

Original Research Article

**Cost Efficiency of Rice Production in Vietnam:
An Application of Stochastic Translog Variable
Cost Frontier**

ABSTRACT

Overuse of inputs in rice production results in not only lower profit but also environmental pollution. Hence, the study estimated cost efficiency and investigated the determinants of efficiency gaps. By applying stochastic translog variable cost and the data set from a survey of 199 rice farmers in 2014 in An Giang Province of the Mekong Delta, the study showed that the mean cost efficiency score was 90%, which suggested that on the average these farmers could reduce proportionally their current variable cost by 10% without any reductions in the output level. The mean overused cost was estimated about 3,651 thousand VND (equivalent to 167.74 USD) per ha. This value is equal to the sales of 702.24 kg of output per ha or the efforts to increase approximately 10% of output level. To improve cost efficiency, rice farmers should cultivate three crops per year and use collective pumping. Regardless of output price, Jasmine and IR50404 rice varieties and numbers of paddy plot had negative relationship with cost efficiency.

Keywords: Cost efficiency; stochastic frontier analysis; translog variable cost frontier; rice production.

1. INTRODUCTION

The agricultural sector has always played an important role in the economic development of the Vietnamese Mekong Delta (VMD), where more than 75% of residents are living in rural areas and their livelihood activities rely mainly on agricultural production, particularly rice production [1-3]. In the recognition of the agricultural sector in economic development and stability, the Vietnamese government had invested intensively and paid many considerable efforts to promote the development and growth of agricultural sector, particularly in improvement of productivity and encroachment of farm land. After the policy reform or “Doi Moi” in 1986, on the average the agricultural sector accounted for more than 26% of total GDP for the period 1987-2013 (the World Bank data, 2013). One of the main objectives of the policy reform was to further liberalize the agricultural sector through de-collectivization of land, independent operation of business, removal of price controls and trade barriers, increased investment in technology and extension services [4]. As a

consequence, Vietnam has gradually become one of the leading rice exporters in the world. Further, the majority of rice exports originates from the VMD. In fact, the VMD contributes annually more than 50% of total rice production and 90% of total export volume in Vietnam [5-7].

Although the VMD has had a long history of rice production and achieved significant progresses in terms of productivity improvement and the linkage of actors in value chain [8-12], the rice farmers have been facing challenges such as high input prices, unstable market, low technology and experience-based production. These constraints was considered to be the main factors leading to higher production cost and inefficient use of input mix.

According to Kompas, Che, Nguyen and Nguyen [12], based on the measurement of total factor productivity (TFP) they found that not only TFP score but also the growth in TFP as compared to other regions of Vietnam was highest in the VMD. However, as a whole rice production in Vietnam has faced the problem of TFP slowdown. These results suggested that production technology was very high, especially in the VMD. Belbase and Grabowski [13], Khai, *et al.* [14], and Shapiro and Müller [15] suggested that it was more cost-efficient to improve productivity with existing technologies rather than introducing new ones. It is therefore crucial to consider the ability to reduce production cost rather than improving productivity, as cost reduction is one of the three components resulting in higher profit for rice farmers.

As regards rice production, some studies using stochastic frontier analysis (SFA) and data envelopment analysis (DEA) to measure the productive efficiency have been conducted and considered the VMD. For instance, Kompas [11] estimated the technical efficiency scores of rice farmers in Vietnam and the VMD by applying SFA. The study showed that the average TE was 78% for the Mekong Delta in 1999. Khai and Yabe [16] also estimated such efficiency scores by using the data from the 2006 Vietnam Household Living Standards Survey. The study showed that the mean efficiency was 81.6%. However, neither of the two studies did consider about the cost efficiency.

Nhut [17] estimated and compare the cost efficiency of mono rice culture to crop-rotation farming in two different zones – flood-protected area and non-flooded area in the VMD. The study showed that the mean cost efficiency scores in the flooded area were 71% and 74% for mono rice and crop-rotation patterns, respectively, while these values were a bit lower in the non-flooded area, 65% for mono rice and 67% for crop-rotation farming. However, the data of this study was collected in 2004/2005 agricultural years. It is crucial to provide updated values for policy makers and researchers. Moreover, the study applied DEA approach to estimate the cost efficiency while the well-known drawbacks of the method are non-parametric, mathematical programming-based and impossible to separate noise effects apart from a common deterministic frontier.

