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The Determinants of Farmers' Cropping Systems Adoption: A Case of the Upland Farmers in Northern Thailand

Chaowana Phetcharat

Faculty of Economics, Chiangmai University, Thailand, E-mail: chaowana@gmail.com

Juthathip Chalermphol

Faculty of Agriculture, Chiangmai University, Thailand. E-mail: jutha073@gmail.com

Phuphing Siphumin

Faculty of Sciences and Agricultural Technology, Rajamangala University of Technology Lanna, Thailand.
E-mail: phuping.s@gmail.com

Saibua Khempet

Faculty of Agricultural Technology, Chiang Mai Rajabhat University, Thailand. Email: saibua.cmru@gmail.com

Abstract

Lack of farming knowledge still appears in the remote areas of northern Thailand particularly among upland farmers who often use conventional farming and mono-cropping techniques. The cropping system involves a specialization skill in production from farmers and it does require a large quantity of land to meet and individual farmer's need. Over the past decade, the forest cover in northern Thailand had dramatically decreased due to demands of land cultivation. As a multi-cropping system may provide advantages to the farmers, intercropping and sequential cropping system can help to minimize crop production and price risks. The system does not only give sufficient economic returns but it also provides a long-term ecological sustainability. This practice is a way to transform upland farmers into becoming more self-reliant. This research aimed to analyze and determine the key factors of farmers' decision to adopt the multi-cropping practice. Logit model was applied in the study, and was based on a survey of 202 respondents from the highland communities of northern Thailand. The results showed that the famers' education attainment, attitude toward environmental awareness, and household financial situation are important to their choice of practicing the multi-cropping system. Education and lower debt amount led to an increase in the probability of upland farmers to try the multi-cropping system. The households with larger farms are willing to use part of their available land to do the multi-

cropping. An increase in the farmers' level of environmental concern was also observed to increase the probability of the multi-cropping system being adopted.

Key words: cropping system, farmers' decision, logit model, multi-cropping, upland farmers
JEL classifications: *Q01, Q10, Q12, Q18*

Introduction

More than 21% of the areas in the northern region of the country are devoted to agriculture (National Statistical Office Thailand [NSO], 2013). Households in the areas earned incomes from selling agricultural products such as rice, maize, potato, lychee, coffee, and vegetables. However, the lack of farming knowledge and techniques, including the use of shifting cultivation are still dominant in these highland areas. Farmers most often use conventional farming and mono-cropping practices, and because of the short-season harvest and double-crop option to farmers, cash crops such as maize, potato, and chick pea became a common monoculture of food crops in the area. Furthermore, cash crops grown in the highland communities of northern Thailand tend to fall under contract farming. In this operation, farmers and marketing firms have an agreement for both agricultural supplies and production. Farmers agree to provide a specific product to a purchaser while the purchaser agrees to supply some inputs and technical advice to the farmers. The contractual agreement motivates upland farmers to grow a single crop year after year without rotation. This extensive agriculture results in early soil nutrients depletion and crop losses due to insect damage.

This study was conducted in the three sub-districts (Tumbon) of Lampang province: Pongtoa, Nanga, and Baanrong, classified as highland communities of northern Thailand. Here, the households rely on only one source of income from growing a single crop (either maize, rice, potato, coffee, or lychee). An average household's income is less than haft of an average household in other parts of the country (Highland Research and Development Institute [HRDI], 2013). In a way, mono-cropping techniques most often provide an insufficient income to satisfy basic needs of the household thus causing a high demand for more lands for cultivation. Although the mono-cropping system may offer a specialization in production to farmers but it does require a large quantity of land to meet an individual's return needs. Over the past decade, deforestation continues at a high level in the northern highland communities. Land use in the three sub-districts located nearby the watershed area of Yom and Ping rivers has been changed from forest cover to agriculture cultivated land. Phuping (2015) reported that agriculture cultivated land has been found to increase from 11,242.41 rais in 2007 to 22,531.22 rais in 2014 (1 rai is equal to 0.39 acre). As observed, improper management has not only caused low production yield and returns but has also led to environmental degradation.

