Profitability and Profit Efficiency of Rice Farming in Tra Vinh Province, Vietnam

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ABSTRACT

This study attempts to identify profit, profit efficiency as well as determinants of profit efficiency among rice farmers in Tra Vinh province, Vietnam based on the data collected from 196 sample rice farmers in two districts of Tra Vinh province. The Cobb-Douglas stochastic frontier profit function incorporating profit inefficiency effects was employed to analyze the data. The results revealed that the net income and the net income over gross income ratio of rice production were 9.5 million VND/ha (~ 420 USD) and 30.6 percent, respectively; profit efficiency ranged between 33.87 to 97.22 percent, with an average of 75.61 percent. Significant factors found negatively affect the rice farm profit include prices of fertilizer and pesticide, while positive effects came from seed price, wage rate and land area (fixed factor). Significant determinants that were found positively affect profit efficiency of rice farmers were education attainment, household farm labor, farm size dummy, training dummy, and farmer's association membership.

Keywords: rice profitability, profit efficiency, determinant of profit efficiency, stochastic frontier profit function.

1. INTRODUCTION

Rice production in Vietnam is mostly concentrated in the Mekong Delta, which is located in the Southern part of Vietnam, consisting of 13 provinces and covering 12 percent of the total country's land area. The Mekong Delta covers more than four million ha of natural land area, three-fourths of which is agricultural land, and the rest is comprised of rivers and other uses. The Mekong Delta plays a key role in the country's food security and export. It contributed about 90 percent of the country's rice export in volume.

Rice cultivation is the most important subsector in Tra Vinh since it plays a crucial role in employment creation, income generation especially from rice exports, poverty reduction, and food security for the region and for the country as a whole. However, it is difficult to expand rice production by increasing rice land area or crop intensification since almost all the agricultural land in Tra Vinh have been utilized. There are also limitations related to crop intensification such as soil erosion, pest infestation, and other issues concerning sustainable development in agriculture. Especially, rice price always fluctuates over time that the government does not effectively control. Therefore, promoting policies aimed at sustainable growth in rice yield and price will be the basis for sustainable development in the rice subsector in Tra Vinh in the future.

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Recently, rice production in Tra Vinh has been confronted with problems such as the rapid increase in labor cost and other material input costs, which in turn, caused the decrease in the farmers' levels of input use. A reduction in input use may have negative impacts on rice yield and the productive efficiency of rice farmers as well. These lead to questions that how are the profit and profit efficiency of rice farms and what factors affect farm's profit and profit efficiency. Thus, this study attempts to identify profitability and profit efficiency as well as determinants of profit efficiency among the rice farmers in Tra Vinh province.

2. LITERATURE REVIEW

Profit efficiency is defined as the ability of a farm to achieve highest possible profit given the prices of inputs and levels of fixed factors of that farm and profit inefficiency in this context is defined as loss of profit from not operating on the frontier (Ali and Flinn, 1989; Rahman, 2003). Measurement of efficiency began with the study of Farrell (1957) who gave definition for both technical and allocation efficiencies, starting from the deterministic frontiers concept (Tiamiyu *et al.*, 2010). Based on the Farrell 's frontier concept, the profit efficiency index is the ratio of maximum profit over actual profit of a farm, given input prices and fixed factors. The predicted efficiency indexes were regressed against a number of household characteristics, in an attempt to explain the observed differences in efficiency among farms (Rahman, 2003).

There are serveral studies on profit efficiency and determinants of profit efficiency. Ali and Flinn (1989) found that socioeconomic factors related to profit loss were the farm household's education, nonagricultural employment, and credit constraint in the Basmati rice producers. Bhattacharyya and Glover (1993) found that small farms were less profit inefficient than their larger counterparts. Abdulai and Huffman (1998) showed that farmers' human capital represented by the level of schooling contributed positively to profit efficiency of the rice farmers in the Northern Region of Ghana. Rahman (2003) indicated the efficiency differences were explained largely by infrastructure, soil fertility, experience, extension services, tenancy and share of non-agricultural income among Bangladeshi rice farmers. Ogundari (2006) revealed that profit efficiency was positively influenced by age, educational level, farming experience, and household size among small- scale paddy rice farmers in Nigeria.