Hence, the main objective of this study is to estimate the ability to reduce proportionally production cost of rice farmers by using SFA approach. The remainder of this paper is presented as follows. Sections 2 describes the analytical framework to estimate cost efficiency by using SFA approach and Tobit regression to investigate the factors affecting cost efficiency. In this section, we also provides a brief description of data collection and characteristics of data used for the measurement of cost efficiency. Following this, section 3 illustrates empirical results and detailed discussions about cost efficiency as well as the determinants of efficiency gaps. Finally, section 4 provides conclusions of this study.

2. METHODOLOGY AND DATA

2.1. Analytical analysis

Economic efficiency was first proposed by Farrell [18] under the term *overall efficiency*. Such efficiency is defined as the ability to produce predetermined quantity of output at optimal cost of inputs or the product of technical efficiency and allocative efficiency [18-22]. According to Coelli, *et al.* [23], and Kumbhakar and Lovell [24], economic efficiency can be cost efficiency, revenue efficiency and profit efficiency. In this study, we think that the cost efficiency is more appropriate because many research in the literature showed that the rice farmers did not use efficiently their inputs and input mix [11,16,25,26]. Further, cost reduction seems to be more important to increase farmers' production profits in this context. Cost efficiency which is explicitly input-oriented indicates the ability to obtain predetermined output at minimum cost with respective input prices [16,18,19,23,27-30]. Cost efficiency can be decomposed into cost allocative efficiency and input-oriented technical efficiency. The process to obtain cost efficiency by using stochastic frontier analysis is described as follows:

In this study, we adopted the translog variable cost frontier to obtain estimates of the parameters and the magnitude of cost efficiency because a producer can be assumed to be in static equilibrium with respect to a subset of inputs given observed levels of other quasi-fixed inputs [31,32]. Moreover, we could not estimate the total cost function because the prices of all inputs are unavailable [33]. According to Kumbhakar and Lovell [24], and Grisley and Gitu [33], the translog variable cost frontier can exploit the quasi-fixity of some inputs and allow scale economies to vary with respect to output level. The translog variable cost frontier can be written in the compact form as follows

$$c_i \geq c(y_i, w_i, z_i; \beta, \alpha, \gamma) e^{v_i} \quad (1)$$

where c_i is the total observed variable cost of producer i ; w_i is a vector of variable inputs' prices; y_i is a scalar output produced by the i -th producer; $c(y_i, w_i, z_i; \beta, \alpha, \gamma)$ is the common deterministic cost frontier of all producers that is non-decreasing, linearly homogenous and concave in input prices; β, α, γ are parameters to be estimated; and e^{v_i} is symmetric, identical and independently distributed as $v_i \sim iid N(0, \sigma_v^2)$, indicating noise effects not under the control of producers. The inequality (1) indicates that producers can reduce their expenditure by the ratio of minimum feasible cost to total observed cost. This shortfall is due to the cost of input-oriented technical inefficiency and the cost of input allocative inefficiency. The cost efficiency abbreviated as CE_i hereafter can be obtained from equation (2)

$$CE_i = \frac{c(y_i, w_i, z_i; \beta, \alpha, \gamma) e^{v_i}}{c_i} \quad (2)$$

The detailed expression of translog variable cost can be written as

$$\begin{aligned} LnVC_i = & \beta_0 + \beta_y \ln y_i + \sum_n \alpha_n \ln w_{ni} + \sum_m \gamma_{mi} z_{mi} + \frac{1}{2} \beta_{yy} (\ln y_i)^2 \\ & + \frac{1}{2} \sum_n \sum_k \alpha_{nk} \ln w_{ni} \ln w_{ki} + \frac{1}{2} \sum_m \sum_r \gamma_{mr} \ln z_{mi} \ln z_{ri} \\ & + \sum_n \alpha_{ny} \ln w_{ni} \ln y_i + \sum_m \gamma_{my} \ln z_{mi} \ln y_i + \sum_m \sum_n \gamma_{mn} \ln z_{mi} \ln w_{ni} \\ & + v_i + u_i \end{aligned} \quad (3)$$

where the subscript $i = 1, \dots, I$ is the number of producers who use a vector of variable inputs $x_i = (x_{1i}, \dots, x_{ni}) \in R_+$, at its respective prices $w_i = (w_{1i}, \dots, w_{ni}) \in R_+$, and a vector of quasi-fixed inputs $z_i = (z_{1i}, \dots, z_{mi}) \in R_+$ to produce a single output $y_i \in R_+$. Total variable cost that each producer incur is $VC_i = \sum_n x_{ni} w_{ni}$. The term $u_i \geq 0$ is symmetric, identical and independently distributed as $u_i \sim iid N(0, \sigma_u^2)$, reflecting the cost of inefficiency.