Despite the fact that a multi-cropping sytem (i.e., intercropping and crop rotation) can reduce variability of farm income the single crop may also result in low crop production and/or farm return in some harvest years due to uncertain weather conditions and market price volatility. But intercropping can help to reduce risks of

crop production and price. When farmers intend to maximize farm returns over their resource constraints, farm inputs become optimally allocated to grow a certain crop choice. Under this framework, the farmers' choice on a farming system is associated with a relative utility of the practices (intercropping versus monocropping). Several studies have determined the optimal acreage of multi-cropping productions on farm returns (Hassan et al., 2004; Sarker et al., 1997; Vitale et al., 2014). In addition, farm output and revenue can be increased when two different crops are grown simultaneously on the same land. The intercropping system provides a long-term ecological sustainability because of the genetic diversity giving better pests and diseases control. Also, biological interactions can help to increase organic matter in the soil.

Recognizing the values of the intercropping systems and transferring this related knowledge are one solution to improve living standards and eliminate poverty among households in the highland communities. However, much of the previous related efforts of local projects often received little attention from the famers. Their decision needs to be understood, however, to promote further adoption of the multi-cropping practice. Previous research has determined the influential factors of farmers' motivation to employ a new farming practice. AThipanyakul and Pak-Uthai (2012) have identified factors affecting adoption's decision of farmers under the Good Agricultural Practice (GAP) for chili producers in the northeastern part of Thailand. GAP refers to a program that attempts to reduce the use of pesticides, increase the production, and marketing standards of agricultural commodities. Researchers applied a treatment effect model to the 179 survey data of chili producers in Chaiyaphum province including both GAP participants and non-participants. The result showed that age has a negative effect on farmers 'decision. The participation of GAP and farmers' knowledge together has a significant effect on the number of adoption practices. The reason might be that farmers could gather information and exchanged their experiences with others when participating in the program. An effective approach such as the participatory research program needs to encourage farmers for the adoption of knowledge-intensive technologies. Rola, Sajise, Harder, and Alpuerto (2009) examined soil conservation decisions of upland households in the municipality of Lantapan, Bukidnon, Philippines. The study used the probit regression to investigate the factors affecting farmers' land- and labor-use decisions. The results revealed that factors affecting the adoption of soil conservation included land tenure and availability of family labor. For the adopter farmers, the variables on seeds, hired labor, and education gave statistically significant impact to corn yield.

Furthermore Popp, Faminow, and Parsch (1999) have applied a discrete choice logit model to estimate the effect of farm size, human capital, perception of risk/return and enterprise diversification on the decision of cow-calf operators to feed or sell calves at weaning. The results came from 661 mail surveys of cow-calf producers in Arkansas and indicated that a 100-acre increase in farm land could lead to a 1% increase in the likelihood that the operator chose to feed weaned calves. The operator perceptions about risk significantly affected the calf retention decision. Likewise, operators who reported that price risk (the price of feeder cattle)

was not an important problem, were more likely to feed calves than sell them at weaning. On the other hand, age and education of the operators did not affect the calf retention decision.

This research intended to identify influential factors of farmers' decision to adopt the multi-cropping practice. "What would be a key factor to motivate farmers?". The study hypothesis was that socioeconomic status (SES) and farming knowledge and skill could link to farmers 'decision. If scientific research and technical knowledge from agricultural extension agencies were transferred and clearly communicated to the farmers, the latter were more likely to adopt the practice. On the other hand, household income, age, gender, and educational attainment of the household head could either enhance or hinder farmers' motivation to adoption. The country's public policy and educational research outreach programs could be more effectively developed if the relevance factors were known. This research hoped to provide a constructive input into the agricultural policy to advance an economic status of upland farmers as a first priority and develop it into a potentially large-scale program.