Kolawole (2006) revealed that age, educational attainment, farming experience, and household size positively affected profit efficiency. Adeleke *et al.* (2008) indicated that labor was an important factor explaining changes in profit among female smallholder farmers in Atiba, Oyo State. Karafillis and Papanagiotou (2009) found that more innovative farmers performed better than less innovative ones regarding in terms of profit efficiency among organic olive farmers in Greece. Wadud (2011) Socio economic variables such as agricultural information and family dependency ratios showed positive effect on profit inefficiencies among rice farmers in selected districts of Bangladesh.

3. METHODOLOGY

3.1 Sampling and data collection

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The data this study is cross – sectional data collected by direct interview 196 rice farmers in two districts of Tra Vinh province, namely Cau Ke and Tieu Can. About 100 rice farmers per each district were selected by random sampling. The data collection includes quantity of input use, paddy yield, prices of input use and paddy in the first crop of 2015 and other data related to the farm's specific characteristics.

3.2 Stochastic frontier profit function

This study adopted the models developed by Battesse and Coelli (1995) and Abdulai and Huffman (1998) by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier framework. Consider a firm that maximizes profits subject to perfectly competitive input and output markets and a single output technology that is quasi-concave in the (n x 1) vector of variable inputs, X, and the (m x 1) vector of fixed factors, Z. The actual normalized profit function can be expressed as:

$$\pi\,(p, F) = Y(X^*, F) - \Sigma p_i X_i^* \qquad (1)$$

where:

Y (X*, F) is production function; the asterisk denotes optimized values.

p_i is the normalized price of input i, p = W/P, where P and W are the output and input prices, respectively.

The stochastic normalized profit function can then be expressed as:

$$\pi_i = f(p_{ji}, F_{ji})\, exp(V_i - U_i) \qquad (2)$$

where:

π_i is normalized profit of the i^{th} farm, computed as gross revenue less variable cost, divided by farm specific output price P_y;

p_{ji} is the normalized price of input j for the i^{th} farm, calculated as input price divided by farm specific output price P_y;

F_{ji} is the level of the j^{th} fixed factor for the i^{th} farm

V_i is the symmetric error term and U_i is a one-sided error term. v_i is normally independently and identically distributed as $N(0, \delta_u^2)$ two-sided error term representing various random shocks and effects of measurement error of variables. The U_i is the non–negative or one-sided residual representing farm-specific profit inefficiency. Hence if $U_i = 0$, the farm's profit inefficiency is nonexistent, i.e., the farm makes maximum possible profit (being on the frontier) given its input prices and fixed factors. Conversely, $U_i > 0$ indicates that the farm forgoes profit due to inefficiency (Ali and Flinn, 1989).

The profit efficiency (PE) in relation to the stochastic profit frontier is given by

$$PE = U_i = \frac{\pi_i}{\pi_i^*} = \frac{f(p_{ji}, F_{ji})\exp(V_i - U_i)}{f(p_{ji}, F_{ji})\exp(V_i)} = \exp(-U_i) \qquad (3)$$

π_i is an observed profit and π_i* is the frontier profit. The p_{ji}, F_{ji}, U_i and V_i have been defined earlier. In this case, π_i achieves its maximum value of $f(p_{ji}, F_{ji})\, exp(V_i)$ if and only if $PE_i = 1$. Otherwise, $PE_i < 1$ provides a measure of the shortfall of observed profit from maximum feasible profit.

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The profit inefficiency (PIE) derived using the results from equation (3) is given as:

$$PIE = 1 - exp\ (-U_i) \qquad (4)$$

The stochastic profit frontier model as shown in (2) above could be estimated using maximum likelihood method, which is asymptotically more efficient than the other alternative, Corrected Ordinary Least Squares (COLS) method (Battese and Coelli, 1995). Mean profit efficiency (industry profit efficiency) could be easily predicted using the mathematical expectation of profit efficiency. A natural predictor of mean profit efficiency would be the arithmetic mean of the farm specific efficiencies in the sample.

