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RESEARCH ARTICLE

TECHNICAL EFFICIENCY OF RICE FARMS IN COOPERATIVES IN MEKONG DELTA OF VIETNAM

***[1]Le Truc Linh, [1]Pai Po Lee and [2]Ke Chung Peng**

[1]Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan
[2]Department of Agribusiness Management, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan

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ABSTRACT

Agricultural cooperatives and rice farmings are now key concerns in development of Vietnam's agriculture. This study was carried out to determine factors affecting the technical efficiency of rice producers in agricultural cooperatives in Tra Vinh and Dong Thap province, using a stochastic frontier production function. The results indicated that the mean level of technical efficiency was 0.81, ranging from 0.61 to 0.97. The mean technical efficiency score could be increased by 0.19 through improving rice farming practices. The use of fertilizer, chemical expenditure, education, experience and tranings had positive and significant influences on technical efficiency. The variable of land and credit access were negative indicating that managerial skills of farmer on their farm size and capital were inefficient. The findings recommend that besides supporting new farming technologies, farmers should be trained in managerial skills to manage the farm and allocate the capital effectively.

INTRODUCTION

Although Vietnam used to import rice for domestic consumption in 1980's, it is now famous for rice exporting thanks to the improvement of yield and production. Vietnam's rice exports in 2014 amounted to 6.33 million ton contributing 2.94 billion USD to the export value. Particularly 90% rice for exporting came from Mekong Delta. In 2014, the Mekong Delta contributed over 25 million tons for national rice production from 4.3 million hectares of rice cultivated areas (GSO, 2015). Hence, efficiency of rice farm is not only important for life of million farmers in the Delta but also for the nation's economy. In common with many farmers in developing countries working independently on small farms, rice growers in the Mekong Delta produce small quantities and low quality rice with high input costs, making their rice difficult to compete with other countries such as Thailand in trade and resulting in low farmer incomes. Most previous studies (Hien *et al*., 2003; Linh, 2007; Khai and Yabe, 2011; Huy, 2009; Dang, 2012; Tung, 2013) focused on estimating technical efficiency of individual farms, little attention has been given in cooperative farms.

Corresponding author: Le Truc Linh,
Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung 91201, Taiwan

In many countries, agricultural cooperatives offer small producers the wide range of services, including access to markets, available resources, updated information, communications, advanced technologies, credit, training and warehouses. They also facilitate smallholder producers' participation in decision-making at all levels, support their members in securing land-use rights, improving negotiating skills for engagement in contract farming and lower prices for agricultural inputs including seeds, fertilizer and equipment. Thanks to these supports, smallholder producers can secure their livelihoods (FAO, 2012). In the Mekong Delta, Thanh (2010) found that the development of cooperatives in the region was limited both in quantity and quality. In 2008, the entire region had 1,623 cooperatives accounted only 8.93% compared with total cooperatives in the whole country indicating that the development of cooperatives was not corresponding to their potential. The objectives of this study were to estimate technical efficiency of rice producers in cooperatives and to determine the effects of some farm-specific variables on rice farmings using a stochastic frontier production function.

MATERIALS AND METHODS

Study Area

The study was conducted in Tra Vinh and Dong Thap province which located in one of the most fertile delta in the world - the

Mekong Delta of Vietnam. These two provinces are major rice-growing areas and have contributed in over 17.7% of total delta's production in 2012. Cross – section data related to Winter-Spring season 2013-2014 was collected from 200 rice farmers who were members of the agricultural cooperatives using multistage sampling techniques during July-September 2014. Household data was collected from six districts which were purposely selected as the first stage, namely Cau Ke, Cang Long, Chau Thanh (Tra Vinh province), Tam Nong, Thap Muoi and Lap Vo (Dong Thap province). In the second stage, random selections of 200 members in ten representative cooperatives were implemented. The survey wasconducted with structured questionnaires including a wide range of indicators in order to capture information related to crop production relating to yield, output price and input prices such as fertilizes, seeds, pesticides, and farm capital assets. Besides, some socio-economiccharacteristics of the farmers such as the level of education, age, farming experience, and cultivated land were also collected.

Stochastic production frontier model specification

The stochastic frontier analysis (SFA) is a parametric approach and it is widely used to estimate efficiency of farms. The stochastic frontier method is recommended for use in agricultural applications, because measurement errors, missing variables and weather are likely to play a significant role in agriculture (Coelli, 1995). The main advantage of this approach is its incorporation of stochastic errors, and therefore hypothesis can be tested (Coelli, 1995; Coelli *et al*., 2005). In this study, the technical efficiency of rice farms was estimated by using the Cobb-Douglas frontier production function. The results of the likelihood ratio test showed that the Cobb-Douglas was an appropriate model for the data compared with the translog model.

