Determinants of Crop Diversification on Paddy Field :
A Case Study of Diversification to Vegetables

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ABSTRACT

This study aims to find the determinants of land diversification from paddy to vegetables. The logit analysis reveals the importance of the infrastructural factors, i.e. available area and timing to grow other crops, in the diversification. The analysis also shows that the probability of the diversification is determined by family labour and main farmers' management characteristics, including education, trading experience, and level of information obtained by the farmers.

Therefore, to promote the diversification, the improvement of infrastructural conditions, especially water availability, and farmers' management characteristics should be implemented.

Key words : crop diversification, logit model

INTRODUCTION

In Thailand, rice is the most important crop, occupying about 40% of the total arable farm land area of the country and about 2 million households are engaged in the cultivation of the crop. To improve rice farming, the Thai government has implemented various measures, especially infrastructural development and technological innovation. In spite of these improvements, the productivity of Thai rice farming remains very low. Moreover, since rice farmers are small in size, their bargaining power is quite weak, leading to the situation where they commonly face high input prices and low product prices with the consequence of low income and standard of living.

Although, farmers' income may be improved through both farm and off-farm activities, this paper focuses on farm activities. Besides expansion of farm size, productivity improvement, and increase in the product price, it is believed that the desired increase in farm income may be realized through intensification and diversification of land use (Efferson, 1953; Fujimoto and Matsuda, 1990). There is an increasing importance in land diversification at present especially when Thailand faces an increased competition from Indo-China countries in the world rice markets. Actually, since 1994 the Thai Government has implemented an important policy, Structural Adjustment of Agricultural Production System Program, 1994-1996, in which diversification of rice land to vegetables

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is an important target (Department of Agricultural Extension, 1994). To support the policy, understanding of determinants of the diversification is necessary and will be the focus in this study.

REVIEW OF LITERATURE

Generally, the diversification of rice land seems to be determined by a set of factors as mentioned by Seetisarn (1977) and Matsuda (1990). Seetisarn (1977) revealed that the most important factor influencing the existing cropping patterns in Chiang Mai Valley was the availability of water. Matsuda (1990) and Matsuda and Igata (1993) pointed out that water condition was a key determinant of rice land diversification in Thailand and the Philippines. Jodha (1977) also revealed the same conditions in cropping patterns in semi-arid area of India. Moreover, Matsuda (1994) proposed a hypothesis on the relationship between irrigation freedom (degree of water control by farmers) and crops grown.

Besides water conditions, Seetisarn (1977) pointed out that farm size would influence cropping patterns while the opposite was reported by Jodha (1977). Moreover, market and desire for higher income among farmers were also important determining factors of cropping patterns (Seetisarn, 1977). Limpaphinun (1992) concluded that factors accelerating the change from paddy growing to orchard cultivation were (1) household head characteristics including education and orchard activity experiences and (2) resource endowment, especially farm assets. She further revealed that farmers' age, farm size, number of plots occupied, and off-farm income had a negative influence on the change.

From the above review of literature, it is certain that infrastructural conditions, especially water availability, farm's resource endowments, and farmer's characteristics are among the important determining factors of land diversification and will be the focus of the following analysis.

METHODOLOGY

DATA COLLECTION

With suggestions of the Provincial Agricultural Office in Suphan Buri, a village of Amphoe Sam Chuk, Mu 6 Tambon Wangluk (WL), where paddy fields were significantly diversified to cultivate vegetables especially sweet corn, was selected as the study village. Although data from all farm households were planned to be collected, because of time and budget limitations together with farmer conditions, especially seasonal migration and off-farm jobs, only 96 households (about 78% of total farm households in the village) could be interviewed and used in this study.

