rice Mega Farm project[2]. In addition, Ayutthaya was one of the first provinces where Q-GAP was introduced in Thailand (Srisopaporn et al., 2015), thus, it was included in the area of study.

Figure 2. Map of Study Area



[2] Mega Farm project is under the Ministry of Agriculture and Cooperatives (MoAC) which the government is aims to provide agricultural inputs in order to reduce production costs and rise productivity (Arunmas, 2016).

4.2. Data Collection and Sampling Method

Our study was conducted using cross-sectional survey. Our interest group comprised farmers in the Central and Northeast Thailand, because it is one of the largest rice producers in Thailand. In collaboration with the Faculty of Economics in Khon Kaen University (KKU) and Center for International Agricultural Development in Seoul National University. A list of provinces that participate in GAP in both Central region and Northeast region were retrieved and the method how the sample was selected is in the Appendix.

Related to information usage by rice farmers in Thailand, farmers were first asked whether they ask agricultural information. Then for those farmers who answered they get agricultural information, they were asked which source of information they gain both inside and outside village (Table 3). Reason for separating inside and outside village information source was that an empirical study in Tanzania banana farmers, farmers in a village can learn agricultural techniques from both inside and outside sources (Van den Broeck & Dercon, 2011). Especially most farmers in the village are connected to an outside learning source, either directly, or through only one other farmer. This suggests that outside sources play an important role in disseminating agricultural knowledge within the community. However, in this study, it was found that farmers who are part of larger network or living closer to other farmers reduces the likelihood of seeking outside information sources. These social networks facilitate the flow of information within the village, but only kinship-related groups have social externalities in banana output (Van den Broeck & Dercon, 2011).

In addition, considering that Thailand's national religion is Buddhism, research on related religion mindset and agricultural production have been widely studied. According to Limprapoowiwattana (2022), the rice farmers that have transitioned to organic agriculture rely on the Buddhist values in their mindsets in shaping production system. From this study, promoting environmental sustainability by avoiding harmful pesticides and chemicals through organic rice production is reflected from the Buddhist principles. Therefore, the monks and religious leaders

were included in the source of information in considering that farmers interact with may have positive impact on shaping production. Following the question of information source, the Thai rice farmers were asked what kind of information they use (seeds, fertilizer, pesticide, herbicide information).

Table 3. Sources of Agricultural Information

Sources of Information			
Inside the village		**Outside village**	
01 Relative	06 Government agency	01Relative	06 Exert in university
02 Friend/Neighbor	07 Monk	02 Friends	07 Input dealer
03 Community leader	08 Eloquent person	03 Members in farm group	08 Middlemen
04 Members in farm group	09 Religious leader	04 Leader of farm group	09 Monk
05 Leader of farm group	10 Input dealer	05 Extension agent	99 None
	11 Middlemen		
	99 None		

4.3. Variables and Descriptive Statistics

The information collected from the CA and GAP groups was divided into three groups, farm characteristics (level of household production, land size, region, province, irrigation), farm operating costs (cost of inputs for fertilizer, herbicide, and pesticide, cost of labor, cost of machine, seed rate) and usage of agricultural input-related information (use of fertilizer information, pesticide information, herbicide information, seed information). Table 4 indicates descriptive statistics of CA, GAP, and all types and Table 5 is result of t-test were used to describe the differences between CA and GAP farms.

In terms of full sample of two type of farmers, it is indicated 0.47 which is quiet balanced to be compared. In average, the sample of both farm households produce 5502.56 kg of rice. The average production on CA and GAP farms was 4817.21 kg and 6404.08 kg respectively which indicates to be the one of the biggest difference between two farm groups. Since GAP farm households own bigger land compared to CA farm households, the operating costs were measured in terms of per hectare. Main difference between GAP and CA is in the cost of machine and seed rate. Considering the fact that Thailand rice farmers do not own their own machines, the cost for machine of both farm households tend to be low compared to labor cost.

Also, both farm households spent 825.45 baht/ha more for machines which is quiet small considering the farm gate price of rice farmers in Thailand. The seed rate by CA farmers (270.63 kg/ha) were less than GAP (303.79 kg/ha). However, in terms of region, the data is not balanced as the province that were selected were mainly in the Northeast Plains. When looking into the province level, most of sampled data were to be in Sakon Nakon province which is located in the Northeast.

Considering that the data is mostly from the Northeast Plains, the irrigation variable is expected to be small. The actual mean of irrigation access indicated only 0.34 farmers have access which is quiet low, despite the fact that rice production requires large amount of water. Moreover, the lack of access to irrigation system indicated to be almost the same across GAP and CA farms. When looking into other operating costs in terms of labor cost and machine costs, we can identify that Thailand farmers use less of machines and more of labors. To be more specific, GAP farmers tend to spend more cost for labor, while CA farmers tend to spend more for machine. Subject to cost of input per hectare for GAP, it was expected that GAP farm household would less use fertilizer, pesticide, and herbicide as GAP promotes sustainable farming. The data indicated to be align with the expectation. However, in terms of t-test, the result was not statistically meaningful.

Lastly, in terms of information usage, it was expected that GAP farmers would more use information, as they have to follow the given standards to maintain the certification. However, all types of agricultural input-related information and seed information are similar between two types of farms. The most frequent use of agricultural information was fertilizer information. While the least use of information was in herbicide information. From this we can infer that most farmers use production management, while farmers are less interested in pest and diseases management.

However, in Table 6 there is difference in terms of production between those who use the information and do not use information in between type of farmers. As for CA farm households, production level is different in case of pesticide information usage and indicate that those who use information have higher level of production.

While GAP farm households, production level is different for pesticide and herbicide information usage and those who use information are likely to have higher production. Simple t-test results do not ascertain causal relation gaps of rice production between information and non-users. However, they may be used for helping understand the results of OLS and 2SLS. From this result, we can infer that those who have knowledge on proper application on pesticide can result in higher production. According to Zhiguo et al. (2019) and Savci (2012), inappropriate fertilizer and pesticide applications impact on the environment also reduce yield and quality. However, in terms of usage of seed information, production level between information user and non-user was not statistically meaningful.

When it comes to information sources between two group of farmers, it demonstrated the similar pattern in Table 7. With reference to the information source from inside and outside village, majority of information is learned within the village. Both CA and GAP farmers identified that community leader is the main source of agricultural information when it is learned from inside village. Also, when farmers get information from outside source, it is often the leader of farm group. Surprisingly all farmers rarely get farming information from input dealer. Therefore, from this word of mouth is highly dependent on upper reachability. Upper reachability pertains that people approach to higher positions with the expectation of possessing more valuable information and resources (Zhu et al., 2013).

Table 4. Descriptive statistics of variable in analysis by type

	CA (N = 338)				GAP (N = 304)				Full sample (N = 642)			
Variables	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Farm characteristics												
Production (kg)	4817.21	5097.65	500	53000	6264.57	6505.08	78.75	51250	5502.56	5847.03	78.75	53000
Land size (ha)	1.74	1.09	0.24	9.6	1.92	1.20	0.26	7.79	1.83	1.14	0.24	9.6
Type (1=GAP)									0.47	0.50	0	1
Region (1=Northeast)	0.84	0.36	0	1	0.74	0.44	0	1	0.79	0.40	0	1
Province												
Ayutthaya	0.02	0.15	0	1	0.05	0.22	0	1	0.04	0.19	0	1
Chainat	0.03	0.18	0	1	0.07	0.25	0	1	0.05	0.21	0	1
Khon Kaen	0.17	0.38	0	1	0.14	0.35	0	1	0.16	0.36	0	1
Nakhon Ratchasima	0.19	0.39	0	1	0.16	0.37	0	1	0.18	0.38	0	1
Sakon Nakhon	0.09	0.29	0	1	0	0	0	0	0.05	0.21	0	1
SuphanBuri	0.10	0.30	0	1	0.14	0.35	0	1	0.12	0.32	0	1
Surin	0.27	0.44	0	1	0.20	0.40	0	1	0.23	0.42	0	1
Ubon Ratchanthani	0.07	0.26	0	1	0.15	0.36	0	1	0.11	0.31	0	1
Udon Thani	0.05	0.21	0	1	0.09	0.29	0	1	0.07	0.25	0	1
Irrigation (1=Yes)	0.32	0.47	0	1	0.36	0.48	0	1	0.34	0.47	0	1
Farm operating costs												
Cost of inputs (Baht)	605.84	613.52	1	5120	625.47	592.21	1	4161.36	615.13	603.13	1	5120
Cost of labor (Baht)	3304.26	3994.74	144	37626	3995.28	4848.15	288	51140.99	3631.47	4429.40	144	51140.99
Cost of machine (Baht)	1050.60	435.89	20.48	2681.25	982.43	401.34	54	2521.15	1018.32	420.94	20.48	2681.25
Seed rate (kg)	463.79	396.68	40	3500	595.52	491.80	50	3290.00	526.17	448.76	40	3500
Type of information usage												
Fertilizer info	0.65	0.48	0	1	0.64	0.48	0	1	0.65	0.48	0	1
Pesticide info	0.08	0.28	0	1	0.09	0.29	0	1	0.09	0.28	0	1
Herbicide info	0.04	0.19	0	1	0.06	0.24	0	1	0.05	0.22	0	1
Seed info	0.53	0.50	0	1	0.55	0.50	0	1	0.54	0.50	0	1

Table 5. Mean Statistics of the Full Sample by Type

Variables	CA (N=338)	GAP (N=304)	Full (N=642)	T-test
Production (kg)	4817.21 (277.28)	6264.57 (373.09)	5502.56 (230.76)	-3.15***
Land size (ha)	1.74 (0.06)	1.92 (0.07)	1.83 (0.05)	-2.05**
Region (1= Northeast)	0.84 (0.02)	1.92 (0.07)	1.83 (0.05)	3.25***
Irrigation (1=Yes)	0.32 (0.03)	0.36 (0.03)	0.34 (0.02)	-0.88
Cost of input (baht/ha)	571.35 (73.05)	436.91 (28.07)	507.69 (40.75)	1.65*
Cost of labor (baht/ha)	2048.40 (101.09)	2197.78 (100.21)	2119.14 (71.31)	-1.05
Cost of machine (baht/ha)	905.27 (44.41)	736.71 (34.17)	825.45 (28.60)	2.96***
Seed rate (kg/ha)	270.63 (7.01)	303.79 (7.75)	286.33 (5.24)	-3.18***
Use of fertilizer info (1=Yes)	0.65 (0.03)	0.64 (0.03)	0.65 (0.02)	0.16
Use of pesticide info (1=Yes)	0.08 (0.02)	0.09 (0.02)	0.09 (0.01)	-0.41
Use of herbicide info (1=Yes)	0.04 (0.01)	0.06 (0.01)	0.05 (0.01)	-1.40
Use of seed info (1=Yes)	0.53 (0.03)	0.55 (0.03)	0.54 (0.02)	-0.49

Notes: 1. Cost of input calculated based on sum of fertilizer cost, pesticide cost, and herbicide costs
2. Figures in parentheses are standard errors
3. *** p < 0.01;**p < 0.05; *p < 0.1

Table 6. Differences in means of rice production by information use

Rice production (kg)		Fertilizer information	Pesticide information	Herbicide information	Seed information
CA (n=338)	Users	5145.35 (397.06)	7971.91 (1087.91)	6583.41 (1300.45)	4711.32 (412.24)
	Non-users	4205.43 (281.42)	4532.27 (280.92)	4746.56 (283.30)	4935.01 (365.52)
	Difference	939.92 (580.27)	4817.21 (277.28)	4817.21 (277.28)	4817.21 (277.28)
	t values	1.62*	-3.48***	-1.28	0.40
GAP (n=304)	Users	6047.97 (440.53)	9911.15 (1199.65)	10989.50 (1952.99)	6298,21 (530.47)
	Non-users	6657.66 (682.24)	5894.63 (386.25)	5949.57 (369.74)	6224,10 (520.09)
	Difference	609.69 (780.06)	4016.53 (1271.50)	6264.57 (373.09)	74.12 (750.60)
	t values	0.78	-3.16***	-3.32***	-0.10

Notes: 1, Figures in parentheses are standard errors
2 *** p < 0.01;**p < 0.05; *p < 0.1

Table 7. Proportions of CA and GAP farmers using information sources

Sources of Information		CA (n=338)		GAP (n=304)	
		Frequencies	Percentage	Frequencies	Percentage
Inside village	Relative	15	4.44	15	4.93
	Friend/Neighbor	30	8.88	22	7.24
	Community leader	153	45.27	132	43.42
	Members in farm group	28	8.28	34	11.18
	Leader of farm group	74	21.89	65	21.38
	Government agency	16	4.73	17	5.59
	Input dealer	2	0.59	1	0.33
	None	20	5.92	18	5.92
Outside village	Relative	34	10.06	27	8.88
	Friends	27	7.99	30	9.87
	Members in farm group	41	12.13	35	11.51
	Leader of farm group	107	31.66	97	31.91
	Extension agent	4	1.18	6	1.97
	Expert in university	11	3.25	13	4.28
	Input dealer	2	0.59	2	0.66
	Middlemen	0	0	5	1.64
	None	112	33.14	89	29.28

4.4. Empirical Model

In this study in order to estimate impact of information usage on rice production both by GAP farms and CA farms, this study first use Ordinary Least Squares (OLS) regression by following equation:

$$Y_{ipk} = \beta_0 + \sum_{k=1}^{2} \beta_1 \left(IU_{ipk} \text{ x } IC_{ipk}\right) + \boldsymbol{X'}_{ip}\boldsymbol{\gamma} + \mu_p + \varepsilon_{ir} \quad (2)$$

Where Y is rice production in household i in province p, $InfoUsage$ is a dummy variable where household i in a province p can use five agricultural information k, $\boldsymbol{X'}$ is a vector of explanatory variables of farm inputs, such as land size, and input expenditure, μ_p is province fixed effect, ε_{ip} is error term of unobservable household characteristics. Then natural logarithm of both sides of Eq. (1) is estimated.