The Cobb-Douglas functional form which specifies technical efficiency of rice farms is expressed as follow:

$$\ln \mathrm{Y}_i = \beta_0 + \sum_{i=1}^{n} \beta_i \ln \mathrm{X}_{ij} + V_i \quad U_i \qquad \mathrm{i} = 1 \ldots\ldots\ldots \mathrm{n} \quad (1)$$

Where, Y_i represents output value of the *i*-th farm, X_{ij} is a vector of input j for *i*-th farm, β_0 and β_i are intercept and vector of unknown parameters respectively, ln is natural logarithm, V_i is random variables assumed to be independently and identically distributed, and $U_i$is non-negative random variables account for technical inefficiency in production and assumed to be independently distributed as truncations at zero distributions.

The model for estimating technical inefficiency was specified as follow:

$$U_i = \delta_i + \sum_{i=1}^{n} \delta_i z_i \quad (2)$$

Where z_i is a vector of explanatory variables that may influence the technical efficiency of a farm and δ_i is a vector of parameters to be estimated.

Model specification

The Cobb-Douglass model for estimating technical efficiency was defined by

$$\ln \mathrm{Y}_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \mathrm{V}_i \quad \mathrm{U}_i \quad (3)$$

Where: $Y_i$represents the quantity of rice harvested for the i[th] farm (kg); X_1 is the total amount of seed sown (kg); X_2 is the amount of fertilizer applied (kg); X_3 is the total cost of chemicals (pesticides and herbicides) spent (1.000dong); X_4 is land cutivated (ha).

Inefficiency effect model

The model for estimating technical inefficiency was specified as follow:

$$\mathrm{U}_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 (4)$$

Where: $U_i$representslevel of technical inefficiency farms; age of household head in years (Z_1), experience of household head in years (Z_2), education of household head in years (Z_3), credit access (Z_4, dummy variable is 1 if farmer accessed to credit; 0 otherwise), and trainings (Z_5, dummy variable is 1 if farmer tooktrainings; 0 otherwise). Estimates for the parameters for this stochastic frontier production function model were analyzed by using the computer program, FRONTIER Version 4.1, written by Coelli (1996).

RESULTS AND DISCUSSIONS

Some main characteristics of variables selected for use in this study were illustrated in Table 1. Rice yield is one of the most important point that can be seen clearly from the Table. On average, rice growers in these cooperative produced 7,400 kg/ha. This figure was relatively higher than the average yield of Mekong Delta which was about 7,160 kg/ha (GSO, 2014). There was a wide range of farms' size from 0.5 to 10 ha/farm, with average size of 1.79 ha per farm. Farm operators averaged 48 years old and had over 24 years of rice-cultivating experience. The average years of education was 7.5, however some of them had very low level of education even no year of schooling.

Table 1. Summary statistics of variables for rice farms

Variables	Unit	Mean	Standard Deviation	Minimum	Maximum
Rice yield	Kg/ha	7,400.48	969.78	7,400.48	68.57
Seed	Kg/ha	143.41	48.87	30	250
Fertilizer	Kg/ha	438.37	99.50	250	850
Chemical	1000VND/ha*	3,126.19	384.59	2,038	4,562
Land cutivated	ha	1.79	1.56	0.50	10
Age of household head	year	48.05	10.37	22	74
Experience of household head	year	24.45	9.45	2	50
Education of household head	year	7.50	2.86	0	12

*1 US$ = 21,270 VND (as of June 31, 2014)

Table 2. Maximum Likelihood Estimates of the Cobb-Douglas stochastic production frontier function

Variables	Parameters	Coefficient	*t*-ratio
Production function			
Constant	β_0	6.148	9.802***
Ln seed (kg)	β_1	-0.045	-2.236**
Ln fertilizer (kg)	β_2	0.112	2.625***
Ln chemical (1,000VND)	β_3	0.313	4.423***
Ln land (ha)	β_4	-0.029	-2.231**
Sigma squared	σ^2	0.014	5.346***
Gamma	γ	0.802	2.526***
LR test	24.492		
Inefficiency effect model			
Constant	δ_0	0.220	1.491*
Age of household head	δ_1	0.003	1.760**
Experience of household head	δ_2	-0.002	-1.428*
Education of household head	δ_3	-0.007	-1.933**
Credit access dummy	δ_4	0.028	1.354*
Training dummy	δ_5	-0.061	-2.388***

* Significant at 10% level ** Significant at 5% level; *** Significant at 1% level

Table 3. Distribution of rice farms based on technical efficiency

	No. of farms	Percentage distribution (%)
0.90 or more	26	13.0
0.80-0.89	83	41.5
0.70-0.79	79	39.5
0.60-0.69	12	6.0
Total	200	100.0
Mean	0.81	
Minimum	0.61	
Maximum	0.97	

The results of production frontier function were presented in Table 2. The generalized likelihood-ratio statistic for testing the null hypothesis that the absence of inefficiency effects was calculated as$LR = 2(144.067 \quad 156.313) = 24.43$. This value is significant as it exceeds the critical value of Chi-squared distribution for the degree of freedom equal to 7 (14.067). Therefore, the null hypothesis was strongly rejected and showed that technical inefficiency did present in rice production in study areas. It can also be found that the coefficient of gamma parameter (γ) of 0.80 in Table 2 was significantly different from zero at 1 percent level indicating that 80% of the variation in rice production was due to producers' practices or technical inefficiency rather than random variability (20%) which farmers could not control.

