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Impact of farmer education on production efficiency: The case of rice farms in Vietnam

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A B S T R A C T

This paper examines the production efficiency and its determinants of 3301 rice farms in Vietnam. Our empirical results from data envelopment analysis (DEA) technique show that rice farms perform on average level of efficiency. There are differences in production of each farm related to some demographic factors and educational level. Results from Tobit model indicate that education played an important role in helping farmer improve their efficiency. In addition, policies on increasing the cultivation area may also promote the farm efficiency.

1. Introduction

Until now, Vietnam has had a great advantage in rice production with two major production regions: Red River Delta and Mekong River Delta thanks to the favorable weather conditions and natural fertile of soil. In 2017, the total farming area of rice was over 7,700 ha, which is the largest area in the group of annual plants. In the same year, Vietnam exported about 5.7 million tons of rice (GSO, 2017). Vietnamese rice was exported to 150 countries in different regions, of which the Asian countries were accounted for 68.41%; the African was 14.93 %; the American and Pacific were 6.54% and 5%, respectively (General Department of Vietnam Customs and Vietnam Food Association, 2017). Although rice production has a centuries-long history in Vietnam, it is primarily based on long-term experiences and natural resources (Quan, 2006; Hoang, 2007; Pham et al., 2011). As a result, the efficiency of rice production is low. In previous studies on other countries indicated that several policies had been promoted strongly aiming at helping farmers to improve the production efficiency such as knowledge transfer, up-skill training, farm planning, or credit incentives. In particular up-skill training has remained as the most important factor in promoting the efficiency of the farms. Furthermore, education can bridge between policies and

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stakeholders to change the farm efficiency (Lockheed et al., 1980; Ali & Flinn, 1989; Strauss et al., 1991; Poulton et al., 2010; Elias et al., 2013). In this paper, we study the role of education for the farm efficiency in Vietnam.

2. Theoretical Framework and Empirical Models

2.1 Production efficiency of farms

Technical efficiency reflects the ability of a production unit to create an amount of given output from the minimum amount of input or maximum output from given input. It can be analyzed from two ends: input-oriented technical efficiency and output-oriented technical efficiency. The former indicates how observed inputs with ratios unchanged can be decreased while producing the same quantity of output; while the latter needed at best practice to produce maximum quantity of output with the same observed inputs. Färe et al. (1987) claimed that if economies of scale remains unchanged, the above evaluation methods would give the same results. In this paper, we use "production efficiency" or "technical efficiency" with similar and interchangeable meaning which reflects the production efficiency of farms.

2.2. Factors affecting production efficiency of farms

2.2.1. The role of education

In a pioneer research on the topic of farms production efficiency, Lockheed et al. (1980) claims the important influence of education on production efficiency. However, the authors also pointed out how close the relationship between education and production efficiency would be resulted from the research methodologies. Ali and Flinn (1989) use the equation of random marginal profit to study the production efficiency of rice farms in Pakistan. The findings show that the average efficiency of these farms is 0.72 and there is a big difference between the surveyed farms. The authors claimed that farm production efficiency can be influenced by socio-economic factors, which can be explained by education level of which education of the farm head would be essential; non-agriculture activities (diversification of income sources) and credit restrictions (due to the impact of asymmetric information, transaction costs, limited liability).

In the similar vein, Strauss et al. (1991) state that education of farm head is an important factor determining production efficiency in agricultural activities, especially in rice farming. Better education of farm head, who most likely would be a decision maker in the family, enables them to grasp new farming techniques, aware changes in natural or weather conditions; therefore they can choose more suitable techniques to increase productivity and cultivation efficiency. This implies that the farm head' higher education can get the most effective performance they can do. This finding was consistent with other studies on cultivation efficiencies of farm (Strauss et al., 1991; Poulton et al., 2010; Elias et al., 2013).

In an experimental research of 14 Indian rice farms in 10 years, Battese and Coelli (1945) studied about the technical inefficiencies in rice farming. The research results show that technical inefficiencies are coherent to the education limits of farm head. The study of Simar and Wilson (2007) used the Data Envelopment Analysis (DEA) method to estimate the production efficiency of farms. The authors indicated that education improves the literacy of the farm head. Higher education would enable farm heads more quickly to access, capture new production techniques and changeable trends of the natural environment, therefore, to be able to use suitable input elements to promote their farms' production efficiency.

