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Factors enhancing production efficiency of farmer households who are members of saving groups in Upper Northern Thailand

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ABSTRACT

The objectives of this paper are to evaluate production efficiency of farmer households and to analyze factors affecting production efficiency of farmer households being saving group members in upper northern areas. The data are collected from 399 farmer households in Chiang Mai and Chiang Rai provinces and assessed by using Data Envelopment Analysis (DEA) and Tobit model. The results reveal that farmer households have production efficiency in quite low level. Moreover, age of household head, scales of farm, characteristics of only rice farming, characteristics of only livestock, and total loans are the significant determinants affecting production efficiency of farmer households who are the saving group members. The findings of this paper contribute useful guidelines to related agencies for promoting and improving production efficiency of farmer households and bring about farmers' income and quality of life enhancement in the future.

Keywords: Production efficiency, farmer households, members of saving groups, DEA, Tobit model

1. Introduction

The agricultural systems of most developing countries are rural-based with the primary objective to build food security while the productivity is rather low (John and Mellor 1961). Therefore, many of these countries have attempted to promote farmers' adoption of productivity enhancing technologies to generate their highest possible income but funding sources are still lacking to support the financially poor farmers. Consequently, a system of community financial institution or what is commonly referred to as microfinance group has been introduced for use as a mechanism to solve the above-mentioned problems. Microfinance organizations generally function to grant loans to low income individuals or households for productive investment purpose which can lead to household labor employment generation and increase in household income (Morduch, 1995;Zeller, 1999;Aubert, 2009). This type of financial institution is also a credit source for the agricultural sector, enabling the increase in farm productivity and income while contributing to poverty reduction among farming households (Khandker, 2003). The lending operation of savings groups, a form of microfinance organization, has been instrumental for capital investment dispersal to the rural areas and has been successful in many countries particularly those in the African region (Kevane, 2001).

Thailand shares similar characteristics with the developing countries in that it places primary importance on agricultural sector in its national development efforts. Nevertheless, its agricultural sector remains facing a multitude of problems including declining productivity, high production costs, dependence on natural conditions, fluctuating farm prices, as well as the exodus of rural labor from farming to industrial and service sectors (Somchai, 1998) giving rise to the issue of income disparity between the farm sector and the non-farm economy where the average annual income per capita is approximately 155,418 baht more than nine times the income level of poor farming households (Office of Agricultural Economics, 2007). A main cause keeping Thai farmers to remain in poverty has been the low productivity due to the lack of funds for productivity improvement (NESDB, 2009).

The upper northern region of Thailand is rather backward in terms of economic structure with the majority of its population taking farming as their main occupation and living in poverty. For this reason, the formation and establishment in various communities of "microfinance group" or the popularly called "savings group" have been promoted. The savings group in any particular community may be established under different organizational names such as saving groups for production, credit union, village bank, and savings commitment group but all share the common primary objective of functioning as a financial source for farmers to get loan for investment. However, despite the increase in the number of savings group establishments throughout the upper northern region every year (the Federation of Savings and Credit Cooperatives of Thailand, Northern Branch; the 5th Region Community Development Information Center, 2010), the proportion of farm households living in poverty has

historically continued to grow (NESDB, 2008). Consequently, the issues for inquiry emerge pertaining to the technical efficiency of farming households that are members of savings group and the determinants of their technical efficiency.