Note that in the Eq. (1) as well as in Eq. (2) we account for unobserved heterogeneity by means of fixed effects because in Thailand province-specific heterogeneity cannot be assumed to be random. The reason is that there are

substantial differences in terms of notably natural and environmental conditions, resource access, economic status, level of technology.

Heteroskedasticity-robust standard errors are clustered at the province level because production is different for farmers living in different regions (Abadie et al., 2023). The way sampled data from the Thailand rice farm household population was that 9 provinces in Central and Northeast Plains were selected to be sample. And to make that sample to be similar to the broader population, clustered standard errors were used to estimate the Eq. (1).

However, endogeneity issue arises when the key regressor is correlated with the error term. This can happen when there are (1) omitted variables, (2) reverse causation or simultaneity and (3) measurement errors (Wooldridge, 2015). We can have observable variable $InfoUsage$ is correlated with rice productivity. This kind of endogeneity issue occurs because higher productivity can be achieved as those farmers who have higher productivity have better use of information. On the other hand, those farmers who have higher productivity can use to more information. If this kind of errors-in-variables problem entail and Eq. (1) is estimated by OLS model, it results in a biased and inconsistent estimator of β_1 (Wooldridge, 2015).

Then to solve the issue of endogeneity, using instrumental variables estimator, employing two-stage least squares (2SLS). In the Eq. (2), we call $Source_{ip,IV}$ an instrument variable for $InfoUsage$ which can solve errors-in-variables problem.

$$IU_{ipk} = \beta_0 + \sum_{k=1}^{2} \beta_{1k} Source_{ip,IV} + ln\boldsymbol{X'}_{ip}\boldsymbol{\gamma} + \mu_p + u_{ir} \quad (3)$$

Then, $Source_{ip,IV}$ is two main types of information sources. One is acquaintances living same villages known as inside village. The other is the neighboring farmer which is called outside village. Inside village, there are relatives, friends or neighbors, community leaders, farm group members, farm group leaders, government agencies, input dealer, and middlemen. On the other hand, the people outside the villages are consisted of eight sources, including relatives, friends, farm group member, farm

group leaders, extension service agent, expert in university, input dealer, and middlemen.

In order to consistently estimate this equation, we must meet two conditions of instrumental variable for $Source_{ip,IV}$: instrument relevance and instrument exogenity. If instrument variable is relevant, then variation in the $Source_{ip,IV}$ is related to variation in $\widehat{IU}_{ipk}$. If instrument variable is exogenous, then that part of the variation of exogenous can capture movements in $Source_{ip,IV}$ (Stock and Watson, 2002). Then, by estimating the reduced form by OLS, the fitted values from first-stage estimation, Eq. (3) can be obtained and that fitted value goes to Eq. (2) which brings out Eq. (4).

$$lnY_{ipk} = \beta_0 + \beta_1 \widehat{IU}_{ipk} + ln\boldsymbol{X}'_{ip}\boldsymbol{\gamma} + \mu_p + \varepsilon_{ir} \quad (4)$$

Chapter 5. Result and Discussion

5.1. Results of Rice Farms in Thailand

This study first estimated the impact of agricultural production of all type of farmers in Thailand based on last 12 months of rice production. Above all, in order to identify production function, only farm input-production simple linear regression was first estimated. In order to estimate rice production of all farms, simple OLS is estimated through Eq. (2) and then 2SLS estimation is estimated through the Eq. (3) and Eq. (4). The estimation results are displayed in Table 5 where the Cobb-Douglas functional form was applied. Since the natural log form is adopted, the estimated coefficients listed in Table 8 show us the elasticities.

For the effect of the land size on rice production are all positive and statistically significant. This indicates that an increase in land size led to an increase in the rice production; then, a 1% increase in rice farmland would induce a 0.86-0.89% increase in rice production. Also, for the cost of labor impact on rice production is all positive and statistically meaningful where 1% increase in labor cost would increase average 0.06% of production. For the cost of inputs as well increased 0.001% production and was statistically meaningful and when adding information variable in OLS, the result was consistently positive to the outcome variable.

In addition, according to OLS result, the farmland where it is irrigated, it almost has same effect as the labor did to production. Meaning that when there exist irrigation, average 0.05% of production. In average, the farm household when they have access to the irrigated farmland, approximately 275 kg of rice production would increase. While the Northeast area indicated 0.69-0.85% decrease in production which is outstanding impact than the irrigation. From this we can infer irrigation is not the main factor in increasing production. While from the literature where it indicated Northeast region mostly cultivates sticky rice may be outstanding factor that has impact on the rice production.

For the 2SLS to be valid, the test of endogeneity and overidentifying restrictions are implemented. The regression-based test does not reject the null hypothesis at the

5% significance level (p=0.0746 and p=0.0862), solving the endogeneity between IV and the dependent variable. It also informs the valid instrument variables since p-values of score chi2 for the overidentifying restrictions indicate insignificance.

Table A1 in the appendix shows the first stage results of 2SLS using instrument variables for use of information. Instrumental variables are sources of information, which consists of outside and inside village acquaintances as described in Table 4. The reference is “none” source of information. Table A1 in the upper part represent the use of information within village. In terms of input information from within village, input dealer has a negative direction. However, the input information was statistically significant from sources received from outside village. Also, friends, members in farm group, leader of farm group and middlemen from outside village was statistically positive.

Table 8 in the last column the second stage results of 2SLS using IV regarding rice production and use of seed information do not establish a meaningul causal relationship. On the other hand, farms that have used input related information produced 0.057% higher production. Meaning that in average 1% increase in input information with the input cost, Thailand rice cultivating household would increase 313kg of rice production. From this result the overall rice farmers in Thailand apprehends input related information for their production. Also, other variables, including land size and labor indicated statistical significance aligned with OLS result, while irrigation did not indicate meaningful causal relationship to rice production.

Table 8. Results of All Farm Household Production Function with Information Usage

Dep. Variable	The Logarithm of Rice Production (*ln*kg)		
Indep. Variable	OLS		2SLS
Land size	0.880*	0.878*	0.862***
Land^2	-0.012	-0.012	-0.011
Cost of labor	0.055**	0.055***	0.059***
Cost of input	0.011*	0.006*	-0.028
Cost of machine	0.003	0.005	0.016
Seed rate	0.044	0.045	0.051
Irrigation	0.046***	0.045***	0.037
Northeast	-0.853**	-0.828**	-0.692***
Usage of seed info x seed rate		0.004	0.021
Usage of input info x input cost		0.008*	0.057**
Constant	7.761***	7.732***	7.575***
Province fixed effect	Yes	Yes	Yes
Observations	642	642	642
R-squared	0.7875	0.7883	0.7612
Endogeneity test			
Robust Score Chi2 (p-value)			0.0746
Robust regression F (p-value)			0.0862
Test of overidentifying restrictions			
Score Chi2 (p-value)			0.8703

Note: *** p<0.01. **p<0.05, *p<0.1

5.2. Results of Conventional and GAP Rice Farms in Thailand

From this part, type of rice farmer is differentiated to CA and GAP. Table 9 and Table 10 indicates CA and GAP farm household respectively. For the OLS result on the first column for both CA and GAP farm indicated different statistical causal relationship to rice production in terms of cost of machine, cost of inputs, seed rate and irrigation. On the other hand, land size and cost of labor had statistical positve relationship to rice production for both type of farmers.

For the both type of rice farm, an increase in land size led to an increase in the rice production; both in average 1% increase in rice farmland would induce a 0.8% increase in rice production. When the cost of labor for CA farm increase, 0.03% increase in rice production, which is in average 159kg. On the other hand, in average GAP farm would increase 507kg of rice production indicating that GAP rice farm household are better in terms of use of labor. In addition, in terms of cost of input which is used by CA farm indicated statistical meaningful relationship, but the effect on the rice production is 0.013%. Consistent to all farm household result, when CA

farm household has irrigation to their farmland, rice production would increase 0.086%. While CA farm household living in Northeast indicated negative relationship to production. On the other hand, when adding information related variable to CA farm, the seed rate indicated to have causal positive relationship to rice production: 1% increase in seed would increase 0.057%. Moreover, for both information use in the OLS result is not statistically significant.

However, the information variable is likely to be endogenous to rice production. It is because those who use different types of information are likely to achieve higher production, vice versa. To overcome simultaneous causality bias with instrument variables, 2SLS is implemented and the result is in the last column of the table which indicates that in terms of farm characterisitc variables, irrigation, land size factors are statistically meaningful to rice production. in terms of information use, different from OLS result, CA farm who use input related information are likely to have 0.07% increase in production which is approximately 275 kg of rice production would increase 337kg.

Table 9. Results of CA Farm Household Production Function with Information Usage

Dep. Variable	The Logarithm of Rice Production (*ln*kg)		
Indep. Variable	OLS		2SLS
Land size	0.869*	0.862*	0.821***
Land^2	0.035	0.038	0.047
Cost of labor	0.033*	0.031*	0.027
Cost of input	0.013*	0.006	-0.035
Cost of machine	-0.025	-0.024	-0.006
Seed rate	0.049	0.057*	0.089
Irrigation	0.086*	0.087*	0.107*
Northeast	-0.257**	-0.246**	-0.214*
Usage of seed info x seed rate		-0.004	0.006
Usage of input info x input cost		0.011	0.073***
Constant	7.715	7.673	7.265
Province fixed effect	Yes	Yes	Yes
Observations	338	338	338
R-squared	0.7759	0.7777	0.7310
Endogeneity test			
Robust Score Chi2 (p-value)			0.0668
Robust regression F (p-value)			0.0770
Test of overidentifying restrictions			
Score Chi2 (p-value)			0.6621

Note:*** p<0.01. **p<0.05, *p<0.1

While GAP farmer in Table 7, from the OLS estimated result compared to CA farm, cost of machine indicated statistical significance; then, a 1% increase in cost of machine would induce a 0.05% increase in rice production. Also, higher seed rate, higher production of GAP rice, specifically 1% increase in kilo of seed would induce 0.05% of the production. From this compared to CA farm, GAP rice farmers tend to use labor and machine efficiently to production level. Aligning with CA, GAP farm household living in Northeast region had lower production.

However, in terms of OLS result compared to using instrument variable, the effect that has with the use of information to production level is different. In terms of OLS result, indicated usage of input related information had positve significance to production. While in the last column of 2SLS result which have solved endogeneity between dependent variable, usage of seed and input information indicated to increase 0.06% and 0.05% in production respectively. In average GAP farm household who use input and seed information are likely to increase 377kg-382kg of rice. From this we can infer that GAP and CA rice farm make use of different type of information to increase their production level. Also, when there is 1% increase in labor cost, rice production would increase by 0.03%.

However, when the type of information usage is added to the regression Eq (1), the labor indicates not to be significant. In addition, the result represents that using pesticide and herbicide information would increase 0.13% and 0.11% respectively. From this we can infer that there is endogeneity issue, because some variable, such as labor were significant in one, but was not in the other part. Furthermore, the other variable that is significant but negatively affecting the rice production by 0.20%-0.25% is the Northeast region which aligns from the previous study that Northeast farmers are less productive than of Central farmers.