This finding was repeatedly confirmed by the research during 2005-2006 from Indian farms which use DEA technique, Asadullah and Rahman (2009), Nasurudeen (2009) concluded the education and experience of the farm heads have had a positive impact on production efficiency. Moreover, Kachroo et al. (2010) studied technical efficiency and its impact factors of rice farmers in the severe farming conditions such as drought or lack of irrigation system. The finding shows that if the farm heads have higher education level, the higher capability they can be coped under difficult farming circumstances and achieve greater efficiency. In Vietnam, the study of Nguyen et al. (2012) on rice farms echoed that the production

efficiency of surveyed farmers was significantly influenced by their education levels, in which primary education was the main factor in changing efficiency; and the farm head whose education level was equal or above the primary level generated a higher efficiency than those whose education level was below the primary level.

2.2.2. Other factors affecting production efficiency of farm households

In rice farm and other agricultural activities, land is a special element and most important factor. According to the study of Haag et al. (1992), the authors emphasized that soil quality has a significant impact on production efficiency in agriculture. In the same vein, Dorward (1999) echoed that farm efficiency is influenced by many factors of which the cultivated area is the most important one. When the farm area increases to a certain scale, the production efficiency increases based on using more advanced farming techniques. Conversely, Tijani (2006) indicated that small-size farms are more effective than medium-size and large-size farms. This contrasts markedly with common view that large-scale farming is more efficient due to economies of scale.

Nguyen et al. (2012) examine the technical efficiency of rice farming in Vietnam and report that the production efficiency is affected by the cultivated area, i.e., the larger farm area is, the higher the technical efficiency. This finding is similar to that of Hoang et al. (2012) when conducting an analysis of technical efficiency from farms in Red River Delta. The authors emphasize the small-scale of farm has a negative effect to technical efficiency. Nguyen (2012) studied on rice farms during the period of 2008-2011 and analyzed the changes in technical efficiency of farms in the Mekong Delta. Research results showed that leasing land to expand the current farm area is one of the reasons that lead to reduce efficiency of farming. Labor is the second important factor of production. In agriculture, direct labor, which is not only involved in the hands on production of agricultural produces, but also acts as a subject that makes influences on business and application of technologies and techniques in farming. According to Heltberg (1998), the more family members participate in production, the more efficiency of rice production thanks to the motivation and responsibility to work for their own benefits. Meanwhile, Narala and Zala (2010) in a study on the similar topic showed an opposite finding where farms with limited number family member had higher production efficiency. The scarce in labor resource pushed farms to apply more advanced techniques than those with sufficient labor resource. However, the trend of the impact of the relationship with the number of family member had no consistency in empirical studies, which can be changed based on the different observed scale and aspects (Berre et al., 2017).

Capital is the third important resources for any type of business and not just for farming. In agriculture, farmers need capital to buy inputs for farming. As a result, a farm can access to more available financial capital, it will have more potentials to perform better (Feng et al., 2010; Rahman, 2003). In Thailand, a study performed a survey on rice farming and found that an increase in input costs strongly affect the production efficiency. Productivity decreased due to the lower efficiency in using inputs. This study also suggested that access to credit can be a good strategy to improve production efficiency. In addition, characteristics of farms, especially farm head, are important factors to control the farming efficiency. The study of Abdulai and Huffman (2000) using the Tobit model shows that the differences in farming efficiency can be explained by demographic characteristics, i.e., gender, age, education level; and availability of resources. The authors emphasized demographic characteristics such as the gender of farm head and the management capabilities and health which can be seen as an ability of adaption in severe natural conditions and it can influence strongly the farming efficiency. The age of the farm head can be seen as an especially important variable for agriculture because when the farm head is getting older, they would gain more experience in the agricultural activities. Most of the previous studies agreed on the positive effects of the age of farm head on the farming efficiency (Battese & Coelli, 1995; Ayinde et al., 2009). Furthermore, the difference in geographical areas was considered as an important characteristic to create differences in farming efficiency. This trend was confirmed in the study of Narala and Zala (2010) in Central India which showed that geographical characteristics could create differences. Similarly, in Vietnam, geographic difference plays an important role in farming efficiency. Each region has

