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STORAGE DECISIONS OF JASMINE RICE FARMERS IN THAILAND

Orawan Srisompun[1*], **Sakunkarn Simla**[1] **and Surasak Boontang**[1]
[1] Department of Agricultural Technology, Faculty of Technology,
Mahasarakham University ,44150 Thailand
Corresponding author: orawan.s@msu.ac.th

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ABSTRACT

The effects of economic and other factors on the jasmine rice storage decisions of farmers were analyzed using a binomial logistic regression model. The farm survey data from nine major productive provinces in the Northeastern region, and 330 rice farmers sampled during the 2017/18 crop year were examined. The data collection was done in January to April, 2018. The probability of storing jasmine rice was 43.6%, and the physical factors of the farms exhibited the highest effect on the storage decisions of the farmers. Factors such as having a barn, the jasmine rice yield, the region, the cultivation pattern, the female labor proportion, and participation in the rice-pledging scheme positively affected the storage decisions of the farmers. In contrast, household income negatively affected the storage decision. The study results suggest that the implementation of a policy for reducing the paddy supply during the harvest season requires economic and other incentives. Rice barn development is crucial for and correlated with the storage decision. Therefore, providing support for constructing or repairing barns increased the storage decision probability. Primarily, the large-scale farmers benefitted from the rice-pledging scheme. Public schemes should be thoroughly implemented. The need for sophisticated equipment, regulation procedures, and the high cost associated with rice storage reduced farmer participation, but the scheme did not affect the rice farm gate price.

Key words: rice storage, logistic regression, rice supply, pledging scheme, farm price

INTRODUCTION

Jasmine rice is a high-quality rice with long, tapering grains that become soft and scented when cooked. The demand for this rice by both domestic and international consumers is high. Because consumers value the properties of jasmine rice, farmers can sell it at a higher price than other types of rice (Isvilanonda, 2016). However, although jasmine rice has a high value, it has a key limitation. Because of the photosensitivity of jasmine rice, it grows only once a year (in the wet season) and should be harvested during the same year (November-December). Because large amounts of harvested jasmine rice enter the market at the same time, the farmers are forced to sell their rice at a low price during the harvest period (Thongngam, 1999). After harvesting their crops, the farmers have two choices: sell their crops immediately during the low-price season or store their harvested crops for sale later (Tomek and Robinson, 2014). Although the farmers can sell their crops either immediately after harvest or after the humidity decreases, crop storage is more advantageous than immediately selling it because the price of jasmine rice is generally low during the harvest season and high during the off-season (Office of Agricultural Economics, 2018). Therefore, the farmers who store their crops can sell them later at a relatively high price. Moreover, crop storage is necessary for maintaining the supply of rice and other agricultural crops in the market throughout the year because the demand for rice exists throughout the year (FAO, 1994). Agricultural crop storage for sale after the harvest season

is a significant marketing mechanism that solves the problem of low crop prices during the harvest season. Furthermore, storage practices also reduce variations in the yield price and enable the sale of harvested crops in the market throughout the year, including the off-season, thus increasing farmers' incomes. However, without proper storage facilities and storage methods, the crop yield may be damaged by pests or plant diseases. Destruction during storage may cause crop damage or reduce crop quality, thereby reducing the yield value. Hence, farmers require effective and suitable storage methods that enable them to sell their crops for appropriate prices (Nwet et al., 2017). Crop storage not only ameliorates food shortages during the off-season but also helps farmers increase their incomes by selling their crops at a higher price in the off-season, when the crop supply is low (Hofstrand and Wisner, 2006).