ANALYTICAL METHOD

To analyse the factors determining crop diversification, diversification functions were estimated. Because diversification is a quality choice variable, a **logit model** is utilized. The model is based on the cumulative logistic probability function, $P_i = 1/(1+e^{-(\alpha+\beta X_i)})$ when (1) P_i = probability that an individual will make a certain choice, (2) e is base of natural logarithm, (3) X_i = explanatory variable, (4) α and β = constant and coefficient of X_i. The function can be transformed to $L_i = \log(P_i/(1-P_i)) = \alpha + \beta X_i$ which will be used in the estimation. To estimate the model, generally maximum likelihood is applied instead of OLS (Pindyck and Rubinfeld, 1981).

The dependent variable in this model is L_i or $\log(P_i/1-P_i)$ of which P_i is the probability that each farmer will diversify his rice land to sweet corn. On the other hand, a set of variables including farmer characteristics, farm resource endowments, and infrastructural conditions are expected to be the determining factors of the diversifications.

Farmers' characteristics expected to influence the diversifications include age, education, experience (farm and non-farm), and level of information obtained. However, because of close relation between age and farming experience, only non-farm experience is used. For farm's resource endowments, farm size, number of family farm workers, and farm assets will be considered. These factors are expected to influence the diversification as follows:

Farmers' age (years) : In view of the postulate that younger farmers accept new things more easily than their elders, farmers' age (AGE) is expected to have a negative relation with the diversification.

Farmers' education (years) : Because of the importance of education in development, it is expected that there is a positive relation between level of education and the diversification of land use.

Trading experiences of farmers (dummy) : Since trading experience (TRADE) provides farmers with a business sense and wider view point, it is likely that they become more easily exposed to the idea of diversification. In other words, the more trading experience the farmers had, the greater would be their diversification of land use. Therefore, the positive relation between the experience and diversification to sweet corn is expected. In this paper the experience is represented by a dummy variable, whose value is 1 if farmer had experience, on the other hand is 0.

Level of information : The level of information (INFOR) is measured from the frequency of reading agriculture-related books and watching related TV programs.[1] As is the case of trading experience, a positive relation between level of information and diversification to the crop is expected.

Man-Land ratio (persons/rai) : The man-land ratio (FAMLA) is calculated by dividing the number of family farm workers by farm size. Since sweet corn needs more intensive care than rice, the positive relation between the ratio and diversification is expected.

Depreciation (baht) : Due to the fact that equipment needed in sweet corn and rice production are more or less the same, no relation between diversification and capital investment represented by depreciation (DEPRE) is expected.

Possible area and time to grow other crops (rai-month) : Possible area to grow other crops (POSAT), which represents the infrastructural conditions, land and water, is expected to have a positive relation with the diversification to sweet corn.

Besides the above factors, income was also strongly believed to be an important determinant of rice land diversification. However, because the data obtained from the survey was only one year data, the factor will not be included in this analysis.

The empirical models are specified as follows:

$$MODEL1: log(P/(1-P))$$
$$=\alpha+\beta_1 POSAT+\beta_2 DEPRE+\beta_3 FAMLA$$
$$MODEL2: log(P/(1-P))$$
$$=\alpha+\beta_1 POSAT+\beta_2 DEPRE+\beta_3 FAMLA+\beta_4 AGE$$
$$MODEL3: log(P/(1-P))$$
$$=\alpha+\beta_1 POSAT+\beta_2 DEPRE+\beta_3 FAMLA+\beta_5 EDU$$
$$MODEL4: log(P/(1-P))$$
$$=\alpha+\beta_1 POSAT+\beta_2 DEPRE+\beta_3 FAMLA+\beta_6 TRADE$$

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[1] Frequency in receiving information was categorized into 3 levels, high, medium, and low, which represented frequency of reading (watching or listening) agriculture-related documents (related TV and/or radio programs) more than once a week, more than once amonth, and less than once a month respectively. Then, 3, 2, and 1 points were assigned for high, medium, and low respectively. The average score of each farm was calculated and assigned as individual farmer information level in the analysis.