had its own geological, historical and cultural characteristics as well as farming conditions and different cultivation techniques. Nguyen et al. (2012) claimed that 6 regions achieved 6 farming efficiencies where the Central region received the lowest while that of the Red River Delta gained the highest; the Mekong River Delta has a good farming efficiency and still has more potential for improvement (see Table 2 for the further details about 6 regions in Vietnam).

2.3. Metafrontier model

In this paper, we study the factor of education level in technical efficiency for rice farms. The authors use two research techniques to estimate the factor.

First, we used DEA technique to estimate the production efficiency of the farm. Inputs for technical efficiency analysis are cost, land area and human labor while the total income from rice per square meter of land is considered as the output factor (See Table 1).

Table 1
Description, basis of variables in marginal production function model

Variable Type	Variable Name	Source
Input	Human Labor	
Input	Input costs	Pham et al., 2011
Input	Land area	
Out put	Revenue/m^2	Pham et al., 2011; Nguyen et al., 2015

Source: The authors' summary

Second, in order to identify determinants of production efficiency of rice farms, we apply a multivariate regression model (Tobit) with the dependent variable as a technical efficiency score.

Table 2
Description and pretension sign in the technical efficiency model

Variables	Description	Expectation
Technical efficiency score	Estimate technical efficiency score of farms from DEA model	
Year of Schooling	Measured by farm head's year of schooling	+
The square of school year (r^2)	Square variable of education farm head	+
Gender of farm head (female compared with male)	Gender of farm head	+/-
Association participation	Association participation in local community	
Age of farm head	Age of farm head in the survey year 2016	+
Marriage	Does farm head live with a partner or not?	+/-
Ethnicity of farm head	Kinh Ethnicity or other ethnic groups	-
Number of land plots	Total land plots produced rice	+
Farm area	Total area of rice production	+
Farm Labor	Number of farmers in agriculture	+/-
Geographic region(s)	6 geographic regions of Vietnam (Red River Delta, Northern Midlands and Mountains, North Central and Central Coast, Central Highlands, Southeast Region, Mekong River Delta)	

Source: The authors' summary

3. Research methods and data

3.1 Research data

In this study, data were extracted from Vietnam Household Living Standard Survey (VHLSS) in 2016. The 2016 survey covered around 9000 households. Authors performed steps to outline research samples data that included all rice farm household which do not have non-farm activities to ensure the consistency of sample and suitability for technical efficiency analysis techniques. After doing data analysis, we have taken a dataset of 3301 households in agriculture and doing rice farming.

3.2 Analytical methods

In this study, we used non-parametric technical efficiency analysis technique (DEA) with production techniques transfer input factors (labor, input costs) and fixed inputs (farmland) to output factors (output, income from cultivation). The advantage of DEA is that it can estimate the efficiency of production units

that of apply technology, which is multi-inputs to produce multi-outputs. Therefore, the use of DEA became common to estimate the technical efficiency in studies about production efficiency (Nguyen et al., 2007). Specifically, the DEA scores were calculated based on the production boundary that is estimated from the inputs and outputs of the analyzed units. DEA technique examined n production units (i.e., 3301 farms in this study) where each production unit uses m inputs and s outputs. In order to estimate the technical efficiency of production unit q, we need to find the maximum value of X, in which X, v_j is a weighing factor for input number j; u_i is a weighing factor for output number i.

From the results of DEA, we determined the technical efficiency scores of farms. The technical efficiency scores will be ranged from value of 0 (completely ineffective) to value of 1 (most effective - optimal in the observed data set).

In addition, based on the technical efficiency score, we run the regression model on the role of factors on production efficiency of farms. Since the dependent variable (technical efficiency scores) is a limited dependent variable (at the lowest value of 0 and the highest value is 1). In this case, the Tobit model can be more efficient and reliable than other regression models.