Because the demand for rice persists throughout the year in Thailand, the price of rice increases after the harvest season and peaks between April and July (Office of Agricultural Economics, 2018). Accordingly, if the farmers store their rice and sell it between April and July, they can earn higher incomes than those earned from selling their rice during the harvest season; consequently, they can achieve maximum profits (Thongnit, 2008). However, most jasmine rice farmers choose to sell their rice immediately after harvest, preferring to sell freshly harvested rice instead of storing the rice for later sales. One of the causes of this preference is the shortage of agricultural labor, which causes farmers to use machines instead of human labor in rice cultivation. In particular, the harvesting process requires combine harvesters instead of manual labor. The moisture content of freshly harvested rice is approximately 20–27%. Farmers must dry the harvested rice before storage. Consequently, if the farmers do not have an adequate number of workers or a rice drying facility, they are compelled to sell their rice immediately after harvest (Srisompun et al., 2014). Another cause for immediate sale is that rice cultivation is not a major source of household income; the farmers' non-agricultural occupations may encourage them to minimize the time spent on rice production (Srisompun and Jarernrat, 2013) and reduce their household reliance on the income earned from the sale of stored rice. (Giles and Yoo, 2017).

Moreover, the adoption of modern technology and machines that increase farmers' rice yields has increased the costs of rice production (Chowdhury *et al.,* 2010). Most farmers borrow money to pay these increased costs; moreover, they may incur debts for other purposes. Hence, the need to pay off their debts may be a crucial factor in the farmers' decisions to sell their rice immediately (Stephens and Barrett, 2011). Thus, the marginal price of storage or storage costs may not be the key factor in the decision to store rice to obtain a higher price, which was observed previously. Instead, the following three key factors may affect the storage decision: physical factors related to the farm and farmer, economic factors, and social factors (Nwet *et al*., 2017). In this study, the effect of economic and other factors on the Thai farmers' decisions to store jasmine rice was analyzed. The results of this study were used to propose a policy for effectively managing the demand for rice during the harvest season to provide guidelines for creating a policy that supports rice storage for sale at an appropriate time.

MATERIALS AND METHODS

Conceptual framework and econometric model. In economics, the term "storage" indicates a production activity that bridges the time gap between production and consumption. Rice can be stored at farms and in markets. Storage at the nonfarm level involves selling the harvested rice to middlemen. Normally, the price falls for a short time during the harvest season, but farmers are able to sell their crops throughout the year (Tomek and Robinson, 2014). By storing the grain at harvest and waiting for the prices to increase sufficiently during the storage season, farmers can sometimes obtain higher total returns even after accounting for storage costs. However, this strategy is associated with risks because the prices sometimes fall during the storage season or do not increase sufficiently to cover the storage costs (Lai *et al*., 2003). If farmers can correctly anticipate the future supply and

demand, they can store an appropriate amount of their crop for sale when the price increases from a low point during the harvest season and becomes sufficiently high to compensate for the cost of crop storage that the farmers incur (Saha and Stanford, 1994). The difference in price must be sufficient to motivate some farmers to sell their crops and others to hold back their crops until the price increases; consequently, seasonal crops will be allocated for sale in the market throughout the year depending on the relationship between the current yield price and the expected price, excluding the cost of storage. Farmers generally want to achieve the maximum profit or the minimum loss, and they need as much income that can be generated from selling their crops; hence, farmers will store their crops if they expect the profits from crop storage to be equal to or higher than the storage cost equation (1) (Enwet *et al*., 2017).

$$Pf - Pc \geq M \quad (1)$$

where Pf is the estimated income, Pc is the current price, and M is storage cost to crop sale.

In a study on the factors affecting the farmers' decisions to store their crops, although the storage decision was related to many variables, most of the farmers made their decision based on marginal profits (Wright and Williams, 1982). However, storing crops requires a large budget for obtaining a suitable storage system and equipment; hence, the storage decision is not easy for farmers (Strahan and Page, 2003). Moreover, each farmer's decision is related to his or her individual experiences, farm management concepts, socio-demographic background (e.g., educational level, social category, and income), and landholding size; all the aforementioned factors play significant roles in the decision-making ability (Ali and Kumar, 2011). A study that analyzed the factors affecting the decision to store jasmine rice reported a relationship between the physical factors related to the farm and farmers, economic factors, and social factors (Nwet *et al*., 2017) by using a binomial logistic regression model analysis. The decision to store rice was analyzed in two groups of farmers. One group sold their rice immediately, while the other group stored their rice for sale later. Hence, the dependent variable was the decision to store the rice for sale, which was a discrete variable with a value of either 0 or 1. The value 0 represented the farmers who sold their rice immediately without waiting for a price increase, while the value 1 represented the farmers who stored their rice for sale after the harvest season. The binomial logistic model was suitable for this type of data analysis. The hypothesis of the model was used to determine the probability of the farmers' decisions depending on the vector of the independent variable, X_{ij}, which was related to farmer *i*, the variable *j*, and the vector of an unknown parameter (β), as shown in equation (2) (Xiong *et al.*, 2016).