Table 10. Results of GAP Farm Household Production Function with Information Usage

Dep. Variable	The Logarithm of Rice Production (*ln*kg)		
Indep. Variable	OLS		2SLS
Land size	0.840**	0.842**	0.846**
Land^2	-0.0297	-0.031	-0.038
Cost of labor	0.078*	0.081*	0.098*
Cost of input	0.010	0.004	-0.037
Cost of machine	0.057*	0.059*	0.067*
Seed rate	0.059*	0.055*	0.037*
Irrigation	-0.017	-0.027	-0.092
Northeast	-0.836***	-0.804**	-0.6176**
Usage of seed info x seed rate		0.009	0.061*
Usage of input info x input cost		0.007*	0.058*
Constant	7.381	7.358	7.239
Province fixed effect	Yes	Yes	Yes
Observations	304	304	304
R-squared	0.8089	0.8103	0.7617
Endogeneity test			
Robust Score Chi2 (p-value)			0.2347
Robust regression F (p-value)			0.1857
Test of overidentifying restrictions			
Score Chi2 (p-value)			0.9215

Note:*** p<0.01. **p<0.05, *p<0.1

Chapter 6. Conclusion

In order to promote farming and farm incomes, lead farmers inside village were trained to disseminate information on new farming technique and training on input uses. Therefore, policy makers, and previous studies have long been examining the impact of information on productivity. And this study conducted in the background CA rice farms and GAP rice farms in Northeast and Central Plains of Thailand, consisting of total 642 farm households.

The results of each information usage indicated that using input information, it positively influences on CA rice production. While for GAP farmers, using seed and input information is positive influence on rice production. This may be interpreted as since GAP farmers have continued farming methods because they have experience in increasing production through information relating to the previous study on rice GAP in Thailand. Therefore, the likelihood for using information compared to those who continue to practice CA may more willing and highly likely to sought out that information with the intention to applying it.

In addition, despite the fact that the quality of information is not measured in estimating the impact on production, existing usage of information influence on the production and farm activity could be estimated. From this, it will be helpful for the Thai government to focus on the quality of information used by CA farm rather than increasing the accessibility of each farm in order to increase the efficiency of extension officers and farmers. In addition, despite the fact that many existing studies had utilized farm leader or village leader to spread the new knowledge and increase efficiency, it should be considered that farmers in a village can learn new agricultural techniques from both inside and outside sources.

Moreover, not only rainfed region but also Northeast Plains had lowest productivity in both farms, which has been underlying issue. From the previous literature, this is due to lack of irrigation system in the Northeast Plains, thus, many farmers were likely to be subsistence farmers in that area. Therefore, differentiating those who cultivate rice for their living would be another topic to study.

References

Abadie, A., Athey, S., Imbens, G.W., Wooldridge, J.M., 2023. When should you adjust standard errors for clustering?. The Quarterly Journal of Economics. 138(1), 1-35.

Aker., C.J., 2011. Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. Agricultural Economics. 42, 631-647.

Alenea, A.D., Manyong, V.M., 2006. Farmer-to-farmer technology diffusion and yield variation among adopters: The case of improved cowpea in northern Nigeria. Agricultural Economics. 35, 203–211.

Amekawa, Y., 2013a. Can a public GAP approach ensure safety and fairness? A comparative study of Q-GAP in Thailand. The Journal of Peasant Studies. 40. 189-217.

Amekawa, Y., 2013b. Understanding the local reality of the adoption of sustainable practices and farmer livelihoods: the case of pummelo farming in Chaiyaphum, Northeast Thailand. Food Security. 5, 798-805.

Amekawa, Y., Bumrungsri, S., Wayo, K., Gebre, G.G., Hongsibsong, S., 2022. Pesticide use under public good agricultural practices standard: a comparative study in Thailand. Agriculture. 12(5), 606.

Amekawa, Y., Chuan, N.C., Lumayag, L.A., Tan, G.H., Wong, C.S., Abdulra'uf, L.B., Tan, H.B., Tai, W.X., Tan, S.M., Liu, C.H., Chee, L.J., 2017. Producers' perceptions of public good agricultural practices and their pesticide use: The case of MyGAP for durian farming in Pahang, Malaysia. Asian Journal of Agriculture and Rural Development. 7, 1–16.

Amekawa, Y., Hongsibsong, S., Sawarng, N., Yadoung, S., Gebre, G.G., 2021. Producers' Perceptions of Public Good Agricultural Practices Standard and Their Pesticide Use: The Case of Q-GAP for Cabbage Farming in Chiang Mai Province, Thailand. Sustainability. 13, 6333.

Anderson, J.R., Feder, G., 2003. Rural Extension Services. World Bank Policy Research Working Paper 2976. Washington, DC: World Bank.

Aonngernthayakorn, K., Pongquan, S., 2017. Determinants of rice farmers' utilization of agricultural information in Central Thailand. Journal of Agricultural & Food Information, 18:1, 25-43.

Arunmas, P., 2016. "Rice industry to fire up 'mega farm project'." *Bangkok Post*. Jan 30, 2016, n.p.

Attavanich, W., Chantarat, S., Chenphuengpawn, J., Mahasuweerachai, P., Thampanishvong, K., 2019. Farms, farmers and farming: a perspective through data and behavioral insights (No. 122). Puey Ungphakorn Institute for Economic Research.

Banerjee, A., Chandrasekhar, A.G., Duflo, E., Jackson, M.O., 2013. The diffusion of microfinance. Science, 341(6144), 1236498.

Bavorová, M., Unay-Gailhard, İ., Ponkina, V.E., Pilařová, T., 2020. How sources of agriculture information shape the adoption of reduced tillage practices?. Joural of Rural Studies. 79, 88-101.

Bindlish, V., Evenson, R.E., 1997. The impact of T&V extension in Africa: The experience of Kenya and Burkina Faso. World Bank Res. Observer. 2(2), 183–201.

Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., Mbabu, A., Spielman, D.J., Horna, D., Benin, S., Cohen, M., 2009. From best practice to best fit: a framework for designing and analyzing pluralistic agricultural advisory services worldwide. Journal of Agricultural Education and Extension. 15, 341-355.

Black, A.W., 2000. Extension theory and practice: a review. Australian Journal of Experimental Agriculture. 40, 493-502.

Bourne, M., Gassner, A., Makui, P., Muller, A., Muriuki, J., 2017. A network perspective filling a gap in assessment of agricultural advisory system performance. Journal of Rural Studies. 50, 30–44.

Chaikiattiyos, S., Yoovatana, M.G., 2015. Promotion of climate resilience in rice and maize. Thailand National Study. Deutsche Gesellschaft Für. Internationale Zusammenarbeit (GIZ) GmbH, Bonn and Eschborn, Germany.

Chowa, C., Garforth, C., Cardey, S., 2013. Farmer Experience of Pluralistic Agricultural Extension, Malawi. The Journal of Agricultural Education and Extension. 19(2), 147–166.

Cramb, R., 2020. White Gold: The Commercialisation of Rice Farming in the Lower ` Basin. Palgrave Macmillian, Singapore.

Daniel, R., Lebel, L., Manorom, K., 2013. Governing the Mekong: Engaging in the Politics of Knowledge. Strategic Information and Research Development Centre.

Diekmann, F., Loibl, C., Batte, T.M., 2009. The Economics of Agricultural Information: Factors affecting commercial farmers' information strategies in Ohio. Review of Agricultural Economics. 31, 853-872.

Doss, C. R., Quisumbing, A.R., 2019. Understanding rural household behavior:

Beyond Boserup and Becker. Agricultural Economics. 51. 47-58.

Fakkhong, S., Suwanmaneepong, S., 2015. Socio-economic factors influencing rice production in peri-urban area, Bangkok, Thailand. International Journal of Agricultural Technology. 11(8), 2053-62.

Feder, G., Lau, J.L., Slade, H.R., 1987. Does agricultural extension pay? The training and visit system in Northwest India. American Journal of Agricultural Economics. 69, 677-686.

Feder, G., Murgai, R., Quizon, B., 2004. Sending farmers back to school: the impact of farmer field schools in Indonesia. Review of Agricultural Economics. 26, 45-62.

Feder, G., Slade, R., 1984. The acquisition of information and the adoption of new technology. American Journal of Agricultural Economics. 66, 312-320.

Food and Agricultural Organization of United Nations, 2021. Production data for world rice. https://www.fao.org/faostat/en/#data. Accessed 11 April 2023.

Fukai, S., Ouk, M., 2012. Increased productivity of rainfed lowland rice cropping systems of the Mekong region. Crop and Pasture Science. 63(10), 944-973.

Haefele, S.M., Naklang, K., Harnpichitvitaya, D., Jearakongman, S., Skulkhu, E., Romyen, P., Phasopa, S., Suriya-arunroj, D., Khunthasuvon, S., Kraisorakul, D., Youngsuk, P., Amarante, S.T., Wade, L.J., 2006. Factors affecting rice yield and fertilizer response in rainfed lowlands of northeast Thailand. Field crops research. 98(1), 39-51.

Hoang, G.H., 2020. Adoption of good agricultural practices by cattle farmers in the Binh Dinh Province of Vietnam. Journal of Agricultural Extension. 24, 151–160.

Islam, N.M.G., Arshad, M.F., Radam, A., Alias, F.E., 2012. Good agricultural practices of tomatoes in Malaysia: Evidence from Cameron Highlands. African Journal of Business Management. 6(27), 7969-7976.

Kaesm, S., Thapa, B.G., 2011. Crop diversification in Thailand: Status, determinants, and effects on income and use of inputs. Land Use Policy. 28, 618-628.

Kawasaki, J., Herath, S., 2011. Impact assessment of climate change on rice production in Khon Kaen province. Thialand. Journal of ISSAAS. 17, 14-28.

Khataza, R.R., Doole, G.K., Kragt, M.E., Hailu, A., 2018. Information acquisition, learning and the adoption of conservation agriculture in Malawi: a discrete-time duration analysis. Technological Forecasting & Social Change. 132, 299-307.

Krugman, P., 1994. Defining and measuring productivity. The Age of diminishing Expectations.

Laosutsan, P., Shivakoti, P.G., Soni, P., 2019. Factors influencing the adoption of good agricultural practices and export decision of Thailand's vegetable farmers. International Journal of the Commons. 13(2), 867-880.

Lecoutere, E., Spielman, D.J., Van Campenhout, B., 2023. Empowering women through targeting information or role models: Evidence from an experiment in agricultural extension in Uganda. World Development. 167, 106240.

Li, Z., Zhang, R., Xia, S., Wang, L., Liu, C., Zhang, R., Fan, Z., Ceh, F., Liu, Y., 2019. Interactions between N, P and K fertilizers affect the environment and the yield and quality of satsumas. Global Ecology and Conservation. 19, e00663.

Limprapoowiwattana, C., 2022. The art of Buddhist connectivity: Organic rice farming in Thailand. Agriculture and Human Values. 1-17.

Lin, T., Ko, A.P., Than, M. M., Catacutan, D.C., Finlayson, R. F., Issac, M. E., 2021. Farmer social networks: the role of advices ties and organizational leadership in agroforestry adoption. PLoS ONE. 16(8), e0255987.

Mackil, D.J., Coffman, W.R., Garrity, D.P., 1996. Rainfed lowland rice improvement. International Rice Research Institute. Manila, Philippines.

Maffioli, A., Ubfal, D., Baré, G. V., Cerdán-Infantes, P., 2011. Extension services, product quality and yields: the case of grapes in Argentina. Agricultural Economics. 42(6), 727-734.

Minamikawa, K., Fumoto, T., Iizumi, T., Cha-un, N., Pimple, U., Nishimori, M., Ishigooka, Y., Kuwagata., 2016. Prediction of future methane emission from irrigated rice paddies in central Thailand under water management practices. Science of the Total Environment, 641-651.

Mitigation Action Facility. 2022. Thailand Low-Emission Rice Mid-term Evaluation and Learning Exercise Report & Management Response. Berlin, Germany.

Mittal., S., Mehar, M., 2016. Socio-economic factors affecting adoption of modern information and communication technology by farmers in India: Analysis using multivariate probit model. Journal of Agricultural Education and Extension. 22(2), 196-212.

Mungkung, R., Sitthikipanya, S., Chaichana, R., Bamrungwong, K., Santitaweeroek, Y., Jakrawatana, N., Silalertuksa, T., Gheewala, H.S., 2022. Measuring sustainability performance of rice cultivation in Thailand using Sustainable Rice Platform indicators. International Journal of Agricultural Sustainability. 20, 1278-1293.

Nguyen, L.T., Nanseki, T., Chomei, Y., 2019. The impact of VietGAHP implementation on Vietnamese households' pig production. Environment, Development and sustainability.