4. Results and discussion

4.1. Research sample statistic

In the research sample, 81% of farm heads are male. This is consisted with Vietnam culture because to date, the most family representation and decision maker are male. Over 74% of farm heads are Kinh and over 25% are from other ethnic groups. Research sample indicated that 86% of the farm heads were living with a partner. This trend is in line with statistics from censuses revealed the high rate of partnership in Vietnam.

Table 3
Description of research sample based on gender, ethnicity and partnership

Factor	Frequency	Percentage	Factor	Frequency	Percentage	Factor	Frequency	Percentage
Gender			**Ethnicity**			**Partnership status**		
Male	2,778	84.16	Other	852	25.81	Single	469	14.21
Female	523	15.84	Kinh	2,449	74.19	Couple	2,832	85.79
Total	3,301	100.00	Total	3,301	100.00	Total	3,301	100.00

Source: The author proposes and synthesizes

Table 4 shows that the proportion of observed regions is distinctive considerably. The majority of the people surveyed for rice farms was in Northern Vietnam, the number of farms in Red River Delta region; and Northern Midlands and Mountains were about 26% and 28%, respectively. Only 50 rice farms in the Southeast region are observed, accounted for more than 1.5%.

Table 4
Description of research sample based on geographical region

Region	Frequency	Percentage
Red River Delta	879	26.63
Northern Midlands and Mountains	928	28.11
North Central and Central Coast	890	26.96
Highlands	92	2.79
Southeast region	50	1.51
Mekong Delta	462	14.00
Total	3,301	100.00

Source: The authors' calculation

Table 5 shows that percentage of households had loans (money or goods) are 26% and most of households do not borrow. Farm heads participating in a local association is over 61%.

Table 5
Description of research sample based on loan status and association participation

	Frequency	Percentage
Loan status		
Yes	862	26.11
No	2,439	73.89
Total	3,301	100.00
Association participation		
No	1,281	38.81
Yes	2,020	61.19
Total	3,301	100.00

Source: The authors' calculation

Table 6 shows that the percentage of farm head with the average age of 50 was high; the lowest age of the farm head was 20 years old and the highest age of the farm head was 104 years old. The average educational level of farm head was year 7 out of 12, while the average members of farm is 2.5 labors and the biggest number was 11.

Table 6
Statistics based on farming resources

Variable	Average	Standard deviation	Min	Max
Age	50.39	12.66	20.00	104.00
Number of plot	2.14	0.70	1.00	5.00
Land area (m^2)	26186.47	58333.50	350	1107720
Total income /m^2 for rice farm in 1 year	3.34	0.78	0.44	12.50
Education level of farm head	7.17	3.29	0.01	12.00
Number of agriculture labor (s)	2.55	1.23	0.01	11.00

Source: The authors' calculation

The smallest number of land plot is 1; the greatest number of plot is 5. Average farm area is 26 thousands square meters while the smallest is 350 square meters. Average total income per square meter is 3.34 million per year; the maximum income per square meter is 12.5 million.

4.2. Results of estimating technical efficiency

The results of the DEA model estimation show that the average technical efficiency score is at 0.54 with the standard deviation of production efficiency is at 0.24. 152 farms have maintained technical efficiency scores at value of 0; and 555 farms have reached technical efficiency scores of 1. Distribution of technical efficiency by gender of farm head was significant not only based on the graph but also based on the t test. The test result has revealed that the technical efficiency of female farm heads was 3% higher than that of male farm heads (See Fig. 1 and Fig. 2).