$$P_i = F(Z_i) = F(\beta X_{ij}) = 1/[1 + epc(Z_i)] \quad (2)$$

where Zi ranges from -∞ to ∞ and Pi ranges between 0 and 1;
Pi is nonlinearly related to Zi;
F is the cumulative distribution function (CDF); and
β is the unknown parameter.

The model value was estimated using the maximum likelihood method so that the logistic model could be used to estimate the value of the probability of the farmers' decisions to store rice, which can be described as shown in equation (3):

$$P_i = P[y_i = 1] = \frac{e^{x_i\beta}}{1+e^{x_i\beta}} \quad (3)$$

After the model value estimation was performed using the maximum likelihood method, the probability of the farmers' decisions to store rice according to the production type and region was performed, including the marginal model value estimation, which was the probability evaluation of the decision to store rice caused by each of X variables (X_i) by defining the other factors as constant values, as shown in equation (4):

$$\frac{\Delta P_i}{\Delta X_i} \parallel all\ other\ x\ constant = \frac{\partial P_i}{\partial X_i} \quad (4)$$

The dependent variable was the decision to store rice, and the independent variables were divided into the following four groups: the farmers' economic and social characteristics; the farms' physical characteristics; economic factors; and social and communication factors (Mencher and Saradamoni, 1982; Unnevehr and Stanford, 1983; Sthapit *et al*., 1996, Lyon, 2003; Srisompun *et al*., 2014; Hofstrand and Wisner, 2006; Giles and Yoo. 2007; Ali and Kumar, 2011; Tomek and Robinson, 2014). The variable meanings and descriptions are shown in Table 1.

Table 1. Variables affecting the farmers' decisions to store rice using a logistic regression model

Variable	Variable name	Variable description/unit
Dependent variable		
STORAGE	Decision to store rice for sale	1 = storage for sale 0 = no storage for sale
Independent variables		
Economic and social characteristics of the farmers		
SEX	Sex of key laborer	1 = male, 0 = female
AGE	Age of key laborer	Years
EDU	Education level of key laborer	1 = uneducated, 2 = primary school, 3 = secondary school, 4 = high school, and 5 = diploma or higher
AGLABOR	Agricultural labor amount	Person
FEMALESHARE	Female labor proportion	%
MOCCUPA	Major occupation is farming	1 = yes, 0 = no
INCOME	Household income	TH baht/year
DEPT	Have any household debt	1 = yes, 0 = no
Physical characteristics of the farms		
CREGION	Central northeastern region	1= Central northeastern region 0 = Other
SREGION	Lower northeastern region	1= Lower northeastern region 0 = Other
OGROUP	Rainfed area-organic rice	1 = Rainfed area-organic rice 0 = Other
CGROUP	Rainfed area-conventional rice	1 = Rainfed area-conventional rice 0 = Other
MSIZE[1/]	Jasmine rice plantation area	1 = medium size, 0 = other
LSIZE[2/]	Jasmine rice plantation area	1 = large size, 0 = other
BARN	Have a granary/barn	1 = yes, 0 = no
BARNCAP	Storage capacity	Sq. m.
Economic factors		
CASHCOST	Cash cost of jasmine rice	TH baht/year
DRYCOST	Rice drying cost	TH baht/ton
JASYIELD	Jasmine rice yield	Metric ton
JASPRICE	Jasmine rice price in the harvest season	TH baht/kilogram
Social and communication factors		
MEMORG	Member of a financial institution	1 = yes, 0 = no
MEMGROUP	Member of a farmer group	1 = yes, 0 = no
PLEDJOIN	Participated in the BAAC rice -pledging scheme	1 = yes, 0 = no