2. Research objectives

2.1 To find out the extent of technical efficiency of farming households which are members of savings groups.

2.2 To identify factors affecting the technical efficiency of farming households which are members of savings groups.

3. Literature review

3.1 Efficiency concepts

Empirical studies on technical efficiency of decision-making unit (DMU) so far have been based on both parametric and non-parametric approaches. The parametric study of efficiency generally involves the econometric estimation using such model specification as production function, cost function, and profit function. On the contrary, the non-parametric method of data envelopment analysis – DEA involves no assumptions about the functional form of the frontier line but generates the efficiency frontier or envelop curve from the "best" linear combination of input – output sets of all decision-making units under investigation. Thus, the DEA approach can avoid the problem of model misspecification. It is a linear programming procedure for efficiency frontier estimation from the production possibility curve (Charnes et al., 1995) and is rather flexible for its allowing the inclusion of different input factors having different measurement units or different basic characteristics in the model analysis which will generate one value of technical efficiency (Stanton, 2002). An interesting property of the DEA procedure is the permission for a convenient comparison of different inputs in the production process and the DEA scores indicating the technical efficiency can be easily applied for analysis using the standard econometric techniques. Furthermore, the efficiency scores from DEA can be applied for the analysis of factors affecting the performance (Miller and Noulas, 1996; Resti, 1997; and Fried et al., 1999). The basic concept behind the DEA method in numerical term is that the efficiency score of DMU, which uses *n* input factors to produce *m* output products, is measured by the ratio of the weighted sum of outputs and the weighted sum of inputs. The calculated technical efficiency will have the value between 0 and 1. In addition, the linear program which is converted from the DEA model expression must have the assumption on the input-output relationship whether it is in the nature of constant returns to scale – CRS or variable returns to scale – VRS.

3.2 Previous studies related to technical efficiency

Farming household's production efficiency performance can be determined by a number of factors as summarized below.

1) Household characteristics. Age of farming household head and household members (Ajibefun. et al, 1996; Chirwa,2007 and Coelli,1996) and educational attainment of household members (Omonona,2010; Chirwa, 2007;Coelli, 1996; Helfand, 2003; Saima. et al, 2010 and Seyoumet al,1998) have positive effect on their farming efficiency. However, Bates et al (2010) argued that they found no relationship between education and efficiency of farming households. Meanwhile, technical efficiency was found to be associated positively with household size (Nyemeck et al, 2001 and Battese,et al,1996) and length of farming experiences (Ben, 2000; Leonard et al, 2011; Saima. et al, 2010 and Wilson. et al, 2001). On the contrary, the study by Bates et al (2010) found that the lengthy farming experience of household had nothing to do with efficiency performance.

2) Production inputs and systems. Large scale farming or large farm size can help increase technical efficiency as well as help gain higher productivity from the economy of scale (Jabbar & Akter, 2008; Saima et al, 2010; Wilson, et al, 2001; Chirwa, 2007 ;Coelli,1996; Tadesse,1997). However, those households that reduced their cropped area to allow the compartmentalization of farmland appeared to loss their technical efficiency due to uneconomic use of inputs (Chirwa, 2007). Unfavorable farmland location particularly its distance or remoteness from farmer's residence and farm output distribution center can impair farming efficiency (Bates et al, 2010 ; Lyubov& Jensen, 1998 ;Binam et al, 2004). Technical efficiency can be improved with the use of household labor (Omonona et al, 2010) or with the assignment of the right tasks to the right workers (Bates et al., 2010; Lyubov&Jensen, 1998; Ajibefun et al, 1996and Leonard at al., 2011). Meanwhile, the relocation of rural farm workers for employment in urban areas affected negatively the technical efficiency of farming households (Joel, 2005). Certain farming conditions and characteristics were found to enhance efficiency performance of farming households significantly. These include the employment of modern technologies (Leonard et al, 2011; Seyoumet al ., 1998; Helfand, 2003 and Binam et al, 2004), household self-possession of such important agricultural inputs as seeds, fertilizers, and pest control chemicals (Omonona et al.,2010; Bates et al., 2010 ; Saima et al, 2010 and Leonard et al., 2011), number of croppings per year (Saima et al, 2010), holistic cropping system (rotational seasonal cropping pattern) (Binam et al., 2004), reciprocal helps among farming households (Nyemeck et al, 2001), formation of farming group to negotiate with commercial buyers (Binam et al , 2004), and the market price incentive (Joel, 2005).

