Journal of Asian Scientific Research, 2016, 6(4): 66-75

Journal of Asian Scientific Research
ISSN(e): 2223-1331/ISSN(p): 2226-5724

URL: www.aessweb.com

PROFIT EFFICIENCY AMONG PADDY FARMERS: A COBB-DOUGLAS STOCHASTIC FRONTIER PRODUCTION FUNCTION ANALYSIS

Yahaya Kaka[1] --- Mad Nasir Shamsudin[2†] --- Alias Radam[3] --- Ismail Abd. Latif[4]

[1,2,4]Department of Agribusiness and Information System, Faculty of Agriculture, Universiti Putra Malaysia, UPM Serdang Malaysia

[3]Department of Management and Marketing, Faculty of Economics and Management, Universiti Putra Malaysia, UPM Serdang, Malaysia

ABSTRACT

A multiple regression model based on Stochastic Frontier Profit Function which assumed Cobb-Douglass specification form was estimated using a cross-sectional data obtained from a sample of 397 Paddy households via Multi-stage and simple random sampling techniques. Maximum likelihood estimates of the specified profit model revealed that profit efficiencies of the producers varied between 30.5% and 94.8% with a mean of 73.2% suggesting that an estimated 26.8% of the profit is lost due to a combination of technical and allocative inefficiencies in Paddy production. Results from the technical inefficiency model revealed that credit education, farming experience, extension service, MR219 seed variety, broadcast planting method, machine broadcasting method and herbicides were significant factors influencing profit inefficiency. This shows that profit inefficiency in Paddy production could be shortened significantly with improvement in the level of the above socio-economics characteristics of the sampled farmers.

Keywords: Stochastic, Profit efficiency, Cobb – Douglass, Paddy, MADA, Cross –sectional data

Received: 24 May 2016/ **Revised:** 2 August 2016/ **Accepted:** 29 August 2016/ **Published:** 9 September 2016

Contribution/ Originality

Self-sufficiency in Paddy Production has been the foremost issue in Malaysian Agriculture. The best and effective approach to improve Paddy productivity is through more effective utilization of scarce resources. This paper attempts to study production efficiency among Paddy producers in Malaysia employing a stochastic profit frontier and inefficiency effects model.

1. INTRODUCTION

Paddy farming is one of the most important activities in Malaysian Agriculture sector. Paddy (rice) is a crucial part of everyday Malaysian diet. Thus according to Mohd and Shah [1] the crop enterprise was recently identified as the most important food crop in Malaysia for ensuring the nation`s food security. Paddy is the most important cultivated crops, besides oil palm and rubber in the country, covering a total land area of about 684,545 ha in 2012 [2]. It is mostly cultivated in the eight major designated producing areas called Granary Areas. The granary areas which cover over 200,000 hectares of the irrigated paddy land are found in Peninsular Malaysia. The mini granary areas with irrigation facilities totally about 28,000 hectares are also found all over the country. The granary Areas,

† Corresponding author
DOI: 10.18488/journal.2/2016.6.4/2.4.66.75
ISSN(e): 2223-1331/ISSN(p): 2226-5724

which support both main-season and off-season paddy productions, provide about 72% of the rice production in the country [3].

Historically, Malaysia has never meet self-sufficiency level with respect to paddy production the highest level achieved was 92% during the third Malaysian plan [4]. The Ministry of Agriculture and Agro-based Industry, in an attempt to achieve higher self-sufficiency level and food security, adopted 4th National Agricultural Policy, which is now called the National Agro-food Policy 2011-2020. This policy is targeting at making the country to attain 85% self –sufficiency level in rice production by developing large scale paddy farming in Sabah and Sarawak through private sector investment and sector modernization. However, the overall production of rice does not satisfy the country`s need, the country therefore resorts to importation of rice to augment deficit (gap) between consumption and domestic production in the country (figure 1).