109 Using equation (2) and (3), cost efficiency can be obtained by using maximum
110 likelihood estimation and its measure is given by

$$CE_i = \exp(-u_i) \quad (4)$$

111 It is clearly in equation 3 that the stochastic cost frontier is structurally
112 indistinguishable from the stochastic production frontier [21-24]. The main difference is that
113 the composed error term of the stochastic cost frontier is positively skewed while it is
114 negatively skewed in case of the stochastic production frontier. The cost efficiency of each
115 producer therefore can be obtained by adopting the similar manner developed by Jondrow,
116 *et al.* [34] that u_i is predicted by the conditional expectation of u_i , given the value of random
117 composed error $v_i + u_i$. The expression of u_i is given by

$$E(u_i|v_i + u_i) = \sigma^* \left[\frac{\phi(\varepsilon_i \lambda / \sigma)}{(1 - \Phi(\varepsilon_i \lambda / \sigma))} + \left(\frac{\varepsilon_i \lambda}{\sigma} \right) \right] \quad (5)$$

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119 where $\sigma^* = (\sigma_u^2 \sigma_v^2 / \sigma^2)^{1/2}$; and $\phi(\cdot)$ and $\Phi(\cdot)$ represent the standard normal density
120 and cumulative distribution functions.

121 Based on Young's theorem on the equation of second cross partial derivatives, the
122 restrictive assumption of symmetry ($\alpha_{nk} = \alpha_{kn}$ and $\gamma_{mr} = \gamma_{rm}$) must be imposed on the
123 model prior to estimation. Moreover, because the cost function must be homogeneous of
124 degree 1 in input prices, the restrictions $\sum_n \alpha_n = 1$ and $\sum_k \alpha_{nk} = 0$ are also imposed.

125 For better understanding about how to estimate the cost efficiency, we assume that a
126 producer use two inputs (x_1 and x_2) to produce a single output p , represented in Figure 1.
127 The isoquant curve SS describes the technically efficient producers or production frontier
128 which permits the measurement of technical efficiency. If an observed producer uses a mix
129 of inputs, defined by the point A to produce a certain level of output, the technical inefficiency
130 of the producer could be defined as the distance BA . This distance shows the ability to
131 reduce proportionally their inputs mix without compromising their current output level.
132 Commonly, the technical efficiency is defined in percentage term as a radial contraction of
133 inputs by the ratio OB/OA . From Figure 1, it is also possible to estimate the cost efficiency of
134 the given producer if the input prices are available. The isocost line PP' represents the
135 minimum cost frontier at the factor price vector. Let w and x represent the vector of input
136 prices and the observed vector of inputs, respectively, associated with the point A . Let x^*
137 represent the cost-minimizing input vector associated with point C . Then the cost efficiency
138 of the producer which is defined as the ratio of observed input cost and minimum possible
139 cost is given by equation (6)

$$CE = \frac{wx^*}{wx} = \frac{OC}{OA} \quad (6)$$

140 Because the cost efficiency contains input-oriented technical efficiency and input
141 allocative efficiency, it is also possible to decompose the cost efficiency into allocative
142 efficiency by the ratio OC/OB . However, in this study we focus only on the cost efficiency.

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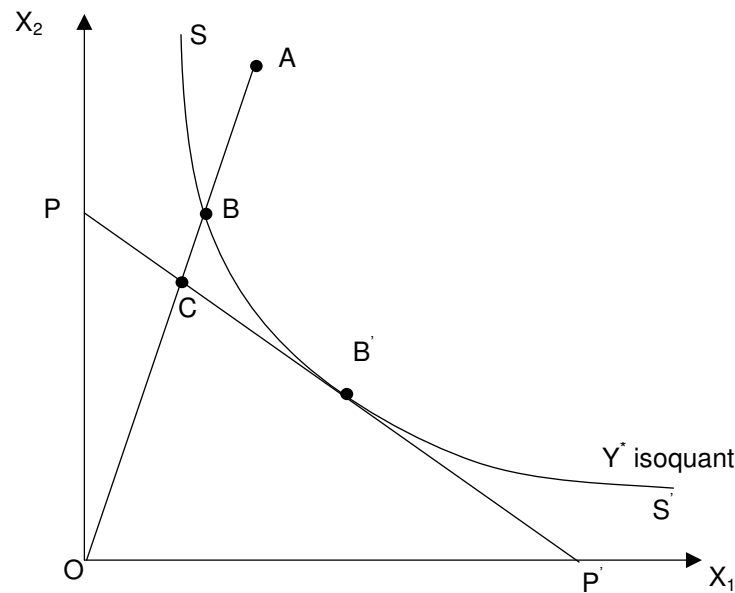