3.3 The Empirical Model

Several studies (e.g. Battesse and Safraz, 1998; Kolawole, 2006) used the Cobb-Douglas functional form to estimate the profit function for different commodities. For this study, the Cobb-Douglas functional form was also used to estimate the stochastic profit function model. The specific farm profit function is expressed as follows:

$$\ln \pi_i = \beta_0 + \sum_{j=1}^{4} \beta_j P_{ji} + \sum_{k=1}^{2} \beta_k \ln F_{ki} + V_i - U_i \qquad (5)$$

Where: β_0 = Intercept; β_j, β_k = regression coefficients of the explanatory variables in the estimated stochastic profit function, where j = 1, 2…5; k = 1, 2; π_i = Restricted normalized profit computed for *jth* farm defined as gross revenue less variable costs per farm divided by farm specific rice price (P_y); P_{ji} = Prices of variable inputs contributing to profit efficiency where (for i = 1, 2 …5), consisting of: P_{1i} = Price of seed (VND/kg) normalized by price of output (P_y); P_{2i} = Weighted average price of fertilizer (VND/kg) normalized by price of output (P_y); P_{3i} = Weighted average price of chemical pesticide (VND/liter) normalized by price of output (P_y); P_{4i} = Price of labor (VND/man-day) normalized by price of output (P_y). F_{ki} = Value of fixed inputs contributing to profit efficiency where l = 1, 2, consisting of: F_{1i} = Land area (ha/farm); F_{2i} = Fixed capital (value of farm production equipment and machinery) (VND/farm); V_{it} = Random variable assumed to be independently and identically distributed (iid) N $(0, \sigma_v^2)$ and independent of U_i; U_i = Non-negative random variable that is assumed to account for profit inefficiency in rice production; Ln = Natural logarithm; i = 1… N, N = number of observations; and The subscripts *j* or *k, i* refer to the j^{th} input used of i^{th} farm.

The rice farm level profit inefficiency (PIE) model was simultaneously estimated with the stochastic frontier profit function model. The PIE model for the rice farm is expressed mathematically as follows:

$$PIE_i = U_i = \delta_0 + \sum_{j=1}^{9} \delta_j Z_{ji} + \xi_i \qquad (6)$$

Where: δ_0 = Intercept; δ_j = Regression coefficients of the explanatory variables in the estimated profit inefficiency model where j= 1, 2… 9; Z_{1i} = Factors contributing to profit inefficiency such as: Z_{1i} = Gender of farmer dummy (male = 1; female = 0); Z_{2i} =Educational attainment of the farmer (years of schooling); Z_{3i} = Experience of the farmer in rice farming (years); Z_{4i} = Household members in farming – number of family members engaged in rice farming (number of

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persons/household); Z_{5i} = Farm size dummy (area ≥ 0.6 hectare = 1; area < 0.6 hectare = 0); Z_{6i} = Credit access dummy (with credit access= 1; no credit access= 0); Z_{7i} = Attendance in training on rice production dummy (with training = 1; no training = 0); Z_{8i} = Membership in a farmers' association dummy (member = 1; not member = 0); Z_{9i} = Distance from the rice field to the key input market (km); ξ_i = Error terms, assumed to be independently and identically distributed with mean = 0 and variance = σ_ξ^2; and The subscripts *j*, *i* refer to the j^{th} characteristic of the i^{th} farm.

4. RESULTS AND DISCUSSION

4.1 Socio-economic characteristics of interviewed rice farming households

On average, the interviewed rice farmers have 7.98 years of schooling, 23.27 years of rice farming experience, 0.85 ha of rice farming area, and 2.57 household labors. The average distance from the main rice field to the key input market is 1.97 km; 86 percent of the interviewed rice farmers are male, 46 percent of that accessed to the formal credit, 57 percent of that participate in rice production training, 64 percent of that is member of local farmer's association (Table 1).