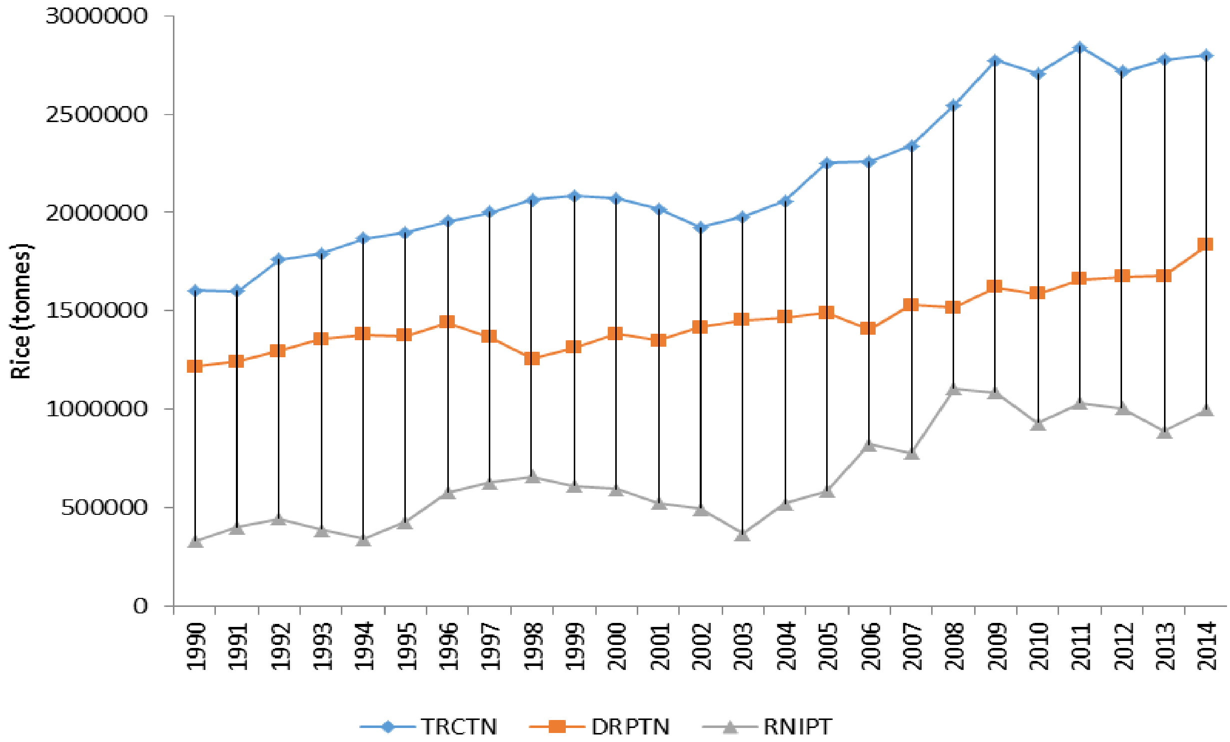

Figure-1. Malaysia Rice Consumption, Domestic Production and Net Import, 1990-2014

Note: TRCTN (Total Rice Consumption); DRPTN (Domestic Rice Production); and, RNIPT (Rice Net Import).

Source: Time-series Data- Department of Statistics Malaysian (2015) and World Rice Statistics Online Query Facility-IRRI

Paddy farming in Malaysia is inherently operated with menace emanating from weeds, pests and diseases, inadequate supply of quality seed, extension support and intensive management practices. Others include limited opportunities for credit and the presence of technical inefficiency, which was identified by previous studies [5-7] focusing on this sector as indispensable for sustainable paddy production. The ability of Paddy farmers to adopt new technology and achieve sustainable production depends on their level of profit efficiency, mostly determined by variable input and output prices as well as cost of fixed factors of production. Some factors would operate to cause changes in farm level profit and its efficiency. Determining this factors and magnitude of their effects on farm level profit efficiency constitute the empirical questions this study sought to answer. However, to assess the resource productivity of Paddy farmers in MADA granary area is one of the prerequisites for increasing Paddy productivity in the study area. Therefore, the need for sustainability of Paddy production in MADA justifies this study. Moreover, the study estimates normalized stochastic profit function in addition to profit efficiency function of the Paddy farmers in MADA granary area.