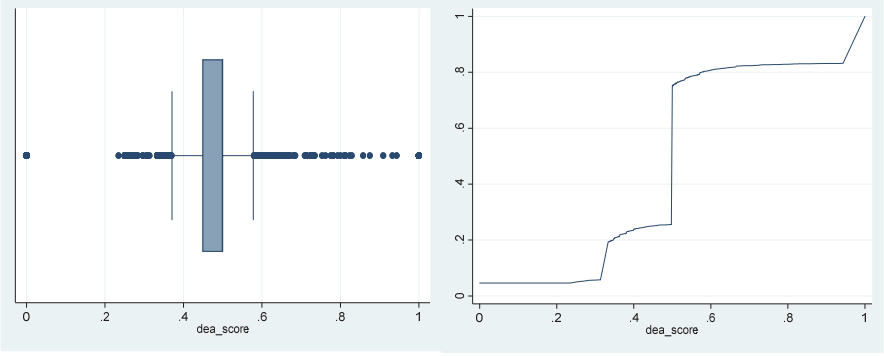

Fig. 1. Distribution about technical efficiency of farms

Source: Analysis results

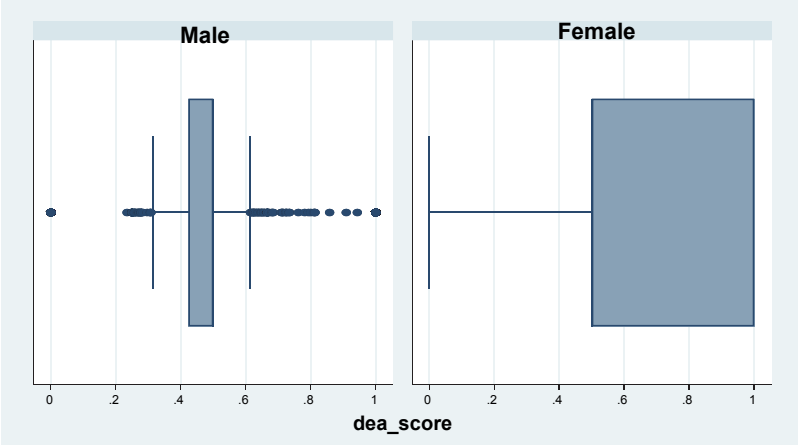

Fig. 2. Technical efficiency by gender of the farm heads

Source: Analysis results

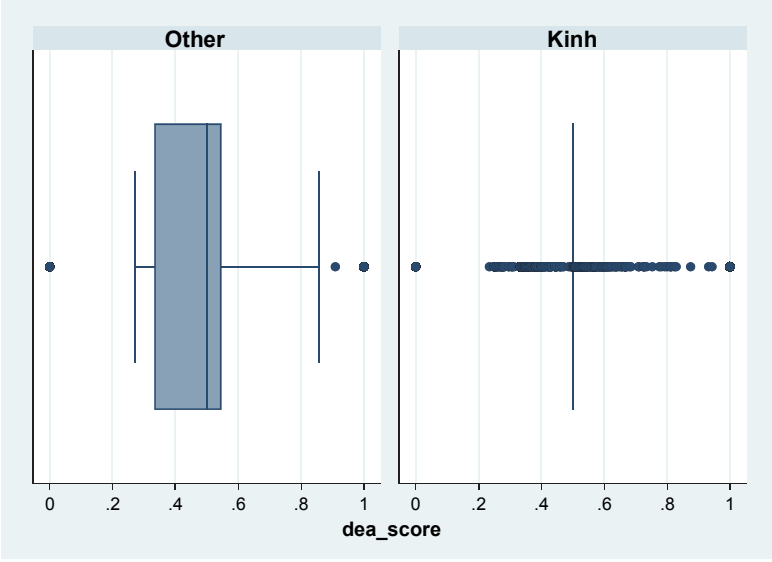

Fig. 3. Technical efficiency by ethnicity of the household head

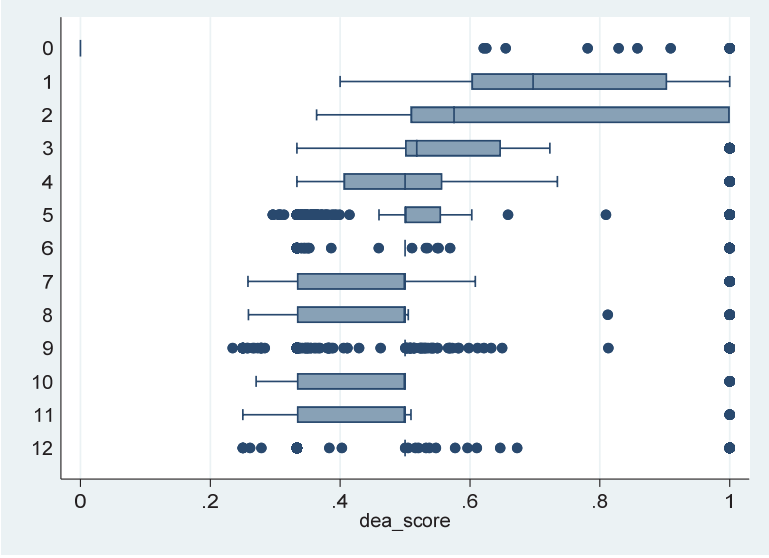

Fig. 4. Technical efficiency by education

In terms of ethnicity shown in Fig. 3, the result of *t* test shows that the average technical efficiency score of the Kinh farm head is 3.2% higher than farm heads who belong to other ethnicities. This is relatively understandable because Kinh people are competent with agricultural cultivations. In terms of technical efficiency for education of households, DEA results show that the average technical efficiency increases as education level increases.

4.3 Results of the role of education on farm production efficiency

The results from Tobit model on the role of education of household head (MH1) and extended model with control elements (MH2) show that the impact of farm heads' education on productivity efficiency is very low. This shows the stability of the model and confirms the role of education variables in production efficiency. R2-pseudo index of model 2 reached 72.8% and shows that the education of the farm head had a positive impact on the production efficiency of farm. When the farm head spends one more year at school, the efficiency of farm production can be increased by 10%. However, the impact of education to increase in efficiency scores will decrease with the increase of education (variable of square education -0.0007). This implies that differences in high level of education are small.

Characteristics of farm land also have impacts on farm efficiency. The bigger the land farm, the lower the technical efficiency. A large farm area does not guarantee an increase in efficiency since the impact of the area on technical efficiency of farm is not statistically significant. The higher the number of labor, the lower the technical efficiency. This finding shows that the technical efficiency can be achieved at a higher level when land and labor inspects are kept at an appropriate ratio. A smaller number of plots can help farms focus on technical aspect to improve efficiency. Moreover, the impact of the number of farm plots on changes in technical efficiency of large-size farm