Figure 1: The measurement of cost efficiency

2.2. Data

The primary data for this study were collected in 2014 in four districts of An Giang Province, where is located in the upstream part of the VMD and borders with Cambodia. According to SOCC [3], and GSO [5], An Giang Province was the largest rice producer in the VMD within the period 2002-2010 and has transferred this position to Kien Giang Province to maintain the second place since 2011. Annually, An Giang Province contributes approximately 16% (about 4 million tons in 2013) of total production in the VMD. Although An Giang Province is an area to suffer annually seasonal flood from July to November, many rice farmers could produce three rice crops per year in the areas that had flood-protected dike systems. The reasons of intensive rice farming in An Giang Province in particular and the VMD in general are due to increasing demands on rice consumption and the mission to ensure food security which have been assigned to the region by the Prime Minister.

We conducted the survey through face-to-face interviews with 199 farmers in four districts of An Giang Province, in which two ones (An Phu and Chau Doc Districts) is located in upstream part, one in the middle (Chau Phu District) and the other one in the downstream region of the province (Thoai Son District). Although the study sites were selected with respect to its locations in terms of different periods of flooding to ensure the representative of the selected observations, the natural conditions were assumed to be identical. This assumption is important for the study to pool all samples because they share the common deterministic frontier. Table 1 provides a summary of the data set used for the measurement of cost efficiency.

Table 1: Brief description of the data set

Variables	Unit	Notation	Mean	Min	Max	St.dev.
Price of fertilizer ^ψ	Th. VND/Kg	W_1	20.71	13.53	31.99	3.77
Price of pesticide	Th. VND/Kg	W_2	417.91	169.75	1,003.09	149.25
Price of seed	Th. VND/Kg	W_3	11.98	3.94	39.35	6.03

Price of labor [*]	Th. VND/day	W ₄	115.83	80	150	17.94
Miscellaneous cost [†]	Th. VND/ha	Z ₁	11,215.95	4,722.01	27,999.46	3,013.73
Output level	Kg/ha	Y	7,128.91	5,015.43	8,865.43	676.48
Total variable cost	Th. VND/Kg	VC	37,406.27	23,037.84	60,918.93	7,068.55
Fertilizer cost share	%		6.64	2.95	11.96	1.81
Pesticide cost share	%		11.24	4.97	22.05	3.44
Seed cost share	%		4.45	0.19	23.89	3.71
Labor cost share	%		77.67	57.12	87.93	5.42

185 Note: ^ψ indicates the price of phosphorus and potash fertilizer; ^{*} refers to the “mean” price of family
186 and hired labor, in which family labor price was determined by the opportunity cost; [†] includes energy
187 cost, nitrogen fertilizer cost, capital and others; Th. stands for thousand; and 1 USD = 21,770 VND
188 Source: Own estimates from the survey in 2014 by the author

189 As shown in Table 1 that the study considered four variable inputs: phosphorus and
190 potash fertilizer, pesticide, labor and seed quantity and one quasi-fixed input –
191 miscellaneous cost (including energy, nitrogen fertilizer cost, capital and others) to estimate
192 cost efficiency. The price of a mix input was derived by the ratio of total cost to its total
193 quantity. For instance, the price of fertilizer (active nutrient of phosphorus and potash) was
194 the ratio of total cost of these kinds of fertilizers to total active nutrient quantity. The same
195 procedure was applied to calculate the prices of labor and seed. The price of pesticide was
196 the ratio of total pesticide cost to one hectare. Because we included family labor cost based
197 on its opportunity cost, the cost share of labor was highest, accounting for more than 77% in
198 total cost. The cost shares of fertilizer, pesticide and seed were 6.64%, 11.24% and 4.45%,
199 respectively.