2. MATERIAL AND METHODS

2.1. Study Area

The study was conducted in Muda Agricultural Development Authority (MADA) located in the north-west of peninsular Malaysia. MADA covers two Malaysian States that comprise Kedah and Perlis with a total area of 126,000 hectare which includes towns, forest and swamp areas. Area irrigated for paddy double cropping is 95,856 hectares of which 80.66% is located in the State of Kedah and 19.34% in the State of Perlis [8]. For easy administration MADA was divided into four regions and through the concept of area development the four regions was further divided into 27 localities (figure 2). About 49,300 farmers are cultivating paddy in the study area either with state of sole ownership of land or renting [9]. MADA area accounts for 40% of national paddy production and 22% of paddy cultivation area in the country.

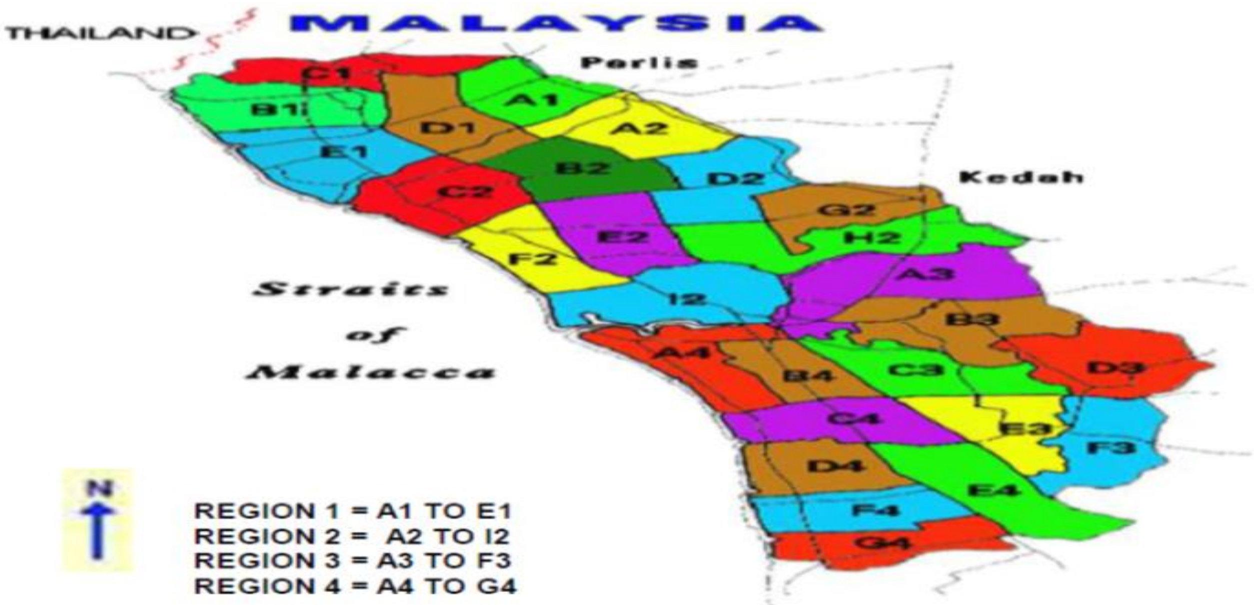

Figure-2. Study Area

Source: Rafidah [9]

2.2. Data Collection

A structured questionnaire was used to collect primary quantitative input-output data and prices of input and output variables from a sample of 397 households. Information on socio-economic variables such as age, education, farming experience, extension contact, credit used, planting method, broadcasting method, use of high yield variety, agrochemicals and harvesting method were also collected.

2.3. Sampling Techniques

The registers of the participating paddy farmers from MADA granary authority constituted a sampling frame. The four regions were taken as the sampling units as a first stage of sampling. At the second stage localities were randomly selected from each region to represent the region. The last stage involved random selection of paddy farmers in each locality making a total of 397 respondents.

2.4. Data Analysis

A multiple regression model based on Stochastic Frontier Profit Function which assumed Cobb-Douglass specification form and Inefficiency function model was employed to determined profit efficiency and determinants of profit inefficiency of paddy farmers using a single stage maximum likelihood function estimation procedure of Frontier version 4.1 [10].