Office of Agricultural Economics, 2022a (in Thai). Types of rice in the year: Planted area, yield, and yield per rai by province. Bangkok, Thailand.

Office of Agricultural Economics, 2022b (in Thai). Planted area and harvested area yields classified by irrigation areas at national, regional, and provincial levels in 2021. Bangkok, Thailand.

Office of National Economic and Social Development Council, 2020. Gross Regional and Provincial Product Chain Volume Measure 2020 Edition. Bangkok, Thailand.

Office of Natural Resources and Environmental Policy and Planning, 2022. Thailand's Fourth Biennial Update Report. Bangkok, Thailand.

Ogutu, S.O., Okello, J.J., Otieno, D.J., 2014. Impact of information and communication technology-based market information services on smallholder farm input use and productivity: The case of Kenya. World Development. 64, 311-321.

Peterson, W., and Y, Hayami., 1978. *Technical Change in Agriculture.* A Survey of Agricultural Economics Literature, L.R. Martin, ed., Minneapolis: University of Minnesota Press. 497- 540.

Pochanasomboon, A., Attavanich, W., Kidsom, A., 2020. Impacts of land ownership on the economic performance and viability of rice farming in Thailand. Land. 9(3), 71.

Praneetvatakul, S., Kuwattanasiri, S.D., Waibel, H., 2003. The productivity of pesticide use in rice production of Thailand: a damage control approach. Thai Journal of Agricultural Economics 22.

Premier, R., Ledger, S., 2006. Good agricultural practices in Australia and Southeast Asia. HortTechnology 16, 552-555.

Rahman, S., Wiboonpongse, A., Sriboonchitta, S., Chaovanapoonphol, Y., 2009. Production efficiency of Jasmine rice producers in Northern and North-Eastern Thailand. Journal of Agricultural Economics. 60(2), 419-435.

Reda, A. G., Tripathi, N. K., Soni, P., Tipdecho, T., 2015. Rain fed rice agriculture under climate variability in Southeast Asia: The case of Thailand. Journal of Earth Science & Climatic Change. 6(8), 1.

Rockenbauch, T., Sakdapolrak, P., Sterly, H., 2019. Do translocal networks matter for agricultural innovation? A case study on advice sharing in small-scale farming communities in Northeast Thailand. Agriculture and Human Values. 36, 685-702.

Rogers, E.M., 1995. Diffusion of Innovations. Free Press, New York.

Sachchamarga, K., Williams, G.W. 2004. Economic factors affecting rice production in Thailand. Texas Agribusiness Market Research Center.

Salaisook, P., Faysse, N., Tsusaka, T.W. 2020. Reasons for adoption of sustainable land management practices in a changing context: A mixed approach in Thailand. Land Use Policy. 96, 104676.

Sarsud, V. 2007. National experiences: Thailand. In: United Nations, ed. Challenges and opportunities arising from private standards on food safety and environment for exporters of fresh fruit and vegetables in Asia: Experiences of Malaysia, Thailand and Viet Nam. United Nations. 53-69.

Savci, S., 2012. An agricultural pollutant: chemical fertilizer. International Journal of Environmental Science and Development. 3(1), 73.

Sawano, S., Hasegawa, T., Goto, S., Konghakote, P., Polthanee, A., Ishigooka, Y., Kuwagata, T., Toritani, H., 2008. Modeling the dependence of the crop calendar for rain-fed rice on precipitation in Northeast Thailand. Paddy and Water Environment. 6, 83-90.

Schreinemachers, P., Schad, I., Tipraqsa, P., Williams, P.M., Neef, A., Riwthong, S., Sangchan, W., Grovermann, C., 2012. Can public GAP standards reduce agricultural pesticide use? The case of fruit and vegetable farming in northern Thailand. Agric. Hum. Values 29, 519-529.

Shimamoto, D., Yamada, H., Gummert, M., 2015. Mobile phones and market information: Evidence from rural Cambodia. Food Policy. 57, 135-141

Sinnarong, N., Chen, CC., McCarl, B., Tran, BL., 2019. Estimating the potential effects of climate change on rice production in Thailand. Paddy and water Environment. 17, 761-769.

Solow, R.M., 1957. Technical change and the aggregate production function. The review of Economics and Statistics. 312-320.

Srisompun, O., Athipanyakul, T., Isvilanonda, S., 2019. The adoption of mechanization, labour productivity and household income: Evidence from rice production in Thailand (No. WP-016). TVSEP Working Paper.

Srisopaporn, S., Jourdain, D., Perret, S.R., Shivakoti, G., 2015. Adoption and continued participation in public Good Agricultural Practices program: The case of rice farmers in the Central Plains of Thailand. Technological Forecasting & Social Change. 96, 242-253.

Stoneman, P. L., David, P. A., 1986. Adoption Subsidies vs Information Provision as Instruments of Technology Policy. The Economic Journal. 96, 142-150.

Suwanmaneepong, S., Kullachai, P., Fakkhong, S. 2016. An investigation of factors influencing the implementation of GAP among fruit farmers in Rayong Province, Thailand. International Journal of Agricultural Technology. 12, 1745–1757.

Suwanmaneepong, S., Kultawanich, K., Khurnpoon, L., Sabaijai, E.P., Cavite, J.H., Llones, C., Lepcha, N., Kerdsrisern, Chanhathai., 2023. Alternative Wetting and Drying as Water-Saving Technology: An Adoption Intenton in Perspective of Good Agricultural Practices (GAP) Suburban Rice Farmers in Thailand. Water. 15(3), 402.

Suwanmontri, P., Kamoshita, A., Fukai, S., 2021. Recent changes in rice production in rainfed lowland and irrigated ecosystems in Thailand. Plant Production Science. 24(1), 15-28.

Taweerattanapanish, A., Soponronnarit, S., Wetchakama, S., Kongseri, N., Wongpiyachon, S., 1999. Effects of drying on head rice yield using fluidization technique. Drying Technology. 17(1-2), 346-353.

Thanawong, K., Perret, S. R., Basset-Mens, C., 2014. Eco-efficiency of paddy rice production in Northeastern Thailand: a comparison of rain-fed and irrigated cropping systems. Journal of Cleaner Production. 73, 204-217.

Tinh, L., Hung, P.T.M., Dzung, D.G., Trinh, V.H.D., 2019. Determinants of farmers' intension of applying new technology in production: The case of VietGAP standard adoption in Vietnam. Asian Journal of Agriculture and Rural Development. 9, 164–178.

Titapiwatanakun, B., 2012. The rice situation in Thailand. Asian Development Bank. Metro Manila, Philippines.

Van Campenhout, B., Spielman, J.D., Lecoutere, E., 2020. Information and communication technologies to provide agricultural advice to smallholder farmers: experimental evidence from Uganda. American Journal of Agricultural Economics. 103(1), 317-337.

Wade, L. J., Fukai, S., Samson, B. K., Ali, A., Mazid, M. A., 1999. Rainfed lowland rice: physical environment and cultivar requirements. Field Crops Research. 64(1-2), 3-12.

Wanger, T.C., Darras, K., Bumrungsri, S., Tscharntke, T., Klein, A.M., 2014. Bat pest control contributes to food security in Thailand. Biological Conservation. 171, 220-223.

Watanabe, K. 2017. Improvement in rainfed rice production during an era of rapid national economic growth: a case study of a village in Northeast Thailand. Southeast Asian Studies. 6(2), 293-306.

Wooldridge, J.M., 2015. Introductory econometrics: A modern approach. Cengage

learning.

Yegbemey, R.N., Bensch, G., Vance, C., 2023. Weather information and agricultural outcomes: Evidence from a pilot field experiment in Benin. World Development. 167, 106178.

Zheng, H., Ma, W., 2021. Smartphone-based information acquisition and wheat farm performance: insights from a doubly robust IPWRA estimator. Electronic Commerce Research. 1-26.

Abstract (Korean)

국 문 초 록

정보활용이 태국 쌀 농업 생산에 미치는 영향: 관행 및 GAP 농가 비교를 중심으로

최민주

국제농업개발협력전공

서울대학교 국제농업기술대학원

본연구는 태국의 관행농가 및 우수농산물관리농가에서 생산관련 종자 및 투입재 (비료, 살충제, 및 제초제) 정보가 쌀 생산에 미치는 영향을 파악하는 것을 목적으로 한다. 본 연구를 수행하기 위해 태국 내 70% 이상 쌀을 생산하는 중부와 북동부 지역의 9개 주를 선정하여 338호의 관행농가와 304호의 우수농산물관리농가로 구성된 총 642호 농가를 조사하였다. 또한 정보를 더 잘 활용하는 농가가 더 높은 생산량이 있을 수 있고, 그 반대로 생산량이 높은 농가가 더 정보를 잘 활용할 수 있는 내생성 문제를 해결하기 위해 정보원을 도구변수로 하여 인과관계를 파악하였다.

연구 결과 대부분의 농가들은 마을 내외로부터 정보를 얻고 있으며, 마을 이장으로부터 43%−45%, 조합 지도자로부터 21%−31%, 그리고 조합 구성원으로부터 8%−12% 비율로 정보를 얻는다는 것을 확인하였다. 관행농가의 경우 경지면적, 노동비용, 투입재 비용이 1% 증가하면 쌀 생산량은 각각 0.87%, 0.03%, 0.01% 증가하는 것으로 나타났다. 우수농산물관리농가의 경우 경지면적, 노동비용, 기계비용이 1% 증가하면 쌀 생산량은 각각 0.84%, 0.08%, 0.06% 증가하는 것으로 추정되었다. 우수농산물관리농가의 경우 투입물 및 종자 정보를 사용하면 쌀 생산량이 평균 0.06% 증가하였다. 반면, 종자 정보는 관행 농가에 영향을 미치지 않았으며, 투입물 정보만 쌀 생산량에 0.07% 영향을 미치는 것으로 나타났다. 이는 우수농산물관리

농가들이 관행농가들보다 생산관련 정보를 더 적극적으로 활용한다는 것을 의미한다. 따라서 기존 관행농가는 쌀 생산량 증대를 위해서는 종자관련 교육 프로그램에 대한 참여율을 높이는 방식의 인센티브를 활용하여야 한다. 그러나 두 농가 모두 전반적으로 투입물 및 생산관련 정보 모두 쌀 생산량 증가에 유사한 영향을 미치는 것으로 나타났고, 따라서 정보는 노동비용 만큼 효율적인 수단이 될 수 있을 것이라 사료된다.

태국은 쌀 생산성을 높이기 위해 화학비료와 살충제 살포를 오랜 기간 사용하였으나, 식품 안전성에 대한 문제로 2000년대 초 우수 농업 관행(GAP)을 도입하였다. 그러나 최근 벼 농업 부문이 상당히 온실가스 배출량에 기여한다는 점에서 태국 농림부차원에서 시행되고 있던 GAP를 개정했다. 관행 농법을 지속가능한 GAP로 전환하고자 하는 목표로 영농 교육을 통해 관련 농업기술을 보급하고 있으나 기존 농가들은 관행농을 유지하고자 한다.

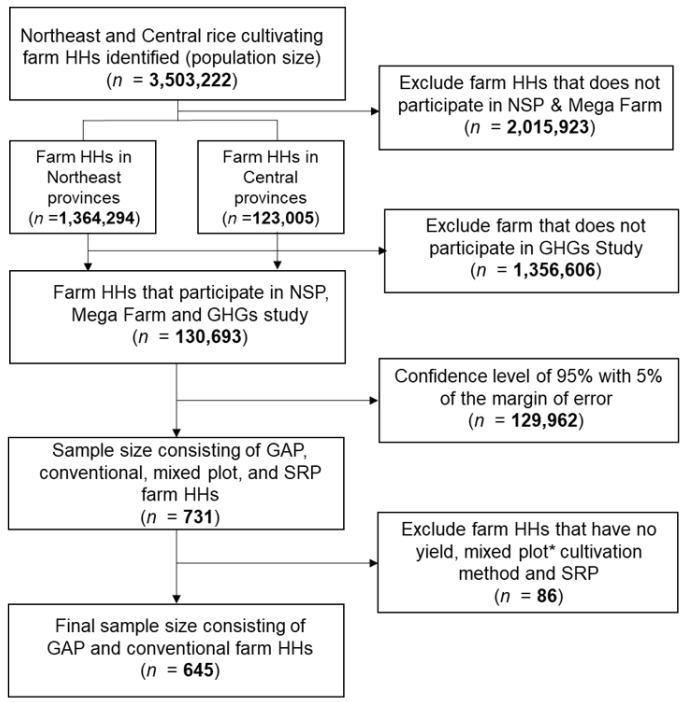
주요어: 태국, 쌀 생산, 정보활용, 관행농가, 우수농산물관리제도, 도구변수
학번: 2021-20437

Appendix

From OAE reported number of rice farm in the Northeast and Central Plains, the population size is 3,503,**222 (Figure A). In** order to sample proportionally both of GAP and CA farms, farms that participate in either NSP project or Mega Farm project were included in the sample, consisting of 1,364,294 and 123,005 in Northeast and Central Plains respectively. Then the rice farms that participate in Green House Gas emissions study conducted by KKU were included as the study tries to promote CA to substitute to sustainable farming. Thus, in the study area where GHGs study is conducted, there are CA, GAP, and SRP farm households. At 95% confidence level with the accuracy of 5% of margin of error, 384 or more surveys were quantified to be needed. Therefore, 731 sample size consisting of CA, GAP, and SRP farm households were collected.