shows that of there is a change in the amount of farm land (for example, exchange and relocation of the farm land) can lead to a significantly change in the cultivation efficiency. This finding is consistent with those of previous studies from other countries and Vietnam. In addition, the association participation itself cannot increase efficiency; however it enables members to acquire more knowledge and experience through sharing as well as receiving new information that will help them improve their farms' efficiency.

Table 7
Estimated results for determinations of technical efficiency

Variable		**MH1**	**MH2**
Education of farm head		0.095***	0.102***
The square of education of farm head (r square)		-0.006***	-0.007***
Participation in local associations			0.014*
Gender of farm head (female compared with male)			-0.015
Age of farm head			0.0003
Partnership status			-0.111***
Ethnicity of the farm head (compared with Kinh)			-0.005
Number of land plot			-0.273***
Farm area			0.001
Agricultural labor of farm			-0.017***
Having loan(s)			0.009
Region (Compared to Red River Delta)	Northern Midlands and Mountains		0.004
	North Central and Central Coast		-0.005
	Highlands		0.01
	South East region		0.061*
	Mekong Delta		0.067***
Constant		0.274***	0.930***
Parameters of model			
Number of observations		3301	3301
AIC		2717.118	827.518
BIC		2741.526	894.639
R2_pseudo		8.54%	73.68%

Note: *, **, *** are meaningful at 10%, 5% and 1% respectively *Source: Estimated results*

5. Conclusion

The study findings show that first, education not only plays an important role in promoting the technical efficiency of the farms but also becomes a helpful link in acquiring knowledge through participation in local association. Second, other factors such as less fragmented farm area and limited labor resources also have positive impacts on farm efficiency. Third, the results also reveal that rice cultivation in the Mekong Delta was the most effective factor in the country. In summary, policy implications for improving the farm efficiency of households are promoting sharing of experiences associated with improving education, especially for farm heads. The policy of "large-scale farming" or "exchange and relocation farm land" is expected to be pursued because this policy would enable farmers to apply advanced, effective farming techniques more easily and improve farms efficiency in Vietnam.

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