2.5. Theoretical Framework

Production inefficiency is usually analysed by its two components: technical and allocative efficiency. Recent development combined both measures into single system, which enable more efficient estimates to be obtained by simultaneous estimation of the system [11]. The profit function approach combines the concepts of technical and allocative efficiency in the profit relationship and any errors in the production decision are assumed to be translated into lower profits or revenue for the producer [12]. Profit efficiency, therefore, is defined as the ability of a farm to achieve highest possible profit given the prices variable inputs and levels of fixed factors of that farm. Profit inefficiency in this context is defined as the loss of profit for not operating on the frontier Ali and John [13]. Battese and Coelli [14] extended the stochastic production frontier model by suggesting that the inefficiency effects can be expressed as a linear function of explanatory variables, reflecting farm-specific characteristics.

The advantage of this model is that it allows the estimation of farm specific efficiency scores and the factors explaining the efficiency differentials among farmers in a single stage estimation procedure. Following Rahman, et al. [15] this study utilizes the Battese and Coelli [14] model by postulating a profit function, which is assumed to behave in a manner consistent with the stochastic frontier concept. The stochastic profit function is defined as:

$$\pi^* = \frac{\pi}{\rho} = h(q_i, z)exp(v_i - u_i) \tag{1}$$

Where: π^* = normalized profit of i-th farmer; $\frac{\pi}{\rho}$ = description of the normalized profit, q_i = vector of variable inputs;

Z = vector of fixed input(s); P = output price used to normalize variables in the model; π = farmer's profit defined as total revenue minus total cost of production (here paddy revenue consists of returns from the sales of paddy output; while total cost is made up of the cost of seed, fertilizer, labour and agrochemical); $exp(v_i - u_i)$ = composite error term.

The profit/economic efficiency (EE) of an individual farmer in the context of stochastic frontier profit function is derived as a ratio of the predicted, observed or actual profit (π_i) to the corresponding predicted maximum profit (π_i^*) for the best farm or frontier profit given the price of variable inputs and the level of fixed factor(s) of production of that farmer. Mathematically, it is expressed following Sunday, et al. [16] as:

$$Profit\ Efficiency\ (EE) = \frac{Actual\ farm\ profit}{Frontier\ profit} = \frac{\pi_i}{\pi_i^*} = \frac{(q_i, z)\exp(v_i - u_i)}{(q_i, z)\exp(v_i)} \tag{2}$$

Then,

$$Profit\ Efficiency = \frac{\exp(v_i - u_i)}{\exp(v_i)} = \exp(-u_i) \tag{3}$$

The stochastic disturbance term (e_i) consists of two independent elements: *"v" and "u"*. The symmetric two sided error term (v) account for random variation in profit attributed to factors outside the farmer's control (random effects, measurement errors, omitted explanatory variables and statistical noise). The one-sided component (u) is a non-negative error term accounting for the inefficiency of the farm. Thus represents the profit shortfall from its maximum possible value that will be given by the stochastic profit frontier. However, when $u = 0$, it implies farm profit lies on the efficiency frontier (i.e. 100% profit efficiency) and $u < 0$ implies that the farm profit lies below the efficiency frontier. Both v and u are assumed to be independently and normally distributed with zero mean and constant variance.

2.6. Stochastic Profit Function Model Specification

A multiple regression model based on the stochastic frontier profit function which assumes Cobb-Douglas functional form was employed to determine the profit efficiency of paddy producers in the study area. The frontier model estimated following Ifeanyi and Onyenweaku [17]; Nganga, et al. [18] and Sunday, et al. [16] was therefore specified as follows:

$$In\pi_i^* = \beta_0 + \sum_{j=1}^{4} \beta_j \, InX_{ji}^* + \beta_k InX_k + v_i - u_i \quad (4)$$

Where:

π_i^* = normalized profit computed for i-th farmer,

In = natural log,

X_1^* = price of seed (RM/kg) normalized by price of paddy,

X_2^* = price of fertilizer (RM/kg) normalized by price of paddy,

X_3^* = price of labour (RM/manday) normalized by price of paddy,

X_4^* = price of herbicides (RM/lt) normalized by price of paddy,

X_k = area of land cultivated (ha),

β_0, $\beta_{1,..4}$ and β_k are parameters to be estimated, v_i represents statistical disturbance term and u_i = represents profit inefficiency effects of i-th farmer.