3) Factors pertinent to savings groups. The organization of microfinance group among farmers either in cooperative, savings group, or other forms can contribute to improved farming efficiency because capital fund can be mobilized from local community (Omonona et al.,2010), farming households can have access to loans for local production investment (Saima et al, 2010; Joel 2005;Tadesse, 1997; Helfand, 2003 and Binamet al., 2004), and in certain cases farmers receive trainings organized (Omonona et al.,2010 and Leonard et al., 2011) by the microfinance organizations to improve their farming experiences.

4. Methodology

The present study used cross – section data from farming household survey in two provinces in the Upper North of Thailand namely Chiang Mai and Chiang Rai, the areas having the largest number of savings group establishments as well as being the two largest agricultural provinces in terms of farming household coverage and farmland acreage in the region. The sample size for data collection was set according to Yamane formula at 90 % statistically significant level. Consequently, a total 400 samples were determined, representing 0.43 % of the farming household population which are savings group's members. The sampling procedure involved two steps. The first step was the sample size determination for the combinations of the two provinces and the two categories of microfinance organization, credit union and savings group for production, on the basis of proportional distribution of membership population (Table 1). The second step was the identification of four samples from each microfinance group in each province to represent farming household in four agricultural systems namely rice cropping only, mixed cropping, livestock farming only, and rice - livestock farming.

Table 1: Number of farming households and samples by province and type of microfinance organization

Province	Credit union		Savings group for production		Total	
	Household	Sample	Household	Sample	Household	Sample
Chiang Rai	9,785	44	47,250	204	57,035	248
Chiang Mai	16,526	76	17,322	76	33,848	152
Total	26,311	120	64,572	280	90,883	400

Source: calculation

The model and data analysis in the present study comprised the following procedures:

Step 1 Analysis of technical efficiency of farming households (TE_f)

For the analysis of technical efficiency, the following non-parametric DEA model proposed by Coelli et al (1998) was adopted.

$$\max_{\mu} Z = \sum_{r=1}^{s} \mu_r y_{rj} \quad (1)$$

Constraints

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} \nu_i x_{ij} \leq 0 \quad (2)$$

$$\sum_{r=1}^{s} \mu_r y_{rj} = 1 \quad (3)$$

$$\sum_{i=1}^{m} \nu_i x_{ij} = 1 \quad (4)$$

$$\mu_r, \nu_j \geq 0 \quad (5)$$

Where Z is the total efficiency score of all farming households under investigation y_{rj} is the amount of output *r* produced by household *j* μ_r is the weight given to output *r*, *r* = 1, 2, ……s, x_{ij} is the amount of input *I* utilized by household *j*, V_j is the weight given to input *j*, *j* = 1, 2, ….m

The variables used for the analysis of technical efficiency are presented in Table 2.

Table 2: Variables in the efficiency study of farming households

Output (y)	**Input (x)**
Y_1 = net income from main crop (rice) (baht/year)	X_1 = land area (rai)
Y_2 = net income from other farming activities (baht /year)	X_2 = private investment funding (baht/year)
Y_3 = off-farm income from simple processing activities (baht/year)	X_3 = borrowing from savingsgroup (baht/year)
Y_4 = net off-farm income (baht/year)	X_4 = value of assets invested for production (baht)
	X_4 = household labor (working day)

Step 2 Analysis of factors affecting technical efficiency of farming households.

The technical efficiency of individual farming household estimated in step 1 was used for model construction for analysis of factors affecting production performance (equation 6). The variables in the model are defined below.

1) Household characteristics variables comprising the number of household members (Z_1), age of household head (Z_2), educational level of household head (Z_3), and farming experience (Z_4).

2) Variables related to production inputs including farm size (Z_5) which has the implication on the economy of scale; farming condition (Z_6) further distinguishable into crop farming only (Z_{61}), livestock farming only (Z_{62}), crop and livestock farming (Z_{63}), and farm location (Z_7) which have implication on transportation cost for both input and output; change in household savings at year-end compared to the beginning of the year (Z_8) which affects the opportunity to acquire greater quality production inputs; borrowing from other sources (Z_9) which permits the opportunity for production expansion, and the number of lending sources utilized presently (Z_{10}) which implies the opportunity for access to capital fund.