Note: [1/] Medium (jasmine rice cultivated area 1.6-4.8 ha); [2/]large (jasmine rice cultivated area >4.8 ha)

Study area and data collection. The present study was an empirical study that used data from farmer interviews in the major jasmine rice plantation areas in the following nine provinces: Nakhon Phanom, Maha Sarakham, Roi Et, Yasothon, Nakhon Ratchasima, Buri Ram, Surin, Si Sa Ket, and Ubon Ratchathani. The farmers who grew conventional jasmine rice and the farmers who grew organic jasmine rice in 12 villages were purposively sampled for this study. Overall, 330 farmer households were sampled. The sampling process was as follows:

1) A database of the farmers in each village in the study area was created to determine the number of farmers who had (or did not have) barns in the village, the average size of the farmers' barns, and the purpose of rice storage. This process was used to create the sampling framework.

2) The farmers in each group were distributed according to a list that provided the sampling framework for the purposive sampling. The data were collected from the groups of farmers who grew organic and conventional jasmine rice according to the proportions of each type of production in each group of the sampling frame. The sampled farmers in each group had the following three purposes for storing rice: storage for consumption or use as seeds only (173 households), storage for sale (78 households), and storage for sale by participating in the rice-pledging scheme of the Bank for Agriculture and Agricultural Cooperatives (BAAC) (80 households). The sample size of each group with a particular purpose for rice storage depended on the sampling framework in each village. For the farmers who grew jasmine rice in irrigated areas, the sampling was conducted according to a proportion of the purpose of rice storage, which was identical to the sampling of the farmers in the rainfed areas.

RESULTS AND DISCUSSION

Farmers' socioeconomic characteristics. From the study results, the average age of the farmers was 54-55 years old; 63.75% of the main labor force was male. Compared to plowing or crop tending during the planting process, the rice drying process is not difficult; therefore, the paddy storage decision may not be much different between the male and female farmers. The key factor should be the number of household laborers, as most rice drying processes use household labor more than hired labor; thus, household labor shortage should be a significant factor affecting the farmers' yield stockpiling decisions. From the observation, the average number of household laborers was 2.50-2.98 people per household, and the main occupation for most of them was farming on their own farm. Organic rice farmers have higher incomes than other population groups partly because of the income from the nonagricultural sector. The farmers who stored their rice had higher incomes than the farmers who keep their rice for household consumption.

Moreover, debt is another factor affecting the decision to store rice, and it was expected that the households with higher debts would tend to sell their rice immediately after harvest more often than the households without debt because they needed to sell their rice to pay their debts, and most of their creditor are BAAC (Bank for Agriculture and Agricultural Cooperatives). The annual scheduled payment period is after the harvest season or until March every year. From the data observation, it was found that more than 70% of the farmers in the study area had debts, and the farmers who stored their rice had average debts of 208,675 baht per household, which is more than the debt of the farmers who kept their rice stored for seeds or consumption; the farmers who grew jasmine rice in the rainfed areas had the lowest debts, while the irrigation area farmers had the highest household debts, approximately 215,357 baht per household.

Regarding the plantation size, the farmers had an average plantation area of 4.60 hectares, of which an average of 3.81 hectares were used for jasmine rice paddies. The farmers who kept their rice stored had 5.06 hectares of jasmine rice paddies, which was more than that of the farmers who did not store their crops by approximately 2 times; the farmers in the rainfed areas had more jasmine rice paddy areas than the farmers in the other areas. The farmers' yield was approximately 7.63 tons per

household. The farmers who stored their crops yielded 10.48 tons on average, which is higher than the amount yielded by the farmers who sold their crops immediately, only 5.07 tons annually. When considering the production environment, the farmers in the rainfed areas had greater jasmine rice yields than the farmers in the other areas. .