2.7. Profit Inefficiency Function Specification

The determinants of profit inefficiency of paddy farmers in line with Ogunniyi [19] were modelled following specific characteristic of farmers in the study area. From equation (4) the u_i component is specified as follows:

$$\mu_i = \lambda_0 + \sum_{r=1}^{15} \lambda_r \, w_r + \kappa \quad (5)$$

Where:

μ_i = Profit inefficiency of i-th farmer, λ_0 and λ_r are parameters to be estimated, w_r are variables explaining inefficiency effects, r =1,2,3....,n, k is truncated random variable, w_1 = Farmer`s age (year), w_2= Level of education (years), w_3 = Marital status (married = 1, single =0), w_4= Household size (number), w_5= Farming experience (year), w_6 = Access to extension contact (number), w_7= Credit usage (access =1, no access = 0), w_8= Farm location (Perlis = 1, Kedah = 0), w_9= Land cultivation technology (tractor = 1, others = 0), w_{10} = Improve seed variety (MR219 = 1, others = 0), w_{11}= Improve seed variety (MR220CL2 = 1, others = 0), w_{12}= Planting method (broadcasting = 1, transplanting = 0), w_{13}= Broadcasting method (machine = 1, manual = 0), w_{14}= agrochemical use (used = 1, not used = 0) and w_{15}= Harvesting method (machine =1, others = 0). Both equation (4) and (5) were jointly estimated by maximizing the likelihood function using the computer program Frontier version 4.1 [10].

3. EMPIRICAL RESULTS

3.1. Estimation Procedure

Maximum likelihood estimates of the parameters in the Cobb-Douglas and trans-log stochastic profit function were obtained using Frontier 4.1. The unknown parameters of the stochastic profit function and inefficiency were estimated simultaneously. To select the lead functional form for the data, hypothesis test base on the generalized likelihood ratio test (LR) was conducted. λ = - 2 {log [L (H_0) – log [L (H_a)]} formula was used to carry out the likelihood ratio test. The first null hypothesis is the statement that the Cobb-Douglas profit function is the best fit for the data. Result indicated that it is fail to reject the first null hypothesis because Lambda (λ) value (-64.33) was less than critical value (24.384) at 5% level of significance, meaning that Cobb-Douglas form was the best functional form for the data (table 1). After having Cobb-Douglas profit functional form as the function that suit the data, it was applied to run another generalized likelihood ratio test for the second null hypothesis which states that profit inefficiency is absent.

Table-1. Generalized likelihood ratio test for stochastic profit model

Null hypothesis	Log likelihood of H_0	Log likelihood of H_a	Test Statistic (λ)	Degree of Freedom	Critical value (5%)	Decision
Cobb-Douglas is the best fit	-121.143	-153.308	-64'330	15	24.384	Fail to reject H_0
No profit inefficiency	-168.161	-121.143	94.036	15	24.384	Reject H_0

Note: Taken from table 1 of Kodde and Palm [20] using 5% levels of significance.

This means that there is no profit inefficiency from the profit function of paddy farms and the actual profit which is higher than the estimated profit is caused by uncontrollable factors. The LR test revealed that this second null hypothesis is rejected at 5% level of significance as test statistics value (94.036) is greater than the critical value (24.384).

Table 2 shows the MLE estimates of normalized frontier profit function. The estimated value of gamma (γ) is close to 1 and is significantly different from zero thus ascertaining the fact that a higher level of inefficiencies exist in paddy production. The estimated gamma parameter of 0.9333 is highly significant at 1% level of significance. This revealed that 93.33% of variation in the actual profit from the maximum profit (frontier profit) among the farms was mainly due to the differences in farmers` practices rather than random variability. The table indicates that the coefficients of the estimated parameters of the normalized profit function were positive except the price of labour.