3) Variables related to savings group encompassing market opportunity (Z_{11}), the amount of loan obtained from savings group (Z_{12}), the frequency of attending training sessions organized by the savings group (Z_{13}), category of the savings group (Z_{14}) either credit union or savings group for production.

The model can be expressed as:

$$TE_{Ft} = g_1(Z_{1t}, Z_{2t}, ..., Z_{8t-1}, \varepsilon_1) \qquad (6)$$

5. Findings

5.1 Technical efficiency of farming households

Farming households most prevalently (42.86 %) attained the lowest technical efficiency level at the average 0.1000 score value. The next most prevalent group (18.30 % of all households) was in the low efficiency level with 0.2797 technical efficiency score on average. There were 8.52 % of the farming households operating at the highest efficiency level at 0.9913 score value on average. The remaining 8.27 % and 2.78 % appeared to be moderately and highly efficient with the average technical efficiency scores of 0.5102 and 0.6687, respectively (Table 3).

Table 3: Efficiency level of farming households by savings group category

Efficiency level		Types of microfinance the households are members		Membership affiliation	Average TE score
Score range	Interpretation	savings group for production	credit union	Total households	
0.8001-1.0000	very high	22 (5.51)	12.00 (3.01)	34 (8.52)	0.9913
0.6001-0.8000	high	7 (1.75)	4.00 (1.00)	11 (2.76)	0.6687
0.4001-0.6000	moderately high	20 (5.01)	13.00 (3.26)	33 8.27	0.5102
0.2001-0.4000	low	51 (12.78)	22.00 (5.51)	73 (18.30)	0.2797
0.0000-0.2000	very low	171 (62.16)	77.00 (19.30)	248 (42.86)	0.1000
Total		271 (67.92)	128 (32.08)	399 (100.00)	0.2593

Source: calculation

Note: ( ) percentage in parenthesis

In the aspect of return to scale of the production, it was found that 255 households (64 %) experienced the decreasing returns to scale : DRS, 86 households (21.55 %) faced the constant returns to scale : CRS, and only the other 58 households (14.53 %) enjoyed the increasing returns to scale : IRS. This finding suggested that most farming households under study obtained output less proportionally than the additional input they put into production and thus resulted in as many as 231 households (58 %) to be evaluated as in the range of low – very low technical efficiency and they need to cut down their input utilization extent to improve their efficiency level (Table 4).

Table 4: Returns to scale and TE scores of farming households

Score range	credit union			savings group for production			Total		
	CRS	IRS	DRS	CRS	IRS	DRS	CRS	IRS	DRS
0.8001-1.0000	11	1	0	9	9	4	20	10	4
0.6001-0.8000	0	2	2	2	3	2	2	5	4
0.4001-0.6000	4	2	7	6	5	9	10	7	16
0.2001-0.4000	9	2	12	10	10	32	19	12	44
0.0000-0.2000	11	8	57	24	16	130	35	24	187
Total	35	15	78	51	43	177	86	58	255

Source: calculation

5.2 Factors affecting the technical efficiency of farming households

The investigation on factors affecting the technical efficiency of farming households that are members of savings groups in the upper northern region of Thailand provided the results as presented in Table 5. Apparently, the most critical factor contributing to the TE at 0.01 statistically significant level was total lending from all savings groups in log form (Z_{12}). The factors affecting the technical efficiency at 0.05 statistically significant level were age of household head (Z_2), farm size in *rai* (Z_5), livestock only farming system (Z_{63}), while the crop only farming system (Z_{61}) factor had a part to enhance the production performance at 0.10 statistically significant level.