200 Stata software version 12 was used to estimate stochastic cost frontier and measure
201 cost efficiency as well as the determinants affecting such efficiency scores.

202 3. RESULTS AND DISCUSSION

204 3.1. Cost efficiency

205 Prior to estimating the stochastic production frontier, it is necessary to identify the
206 variables that significantly correlate with output level using ordinary least square [16,19]. The
207 same was applied for the estimation of stochastic cost frontier. Based on the properties of
208 cost function, the function has to satisfy the properties of non-decreasing in input price and
209 output level, the price of nitrogen fertilizer violated the former property and had insignificant
210 relationship with variable cost. We therefore excluded this variable from the model. Further,
211 the cost function must be homogeneous degree of 1 in input prices. After testing and
212 imposing the restrictive assumptions, the coefficients of the translog variable cost function by
213 using maximum likelihood estimation was presented in Table 2:

214 It is clearly shown in Table 2 that the presence of cost inefficiency was found in the
215 study based on z-test ($z_{value} = \tilde{\lambda}/se(\tilde{\lambda}) = 52.33$). This value exceeds the critical one
216 $z_{0.95} = 1.645$ so we rejected the null hypothesis that there are no inefficiency effects at the
217 5% level of significance. This result was in line with the results of Nhut [17]. The estimated
218 value of $\gamma = 0.7922$ suggested that 79% of variation in variable cost is due to cost
219 inefficiency.

220
221 **Table 2: Coefficients of translog variable cost function with MLE**

Predictor	MLE		MLE (cont.)		
	Coefficient	Std. error	Predictor	Coefficient	Std. error

Constant	99.9147	58.3215	$\ln W_1 \ln W_2$	-0.0491	0.1543
$\ln Y$	-23.0822	13.0414	$\ln W_1 \ln W_3$	0.1134	0.1031
$\ln W_1$	-0.5361	3.8342	$\ln W_1 \ln W_4$	0.5474	0.3615
$\ln W_2$	3.1823	2.4829	$\ln W_1 \ln Z_1$	-0.5369	0.1962
$\ln W_3$	-1.1040	1.9797	$(\ln W_2 \ln W_2)/2$	0.2832	0.1225
$\ln W_4$	-0.5422	4.3873	$\ln W_2 \ln W_3$	-0.0974	0.0633
$\ln Z_1$	0.6519	3.3365	$\ln W_2 \ln W_4$	-0.1367	0.1560
$(\ln Y \ln Y)/2$	3.0132	1.6855	$\ln W_2 \ln Z_1$	0.1557	0.1379
$\ln Y \ln W_1$	0.5529	0.4650	$(\ln W_3 \ln W_3)/2$	0.2554	0.0766
$\ln Y \ln W_2$	-0.5782	0.3341	$\ln W_3 \ln W_4$	-0.2714	0.1225
$\ln Y \ln W_3$	0.2742	0.2306	$\ln W_3 \ln Z_1$	-0.0407	0.0894
$\ln Y \ln W_4$	0.2445	0.5648	$(\ln W_4 \ln W_4)/2$	-0.1394	0.3839
$\ln Y \ln Z_1$	-0.3477	0.4781	$\ln W_4 \ln Z_1$	-0.0562	0.2862
$(\ln W_1 \ln W_1)/2$	-0.6116	0.3995	$(\ln Z_1 \ln Z_1)/2$	0.3646	0.1680
Log Likelihood	162.6002		λ	1.9365	0.0370
Wald χ^2 value	1595.23		γ	0.7922	

Note: The notations Y , W_1 , W_2 , W_3 , W_4 , Z_1 refer to output, price of fertilizer, price of pesticide, price of seed, price of labor and miscellaneous cost, respectively.

Source: Own estimates, data available from the authors

We now turn to estimate the cost efficiency for each rice farmers, which are summarized in Table 3.