Table-2. Maximum likelihood Estimates of Cobb-Douglas Stochastic Frontier profit Function

Variable	Parameter	Coefficient	Std. Error	t - Value
Constant	β_0	0.3879***	0.1111	3.492
Price of Seed	β_1	0.6421*	0.3445	1.864
Price of Fertilizer	β_2	0.8963*	0.5338	1.679
Price of Herbicides	β_3	0.339**	0.1688	2.008
Price of Labour	β_4	- 0.5211	0.8117	- 0.642
Land Area	β_5	0.1346**	0.0606	2.222
Variance Parameters				
Sigma-Squared	δ^2	0.7721***	0.0883	8.746
Gamma	γ	0.9333***	0.0796	11.7254
Log likelihood		-121.143		

Note: *, ** and *** denote significance at 10%, 5% and 1% level respectively.

This implies that a unit increase in the price of inputs with positive coefficients will lead to increase in the normalized profit realized from the production of paddy and vice-versa. Furthermore, the coefficient for price of fertilizer with positive value of 0.8963 was statistically significant at 10% level of significance and this was revealed to be the most important variable determining the profit efficiency. This mean that for a 10% increase in the price incurred through fertilizer purchase, the profit obtained from the paddy production will increase by 8.963%. Oladeebo and Oluwaranti [21] reported similar results. The positively signed and significant coefficient of land area (0.1346) at 5% level of significance indicates the fact that paddy farmers were operating at small scale level, therefore increasing their cultivated land area will improve profit other things being equal. Alternatively a 10% increase in cultivated land area will lead to 1.346% increase in profit obtained from the production of paddy. A research conducted by Ifeanyi and Onyenweaku [17] and Sunday, et al. [16] reported comparable results.

A farm level profit also has negative relationship (-0.5211) with respect to the price of labour in the model. The result shows that continuous increase in the price incurred through labour purchases will lead to the reduction in farm level profit of paddy farmers in the study area. The result is consistent with the findings of Oladeebo and Oluwaranti [21] and Ogunniyi [19]. The analysis also showed that the sign and significance of the estimated coefficient of price of herbicides (0.339) have important implications on the profit of the paddy farmers. In the light of this, the model indicated that as the price increase through the purchase of herbicides the profit obtained by the farmers through the production of paddy will be increased. This finding is also in conformity with result estimated by Oladeebo and Oluwaranti [21].

3.2. Profit Inefficiency Function

The purpose of estimating inefficiency model was to determine factors that explain efficiency or to determine the relationship between profit efficiency and farm household characteristics. The analysis of the model showed that the signs and significance of the estimated coefficients have important implications on the profit efficiency of paddy producers (Table 3).

The parameters estimates as seen in the table consisting of: level of education, farming experience, extension service, MR219 seed variety, planting method, broadcasting method as well as agrochemicals were negative and significant at 10%, 5%, 1%, 5%, 10% and 1% respectively. Apart from the significant variables, other variables that were not significant but have negative relationship with profit inefficiency are: credit access, land cultivation method, MR220 seed variety and harvesting method while age, marital status, household size and farm location possess positive relationship with profit inefficiency. The negative signs of the variables indicates that as these variables increases the profit inefficiency of paddy farmers decreases while the coefficients with positive signs implies that as these variables increases the profit inefficiency of paddy producer increased.

The estimated result with respect to education is consistent with findings of Wallace [22]; Nganga, et al. [18] and Ogunniyi [19]. The positive relationship existing between age and inefficiency implies old tend to exhibit higher level of profit inefficiency and this finding is in accordance with reports of Sunday, et al. [16]. The household size relationship estimated to be positive in this work was similar to the reports by Nganga, et al. [18]. Farming experience and extension service estimated in the profit function model corroborates the findings reported by Ogunniyi [19].