The field survey was conducted face-to-face (15th September to 30th October in 2022) by trained Khon Kaen University researchers. A structured questionnaire was used to compile both at the plot level and household level in the purpose of rice production and household demographics respectively. To compute rice production of each household, the data was collected in a plot-level, in order to drop those households that practice both GAP and conventional rice farming practices in the plots that the households own. Then, plot-level data was aggregated into average of the plots to build household level data. Because the factors affecting production are made by household level choices, such as which crops to grow, which inputs to use, and how to allocate labor among different plots and activities (Doss and Quisumbing, 2019). However, to identify the causal relationship between rice production and agricultural inputs, we dropped 52 households that indicated no rice production. Lastly, considering that GAP certification is based on plot level, farm household may have mixed plot consisting of both GAP and CA. Therefore, in this study those who have mixed plots and SRP certified plot were excluded in the final estimation sample, consisting of 645 farm household.

Figure A. Sampling Method



Note: Mixed plots consists of both GAP and CA in more than two plots.

Table A1. First-stage Results of IV: All farm's Information Use

Sources of Information		Input Information	Seed Information
Inside village	Relative	0.395	0.125
	Friend/Neighbor	-0.083	1.224*
	Community leader	-0.223	1.461***
	Members in farm group	-0.258	1.026
	Leader of farm group	0.221	0.920
	Government agency	-0.678	0.305
	Input dealer	-2.811**	0.660
Outside village	Relative	-0.080	-0.935
	Friends	0.812**	0.285
	Members in farm group	1.269***	-0.242
	Leader of farm group	0.657**	0.399
	Extension agent	0.179	-1.937***
	Expert in university	0.871	1.598***
	Input dealer	3.446***	-2.052*
	Middlemen	1.628***	-1.380

Note: *** p<0.01. **p<0.05, *p<0.1

Table A2. First-stage Results of IV: All farm's Information Use

Sources of Information		CA's Input Information	CA's Seed Information	GAP's Input Information	GAP's Seed Information
Inside village	Relative	0.439	0.122	0.462	0.365
	Friend/Neighbor	-0.176	1.679*	-0.111	0.872
	Community leader	-0.837	2.021***	0.492	1.016
	Members in farm group	-0.299	0.918	-0.051	1.404
	Leader of farm group	-0.432	1.710**	0.953	0.303
	Government agency	-0.771	0.643	-0.346	-0.030
	Input dealer	-3.679*	-0.065	-3.457***	4.380***
Outside village	Relative	-0.516	-1.516	0.452	-0.426
	Friends	1.008*	0.066	0.300	0.835
	Members in farm group	1.158**	0.148	1.128*	-0.680
	Leader of farm group	0.791**	0.264	0.360	0.676
	Extension agent	1.411**	-0.807	-0.830	-2.826***
	Expert in university	0.901	1.282	0.400	2.098
	Input dealer	4.772***	-2.659	2.249***	-0.470
	Middlemen	-	-	1.196	-1.274

Note: *** p<0.01. **p<0.05, *p<0.1

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ID

GSIAT GRADUATE SCHOOL OF INTERNATIONAL AGRICULTURAL TECHNOLOGY SEOUL NATIONAL UNIVERSITY

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SOCIAL NETWORK QUESTIONNAIRE FOR THAI FARMERS (2022)

Center for International Agricultural Development (CIAD) E-Saan Center for Business and Economic Research (ECBER)

Seoul National University		Khon Kaen University	
http://snuciad.or.kr/		hppt://www.kku.ac.th	
Enumerator Name/Code		Date of Interview	
Province Name		Household Number	
District Name		Name of Household Head	
Village Name		ID of Household Head	
Phone number		Sex of Household Head	

The Center for International Agricultural Development (CIAD) at Seoul National University in the Republic of Korea aims to explore, contribute, and take the lead in global agricultural development issues focusing on poverty reduction, sustainable development, and regional cooperation. The following research of Social Network Survey Questionnaire for Thai Farmers (2023) is collaboratively conducted with the Faculty of Economics, Khon Kaen University, Thailand for agricultural activity and the local economy of Thailand. This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2021S1A5A2A03071226).

This survey contains questions about your household information, which consists of questions about the household economy, opinions about the community and society and includes questions about the environment within your community. Answering questions is not a right or wrong type of question. For your generous agreement to participate in this survey, all the information collected will remain strictly confidential. Your answers will never be shared with anyone other than our project team.

Do you agree to participate in this survey? ☐ **Yes** ☐ **No**

Interviewer Name **Signature**

Ver 1.1(2023.04.27.)

Project participation	
1. Do you or a member of your household participate in any governmental project or policy? Please answer all questions.	Participate
1.1. Corporal: Learning Center for Agricultural Product Production Efficiency	1.❑ Yes 2.❑ No
1.2. Big Plot: Grouping together to reduce costs and increase agricultural productivity	1.❑ Yes 2.❑ No
1.3. Smart Farmers	1.❑ Yes 2.❑ No
1.4. Water Management: Irrigation projects in the area both large/medium/small including community water sources, Farm water source (mini pond)	1.❑ Yes 2.❑ No
1.5. Comprehensive rice production plan: Promoting and supporting rice planting for farmers and planning a comprehensive rice market	1.❑ Yes 2.❑ No
1.6. Thai Rice Nama: Project to increase production efficiency and reduce global warming from farming for sustainable development	1.❑ Yes 2.❑ No
1.7. Zoning by Agri-Map: Support and encourage farmers to change; Producing in unsuitable areas is Proper Production	1.❑ Yes 2.❑ No
1.8. Agricultural Products Bank: Support for farmers to access and use benefit from production factors such as cattle, fertilizer, seed	1.❑ Yes 2.❑ No
1. 9. Sustainable Rice Project (SRP): Support and encourage farmers to change Planting rice that is good for the environment	1.❑ Yes 2.❑ No
1.10. GAP Agricultural Standards: Increasing production efficiency in large agricultural areas to meet standards/ Supporting, promoting and developing farmers according to GAP guidelines	1.❑ Yes 2.❑ No
1.11. New Theory Agricultural Extension Project:Supporting farmers to have knowledge and understanding of the implementation of the agricultural system; New theory and can be adapted for a stable and sustainable career	1.❑ Yes 2.❑ No
1.12. Standards for organic agricultural products: Increasing production efficiency in large agricultural areas to meet standards/ Supporting, promoting and developing farmers according to organic farming guidelines	1.❑ Yes 2.❑ No

10. **Land and crop damage**	
10.1. What is the **total size of your farmland**[1]? (including leased land for agriculture)	[_____ Rai]
10.2 What is the **total size of your rented farmland?**	[_____ Rai]
10.3. How many rai in your **own property** were used in cultivation?	[_____ Rai]
10.4. How many rai that you **rent from others** were used in cultivation?	[_____ Rai]
10.5 How many rai of your cultivated land are borrowed from others **free of charge**?	[_____ Rai]
10.6 How much do you pay for land rent[2]? (If not = 0, If you paid the rent by amount of yield, how much was the value)	[_____ bath]
10.7 Does any /all plot(s) of your cultivated land have an **irrigation system**[3]?	1.❑ Yes 2.❑ no
10.8 How many rai of your land have access to the irrigation water to cultivate all year	[_____ Rai]
[1] Farmland: The land for conducting agricultural activities. It includes land where you currently do not grow anything (fallow land), and land that you rent to others. [2] Land rent: The land that you use for a certain amount of money in return. [3] Irrigation system: It includes a water pump and reservoir for storing rainwater to cultivate crops.	
10.9. How many times have you experienced **flood**[4] within the last 3 years?	❑0 ❑1 ❑2 ❑3 ❑4 ❑5 or more
10.10. How many times have you experienced **drought**[5] within the last 3 years?	❑0 ❑1 ❑2 ❑3 ❑4 ❑5 or more
10.11. Was there any crop **damage** on your crop within the last 3 years?	1.❑ Yes 2.❑ no
10.12. What was **the main cause of damage**[6] to your crop?	Damage ***cause code*** [_____]
[4] Flood: Excess rainfall causing damage to the yield. [5] Drought: Lack of rain causing damage to the yield. [6] Damage: The damage brings about the most losses to your crops.	

Crop Damage Code *(question 10.12)*			
01 Heavy rain	04 High Temperature (Too hot)	07 Plant Diseases	10 Soil erosion (landslide)
02 Flood	05 Low temperature (too cold)	08 Weed	11 Contaminated Seed (Mutant)
03 Drought	06 Pests	09 Wild animals	12 Other (specify)

9. **Crop Production and Sales**			
	plant code	**quantity**	**organic**
9 .1. What crop have you ***produced*** the 1st most for the last 12 months?	9 .1.a. **[code____]**	9 .1.b. **[_____kg]**	9. 1. c. ❑ Yes 0. ❑ no
9 .2. What crop have you ***produced*** the 2nd most for the last 12 months?	9 .2.a. **[code____]**	9 .2.b. **[_____kg]**	9. 2. c. ❑ Yes 0. ❑ no
	plant code	**quantity**	**value**
9 .3. What crop have you ***sold*** the 1st most for the last 12 months[1]?	9 .3.a. **[code ___]**	9 .3.b. **[_____kg]**	9 .3. c **[_____ baht]**
9 .4. What crop have you ***sold*** the 2nd most for the last 12 months?	9 .4.a. **[code ___]**	9 .4.b. **[_____kg]**	9 .4. c **[_____ baht]**
9 .5. **To whom** do you sell your products the most?		Buyer Code [_____]	
9 .6. **The amount of Self-consumption[2]** from total crop production for the last 12 months?		[_____ kg]	
9.7. Time taken from your house to local market[3] for selling your agricultural products (on vehicle)?		[_____] minutes	

[1] This question indicates the crop which you earn the most from through selling.
[2] Self-Consumption: It includes crops used for food or seeds kept for the next cultivation.
[3] Local Market: All places where you sell your agricultural products to others or buy agricultural inputs (fertilizer, pesticide, herbicide)

plant code *(question 9.1~9.4)*				
01 Rice	05 sugarcane	11 Cantonese	16 lemongrass	21 Durian
02 Glutinous Rice	06 Cassava	12 hatch / pumpkin	17 coriander	22 Longans
03 corn	07 Rubber	13 spring onions	18 ginger / leg	23 other (specify)
04 Maize	09 morning glory	14 Eggplant	19 chili	
08 Pineapple	10 Cucumbers	15 kale	20 banana	

Buyer Code *(Question 9.5)*		
01 middlemen who come to buy 02 village market 03 people in the village who have direct contact with the company	04 Relatives in the village 05 Agricultural Community Enterprise 06 Community restaurants	07 The Company You Contact Directly 99 other (specify)

Household information						
6. **Members of your household**						
Relationship with the household head	**Age (Years)**	**Sex (Male= 1, Female= 0)**	**Studying (Study=1, No=0)**	**Education level**	**Main occupation**	**Do members go to work outside the area?**

*** Always enter head of household information first. followed by spouse Then sort by age.

Relationship with head of household:

1= Head of household/ 2 = Wife/ 3 = Husband/ 4 = Children/ 5 = Grandchildren/ 6 = Father/ 7 = Mother/ 8 = Father-in-law/ 9 = Mother-in-law/ 10 = Son-in-law/daughter-in-law/ 11 = Relative/ 12 = Other , specify.