Table 1. Socio-economic characteristics of interviewed rice farming households in Tra Vinh province

Farm 's characteristics	Unit	Average	Std. Dev.
Gender dummy	1: male; 0: female	0.86	0.34
Educational attainment	Year	7.98	3.58
Rice farming experience	Year	23.27	11.18
Household farm labor	Person	2.57	1.01
Farm size	Ha	0.85	0.56
Credit access dummy	1: borrowed; 0: not	0.46	0.49
Training dummy	1: Participated; 0: not	0.57	0.50
Farmer's association membership dummy	1: member; 0: not	0.64	0.48
Distance from the main field to the key input market	Km	1,97	1.26

Source: Author's survey in 2015.

4.2 Profitability of rice production

On average, rice yield and prices are 6,587.7 kg/ha and 4,735.1 VND/kg, respectively which results in a gross income of 31,193.7 VND (~1,356.25 USD). With the total costs of production of 21,662.7 VND/ha, the net income is 9,531.0 VND/ha (~ 414.39 USD). The net income on gross income and total cost ratios are 30.6 percent and 44.0 percent, respectively (Table 1).

Among cost items, cost of labor occupies the largest share of total costs, around 26.0 percent of total costs, in which cost of hired and family labor are account for about 11.0 percent and 15.1 percent of total costs, respectively. The following is the cost of fertilizers, accounting for 25.3 percent of total costs. Thus, costs of labor and fertilizers are account for about 51.1 percent of total costs while other 6 cost items are account for another 48.9%.

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Table 2. Costs and returns per hectare in rice production of 196 rice farmers in Tra Vinh province.

Item	Unit	Value	Cost structure (%)	Std. Dev.
Gross income	**Kg/ha**			
Paddy yield		6,587.7		388.8
Average selling price	VND/kg	4,735.1		254.2
Total gross income (GI)	'000 VND	31,193.7		2,519.9
Costs				
Cash costs				
Land preparation	'000 VND	1,387.2	6.4	106.2
Seeds	'000 VND	1,490.8	6.9	553.2
Fertilizers	'000 VND	5,486.1	25.3	1,125.6
Pesticides	'000 VND	2,952.0	13.6	1,047.2
Hired labor	'000 VND	2,378.4	11.0	534.4
Irrigation	'000 VND	947.7	4.4	449.1
Harvest and transport	'000 VND	2,447.3	11.3	212.8
Interest payment	'000 VND	782.4	3.6	518.6
Sub-total	'000 VND	17,871.9		5,943.7
Non-cash costs				
Family labor	'000 VND	3,263.1	15.9	490.0
Depreciation	'000 VND	527.7	2.6	432.0
Sub-total	'000 VND	3,790.8		1,713.5
Total cost (TC)	'000 VND	21,662.7	100.00	7,504.0
Net income (GI-TC)	**'000 VND**	**9,531.0**		**7,149.5**
Net income/gross income (%)	%	30.6		9.6
Net income/Total costs (%)	%	44.0		24.0

Note: USD 1 ≈ VND 23,000.
Source: Author survey in 2015

4.3 Results of the stochastic frontier profit analysis

In the stochastic Cobb-Douglas frontier profit model, the estimated coefficients of the independent variables are profit elasticities. The profit elasticity shows the percent change in farm profit with respect to a percent change in given variable input price or fixed factor, *ceteris paribus*. Among the seven parameters of input prices and fixed factors included in stochastic frontier profit model, only equipment had no significant effect on farm profit in rice production in the study areas (Table 3). The regression coefficients of prices of fertilizer and pesticide exhibit negative signs and are statistically significant, which imply that the increases in prices of these inputs would lead to decrease of the farm profit level and vice versa. This finding conforms to the results of the studies on rice farming conducted by Rahman (2003) in Bangladesh, Ogundari (2006) in Nigeria, and Wadud (2011) in selected districts of Bangladesh.