Table-3. Maximum likelihood Estimates of Cobb-Douglas profit Inefficiency Function

Variable	Parameter	Coefficient	Std. Error	t - Value
Constant	λ_0	1.0662**	0.3904	2.731
Age	λ_1	0.0990	0.2828	0.350
Education	λ_2	-0.5749*	0.3239	-1.775
Marital Status	λ_3	0.0683	0.6899	0.099
Household size	λ_4	0.0045	0.0037	1.203
Farming experience	λ_5	-0.0284**	0.0142	-1.997
Extension service	λ_6	-0.5115***	0.1427	-3.584
Credit access	λ_7	-0.4331	0.6532	-0.663
Farm location	λ_8	0.0079	0.0174	0.454
Land cult. method	λ_9	-0.3512	0.6877	-0.511
MR219	λ_{10}	-0.7427*	0.3834	-1.937
MR220CL2	λ_{11}	-0.0053	0.0162	-0.327
Planting method	λ_{12}	-1.4226**	0.5267	-2.701
Broadcasting method	λ_{13}	-0.0024*	0.0014	-1.714
Chemicals	λ_{14}	-0.8641***	0.1010	-8.555
Harvesting method	λ_{15}	-0.0106	0.0081	-1.307

Note: *, ** and *** denote significance at 10%, 5% and 1% level respectively.

Planting method (-1.4226) followed by chemicals (-0.8641) and MR219 seed variety tend to show evidence of high levels of profit efficiency for paddy farmers in the study area. However, completely in line with a priori expectation, the analysis indicates that the application of modern farming technology in paddy production has significant function on elevating profit efficiency of farmers.

3.3. Profit Efficiency Distribution of Paddy Farmers

The frequency distribution of farm specific efficiency scores for the paddy producers is presented in Table 4. The estimates showed that, considerable amount of profit is lost from the paddy production because of the existence of profit inefficiency in resource use among paddy farmers. The findings revealed that paddy farmers achieved on the average 73.2% level of profit efficiency.

The result had revealed profit inefficiency gap of about 26.8%. This implies that the average farmer in the study area could increase profit by 26.8% by improving their technical and allocative efficiency.

Table-4. Frequency Distribution of Profit efficiency

Efficiency scores	Perlis State		Kedah State		MADA	
	Frequency	%	Frequency	%	Frequency	%
1.00	0	0.00	0	0.00	0	0.00
> 0.90 < 1	7	8.00	4	1.30	11	2.80
> 0.80 ≤ 90	23	27.40	82	26.20	105	26.50
> 0.70 ≤ 0.80	30	35.70	109	34.80	139	35.00
> 0.60 ≤ 0.70	16	19.10	78	24.90	94	23.70
> 0.50 ≤ 0.60	4	5.00	22	7.00	26	6.50
> 0.40 ≤ 0.50	2	2.40	12	3.90	14	3.50
> 0.30 ≤ 0.40	2	2.40	6	1.90	8	2.00
Total	84	100	313	100	397	100
Mean	0.757		0.725		0.732	
Minimum	0.340		0.305		0.305	
Maximum	0.948		0.939		0.948	
Std. Dev.	0.124		0.119		0.121	

Source: Author computation from field survey data

The paddy farmers exhibited varied profit efficiencies ranging from 30.5% to 94.8%. However, the least profit efficient paddy farmer needs an efficiency gain of 73.3% (1-0.305/0.948)100 of production if such a farmer is to attain the profit efficiency of the best efficient farmer in the study area. Likewise for an average profit efficient farmer, he will need an efficiency gain of 28.2% (1-0.733/0.948)100 to attain the most efficient level of production. Furthermore, the most profit efficient farmer in the study area needs about 0.052% gains in profit efficiency to be on the frontier efficiency. However, despite the variation in efficiency, it could be seen that about 87.9% of paddy farmers seemed to be skewed towards efficiency level of greater than 60% and above. On State wise, Perlis is revealed on the average to be the most profit efficient (75.7%) with minimum, maximum and coefficient of variation in the profit of 34.%, 94.8% and 12.4% respectively compared to Kedah with average profit efficiency level of 72.5%, minimum, maximum and coefficient of variation of 30.5%, 93.9% and 11.9% respectively.