Education level:

1 = Elementary school or lower/ 2 = Junior high school/ 3 = High School/ 4 = Vocational Certificate/ 5 = High Vocational Certificate/ 6 = Bachelor's Degree/ 7 = Above Bachelor's Degree

Occupation:

1 = Farmer/2 = Private Employee/3 = Civil Servant/4 = Business Personal/5 = Unemployed/6 = Retired/7 = Employed/8 = student/student/9 = other, specify

7. Experienced in farming	
7.1 Farming experience of family head (year)	_____ years
7.2 Have you ever received services or assistance related to farming from an outside agency or not ?	1. ❑ Yes 0. ❑ no

8. During the past **1 year** , have you and your household members been sick from farming?

8.1 **Member**	**Symptom**	**Number of times of symptoms**	**Caused by pesticides (NO=0, YES=1)**	**Does it affect activities in daily life? (affected=1, not affected= 0)**	**Cost of treatment/care (direct treatment and other expenses such as travel expenses, Average expense per time)**

For questioners: headache=1, eye pain, eye irritation=2, dermatitis/skin irritation=3, fever=4, diarrhea=5, allergies=6, dyspnea(breathing problem)=7, joint pain=8. , nausea=9, tremor=10, other (please specify) = 11

Happiness in life		
2. How happy are you with your life overall? 0 means "Not happy at all" and 10means "Most happy".	0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10	
3. In the past 3 months, have you experienced an event that caused:	☐Happier than usual ☐Suffering more than usual ☐There is happiness and sorrow equally. ☐There were no incidents that resulted in happiness and suffering.	
4. Please rank in order of what you think affects your happiness **(1–3 in order, with 1 meaning the most effective).**	**Rank (1-3)**	**Things that affect happiness**
		Money
		Family
		Job /career
		Have a place to eat
		Healthy
		Other,specify_____
5. What is the main reason that causes you the most stress in your life **(in order of 1–3, with 1 meaning the most effective).**	**Rank (1-3)**	**What affects stress**
		Money
		Family
		Debt
		Arable land
		Health
		Other,specify_____

12. **Livestock and other income**				
12.1. How much did you earn by **selling livestock and livestock products** for the last 12 months?	list		**net income**	
	12.1.1. **Poultry** [1]		[_____ Baht]	
	12.1.2. **Pigs**		[_____ Baht]	
	12.1.3. Cattle		[_____ Baht]	
	12.1.4. **Aquatic animals** [2]		[_____ Baht]	
12.2. Who do you sell livestock or livestock products to the most ?			***Buyer ID*** [___]	
[1]Poultry: including chickens, ducks, and eggs. [2]**Aquatic animals**: **including fish**, crab, **shrimp**, **and shellfish**				
12.3. Do you have any **other income?**			❑ yes ❑ no → **Skip to answer question 12.4.**	
If yes, how much have you earned from these activities in the past 12 months **?**		**net income**		
	12.3.1. **Remittances** [3] **?**	12.3.1. a.	❑ Yes ❑ No	12.3.1 b [_____baht]
	12.3.2. **Hired outside the farming season**[4] **?**	12.3.2.a.	❑ Yes ❑ No	12.3. 2 b [_____baht]
	12.3.3. **Non-farm business** [5] **?**	12.3.3.a.	❑ Yes ❑ No	12.3 .3 b [_____baht]
	12.3.4. **Employed in the agricultural sector** [6] **?**	12.3.4.a.	❑ Yes ❑ No	12.3. 4 b [_____baht]
	12.3.5. **Other tasks** [7] **? (___)**	12.3.5.a.	❑ Yes ❑ No	12.3. 5 b [_____baht]
12.4. Have you ever borrowed money from a bank ?		12.4.a.	❑ Yes ❑ No	12. 4.b [_____baht]

[3] Remittances: Remittances from family members who work in the city or abroad.
[4] Hired outside the farming season : a job where you are employed in the dry season and paid monthly, where you have to go to work more than three times a week.
[5] Non-farm business: Self-employed or small business associated with a shop, motorcycle taxi or transportation services, etc.
[6] Employed in the agricultural sector: work employed by neighboring farmers during the planting, harvesting, or packing of goods to the market.
[7] Other work: Income that comes from letting other farmers rent your agricultural machinery or land.

Buyer Code (Question 12.2)
01 Middlemen who come to buy
02 Village market
03 People in the village who have direct contact with the company
04 Relatives in the village
05 Agricultural Community Enterprise
06 Community restaurants
07 The Company You Contact Directly
99 other (specify)

General information on agricultural area													
13. What agriculture does your household do in the past **1 year** ? (can answer more than 1 answer)													
Plant	**Period of time to do (What month do you do it?)**												
	Jan.	Feb.	Mar.	Apr	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec
1 = Rice												
2 = Off-season rice												
3 = Sugarcane												
4 = Cassava												
5 = Plant vegetables												
6 = Para rubber												
7 = Corn												
8 = Legumes												
9 = Fruit trees (mango, banana, durian, etc.)												
10 = planting perennial plants (teak , agarwood)												
11 = Other, specify _____												

14. Please provide details of activities in each plot of land (Both owned and rented). How many plots are there? (Fill in the table)

Conversion sequence	**Property nature**	**Doing what?**	**Certified standards**	**Year of accreditation standards (B.E.)**	**Number of years of farming this type**	**Standard certificate cost**	**Area size (farm)**	**Planting period (Jan.-Dec.)**	**Household consumption (kg.)**	**Sales volume (kg.)**	**Sales revenue (Baht)**	**Cost per planting cycle**
Plot1												
Plot2												
Plot3												

For the questioner : What do you do? : 1-11 = Use the code as in item 13, raising livestock = 12, raising aquatic animals = 13, housing = 14, vacant space = 15 , what to do with the rental area _____ =16 , Other (specify) _____ = 17

Ownership : Title deed=1 private land, =2 governmental land (farmers are the users of the land without rents or interests), Rent = 3, Public area = 4, Others specify _____ = 5

Approved standards: N = 1, GAP = 2, SRP= 3, PGS= 4, IFOAM= 5, EU .= 6, NOP = 7, COR= 8, organic rice Thailand = 9, others specify_____ = 10

(4 ngan = rai, 1 ngan = 0. 25 rai, 2 ngan = 0. 5 rai, 3 ngan = 0. 75 rai)

Note: In the month of Jan-Dec, put a check mark or a cross to indicate the month in which water is added to the rice field.

15. In the farming process **Please specify the details of farming during the period as shown in the table below.**																		
Farming process (Napi)	Jan	Feb	March	April	May	June	July	Aug	Sept.	Oct.	nov	Dec	Number of days in which water was stagnant in the field	Water level in the field (cm) □ Estimated by experience □ water level sensor in rice fields				
														0	1-10	11-20	21-30	>30
burn waste material																		
Taida																		
plow																		
plow																		
Thuek (Kanna)																		
dare																		
Farming (_____) (day/month/year)																		
sowing rice (___) (day/month/year)																		
Dropping rice () (day/month/year)																		
Water logging () (day/month/year)																		
Drain water (__) (day/month/year)																		
maintenance of rice																		
Fertilizer #1																		
Fertilize #2																		
Fertilize #3																		
Harvesting rice () (day/month/year)																		

	☐herbicide Name _____ Number of ___ times Name _____ Number of ___ times ☐insect repellant Name _____ Number of ___ times Name _____ Number of ___ times ☐plant insect repellent plants ☐Other, specify				☐another Any, specify _____						
watering ☐public pool ☐own pool ☐Others specify_	☐oil ☐water bill ☐Others specify ____				☐do it yourself ☐hire ☐Other, specify						
harvest	☐oil ☐Sickle Harvester ☐Other, specify _____				☐hire a harvester ☐do it yourself ☐hire labor ☐hire a car to paint rice ☐Other, specify						
relocation	☐oil ☐Other, specify ____				☐use your own car ☐chartered car ☐Other, specify_						

planting ☐Nadam ☐field ☐Na Yod	**seed value** ☐Jasmine 105 ☐RD 15 ☐RD 6 ☐ RD 41 ☐RD 43 ☐RD 47 ☐RD 61 ☐RD 57 ☐RD 85 ☐Pathum Thani 1 ☐Phitsanulok 2 ☐Others Any one specify				☐do it yourself ☐hire labor ☐hire a planter ☐another Specify_____						
maintenance	**fertilizer** ☐chemical fertilizer Formula _____ Amount ____ kg./rai Formula _____ Amount ____ kg./rai Formula _____ Amount ____ kg./rai ☐Manure amount ____ kg./rai Types of manure ☐, cow ☐manure, chicken ☐manure, bat manure ☐Compost amount ____ kg./rai ☐Hormone , amount ____ ml./rai ☐Bio liquid fertilizer amount __ liter/rai ☐Other, specify __				☐fertilize by yourself ☐hire labor ☐another specify _____						
	pest prevention and elimination				☐do it yourself ☐hire labor						

17. Please provide details of the **cost** of rice cultivation and crops grown in the rice field for the past 1year.

For the questioner: the cost of purchasing materials. If there is none, ask where you got it and fill it in instead.

off-season	**Plot**										
	Plants _____										
process	**expenses**				**expenses**					**taking notes**	**note**
	material/equipment	**amount**	**unit**	**expenses (1)**	**Labor/Machine**	**amount**	**unit**	**expenses (2)**	**Net expenses (1)+(2)**	**1 = Save 0 = do not save**	**age <18=1, >18=0 labor sex G =1, G =0**
area preparation ☐make a rafter to widen the plot ☐equalize the area □ normal tractor □ Laser plow	☐oil ☐another Specify _____ _				☐do it yourself ☐contract ☐Other, specify _____						
soil preparation ☐plowing straw ☐burn straw ☐green manure ☐another Any one specify _____	☐oil ☐green manure ☐another Specify _____				☐do it yourself ☐contract ☐Other, specify _____						
soil preparation ☐Plow/plow back to the ground ☐Plowing / Tina ☐plow ☐another Any one specify _____	☐oil ☐another Specify _____				☐do it yourself ☐contract ☐Other, specify _____						

storage ☐not preserved Sell immediately after harvest. ☐warehouse/barn ☐inside the house ☐leave a neighbor	**protection during storage** ☐insect repellant/killer ☐Other, specify _____				☐do it yourself ☐hire ☐Other, specify _____						
Processing (rice color)	☐group mill ☐general mill ☐home color ☐Other, specify				☐do it yourself ☐hire ☐Other, specify _____						
packaging for sale	☐sack ☐Package for 1 kg. ☐Package for 5 kg. ☐Package for 10 kg. ☐Other, specify				☐do it yourself ☐hire labor ☐use the machine ☐Other, specify						
Distribution channels ☐Selling to the group ☐Someone came to buy ☐Sell to factories/ mills ☐Others specify _	☐oil ☐Other,specify ___				☐do it yourself ☐contract ☐Other, specify __						

☐another Any one specify											
planting ☐Nadam ☐field ☐Na Yod	**seed value** ☐Jasmine 105 ☐RD 15 ☐RD ☐ RD 41 ☐RD 43 ☐RD 47 ☐RD 61 ☐RD 57 ☐RD 85 ☐Pathum Thani 1 ☐Phitsanulok 2 ☐Others Any one specify				☐do it yourself ☐hire labor ☐hire a planter ☐another Specify _____						
maintenance	**fertilizer** ☐chemical fertilizer Formula _____ Amount ____ kg./rai Formula _____ Amount ____ kg./rai Formula _____ Amount ____ kg./rai ☐Manure amount ____ kg./rai Types of manure ☐, cow ☐manure, chicken ☐manure, bat manure ☐Compost amount ____ kg./rai ☐Hormone , amount ____ ml./rai				☐fertilize by yourself ☐hire labor ☐another specify _____						

Note: In the month of Jan-Dec, put a check mark or a cross to indicate the month in which water is added to the rice field.

16. Please provide details of the **cost** of rice planting and crops grown in the rice fields for the past 1 **year.**

***** **For inquirers:** Expenses for purchasing equipment, if none, provide. Ask where did you get it and fill it in instead?