The estimated coefficients of all the variables included in the production model were significantly different from zero. Fertilizer and chemical had positive signs as expectation. The elasticity for chemical was the highest (0.31) followed by fertilizer at 0.11. This meant that the productivity of rice could be increased by improving the use of chemical and fertilizer. Conversely, the coefficient of seed use and farm size were in the negative signs. Output elasticity of seed was estimated at -0.05 indicating that a 10% increase in seed use will reduce output by about 5%. In terms of farm size, it was found to have positive effect on technical efficiency of farm (Oluwatayo *et al*., 2008; Alam *et al*., 2011; Piya *et al*., 2012; Ukpong and Idiong, 2013). However, the small farm was more technically efficient than the large one in this study. This result confirmed the similar findings of previous studies conducted by Ali *et al*. (1994), Tien and Thong (2014), and Etim and Udoh (2014). Farmers with small areas achieve better quality products since they are able to take care of their rice more carefully compared with large farms where farmers have to hire workers.

As can be seen from the lower part of Table 2, all explanatory variables had significant effects on the technical inefficiency at least 10% of significant level. The negative sign of education level indicated that farmers with higher education tended to obtain higher technical efficiency. This result was consistent with findings of Ali and Flinn (1989), Nganga *et al*. (2010), Trong and Napasintuwong (2015), Chi and Yamada (2005), Khai and Yabe (2011), and Shamsudin (2014). The negative sign of experience showed that experience is a very precious factor in the rice farming. The variable of training variable had negative and highly statistically significant effect on technical inefficiency. This meant that taking technical trainings helped farmers to approach updated and new technology in rice farming leading to enhance rice production.

However, there were two unexpected signs of explanatory variables. Age of farmer had a positive and statistically significant influence on technical inefficiency. This showed that old farmer obtained lower technical efficiency level than that of young producer. The inverse relationship between age of farmers and farm efficiency can also be found in studies of Bozoğlu and Ceyhan (2007), Trong and Napasintuwong (2015) indicating that old farmers would be afraid of taking risks and less willing to apply new technology in their routine procedures. In contrast, age was found to have statistically significant positive effects on technical efficiency in rice production in South-East China and possible explanation for this is that older farmers were more experienced than their younger counterparts (Tan *et al*. 2010). Another notable point that should be mentioned in this study was a positive sign of credit access on the technical inefficiency model implying that the more access to credit, the lower technical efficiency. While access to credit is expected to help farmer to purchase more inputs or adopt new technologies which in turn increase revenues and profit; in this study areas, this variable decreased technical efficiency. Although access to credit was often found to have a positive effect on efficiency of farms in majority of cases (Bozoğlu and Ceyhan, 2007; Duy, 2012; Enwerem and Ohajianya, 2013; Shrestha *et al*., 2014), the negative effect was also obtained in many studies (Idiong, 2007; Abu *et al*., 2012).

The frequency distribution of technical efficiency scores for rice farms was demonstrated in Table 3. Rice producers in study sample exhibited varied technical efficiency estimates, ranging from 0.61 to 0.97 and a mean level of 0.81 (Table 3). Compared to previous studies, the mean technical efficiency score in this study was generally higher than both the average for the whole rice farmers in Vietnam which was 0.71 in 2003-2004 (Linh, 2007), and the values for rice producers in the Mekong Delta which were 0.76 in 2006 (Huy, 2009), 0.65 in 2010 (Tung, 2013). The main reason for the higer efficiency score of this study may come from sample respondents. All rice producers in this study are members of agricultural cooperatives or farmer cooperative groups. Farmers in these organizations could share their experiences and agricultural resources, access to technical trainings and other supports from government. The technical inefficiency score was 0.19 suggesting that rice output could be increased by improving rice farming practices.

Conclusions

Technical efficiency of rice farms in agricultural cooperatives was estimated by using the stochastic frontier production function. The results indicated that the mean technical efficiency was 0.81, ranging from 0.61 to 0.97. This score showed that there remained a considerable room to achieve higher production by 0.19 through improving farming practices of rice producers in study areas. The variables of education, experience and trainings had positive influences on technical efficiency of rice growers. These variables should be noted in agricultural cooperatives that are suitable places for farmers to share precious experiences and to adopt new technology for their better farmings. Thus, the development of cooperatives should be encouraged in order to promote good relationships among farmers in rural areas. Strengthening the membership of cooperatives in the region is also a key point of increasing technical efficiency in rice farming. Moreover, based on the fact that, rice farmers who availed credit reduced their efficiency, this study recommends that trainings on managerial skills such as how to manage the farms and allocate the capital effectively should be added in training programs.

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