Data and Methodology

Data

Data presented came from a face-to-face survey of 202 sample respondents from six villages in the three sub-districts of Lampang Province. The particular sub-districts (Pongtoa, Nanga, and Baanrong) were chosen as each one is located in the highland community of northern Thailand and had been sampled as study areas for the initial research project. Sample size was determined under the 95% confidence level. Within each of the three sub-districts, a proportional stratified random sampling method was employed to select the household units of each village segment. At the village level, random selection of household samples was based on household identification by the village head and local government officers. The survey was conducted in local northern dialect from June 2014 to May 2015. Using a fully specified questionnaire, farmers were interviewed of their households' socio-economic status, followed by questions on farmers' adoption decision and Likert-scale of the variables in the second section. General information of the respondents (age, gender, and education) were contained the last section of the survey.

Resulting data showed that most of the respondents were male (70.5%) and 37% were 41-60 years old. More than half of the respondents (53.5%) had no formal education, and on average a household had five members. An average farmland managed by each household was 27 rais (around 10.5 acres), while less than 6% of the household had farms larger than 60 rais (23.4 acres). Cash crops, maize, potato, and rice, were major products in the area, and 78% of the yield was marketed. While 72% of the households had an average annual income of less than 120,000 baht ($1 is approximately equal to ฿35), around 78% of them had an outstanding debt. Farm investments such as input costs and land preparation were a major source of creating debt. The borrowing sources included the community monetary fund, relatives, and sponsoring companies under contractual agreement. About 84% of the households indicated that they wanted to apply the multi-cropping

practice. Also, 66.7% of this household group expressed their desire to start the practice in the coming season while 15.4% wanted to start in the next growing season year. Meanwhile, the remaining 18% had not specified their time to start the multi-cropping practice because they wanted to observe the resulting profitability of the already practicing households before doing so. In addition, only 16% refused to pursue this farming practice.

Method

Since the farmers' decision would be used in two different contexts: adopt and not to adopt the multi-cropping practice, the choice dependent variable consisted of only two discrete values, one and zero. The binary choice model was considered suitable for estimation (Greene, 2008). Based on the values of explanatory variables, the probability of the outcome was estimated by using Logit procedure in STATA. The farmers' decision to adopt or not to adopt was specified as

$$MultiC_i = \beta_0 \ + \beta_k X_{ki} + u_i \quad (1)$$

where $MultiC_i$ serves as the decision of the i^{th}household to adopt the multi-cropping system or to continue the traditional farming practice (single cropping). The variable $MultiC$ is equal to one when households indicated that they wanted to adopt the multi-cropping system, and *MultiC* is zero otherwise. X_{ki} is the explanatory variables (k = 1, 2, …, K), β_0 is a constant term, and β_k the parameter estimates, and as the random error term for the outcome model.

Under the binary model, the probability of i^{th}household selecting to adopt the multi-cropping system is given by;

$$p_i = \frac{exp(\beta' X)}{1+exp(\beta' X)} \quad (2)$$

where X is the vector of explanatory variables and β' is the vector of estimated parameters. A weighted average of the indicated numbers from all respondents was calculated for each variable. Table 1 presents a statistical summary of the modelling variables.