Farmers' decisions to store rice. Regarding the storage pattern, we found that most of the farmers (78.85%) sold their rice immediately after harvest, whereas 21.15% dried their rice and stored it in barns. The farmers who stored their rice had the following three main purposes: household consumption, planting seeds, and later sale. Some of the farmers in the storage group may have participated in the rice-pledging scheme of BAAC to wait for a price increase after the harvest season. The data survey showed that approximately 52.57% of the farmers stored their rice only for household consumption and for use as seeds for the next planting season. Furthermore, 23.26% and 24.17% of the farmers stored their rice crops to sell and to participate in the rice-pledging scheme of the BAAC, respectively (Table 2).

Table 2 The sampled farmers' decisions to store jasmine rice categorized by region, farm size, production environment, and storage facility in the 2017/18 crop year

Rice sale	Region			Farm size		
	Upper north-eastern	Central north-eastern	Lower north-eastern	Small	Medium	Large
			(%)			
· Store for consumption and seeds	96.00	56.36	37.43	75.45	45.45	33.33
· Store for sale	4.00	41.82	16.96	22.73	27.27	16.67
· Store for the rice-pledging scheme	0	1.82	45.61	1.82	27.27	50.00
	Production environment			Have a barn		Total
	Rainfed		Irrigation	Yes	No	
	Conventional	Organic	Conventional			
· Store for consumption and seeds	40.49	51.85	86.67	46.30	80.33	52.57
· Store for sale	25.77	25.00	13.33	25.19	14.75	23.26
· Store for the rice-pledging scheme	33.74	23.15	0.00	28.52	4.92	24.17

Note: [1/] Small (jasmine rice cultivated area <1.6 ha); medium (jasmine rice cultivated area 1.6-4.8 ha); and large (jasmine rice cultivated area >4.8 ha)

The project of postponing paddy selling via the BAAC (granary-pledging scheme) is the government's policy to support farmers in the harvesting season when the rice price drops and decreases the paddy supplies in that period, which provides options to farmers to postpone their sales without concerning their household expenses and debts. The farmers are able to get a loan with the BAAC for their jasmine and sticky paddy yield at 90% of the market price, which is limited up to 300,000 baht, without any interest. The farmers have to pay back the loan within 4 months after the loan is approved. The farmers who participated in the granary-pledging scheme tended to keep their paddy crops more than the farmers who had never participated in this project; this was because of their experience of storing their paddy crops with the scheme and the ability to evaluate the risks and revenue from stockpiling rice. From the observation, it was found that 76.43% of the farmers who kept their rice stored had participated in the granary-pledging scheme before, while 29.59% of the farmers had never participated in this project. From the overview of the production environment, 63.19% of the rainfed crop farmers had participated in the granary-pledging scheme, which was the highest proportion, while only 15% of the irrigation crop farmers had participated in the granary-

pledging scheme; however, most of the farmers, more than 80%, knew about the granary-pledging scheme and that it is still operated.

Moreover, the survey data showed that most of the farmers who stored their rice for sale or who participated in the rice-pledging scheme of the BAAC were large-scale farmers with a jasmine rice planting area of >4.8 ha. These large-scale farmers (66.67%) stored their jasmine rice for sale and/or participation in the rice-pledging scheme of the BAAC, while most of the small farmers (33.33%) stored their rice for household consumption and use as seeds for the next planting season (Table 2). Therefore, the rice-pledging program, which was intended to benefit several small farmers, was mainly beneficial to the large-scale farmers. However, the farmers who participated in the rice-pledging program sold their rice at a relatively high price. The need for sophisticated equipment, regulation procedures, and the high cost and high risk associated with rice storage affected the storage decision, but the scheme did not affect the rice farm gate price because the number of farmers participating in the program was low (Paopongsakorn, 2010).