Table 5 Tobit model estimation of the effect of explanatory variables on technical efficiency

Variable	coefficient	t-statistic	marginal effect	t-statistic
Constant term	0.1484	1.587	0.1233	1.581
Z_2	0.0033	2.218**	0.0028	2.216**
Z_5	-0.0028	-2.012**	-0.0024	-2.010**
Z_{61}	0.0567	1.794*	0.0471	1.794*
Z_{63}	0.2142	2.448**	0.1780	2.446**
Z_7	0.0004	0.182	0.0004	0.182
Z_{12}	-0.0128	-4.991***	-.0107	-4.974***
Z_{14}	0.0445	1.398	0.0370	1.398

Source**:** calculation Note: * significant at 0.10 , **significant at 0.05 , *** significant at 0.01

Meanwhile, the marginal effect of a change in any explanatory variable on the technical efficiency of the farming households in the present study in terms of extent and direction at statistically significant level was calculated and summarized below.

The change by one unit in the factor of total lending from all savings groups in log form (Z_{12}) has the likelihood to reduce technical efficiency score by 0.0107.

The change to practice livestock farming only (Z_{62}) has the likelihood to improve technical efficiency by 0.178.

The change in the age of household head (Z_2) by one unit is likely to cause the change in technical efficiency in the same direction by 0.0028.

The increase in farm size (Z_5) by one *rai* has the likelihood to reduce technical efficiency by 0.0024.

The change to crop only farming system (Z_{61}) has the likelihood to improve technical efficiency by 0.047

6. Discussions

The above empirical findings suggested that certain household characteristic variables like age of household head can positively affect the technical efficiency of farming household in line with the previous study results of Ajibefun. et al.(1996) and Coelli&Battese (1996), but not the number of household members which had no effect on technical efficiency in the present study thus in contradictory to the findings of the

previous two studies. Meanwhile, the present finding that educational level of household head had nothing to do with technical efficiency appeared not in consistence with the reports by Omonona et al.(2010),Helfand (2003), and Saima et al.(2010) but in consonance with that by Bates et al (2010). Similarly, the finding by Bate et al (2010) and that from the present study share the same conclusion that lengthy farming experience had no effect on technical efficiency, which is not in agreement with the conclusions made by Ben(2000), Saima et al.(2010) and Wilson et al.(2001). In the aspect of household input factors, the present investigation revealed farm size to be negatively related to technical efficiency just opposite to the reports by Tadesse&Krishnamoorthy (1997), Wilson et al.(2001) and Jabbar&Akter (2008). that they found large scale farming or large farm size to be able to enhance agricultural productivity. The farm location factor in the present study was found to have no positive effect on technical efficiency, unlike the findings of Lyubov& Jensen(1998),*Bates* et al.*(2010),* and Binam et al.(2004). Among various factors related to savings group, only the total savings group lending variable was found to have the effect, negatively, on technical efficiency of farming households and this finding is contradictory to the report by Omonona et al (2010).

7. Conclusions

This research on technical efficiency and its determinants of the farming households that are members of savings groups in the upper northern region of Thailand employed DEA method and Tobit regression model as analytical tools, based on the information from 399 pertinent farming household samples in Chiang Rai and Chiang Mai provinces. The empirical results indicated the rather low technical efficiency level among the majority of farming households under study. The factors having statistically significant effect on the technical efficiency in the present case were found to be total lending of all savings groups in logarithm term, farm size (rai), livestock only farming system, and crop only farming system.

The above findings have provided the basis for drawing a number of recommendations to help enhance the technical efficiency of farming households that are members of savings groups as follows: 1) the farming households should specialize in either livestock only or crop only farming system due to their limited input availability and the fact the production diversity alternative will face the problem of input use competition which is likely to cause some production component to obtain inadequate inputs; 2) the extent of borrowing should be cut down as some farming households asked for loan more than necessary; 3) farming households should take the option of being the member of savings group in the form of credit union as they can gain relatively more benefit in terms of low interest loans and continuing access to management training courses supported by the Federation of Savings and Credit Cooperatives of Thailand.

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