Table 3: Cost efficiency of rice production

Cost efficiency (%)	Frequency	Percentage	Cumulative
≥ 90	119	59.80	59.80
80-90	68	34.17	93.97
≤ 80	12	6.03	100.00
Mean CE		90.00	
Minimum CE		72.21	
Maximum CE		97.20	
Standard deviation		5.45	

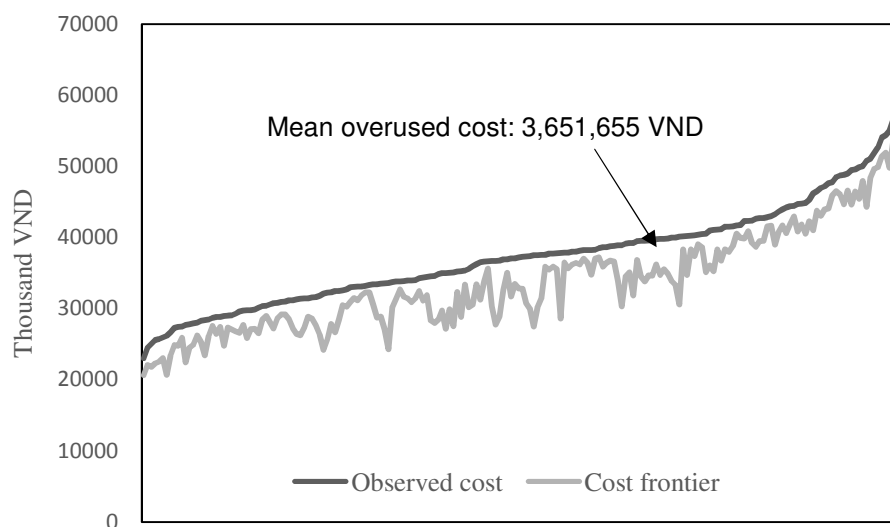
Source: Own estimates, data available on request from the authors

As shown in Table 3 that the mean cost efficiency of rice farmers in the study sites was 90%, suggesting that on the average these farmers could reduce proportionally their current variable cost by 10% without any reductions in the output level. This value (90%) was much higher as compared to the study results of Nhut [17]. In fact, the study of Nhut [17] showed that the mean cost efficiency scores in flooded area were 71% and 74% for mono rice and crop-rotation patterns, respectively, while they were only 65% for mono rice and 67% for crop-rotation farming in non-flooded area. This improvement of cost efficiency indicated that rice farmers had paid many efforts on variable cost reduction.

One of the primary interests from this study is to estimate total variable cost that rice farmers overused or total losses due to inefficient use of inputs with its respective prices. These losses also mean the potential profit that rice farmers could gain if they make use of variable inputs efficiently. Figure 2 illustrates total economic losses in terms of cost inefficiency.

As can be seen in Figure 2 that the differences between observed variable cost and cost frontier were the overused cost that the rice farmers incurred. The mean overused cost was about 3,651 thousand VND (equivalent to 167.74 USD) per ha. This value is equal to the sales of 702.24 kg of output per ha. As summarized in Table 1, the average output was

247 7,128.91 kg/ha, suggesting if the rice farmers made efforts to reduce production cost, the
 248 total possible reduced cost would be equal to the efforts to increase approximately 10% (i.e.
 249 702.24/7128.91) of output level. According to Belbase and Grabowski [13], Khai, Yabe,
 250 Yokogawa and Sato [14], Shapiro and Müller [15], and Khai and Yabe [16], it is more cost-
 251 efficient to improve productivity by using existing technologies rather than introducing new
 252 ones. Hence, cost reduction for rice farmers in the study sites is important to increase
 253 production profit.



254

255 **Figure 2: Overused cost for rice cultivation**

256 *Note: 1 USD = 21,770 VND*

257 This result suggested that the rice farmers in the study sites seriously overused
 258 variable inputs and cost reduction is one of the significant ways to increase the profit of rice
 259 production.

260 We now turn to investigate the factors affecting such efficiency scores by using Tobit
 261 function.

262 **3.2. The factors affecting the efficiency**

263 As mentioned in many literature and known as the second stage of efficiency analysis,
 264 it is crucial to investigate the factors affecting the efficiency scores or the sources of
 265 inefficiency [16,17,19,35-38]. The results from this stage are important for policy
 266 implications. In this study, we therefore used the estimated efficiency scores as dependent
 267 variable. The independent variables were the endogenous and exogenous characteristics of
 268 rice farmers (see Table 4 for the detailed description). However, in this study, we only
 269 considered the exogenous factors or technical interventions which were associated with the
 270 cost efficiency because the endogenous factors (age, gender, education and technical
 271 training) were already covered in previous studies of Khai and Yabe [16], Nhut [17]. The
 272 results of estimates with Tobit regression are presented in Table 4.