Considering the regional or geographical characteristics of the study area, a difference was observed in the storage decision by the farmers in the lower northeastern region, who stored their rice for sale (approximately 16.96%), and those who participated in the rice-pledging scheme of the BAAC (45.61%). In contrast, only 4% of the farmers in the upper northeastern region stored their rice for sale, and none of them participated in the rice-pledging scheme of the BAAC; 96% of the farmers stored their rice only for household consumption or use as seeds for the next season (Table 2). The storage proportion varied between the regions with the type of rice required for home consumption. The main type of rice consumed by most of the farmers in the lower northeastern region was jasmine rice. Consequently, the farmers only grew jasmine rice to ensure that they had sufficient jasmine rice for home consumption throughout the year. In the upper northeastern regions, the farmers mainly consumed glutinous rice, while jasmine rice was only grown for sale.

An analysis of the decision to store paddy rice in different production environments showed that 78.83% of the farmers in the irrigated areas sold their rice immediately after harvesting it, and 8.33% stored their rice for later sale. None of the farmers in the irrigated areas stored their rice to participate in the rice-pledging scheme of the BAAC because most of the farmers in the irrigated areas needed to invest in dry-season rice, and some had to prepare the plantation areas for dry-season rice cultivation. These farmers either lacked an adequate number of workers to dry the rice or did not have rice storage facilities. More than 93.44% of the farmers who did not have barns sold their rice immediately after harvest, while only a few farmers who had barns sold their rice immediately. The proportion of farmers who stored their rice for sale was higher in the rainfed areas than in the irrigated areas. In the rainfed areas, approximately 50% of the farmers stored their rice for sale, and approximately 33.74% of the farmers participated in the rice-pledging scheme of the BAAC (Table 2).

Factors affecting the farmers' decisions to store rice. In Table 3, which presents the estimation results of the logistic regression model, the value of the probability χ^2 indicated that the independent variable in the model could explain either the dependent variable or the decision to store jasmine rice with an explanatory power of 43.60%. The coefficient estimation result showed that the proportion of female labor ($p < 0.10$) and household income ($p < 0.05$) significantly influenced the decision to store jasmine rice for sale. This result indicates that a household with a high proportion of female laborers was more likely to decide to store their rice for sale than a household with a lower proportion of female laborers. This variable coefficient analysis result reflects the role of female members in the postharvest process of rice cultivation (Mencher and Saradamoni, 1982; Unnevehr and Stanford, 1983; Sthapit *et al*., 1996). The farmers who required fine and constant operation, which requires fewer workers than are needed for land preparation, weed and pest prevention, or activities that require large farming machines, tended to hire fewer female workers than male workers (Barker and

Cordova, 1978; Paris et al. 2005). The household income variable had a negative coefficient value, which indicated that the households with high incomes were less likely to store their rice than those with low incomes that sold their rice immediately after harvest. Currently, the proportion of the sampled farmers' household income from the non-agricultural sector was approximately 80%. Hence, the members of the high-income households also spent time on activities outside the agricultural sector, which caused a labor and time shortage in the rice drying process (Srisompun et al. 2014). Thus, the farmers in the high-income households chose to sell their rice immediately and did not store it.

Table 3. Estimated results of the factors affecting the decisions of farmers to store jasmine rice