Napi	**Plot**										
Process	**expenses**				**expenses**					**taking notes**	**note**
	material/equipment	**amount**	**unit**	**expenses (1)**	**Labor/Machine**	**amount**	**unit**	**expenses (2)**	**Net expenses (1)+(2)**	**1= Save 0=do not save**	**age <18=1, >18=0 labor sex G=1, G =0**
area preparation ☐make a rafter to widen the plot ☐equalize the area □ Normal tractor □ Laser plow	☐oil ☐another Specify _____				☐do it yourself ☐contract ☐Other, specify _____						
soil preparation ☐plowing straw ☐burn straw ☐green manure ☐another Any one specify	☐oil ☐green manure ☐another Specify _____				☐do it yourself ☐contract ☐Other, specify _____						
soil preparation ☐Plow/plow back to the ground ☐Plowing / Tina ☐plow	☐oil ☐another Specify _____				☐do it yourself ☐contract ☐Other, specify _____						

storage ☐not preserved Sell immediately after harvest. ☐warehouse/barn ☐inside the house ☐leave a neighbor	**protection during storage** ☐insect repellant/killer ☐Other, specify _____				☐do it yourself ☐hire ☐Other, specify _____						
Processing (rice color)	☐group mill ☐general mill ☐home color ☐Other, specify				☐do it yourself ☐hire ☐Other, specify _____						
packaging for sale	☐sack ☐Package for 1 kg. ☐Package for 5 kg. ☐Package for 10 kg. ☐Other, specify				☐do it yourself ☐hire labor ☐use the machine ☐Other, specify						
Distribution channels ☐Selling to the group ☐Someone came to buy ☐Sell to factories/mills ☐Others specify	☐oil ☐Other, specify _____ _				☐do it yourself ☐contract ☐Other, specify _____						

Post-harvest management		
18. How much is left per cob in the field?	_____ cm	
19. What percentage of rice stubble is left in the field? of all rice plants (approximately visually)	_____ % or _____ (tons per rai)	
20. The size of the scrap burning area	_____ Rai	
21. Burning time	☐ morning ☐ daytime ☐ cool ☐ nighttime	
22. Burn time	_____(hours)	
23. How to handle agricultural waste	☐ plowing the rice stubble ☐ burn rice stubble ☐ release water into fields ☐ used to feed animals _____ % ☐ Other, specify_____	
24. Sequence of agricultural waste management. Set aside the top of the soil for the day before plowing/ releasing water into the field. (Please enter the number of steps before and after).	**List**	**Number**
	Taida	
	Release water into fields Leave it on __Day	
	Tak the soil_____.Day	
	Plow (plowing) _____times	
	Plow	
	Other, specify_____	
25. In the period between plowing, is there water standing in the fields?	☐No ☐Yes	

	8.Others, specify_____	
32. In case you currently do not grow sustainable rice, organic, GAP, please choose the method of growing rice that you used to grow **(ask only those who have done it in item 28).**	**list**	**0= never, 1= ever**
	1. GAP rice	
	2. Rice SRP	
	3. Organic rice	
	4. Other Specify _____	
33. The reason why you quit Sustainable Agriculture, Organic, GAP Please **give the 3 most important reasons.**	List	Rank (1-3)
	1. Request for organic standards GAP has a detailed process and must be recorded.	
	2. There is no fixed buying market	
	3. There is a standard audit fee.	
	4. Price is not different from general rice	
	5. Difficult to maintain due to restrictions on the use of chemicals	
	6. Don't have the knowledge to do it.	
	7. Do you think sustainable rice cultivation has low productivity?	
	8. Cost per rai is higher than normal rice cultivation.	
	9. Others, specify_____	

Farming		
27. Do you currently make sustainable, organic, GAP rice ?	☐ Do – **(Skip to question 30 (**	☐don't do
28. If you don't make sustainable rice, organic, GAP, have you ever done it?	☐Yes – **(Skip to question 32 (**	☐Never
29. Why have you never done organic farming or GAP before. Please give the 3 most important reasons. ***The issue of motivation for sustainable rice cultivation (SRP) must explain information about sustainable rice to farmers to understand first.	List	Rank (1-3)
	1. Organic standards, GAP There is a detailed and written process.	
	2. No knowledge of doing	
	3. Unsuitable area due to chemical contamination in water sources	
	4. Difficult to maintain due to restrictions on the use of chemicals	
	5. Do you think that sustainable rice cultivation has low yields?	
	6. Other, specify_____	
30. Direct motivations that makes decisions sustainable rice cultivation. Please give the **3 most important reasons.**	List (direct)	Rank (1-3)
	1. Selling at a higher price than normal rice	
	2. The health of the producer	
	3. Lower cost	
	4. Productivity per rai is higher than conventional rice cultivation.	
	5. Help reduce the effects of air pollution.	
	6. Make the environment good There is an increase in animal diversity in the paddy fields.	
	7 .Others, specify_____	
31. Extrinsic motivations that drive the decision to grow rice sustainably. Please give the top 3 reasons.	List (external)	Rank (1-3)
	1.Government support money	
	2. There is a market to support	
	3 .The leader of the group invites and introduces how to do it.	
	4. Get privileges from the group	
	5. Government agencies invite and suggest methods to do it .	
	6. Neighbors invite / and suggest how to do it.	
	7. Relatives invite / and advise how to do it.	

Snakehead/Catfish/Cichlid group			
Group of fish, carp/gourami/other scaled fish big			
Minnow/Small fish/small fish group			
other fish			
field crab			
shrimp			
Cherry clams/nautilus/periwinkle			
frog / bullfrog			
mouse			
snake			
pimp			

26.3. Please provide information about the living things that you know and found in the fields during the past 1-5 years as follows.

	Group of animals	Year				
		1	2	3	4	5
1	Mammals (Rices, Weasel, Jon Faun) that you see in your fields.					
2	What birds that come to eat in your fields that you know?					
3	What fish do you know and found in your fields ?					
4	In his fields there are frogs. What are the types of frogs that you know?					
5	In his fields there are snake-like creatures. What kinds do you know?					
6	Are there standing trees in your field? What kind and the number of (trees) approx					
7	Plants do you use that naturally occur in the rice fields ?					

Examples of mammals in rice fields: field rat, weasel, fox/ hyena;
Examples of birds in rice fields: open bill ibis, egret, fire tires, fill rubber, E Lum;
Examples of fish found in rice fields: snake, duke, doctor, flow, sew;
Examples of frogs / bullfrog found in rice fields: frog, khian chana, kiet nong, khet kha kham, Ung Yang;
Examples of snakes found in rice fields: cobra, snake fish, possessed snake;
Examples found in rice fields: cache, Acacia, rubber field, yang hiang;
Examples of spontaneous and usable plants found in rice fields: water spinach.

Livestock			
26. Please provide information on animals found in the fields in the past year.			
26.1. Please specify the encounter and consumption of living organisms found in the following fields during the past 1-5 years	**Finding**	**Sell**	**Household consumption**
snakehead fish	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
litter fish	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
catfish	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
cichlid	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
eel	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
carp	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
gourami	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
other fish	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
field crab	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
shrimp	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
shellfish	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
bird	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
frog / bullfrog	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
mouse	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
snake	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
pimp	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
earthworm	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no	1. ❑ Yes 0. ❑ no
Insect pests such as thrips		Do you think you are affected by these insects?	o received o did not receive
Insect pests such as predators.		Do you think you can benefit from these insects?	o received o did not receive
26.2. Please give an estimate of the amount of utilization of living organisms that are commonly found in the rice fields.	**Quantity captured (kg)**	**Sales volume (kg)**	**Household Consump. (Kg)**

A-Water management in your community area					
Please select the answer that best describes your opinion.					
34. Is your farm in an irrigated area?	□Away = **End of this section, skip to Section B. Adapting to climate change.** □stay =□ All □part _____ farm				
35. Your field is next to the irrigation canal,	□not stuck, □stuck = □main □canal, soi □etc _____				
36. Where is your field located in the canal	□the beginning of the canal □ in the middle of the canal □ at the end of the canal ?				
37. Have you paid for irrigation water?	□No, □paid = _____ baht/year				
38. Are you a member of the community's irrigation water user	□No group □Not a member □Member = Since the year _____				
39. The irrigation canals are ready for use all year round.		3	2	1	0
40. He had enough water for irrigation throughout the year.		3	2	1	0
41. You have equal access to irrigation water.		3	2	1	0
42. The current water bill collection system is efficient.		3	2	1	0
43. Your current irrigation water rate is appropriate.		3	2	1	0
44. The irrigation system is properly managed.		3	2	1	0
45. There is a conflict between water users in your community area.		3	2	1	0
46. He was satisfied with the current irrigation water allocation and management system.		3	2	1	0

Remarks : 4 = Strongly agree 3 = Moderately agree 2 = Slightly agree 1 = Not sure

Adaptation to climate change, droughts, floods, natural disasters such as summer storms, sudden weather changes				
47. Droughts, floods, sudden weather fluctuations are the result of global climate change.	3	2	1	0
48. You can cope with climate change on your own without the help of government agencies or relevant sectors.	3	2	1	0
49. Government agencies or relevant sectors have a system to help farmers effectively cope with climate change.	3	2	1	0
Remarks : 4 = Strongly agree 3 = Moderately agree 2 = Slightly agree 1 = Not sure				
50. Your adaptation patterns to climate change, such as droughts, floods, and extreme weather.				
□Dig a pool for your own use, pool size (width x length x depth) _____ meters, the number of pools on your property _____ pools, total expenses_____ baht □Change the rice varieties planted that can tolerate drought/flood better. □Buy insurance to cover damage from natural disasters. Please specify insurance premiums _____ baht/year □Change the pattern of rice cultivation from a black field to a sowing field. □Reduce the number of days to divert water into the paddy field. From the original number of days that water was standing in the average paddy field _____ Approximate discounted days.... □Groundwater drilling Amount _____ Pond. Average pond depth_____ m. The cost of drilling _____ baht/pond □Plant a mix of crops such as bananas, horticulture, and economic trees on the fields, along the ridges, or around the edge of the pond. □divide some of the paddy fields for mixed farming to increase productivity Approximate area _____ Rai or _____ % of the total area □reduce the area of rice planting according to the water situation and weather forecast of that year □Bring agricultural technologies such as drones, quantity calculation systems and fertilizer application times to help in farming □Other, please specify _____				
51. Assistance from the government or relevant sectors that you think are necessary for farmers to adapt to climate change. □Accurate and up-to-date weather forecasting system □Natural disaster insurance □Low interest loan □Agricultural technology to help plan and manage the agricultural system with precision and efficiency. □A channel to give advice on agricultural problems. □Modern marketing promotion system Easy access to all households. □Grants for digging a pool or drilling groundwater □Price insurance system for rice and agricultural products				

57. Grouping			
57.1 You have joined various groups. other In the area or not? If joining Please specify which group you belong to.	**group code**	**Number of group members (person)**	**6 months ago, have you Participated in group activities? how much (specify %)**
	57.1.1.a	57.1.1.b	57.1.1.c
	57.1.2.a	57.1.2.b	57.1.2.c
	57.1.3.a	57.1.3.b	57.1.3.c
57.2 In the below list of groups to which you belong. Which group do you like the most?	**Specify code :**		

Group Code (Questions *57.1.1a – 57.1.3a and* 57. *2)*

01 Village Fund	06 Community Enterprise	11 groups of plants behind the rice fields
02 Saving for production	07 Organic Rice Group	12 groups of vegetables
03 Saving baht per day	08 Large rice field group	13 fruit groups
04 Cremation	09 Senior Citizens Club	14 Animal groups
05 Truth group	10 fertilizer groups	15 career groups
		99 other

58. Reason for your household to join or unsubscribe from a community rice organization/group?

Group	**Start year**	**Reason for being a member**	**Reason for canceling membership**	**Length of membership** (in case of termination of membership)	**Role in the group**	**Rewards**

Reasons for being a member : Increased loan channels = 1 , Increased saving channels = 2 , Increased channels for knowledge and cooperation in making a career = 3 , To exchange knowledge in farming = 4 , increasing income channels = 5, group strength = 6 , other Specify _____=7

Reasons for canceling membership: Lack of time = 1 , time wasted not worth the money received = 2 , group did not benefit = 3, location of rice fields far from group = 4, managed Management is not transparent = 5, others specify = 6

59. Please specify how often you participate in activities in your community. (5 = go every time, 4 = go often, 3 = go	**List**	**Frequency of attending activities**
	1. Activities of the group/community/organization that you are a member of.	
	2. Important religious days such as Buddhist Lent Day, Vesak Day, etc.	
	3. Traditional and cultural events such as Songkran, making merit at home, housewarming	
	4. Activities organized by government agencies in the area such as SAO schools, SAO hospitals	

□Other, please specify _____	

Debt	
52. consumption cost by month for your household (**last 1 month**)?	[_____Baht]
53. How many total loans does your household have? What is the total value?	Number of debt piles ____
	Current total debt _____
54. If so, how does your household borrow money?	