Otherwise, the coefficient of seed is found positive sign and is statistically significant at one percent level, which means that the higher price of seed leads to the higher profitable and vice versa. This would attribute to that the farmers who use the higher quality seed (imply the improved seeds) gain more profitable than those who use

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the lower quality one, given assumption price of seed is consistent with its quality. Likewise, the wage rate or the price per man day of labor is statistically significant at five percent probability level. However, contrary to expectations, the sign of the regression coefficient of labor is positive. This may be due to the fact that rice production is labor intensive considering that most farm operations are done manually which resulted to an increase in the cost of labor since the services of hired laborers are frequently used by the farmers especially in planting and nursing activities. The same finding was found by Ogundari (2006), Adeleke et al. (2008) in Atiba, Oyo State, and Wadud (2011). Similarly, the coefficient of land area is also found positive signs and statistically significant at one percent probability level, which impliea that the larger farm gain greater profitable than the smaller one and vice versa. This would attribute to that the larger farms gain more economic scale in terms of costs of production, which lead to more profitable than smaller one.

Table 3. MLE of the Cobb-Douglas stochastic profit function and profit inefficiency model, 196 interviewed rice farmers in Tra Vinh province.

Variable Symbol	Variable name	Para-meters	Coefficient	Std. Error	t-ratio
Frontier profit function					
	Constant	β_0	10.592^{***}	0.997	10.626
ln Ps	Price of seed (vnd/kg)	β_1	0.158^{***}	0.059	2.691
Ln Pf	Price of fertilizer (vnd/kg)	β_2	-0.083^{*}	0.048	-1.734
ln Pp	Price of pesticide (vnd/litter)	β_3	-0.187^{*}	0.097	-1.912
ln W	Wage rate (vnd/day)	β_4	0.055^{**}	0.023	2.441
ln L	Land area (hectare)	β_5	0.096^{***}	0.035	2.761
ln E	Equipment (vnd)	β_6	-0.025^{ns}	0.049	-0.504
Profit Inefficiency function					
	Constant	δ_0	1.823^{***}	0.526	3.467
Z_1	Gender dummy	δ_1	0.031^{ns}	0.065	0.468
Z_2	Educational attainment (years)	δ_2	-0.039^{**}	0.016	-2.390
Z_3	Rice farming experience (years)	δ_2	0.031^{ns}	0.203	0.154
Z_4	Household farm labor (persons)	δ_3	-0.084^{**}	0.041	-2.059
Z_5	Farm size dummy	δ_4	-0.077^{***}	0.025	-3.123
Z_6	Credit access dummy	δ_5	-0.025^{ns}	0.044	-0.568
Z_7	Training dummy	δ_7	-0.203^{**}	0.089	-2.296
Z_8	Association membership dummy	δ_8	-0.125^{*}	-0.072	1.740
Z_9	Distance from the main field to the key input market (km)	δ_9	0.016^{ns}	0.024	0.658
Variance Parameter					
σ^2			0.412^{**}	0.104	3.928
γ			0.948^{***}	0.025	37.323
Log-likelihood function			132.524		
LR test of the one-sided error			34.675		
Mean profit efficiency (%)			75.612		
N			196		

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*Note: ***, **, and * indicate statistically significant at 1%, 5%, and 10% probability level, respectively; and ns denotes insignificant at 10% probability level.*
Source: Author estimates

Determinants of profit efficiency: the average profit efficiency was 75.61 percent, which implies that with the recent price of inputs and fixed factors, the interviewed rice farmers could be able to increase their rice farming profit by 24.39 percent by improving technical efficiency factors. This is to examine the effects of socio-economic and farm-specific factors on profit efficiency of the interviewed rice farmers. A negative sign of the regression coefficient of an explanatory variable in the profit inefficiency function indicates that the variable improves profit efficiency. A positive sign means the opposite. The factors which were found positively affect profit efficiency of the interviewed rice farmers were education attainment, household farm labor, farm size, participation in rice production training programs, and membership in a farmers' association.

Educational attainment. Education exhibits a significant effect on profit efficiency. The regression coefficient of the educational attainment of the farmer-respondents is negative and statistically significant at ten percent probability level. The negative coefficient means that as the farmer's educational level increases, the profit inefficiency of the farmer decreases. In other words, this implies that that the more educated the interviewed rice farmers have higher profit efficiency than those with lower educational attainment. This could be explained by the fact that the more educated farmers have better access to information on input and output prices as well as other economic and technical information, which help them in making better farm management decisions as compared to less educated farmers. This finding is in conformity with the works of Abdulai and Huffman (1998) in the Northern Region of Ghana, Rahman (2003) in Bangladesh, and Ogundari (2006) in Nigeria.