Variable name	Coefficient estimates			Marginal effect model		
	Coeff.	Std. Err.	P>z	Coeff.	Std. Err.	P>z
Economic and social characteristics of the farmers						
Sex of key laborer	0.1455	0.3394	0.6680	0.0358	0.0834	0.6680
Age of key laborer	0.0147	0.0171	0.3880	0.0036	0.0042	0.3880
Education level of key laborer	0.0700	0.1369	0.6090	0.0172	0.0336	0.6090
Agricultural labor amount	-0.0259	0.1564	0.8680	-.0064	0.0385	0.8680
Female labor proportion	0.0107*	0.0065	0.0990	0.0026*	0.0016	0.0990
Major career is farming	0.2132	0.1522	0.1610	0.0524	0.0375	0.1620
Household income	0.0000***	0.0000	0.0490	-0.0000***	0.0000	0.0500
Household debt	-0.4426	0.3424	0.1960	-.1095	0.0847	0.1960
Physical characteristics of the farms						
Central northeastern region	2.5233**	0.8566	0.003	0.5560***	0.1456	0
Lower northeastern region	2.9652***	0.8858	0.001	0.6210***	0.1285	0
Rainfed area-organic rice	0.9082*	0.5475	0.097	0.2227*	0.1305	0.0880
Rainfed area-conventional rice	1.1330**	0.5104	0.026	0.2720**	0.1160	0.0190
Plantation area-medium size	-0.0376	0.3985	0.925	-.0092	0.0980	0.9250
Plantation area-large size	-0.8588	0.6663	0.197	-.2000	0.1446	0.1670
Have a granary/barn	1.2942***	0.4730	0.006	0.2833***	0.0858	0.0010
Storage capacity	0.0025	0.0232	0.916	0.0006	0.0057	0.9160
Economic factors						
Cash cost of rice production	0	0	0.675	-0.0000	0	0.6750
Rice drying cost	0.0003***	0.0001	0.003	0.0001***	0	0.0030
Jasmine yield	0.0001***	0	0.004	0.0000**	0	0.0040
Jasmine rice price in the harvest season	0.0740	0.1267	0.559	0.0182	0.0311	0.5590
Social and communication factors						
Member of a financial institution	-0.5781	0.3276	0.078	-.1423	0.0801	0.0760
Member of a farmer group	0.0879	0.3273	0.788	0.0216	0.0802	0.7880
Participated in the rice-pledging scheme	0.9992**	0.3272	0.002	0.2404**	0.0759	0.0020
Constant	-7.9721	2.3021	-3.460			
Log likelihood = -156.43	LR χ^2 = 156.4300			Power of prediction = 43.60%		
Pseudo R^2 = 0.3416	Prob. [χ^2>value] = 0.000					

Note: *, **, and *** indicate statistical significance at the 90%, 95%, and 99% levels

The environment and rice production type, which were considered the physical characteristics of the farms, were significantly related to the decision to store rice. In the irrigated areas, the farmers who grew conventional rice were less likely to store their rice for sale at a higher price than the other farmers, while the farmers who grew conventional rice in the rainfed areas exhibited a higher probability of storing their rice for sale than the farmers who grew organic rice in the rainfed areas. The relevant study results are presented in Table 4. The farmers in the rainfed areas exhibited the highest probability of storage, whereas the farmers in the irrigated areas exhibited the lowest probability of storage; this was because some of the farmers in the irrigated areas needed to sell their rice to invest in the next season's crop and used household labor to cultivate the dry-season rice. Thus, no labor was available for drying the rice, while the farmers who grew organic rice in the rainfed areas exhibited a lower likelihood of storing their rice than the farmers who grew conventional rice; this was because most of the organic rice farmers had marketing support and sold their rice to the organic farmer group immediately after harvest. The consumer demand for organic products is increasing in Thailand (Songkhumchailiang and Huang, 2012); consequently, this farmer group chose to sell its crops immediately instead of storing them for later sale. Other physical factors, such as the region or having barns, were positively associated with the storage decision. The households in the lower northeastern region were more likely to store their rice than those in the other regions. Furthermore, having a barn was another significant factor in the farmers' decisions. The farmers who had barns decided to store their rice more often than those who did not have barns. Other factors, such as the storage capacity and farm size, did not significantly affect the decision to store rice.