Table 1: A Statistical summary of the modelling variables

Variables	Description (Units/ Variable type/ Question)	Mean Value	Std. Dev	Hypothesized Direction of the Effect
Household head/ respondent characteristics				
Age	Age of the household head (years old)	47.13	12.19	-
Gender	Age of the household head dummy variable: 1 if the respondent is a male, and 0 otherwise.	0.70	0.46	+
Edu	Education attainment of the household head dummy variable: 1 if attended at least an elementary school, and 0 if no formal education.	0.45	0.50	+
Physical farm factors				
Hm	Number of household members (persons)	5.34	2.39	+
FarmS	Operational farm size of the household in (one rai is approximately equal to 0.39 acre)	27.10	19.24	-
Fp	Farm production dummy variable: 1 if the household currently grows cash crop (maize, potato, rice, and chick pea), and 0 if grows fruit crop (lychee and avocado).	0.81	0.39	+
Household financial factors : Household outstanding debt				
SmallD	Debt repayment amount in previous year dummy variable: 1 = 40,000 baht or fewer amounts, and 0 otherwise.	0.42	0.49	+
ModD	Debt repayment amount in previous year dummy variable: 1 = 40,001-80,000 baht, and 0 otherwise.	0.26	0.44	+
LargeD	Debt repayment amount in previous year dummy variable: 1 = 80,000 baht or more, and 0 otherwise.	0.11	0.32	+
Opinion scale factors*: ranged from 0 to 10*				
Rev	Farm expected return Is the higher return form doing multiple cropping important to employ the practice? *(where 0 = not important at all, and 10 = strongly important)*	7.41	2.64	+
Ls	Family labor skill on multicropping Is the multicropping skill of family labors important to employ the practice? *(where 0 = not important at all, and 10 = strongly important)*	5.39	2.93	-
Evn	Degree of environmental concern What are your level of concern about the environment around your community? *(where 0 = does not have any concern about the environmental degradation, and 10 = highly concern)*	7.94	2.36	+

In the study, we hypothesized that;

Variable *A* represented the age of respondents in years. Age could decrease farmer's ability to acquire new knowledge and skill, as well as older farmers were more risk averse than young farmers. Therefore, the age was hypothesized to impact the farmers' decision in a negative manner.

Similarly, female farmers tended to be more risk averse than the males so it was hypothesized that male farmers expected to have higher probability of adopting the multi-cropping practice than female farmers.

The education level of the farmers (*Edu*) served to help them to evaluate new information about the multiple cropping techniques and market opportunities. It was hypothesized that the more educated farmers were the higher the probability of farmers to adopt the multi-cropping practice.

The multiple cropping practice itself often required more farm chores than monocropping. The number of household members, denoted as *Hm*, was expected to be positively associated with multi-cropping system.

Farm production type (*Fp*) was also hypothesized to be positively related to the probability of adopting the multi-cropping practice. Specifically, households who were currently growing cash crops (e.g., maize, potato, rice, and chick pea) were more likely to adopt the system than those who were growing fruit crop. Due to shorter planning horizon of the cash crop, the farmers were more flexible and willing to change their farming practice.

The size of the farm (*S*) was expected to be negatively associated with the multi-cropping system adoption. Households with large farm size tended to be more specialized in specific production and were inclined to do multi-cropping. However, the land tenure variable was not included in the model because the cultivated lands in the study area were mostly acquired through spontaneous settlement of the hill tribe people. As the result, there was little difference in the land tenure among households, and land tenure information was not contained in the survey that could determine difference in adoption decision.

The repayment amount of debt in previous year is used to proxy the level of the household outstanding debt. The amount of debt is categorized into four levels (zero debt, small amount, moderate amount, and large amount of debt) and expect to have a positive impact on the multi-cropping system adoption. The household with a large amount of debt would be more inclined to grow more varieties of crop in the same harvest year because it generates consistent and better income.

Opinion scale factors such as family labor skills on multi-cropping and farm returns were also hypothesized to affect the probability of the multi-cropping system adoption. The survey respondents provided the ragged score to indicate how the factor was important in deciding to adopt the practice (where 0 = not important at all, and 10 = strongly important).

Farmer's opinion about multi-cropping skills of family labor (denoted as *Ls*) was expected to be negatively related to the multi-cropping adoption decision. The households who viewed labor skill to be strongly important, were less inclined to adopt the multi-cropping system than those who did not.

Farmer's opinions regarding farm returns (*Rev*) were expected to be negatively related to the adoption decision. It was often that risk averse farmers wanted to avoid risk by not employing new farming techniques unless certain level of farm income was guaranteed or compensated.

Farmer's level of concern about environment degradation, denoted by *Env*, was scaled from zero to ten (where 0 = does not have any concern, and 10 = highly concern).The slowdown of deforestation could be done by not shifting cultivating and clearing forest land. Therefore, farmers who were highly concerned about the environment surrounding their community would be more inclined to adopt the multi-cropping system than those who were less concerned.