Household farm labor. Household farm labor has a negative regression coefficient and is statistically significant at five percent probability level. This indicates that farmers who have more family labor engage in farming gain higher level of profit efficiency than others. This may be due to the fact that rice production in Tra Vinh is labor intensive and most farm operations are done manually; the farmers who have more available family labor might used higher level of labor input, which lead to higher level of profit efficiency than others.

Farm size. Farm size has a negative regression coefficient and is statistically significant at five percent probability level. This indicates that farmers with larger farms earn significantly higher profit and operate at significantly higher level of profit efficiency than those operating smaller farms. This is logical since those operating large farms frequently purchase material inputs in bulk or in larger volume to get price discounts and in turn lower their input procurement cost. Selling a larger volume of their produce also enables them to bargain for a higher price for their product and minimize marketing/transportation cost as well.

Farmers' participation in training programs on rice production. As expected, the participation in training dummy has a negative sign and is statistically significant at five percent probability level. This suggests that the farmers who participated in training programs on improved rice farming technologies and practices have higher levels of profit efficiency than those who did not participate in such training programs.

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*Membership in farmers' association***.** The regression coefficient of the dummy variable for membership in a farmers' association has a negative sign and is statistically significant at five percent probability level. This indicates that the farmers who are members of a farmers' association receive higher profits and have higher levels of profit efficiency than non-members. This could be attributed to the fact that the members of a farmers' association have better access to support services like extension and training. Members of a farmers' association may also benefit from selling their produce through their association than selling individually since their association can bargain for a higher price. This result corroborates with the findings of Ali and Flinn (1989) who reported that farmers in remote villages were less profit efficient, even when other factors were taken into account.

Distribution of technical efficiencies: The predicted profit efficiencies of the interviewed rice farmers in Tra Vinh province differed substantially ranging from 33.87 percent to 97.22 percent. About 6.33 percent of total interviewed rice farmers belonged to the most efficient category (95 - 100%). Around 12.24% of the the interviewed rice farmers had profit efficiencies below 50 percent. Majority (30.10%) of the the interviewed rice farmers belonged to the category (80 - >90%), indicating that most of the interviewed rice farmers were very profit efficient (Table 4).

Table 4. Distribution of profit efficiencies of 196 rice farmers in Tra Vinh province

Profit efficiency (PE, %)	No. of farmers	Percent
<50	24	12.24
50-<60	19	9.69
60-<70	22	11.22
70-<80	27	13.78
80-<90	59	30.10
91-<95	32	16.33
95-100	13	6.63
Total	196	100.00
Average		75.61
Minimum		33.87
Maximum		97.22
Std. Dev.		18.06

Source: Author estimates

5. CONCLUSIONS AND RECOMMENDATIONS

This study attempts to determine rice farm profit, profit efficiency and determinants of profit efficiency among rice farmers in Tra Vinh province, Vietnam based on the data collected from 196 rice farmers in two districts of Tra Vinh province. The Cobb-Douglas stochastic frontier profit function incorporating profit inefficiency effects was employed to analyze the data, using the Frontier 4.1. The results revealed that the net income and the net income over gross income ratio of rice production were 9.5 million VND/ha (~ 420 USD) and 30.6 percent, respectively; profit efficiency was range between 33.87 to 97.22 percent, averages of 75.61 percent. Significant factors that

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were found negative affect the rice farm profit were prices of fertilizer and pesticide while positive effects were price of seed, wage rate and land area (fixed factor). Significant determinants that were found positive affect profit efficiency of rice farmers were education attainment, household farm labor, farm size dummy, training dummy, farmer's association membership dummy.

In order to further improve profit and profit efficiency of rice production, the study recommend to local government and the rice farmers to improve fertilizer management focusing on efficient use of fertilizer; intensifying extension services particularly the conduct of training programs; promoting high-yielding varieties in cooperation with the private sector; strengthening farmers' association; improving the level of education of farmers through short technical training; and promoting the farmers to increase their rice land size.

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