MODEL5: log(P/(1-P)
$=\alpha+\beta_1 POSAT+\beta_2 DEPRE+\beta_3 FAMLA+\beta_4 INFOR$

RESULTS AND DISCUSSION

Study Area and Farmers' Characteristics

Wangluk, about 140 kilometres northwest of Bangkok, is characterized by flat topography. It is irrigated not only by Sam Chuk irrigation project but also Thamanao river. However, it sometimes faced with water shortage in the dry season forcing farmers to develop and widely utilize tubewells. Approximately 41% of farmers in the village diversified their land from paddy to sweet corn.

The average age of the farmers is 45 years (Table 1). As is common among farmers in Thailand, their education levels are quite low. Usually, after finishing grade 4 or at the age of 12, they leave school and start working with their parents as rice farmers. The members of farm family and farm workers in the area are rather few with averages of 4 and 2.2 respectively. The average farm size is as small as 15.7 rais.

Determinants of Diversification to sweet corn

The estimation of five diversification models are presented in Table 2. In the Model 1 in which explanatory variables consisted of only the main variables, ie. POSAT, DEPRE, and FAMLA, all the directions of the relations are as expected. The coefficient of POSAT is significant, but the other variables, DEPRE and FAMLA, are not statistically significant. The Chi-square statistics indicates that the model as a whole is significant

Table 1 General characteristics of the head of farm households in Wangluk.

Items	Wangluk
No. of farmers studied	96.0
Average age (yrs)	45.0
Average education (yrs)	3.9
Agricultural exp. (yrs)	30.4
Family size (persons)	4.0
Farm worker (persons)	2.2
Average farm size (rais)	15.7
Land ownership	
No. of owner farmers	48.0
	(50.0)
No. of owner-tenant farmers	21.0
	(21.9)
No. of tenant farmers	27.0
	(28.1)
No. of farm cultivating sweet corn	39.0
	(40.6)

Source : Survey

Note : Figures in parentheses are the percentages

Table 2   Logit analysis of factors affecting the probability of paddy land diversification to sweet corn.

VAR	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
CONST	-1.175	-0.062	-3.221	-1.374	-3.606
	(2.19)	(0.06)	(2.92)	(2.44)	(3.57)
POSAT	0.005*	0.006**	0.005*	0.005*	0.006**
	(1.83)	(2.01)	(1.65)	(1.87)	(2.03)
DEPRE	0.0001 ns	0.0001 ns	0.0001 ns	0.0001 ns	0.0001 ns
	(1.27)	(1.19)	(1.13)	(1.13)	(0.66)
FAMLA	1.702 ns	2.021*	2.078*	1.862*	1.928*
	(1.53)	(1.76)	(1.69)	(1.65)	(1.71)
AGE	-	-0.027 ns	-	-	-
		(1.30)			
EDU	-	-	0515**	-	-
			(2.24)		
TRADE	-	-	-	2.107*	-
				(1.86)	
INFOR	-	-	-	-	1.172**
					(3.12)
LOG-L	-54.46	53.58	-50.73	-52.05	-48.85
CHI SQ	5.84 ns	7.59*	13.31***	10.67**	17.07***

Note :   Figures in parentheses are the t-values
　　　　***　　　= Significant at the 1% level
　　　　**　　　= Significant at the 5% level
　　　　*　　　= Significant at the 10% level
　　　　ns　　　= Not significant
Variable :   POSAT　= Possible area-time to grow other crops (rai-month)
　　　　DEPRE　= Depreciation (baht)
　　　　FAMLA　= Family farm workers (FAML) / farm size (persons/rai)
　　　　AGE　= Age of the household head (years)
　　　　EDU　= Education level of the household head (years)
　　　　TRADE　= Trading experience (dummy variable, No=0, Yes=1)
　　　　INFOR　= Information level categorized by the frequency of reading and watching agricultural books
　　　　　　　　or TV programmes

Table 3 Probability of diversification to sweet corn.