Borrowed from	**When did you borrow? (month, year)**	**What did you borrow?**	**Loan amount**	**Interest rate**	**What are you using as collateral?**	**Value of collateral**	**How much debt do you currently have left?**

Borrowed from: 1 = BAAC/ 2 = Bank of Commerce/ 3=Co-operative / 4=Village Fund / 5=Rice Bank / 6=Informal borrower/ 7= Factor seller/ 8= Landowner/ 9= Buyer/ 10= Relatives /11=Neighbors / 12= Other, specify__

Borrowed to do what: 1= Buy a walk-behind tractor/ 2= Buy other agricultural equipment / 3= Buy fertilizers, pesticides/ 4= Buy seeds/ 5= Buy animal breeds / 6= Buy land /7= Build/buy House / 8= Pay off another loan /9= Party (e.g. wedding, make merit) / 10= Buy a motorcycle/ 11= Buy a car /12=Buy something comfortable (e.g. TV, air conditioner, computer) / 13=To Education / 14 = Maintaining rights / 15= Loan / 16 = Expenses for treatment of illness / 17 = Use for a career Investment in the agricultural sector / 18= Other household consumption expenses

What are you using as collateral **?** 1=No collateral / 2=Land with title deeds / 3=Land without title deeds/ 4=Bank savings account/ 5=Agriculture to be harvested 6=Land stock to be produced/ 7=Motorcycle Type/ 8=car/ 9=agricultural vehicle/ 10=person guarantor

Savings		
55. How much savings does your household have?	[_____ Baht]	
56. **Do you have any of the following assets?**	**quantity**	**value**
56.1 Walk-behind tractor		
56.2 Tractor		
56.3 Pump		
56.4 Nebulizer		
56.5 Drones		
56.6 Laser		
56.8. House value (if renting, how many months do you rent?)		
56.7. Other, specify _____ .		

sometimes, 2 = Rarely go, 1 = Never joined)	5. Community volunteer activities or village charity work									
60. If you need money urgently But it's not a big amount. For household expenses within 1 week, how many people do you think you could ask for help other than family members?	**Do not have any**	**1-2 people**	**3-4 people**	**5 or more people**						
	1	2	3	4						
61. In the village, are there relatives or close friends that you can visit their houses to play, talk/tell stories? How many people are there?	**Do not have any**	**1-2 people**	**3-4 people**	**5 or more people**						
	1	2	3	4						
62. Please specify the level of credibility and trust for different groups of people in your society (with 0 means not reliable at all and 5 means most reliable)										
1. If talking about the majority of people in your community,how reliable do you think most of them are?	0	1	2	3	4	5				
2. If talking about government agencies in your community, how much trust do you have in the work of government agencies in your community?	0	1	2	3	4	5				
3. If talking about leaders or committees in your community, how much trust do you have in the work of leaders or committees in your community?	0	1	2	3	4	5				

63. **Mobile Data Access and Use**	
63.1. Do you often get information about agriculture from other people?	1.❑ Yes 0.❑ no **→ skip to answer 65.5**
63.2. From ***whom*** did you receive/get **farming information the most?**	***ID*** [_____]
63.3. From ***which*** mean did you receive/get **farming information the most?**	***Source Code*** [_____]
63.4. **What information do** you use the most ? **(from the 1st most to the 3rd most)**	
	Agricultural Information Code [1 ____], [2 ____], [3 ____]
63.5. Do you often receive marketing information from others ?	1.❑ Yes 0.❑ no **→ skip to answer 65.9**
63.6. From ***whom*** did you receive **market information for increasing income the most**?	***ID*** [_____]
63.7. From ***which*** mean did you receive **market information for increasing income the most**?	***Source Code*** [_____]
63.8. **What information do** you use the most to increase your income ? **(from the 1st most to the 3rd most)**	
	Marketing Information Code [1 ____], [2 ____], [3 _____]
63.9. Have you ever received **agricultural information via your mobile phone ?**	1.❑ Yes 0.❑ no
63.10. Have you ever received **marketing information via mobile phone ?**	1.❑ Yes 0.❑ no
63.11. What kind of information do you want to receive to increase agricultural productivity and sales revenue ?	***63. 11.a. Agricultural information code*** [rank 1 _____] ***63.11.b. Marketing Data Code*** [Rank 1 _____]
63.12. What kind of difficulty do you suffer from the most ?	***Difficulty code*** [_____]

Code informant ***(Questions 63.2 and 63. 6)***			
Inside the village		**Outside the village**	
01 Relatives 02 Friends or Neighbors 03 Community Leader 04 members or people in agriculture groups 05 Agricultural Group Leader 06 government agencies	07 Buddha 08 A person who speaks well 09 Sage 10 sales of fertilizers or production factors 11 Middlemen 12 role models 99 other	13 relatives 14 friends 15 members or people in agriculture groups 16 Agricultural Group Leaders 17 Private entities such as CP Betagro 18 Agricultural experts from the university.	19 The company or organization you are dealing with. 20 sales of fertilizers or production factors 21 Middlemen 22 monks 99 other

Source code *(*Question *63.3* and *63.7)*			
01 A book or handbook about gaysorn 02 Radio 03 news on television	04 Agriculture website of ministry of agriculture 05 Phone messages or other applications other (Line, Facebook)	06 YouTube 99 other (specify)	
Agricultural information (*Questions 63.4 & 63.11)*			
01 Planting techniques 02 Fertilizer types and properties 03 Types and properties of insecticides 04 Types and properties of herbicides	05 Seed 06 Employment 07 Equipment rental 08 Animal rental	09 Water management (water system) 10 Weather 11 new plants 12 Cultivation schedule (care period)	13 Agricultural Policy 14 Crop Insurance 15 Borrowing 99 other (specify)
Marketing information code *(Questions* 63.8 *& 63.11)*			
01 Crop Prices 02 Prices of Factors of Production 03 Seller Information (Retail / Wholesale / Middleman)	04 Technology information after cultivation (packaging, container, transportation)	05 Contract Farming Information 06 Mobile Product Trading	99 other (specify)
Difficulty* Code *(* Question *63.12)			
01 restricted area 02 No right to own land 03 Land collapse or landslide	04 Water shortage 05 Disaster 06 Access to funding	07 no labor 08 small profit 09 Difficult market access	99 other (specify)

64. **Section L: Social Network**			
64.1.1. In the last 12 months You asked the people of the village about **Agricultural information** or not?	1.❑ Yes 0.❑ no → **skip to answer 68. 1.9**		
64.1.2. Please **specify the name** of the person who provided you with agricultural information and answer the following questions *(You can choose more than 1 relationship code)*	***name***	***relationship code***	***frequency in the range of 12* a month ago**
	64. 1. 3.1.a.	64. 1. 3.1.b. [_____]	64. 1. 3.1.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.2.a.	64. 1. 3.2.b. [_____]	64. 1. 3.2.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.3.a.	64. 1. 3.3.b. [_____]	64. 1. 3.3.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.4.a.	64. 1. 3.4.b. [_____]	64. 1. 3.4.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.5.a.	64. 1. 3.5.b. [_____]	64. 1. 3.5.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.6.a.	64. 1. 3.6.b. [_____]	64. 1. 3.6.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.7.a.	64. 1. 3.7.b. [_____]	64. 1. 3.7.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.8.a.	64. 1. 3.8.b. [_____]	64. 1. 3.8.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 1. 3.9.a.	64. 1. 3.9.b. [_____]	64. 1. 3.9.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
64.1.3. According to item 64.1.2, who is the person who most frequently **gives** you agricultural information?	Name _____ Relationship Code [_____]		
64.1.4. Have you followed the person's instructions in 64.1.3?	1.❑ Yes 0.❑ no → **Skip to answer question 64. 1.9**		
64.1.5. From 64.1.2, which person's advice do you follow most often ?	Name _____ Relationship Code [_____]		
64.1.6. From 64.1.5, please rank the first-three attributes that can explain this person. (Please choose according to your feelings)		Openness. One who tend to have an open, independent and innovative mind and a sensitive temper. They embrace differences and let themselves be vulnerable to the new and unknown. They therefore typically thrive in agile environments, with a fast paste in changes, and where they can take part in the idea generation.	
		Conscientiousness One who often possess a high level of self-control and discipline and are capable of planning and executing their life accordingly.	
		Extraversion	

		One who is gregarious, talkative, outgoing, seek interaction with other people and stimulus from outer sources.
		Agreeableness One who is humble, well-liked, helpful and have a low degree of selfishness and put others before themselves. They are patient and trusting towards others, and therefore also often in possession of a strong social support foundation.
		Neuroticism One who is anxious, insecure, and prone towards sadness and will often be perceived as emotionally unstable and moody, and with a lack of confidence.
64.1.7 From all of the above. Who do you think is the **best** at farming?		Name _____ Relationship Code [_____]
64.1.7.1 Have you followed the person's instructions in 64.1.7?		1.❑ Yes 0.❑ no → **Skip to answer question 64. 1.8**
64.1.7.3 From item 64.1.7, please rank the first-three attributes that can explain this person. (Please choose according to your feelings)		Openness. One who tend to have an open, independent and innovative mind and a sensitive temper. They embrace differences and let themselves be vulnerable to the new and unknown. They therefore typically thrive in agile environments, with a fast paste in changes, and where they can take part in the idea generation.
		Conscientiousness One who often possess a high level of self-control and discipline and are capable of planning and executing their life accordingly.
		Extraversion One who is gregarious, talkative, outgoing, seek interaction with other people and stimulus from outer sources.
		Agreeableness One who is humble, well-liked, helpful and have a low degree of selfishness and put others before themselves. They are patient and trusting towards others, and therefore also often in possession of a strong social support foundation.

		Neuroticism One who is anxious, insecure, and prone towards sadness and will often be perceived as emotionally unstable and moody, and with a lack of confidence.
64.1.8 Of all the people mentioned above, who do you **trust** the most in farming?		Name _____ Relationship Code [_____]
64.1.8.1 Have you followed the person's instructions in 64.1.8?		1.❑ Yes 0.❑ no → **Skip to answer question 64. 1.9**
64.1.8.3 From item 64.1.8, please rank the first-three attributes that can explain this person. (Please choose according to your feelings)		Openness. One who tend to have an open, independent and innovative mind and a sensitive temper. They embrace differences and let themselves be vulnerable to the new and unknown. They therefore typically thrive in agile environments, with a fast paste in changes, and where they can take part in the idea generation.
		Conscientiousness One who often possess a high level of self-control and discipline and are capable of planning and executing their life accordingly.
		Extraversion One who is gregarious, talkative, outgoing, seek interaction with other people and stimulus from outer sources.
		Agreeableness One who is humble, well-liked, helpful and have a low degree of selfishness and put others before themselves. They are patient and trusting towards others, and therefore also often in possession of a strong social support foundation.
		Neuroticism One who is anxious, insecure, and prone towards sadness and will often be perceived as emotionally unstable and moody, and with a lack of confidence.
64.1.9. Please specify the name of the person who has these features that you know or are closest to in your village		Name

a. Community Leaders			
b. Agricultural government agencies you are familiar with			
c. Agricultural group leader or people who are good at agriculture			
d. Monk			
e. The most talkative person in the village.			
f. folk sage			
64.2 During 12 months ago, did you give **agricultural information** to people in your village or not ?			1.❑ Yes 0.❑ no → **skip to answer 64.3**
64.2.2 Please **specify the name** of the person receiving agricultural information from you and answer the following questions. *(You can choose more than 1 relationship code)*	***name***	***relationship code***	***frequency in the range of 12* a month ago**
	64. 2.2 .1.a.	64. 2.2 .1.b. [_____]	64. 2.2 .1.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .2.a.	64. 2.2 .2.b. [_____]	64. 2.2 .2.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .3.a.	64. 2.2 .3.b. [_____]	64. 2.2 .3.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .4.a.	64. 2.2 .4.b. [_____]	64. 2.2 .4.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .5.a.	64. 2.2 .5.b. [_____]	64. 2.2 .5.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .6.a.	64. 2.2 .6.b. [_____]	64. 2.2 .6.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .7.a.	64. 2.2 .7.b. [_____]	64. 2.2 .7.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .8.a.	64. 2.2 .8.b. [_____]	64. 2.2 .8.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
	64. 2.2 .9.a.	64. 2.2 .9.b. [_____]	64.2 .2 .9.c. ❑1~2 ❑3~4 ❑5~6 ❑7~8 ❑9~10❑ more than 10 time
64.3. Are you a member of any cooperative or association related to agricultural activities or not ?			1.❑ Yes 0.❑ no

Relationship code *(Question 64. 1.2 and* 64. *2.2)*

Inside the village		**Outside the village**	
01 Relatives	08 A person who speaks well	13 Relatives	20 Sales of
02 Friends or Neighbors	09 Sage	14 Friends	fertilizers or
03 Community Leader	10 Sales of fertilizers or	15 Members or people in agriculture groups	production
04 Members or people in agriculture groups	production factors	16 Agricultural Group Leaders	factors
05 Agricultural Group Leader	11 Middlemen	17 Private entities such as CP Betagro	21 Middlemen
06 Government agencies	12 Role models	18 Agricultural experts from the university.	22 Monks
07 Buddha	99 Other	19 The company or organization you are dealing with.	99 Other