Previous economic theories and the results of previous studies have indicated that economic factors are the most crucial factors affecting the decision by farmers to store their crops (Hofstrand and Winer, 2006; Tomek and Robinson, 2014); however, the results of this study showed that economic factors, including the cash cost of growing rice and the price of jasmine rice during the harvest season, did not influence the farmers' rice storage decisions. This implies that the farmers were not concerned about the price obtained. Moreover, the study hypothesis indicated that the farmers who had higher production cash costs sold their rice immediately without any storage; however, the coefficient estimation result was nonsignificant, partly because the farmers with high production costs were large-scale farmers who decided to sell some of their rice immediately after harvesting and stored the remaining crop for sale when the price increased. In contrast, the drying cost and volume of the jasmine rice yield had statistically significant effects on the farmers' paddy storage decisions. This implies that the farmers who had higher drying costs were more likely to store their paddy rice for sale than the farmers who had lower costs and produced relatively low volumes of jasmine rice. The last factor was related to social and communication issues; Lyon (2003) indicated that the community groups in rural or remote areas strongly incentivized the farmers' storage decisions. Accordingly, the farmers who had participated in the rice-pledging scheme of the BAAC were more likely to store their crops than the farmers who had never participated in the scheme. Moreover, although most of the farmers knew about the rice-pledging scheme of the BAAC, neither project awareness nor a financial institution or farmers' group membership affected the storage decision. The positive value of the coefficient of estimation indicated that the group members may have selected rice storage, but the relationship between the knowledge and awareness of the scheme or membership and the storage decision was nonsignificant.

In the marginal effect model analysis, which defined the other factors as constant, the relationship between the independent variables and the dependent variable of each factor were analyzed. The results showed that the coefficient estimation of the dependent variable was in the same direction as the coefficient analysis result in the main model. The results showed that the sampled farmers exhibited a 43.6% probability of storing their jasmine rice when categorized by the production environment and production pattern (Table 4). This study result was consistent with the mentioned model; the farmers who grew conventional rice in the rainfed areas exhibited a higher probability of rice storage than the other farmers. When region was used for the categorization, the

farmers in the lower northeastern region exhibited a higher probability of rice storage (64.4%), which was higher than that exhibited by the farmers in the central (39.8%) and upper northeastern (8.6%) regions.

Table 4. Probability of jasmine rice storage categorized by the production environment and decision to store rice

Production type/region	Probability of storage			
	Mean	**Std. Dev.**	**Min**	**Max**
Production type				
Conventional rice- rainfed area	0.611	0.276	0.027	0.990
Organic rice- rainfed area	0.441	0.280	0.011	0.951
Conventional rice- irrigation field	0.158	0.150	0.007	0.581
Region				
Upper northeastern	0.086	0.072	0.007	0.266
Central northeastern	0.395	0.235	0.036	0.873
Lower northeastern	0.644	0.263	0.066	0.990
Total	**0.474**	**0.307**	**0.007**	**0.990**

CONCLUSIONS

Most of the jasmine rice farmers sold their paddy immediately after harvest. The estimation result of the logistic regression model showed that the physical factors of the farm, namely, the production pattern, region, and having barns, were the most crucial factors affecting the farmers' paddy storage decisions. Moreover, the farmer households that participated in the rice-pledging scheme of the BAAC were more likely to store their paddy rice for sale than the farmer households that did not participate in the scheme. Regarding the socioeconomic factors, the study results indicated that households with high proportions of female laborers and low household incomes exhibited a higher tendency to store their paddy rice for sale than the other households. In contrast, the economic factors, namely, the price of a paddy and the production costs of jasmine rice, did not affect the farmers' paddy storage decisions. The results of the marginal effect model showed that the farmers in the lower northeastern region were more likely (64.4%) than those in the other regions to store their paddy rice for sale at a high price. Therefore, the result of this study is the following major policy proposal to enhance the effectiveness of the current policy for reducing the jasmine rice supply in the market during the harvest season and to encourage farmers to store their rice for maximum profit:

1. The purpose of the rice-pledging scheme is to provide subsidies to farmers and support the rice price during the harvest season. However, the number of farmers who currently benefit from the rice-pledging scheme is low, and most of them are large-scale farmers. Any public policy should ensure the thoroughness of policy implementation.
2. The reasons underlying the decisions of farmers to sell their rice immediately after harvest without participating in the rice-pledging scheme include not only the storage risk but also the need for sophisticated equipment, regulation procedures, and the high cost of storage. The rice-pledging scheme has not affected the rice farm gate price because the number of farmers participating is low.
3. Rice barn development is crucial for and correlated with the storage decision of farmers. Hence, providing adequate support for the construction and repair of barns will increase the probability of the farmers' decisions to store jasmine rice for sale.

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