Items	Logit	P_i
Education level (MODEL 3)		
0	-2.056	0.113
1	-1.541	0.176
2	-1.026	0.264
3	-0.511	0.375
4	0.004	0.501
5	0.519	0.627
6	1.034	0.738
Trading experience (MODEL 4)		
0	-0.268	0.433
1	1.839	0.863
Information level (MODEL 5)		
1	-1.230	0.226
2	-0.058	0.485
3	1.114	0.753
Possible area (MODEL 5)		
40	-0.306	0.424
80	-0.066	0.484
120	0.174	0.543
160	0.414	0.602
200	0.654	0.658
Family farm worker (MODEL 5)		
0.1	-0.401	0.401
0.2	-0.208	0.448
0.3	-0.015	0.496
0.4	0.178	0.544
0.5	0.370	0.591

Source : Calculated from Table 2

Note : P_i = probability of land diversification of each farmer

only at the 12% level, a little higher than the general acceptance level of 10%.

In addition to main variables, AGE is included in Model 2 as another independent variable. All the directions of the relations are as expected. However, only the coefficients of POSAT and FAMLA are statistically significant. DEPRE and AGE are not statistically significant. The model as a whole is significant at the 10% level.

Model 3 shows that not only POSAT and FAMLA but also EDU is statistically significant. Again, DEPRE is not statistically significant.

TRADE variable is introduced in Model 4 instead of EDU in Model 3. It is very interesting to note that trading experience is a significant factor in the diversification to sweet corn, indicating that the farmers who had trading experience tended to diversify more of their land to sweet corn than non-trading experience farmers. In Model 5, the level of information (INFOR) was included. As is shown in Table 2, INFOR has a highly significant positive coefficient, suggesting that the more information the farmers obtained, the higher was the probability of diversification to sweet corn.

Based on the analyses, it can be confidently concluded that DEPRE, and AGE had no relation with the diversification; while POSAT, FAMLA, EDU, TRADE, and INFOR had positive relation. The results demonstrate that the improvement of these factors will increase the probability of diversifying land use to sweet corn, which may also imply the diversification to other vegetable crops whose characteristics are similar to sweet corn.

It should be noted here that there might be some relations between education and other management ability factors, TRADE and INFOR, because education provides farmers' reading and writing abilities which are very important tools for conducting business and obtaining useful information.

These functions not only point out the significant determining factors of the diversification but can also be used as a tool to predict the probability of land diversification of each farmer. Table 3 indicates that, at the mean of POSAT (80.11), DEPRE (1,948.9), and FAMLA (0.274), when the level of education increases from grade 0 to grade 6 the probability of diversification of land use of farmers will increase from 0.113 to 0.738. By the same method, the probability of diversifying land use among farmers who had trading experience is high, at 0.863, compared to only 0.433 for non-trading experience farmers. For in-

formation level, Table 3 also shows that from level 1, the lowest, to level 3, the highest, the probability increases more than three-fold from 0.226 to 0.753. The above analysis again points out the importance of these management ability factors in the probability of diversification.

CONCLUSION

Recently, the diversification of paddy land to vegetables has been promoted as a desirable direction in farm income improvement under the prevailing land and water conditions. This paper aimed to find the determinants of the diversification. The logit analysis confirmed the importance of the infrastructural factor, represented by possible area and time to grow other crops, in land diversification from rice to sweet corn. Besides the factor, the diversification function also showed that the probability to diversify paddy land to sweet corn was determined by family labour and farmers' management characteristics, including education, trading experience, and level of information obtained by the farmers.

The results show that, to promote the diversification, the improvement of infrastructural conditions, especially water condition, are necessary. Moreover, the improvement of farmers' management characteristics should also be done. The improvement of farmers' education may be pursued through formal and informal education. However, for farmers who are generally too old to study in the formal system, informal education is very important and should be emphasized. For trading experience, which probably meant the importance of business ability, the improvement should be carried out through various kinds of activities such as training, study tours, village shop activity, and so on. In the case of information level, the improvement might be done through various media, especially reading materials, TV, and radio.

However, it should be realized that the diversification of rice land use was not always accompanied by the increase in farm income as pointed out by Price (1982). Therefore, the promotion of paddy land diversification should be carefully conducted.

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