Results and Discussion

The logit model depicted in equation (1) was estimated and the transformed log likelihood function (distributed chi-squared) was less than 0.01 at the one-percent level (table 2). This indicates that the overall model was statistically significant. The null hypothesis for all model regression at zero was rejected. Accordingly, the positive sign of the coefficient means that an increase in the explanatory variable was associated with increased likelihood of adoption of the multi-cropping system. Table 2 presents the estimation results of the logit model.

Table 2 Estimated results of the logit regression

Explanatory Variables	Estimated Parameters, β_k	Marginal Effect (in %)
Constant	-1.07	-
	(1.66)	
Household head/ respondent characteristics		
Age	0.02	0.22
	(0.02)	
Gender	-0.09	-0.84
	(0.50)	
Edu	1.21**	11.70
	(0.61)	
Physical farm factors		
Hm	0.01	0.14
	(0.09)	
FarmS	0.03*	0.30
	(0.02)	

Fp	-0.25	-2.33
	(0.61)	
Household financial factors		
SmallD	1.12**	10.49
	(0.51)	
ModD	1.64**	12.47
	(0.75)	
LargeD	0.66	5.36
	(0.91)	
Opinion scale factors		
Rev	-0.18	-0.018
	(0.13)	
Ls	-0.11	-1.07
	(0.09)	
Evn	0.27**	2.68
	(0.12)	
McFadden's R-Squared	0.19	
Log-Likelihood	-71.06	
p-value for log likelihood function	0.00	

Notes: 1. Standard errors are in the parentheses.

2. (*) Significant at ten-percent level, (**) significant at five-percent level, and (***) significant at one-percent level.

Findings showed that education of the household head (*Edu*) increased the likelihood of adopting the multi-cropping practice by 11.7%. Those farmers who attended the elementary school would view the opportunity of doing multi-cropping differently than those who had no formal schooling. Moreover, household operational farm size was significant at ten-percent level but the negative sign of the coefficient was unexpected and was very small. Households with larger farms would be found willing to use part of their available land to grow other new crops. However, none of the age, gender, number of household members, and farm production variables affected the farmers' cropping system adoption, as the coefficients were not statistically significant.

The small and moderate amounts of debt were positively associated with increased probability of adopting the multi-cropping system. A one-level change in the household debt from none to small amount (≤ 40,000 baht per year) was found to increase the probability of adopting the multi-cropping system by 10.49%. In the same way, the change in the household debt from none to moderate amount (40,001- 80,000 baht per year) increased the probability of adopting the multi-cropping system by 12.47 %. This was in contrast

to the larger amount of debt in which the coefficient was not statistically significant. These results suggested that households with large financial problems were unlikely to accept the multi-cropping system with unknown outcome.

While the scale variables such as family labor skill on multi-cropping and expected farm return were not significant in terms of adopting the multi-cropping system, the degree of environmental concern was positively significant. Farmers with high degree of concern about the environment around their community were more inclined to adopt the multi-cropping system. A one point increase in the level of environmental concern was observed to increase the probability of the multi-cropping system being adopted by 2.68 %.

Conclusion

In northern Thailand, upland farmers mostly have less or no education, earn insufficient income, and have debt to repay. Accordingly, these upland farmers tend to shift cultivation and expand their farmland for production. They however often fail to take into account the externality of deforestation. The multi-cropping system is considered a way to help upland households to generate sufficient and consistent income to respond to their consumption needs as well as to help reduce forest land clearing.

Findings of this study are found to reflect the fact that multi-cropping system is a scheme that strongly considers the farmers' education, labor skill, and financial situation of these upland households and does encourage them to join the practice. Thus, the government and/or public organization agencies could engage more with the local communities such as in the provision of knowledge transfer, crop loan with low interest rate, and infrastructure development (e.g. irrigation and rural roads). These are some compulsory policies applied to attract farmers' decision of choosing the multi-cropping system. In short, there is a need to put in place the necessary support programs to transform upland farmers into becoming more self-reliant.

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