273 It is clearly shown in Table 4 that *Crop* had positively and highly significant impact on
 274 the cost efficiency at the 5% level, implying that for farmers who cultivated three rice crops
 275 per year had more potential to reduce variable cost as compared to those who produced
 276 annually two crops. The possible reasons are probably due to appropriate management,
 277 investment and proper location selection programs for intensive rice farming.

The variables *Eco* and *Sesource* had positive but insignificant effects on cost efficiency at the 10% level of significance. The former refers to ecologically engineered rice cultivation, which was introduced in the VMD since 2009. The latter was sources of rice varieties that the rice farmers bought or used. In the study sites, there were two main sources of rice varieties: self-produced seed and seed centers/companies/research institutes. Moreover, family size and OM6976 rice variety had insignificant impacts on the cost efficiency.

Table 4: Descriptive statistics of the variables and Tobit regression coefficients

Variable s	Description	Mean	St.dev.	Coefficient	St. error
<i>Farsize</i>	Rice area in hectares	2.3433	4.0134	-0.2177**	0.0940
<i>Famsize</i>	Number of members	4.6582	1.3794	-0.1854	0.2670
<i>Crop</i>	1 = three crops/year 0 = two crops/year	0.8542	0.3537	2.7188**	1.3076
<i>Sesource</i>	1 = verified source, 0 = otherwise	0.3517	0.4787	1.2298	0.7806
<i>IR50404</i>	1 = IR50404, 0 = otherwise	0.3266	0.4701	-3.1572***	1.0913
<i>OM6976</i>	1 = OM6976, 0 = otherwise	0.3115	0.4642	-1.5593	1.0008
<i>Jasmine</i>	1 = Jasmine, 0 = otherwise	0.1206	0.3264	-5.1669***	1.2719
<i>Pump</i>	1 = self-pumping, 0 = co-operative	0.5276	0.5004	-2.9275***	0.8066
<i>Eco</i>	1 = eco rice 0 = otherwise	0.3718	0.4845	1.2839	0.8289
Pieces	Pieces of land	1.3266	0.8521	-1.0983**	0.4384
Constant				93.2952***	2.0487
Sigma				4.7621	0.2395
Log-likelihood				-591.1588	

Note: ***, ** and * represents the significant levels of 0.01, 0.05 and 0.1, respectively
Source: Own estimates, data available on request from the authors

The remaining variables farm size, rice varieties such as IR50404, OM6976, Jasmine, pumping methods and the numbers of paddy plot had negative and significant relationship with the cost efficiency. Among them, Jasmine and IR50404 rice varieties had the highest negative coefficients, suggesting that regardless of selling price, the farmers incurred higher cost to produce these rice varieties, keeping output constant. As regards pumping methods, its negative coefficient suggested that self-pumping method was not a wise choice for rice farmers. Indeed, collective pumping is more cost-efficient as compared to individual or self-pumping. Further, the farmers with more paddy plots had lower cost efficiency scores than those with few plots. The possible explanation for this is due to higher transportation cost that the farmers incurred.

4. CONCLUSION

By applying stochastic translog variable cost and the data set from a survey of 199 rice farmers in 2014 in An Giang Province of the VMD. We have found that the mean cost efficiency score was 90%, which suggested that on the average these farmers could reduce proportionally their current variable cost by 10% without any reductions in the output level. Further, 79% of variation in variable cost is due to cost inefficiency. The mean overused cost was estimated about 3,651 thousand VND (equivalent to 167.74 USD) per ha. This value is equal to the sales of 702.24 kg of output per ha or the efforts to increase approximately 10%

306 of output level. The study suggested that cost reduction for rice farmers in the study sites is
307 crucial to increase production profit.

308 The results from Tobit regression showed that number of rice crops per year had
309 positively and highly significant impact on the cost efficiency, implying that for farmers who
310 cultivated three rice crops per year had higher cost efficiency as compared to those who
311 produced annually two crops. Regardless of selling price, the farmers cultivating Jasmine
312 and IR50404 rice varieties incurred higher cost to produce these rice varieties, keeping
313 output constant. Another solution to improve cost efficiency is using collective pumping
314 services rather than individual pumping. Finally, the farmers with more plots of paddy land
315 had lower cost efficiency scores than those with few plots. The possible explanation for this
316 is due to higher transportation cost that the farmers incurred.

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