4. CONCLUSIONS

Maximum likelihood estimates of the specified Cobb-Douglass stochastic profit function model shows that farmer`s profit efficiency has not reached the frontier level. The results indicates that paddy farmers profit efficiency could still be increased by 26.8% using the available technology to the farmers. Based on the magnitude of the profit efficiency estimates, the study has found education, farming experience, extension service, MR219 seed variety, broadcast planting method, machine broadcasting method and herbicides as the major significant determinants of profit efficiency among Paddy producers. Finally, inefficiency in Paddy production could be reduced significantly by improving the level of the above identified socio-economics and technological packages.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

REFERENCES

[1] R. R. Mohd and M. D. M. Shah, "Food and livelihood security of the Malaysian Paddy farmers," *Economic and Technology Management Review,* vol. 8, pp. 59–69, 2013.

[2] MOA & AI, "Perangkaan Padi Malaysia-Jabatan Pertanian," Ministry of Agriculture and Agro-Based Industry, 2014.

[3] M. M. M. Najim, T. S. Lee, M. A. Haque, and M. Esham, "Sustainability of rice production: A Malaysian perspective," *Journal of Agricultural Sciences,* vol. 3, pp. 1–12, 2007.

[4] C. Siwar, N. D. M. Idris, M. Yasar, and G. Morshed, "Issues and challenges facing rice production and food security in the Granary areas in the East Coast economic region (ECER), Malaysia," *Research Journal of Applied Sciences, Engineering and Technology,* vol. 7, pp. 711–722, 2014.

[5] R. Alias and L. Ismail, "Estimating economic efficiency in paddy farms: A case of Northwest Selangor IADP," *Pertanika Journal Social Science & Humanities,* vol. 4, pp. 77–82, 1996.

[6] L. Ghee-Thean, M. M. Ismail, and M. Harron, "Measuring technical efficiency of Malaysian Paddy farming: An application of stochastic frontier approach," *Journal of Applied Sciences,* vol. 15, pp. 1602–1607, 2012.

[7] L. Mailena, M. N. Shamsudin, A. Radam, and Z. Mohamed, "Efficiency of rice farms and its determinants: Application of stochastic frontier analysis," *Trends and Applied Sciences Research,* vol. 9, pp. 360–371, 2014.

[8] R. Kamaruddin, A. Jamal, and M. S. Nariman, "Happiness and its influencing factors among Paddy farmers in Granary area of Mada," *World Applied Sciences Journal,* vol. 28, pp. 91–99, 2013.

[9] A. Rafidah, "GIs based Paddy maturity monitoring supporting system," MSc Thesis Unwersiti Teknologi Mara, 2011.

[10] T. J. Coelli, "A guide to frontier version 4.1: A computer program for stochastic frontier production and cost function estimation." CEPA Working Papers WP7/96, University of Queensland, 1996.

[11] J. Wang, W. J. Eric, and C. L. Gail, "A shadow-price frontier measurement of profit efficiency in Chinese agriculture," *American Journal of Agricultural Economics,* vol. 78, pp. 146–156, 1996.

[12] F. Ali, A. Parikh, and M. Shah, "Measurement of profit efficiency using behavioural and stochastic frontier approaches," *Applied Economics,* vol. 26, pp. 181–188, 1994.

[13] M. Ali and F. C. John, "Profit efficiency among basmati rice producers in Pakistan Punjab," *American Journal of Agricultural Economics,* vol. 71, pp. 303–310, 1989.

[14] G. E. Battese and T. J. Coelli, "A model for technical ineffciency effects in a stochastic frontier production function for panel data," *Empirical Economics,* vol. 20, pp. 325–332, 1995.

[15] K. M. M. Rahman, M. I. A. Mia, and M. K. J. Bhuiyan, "A stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh: An empirical analysis. ," *Agriculturists,* vol. 10, pp. 9–19, 2012.

[16] A. B. Sunday, O. E. Uwemedimo, J. N. Elizabeth, N. K. Kesit, J. E. Daniel, and I. Akwa, "Economic efficiency of Cassava based farmers in Southern Wetland Region of Cross River State, Nigeria: A translog model approach," *International Journal of Humanities and Social Science,* vol. 3, pp. 173–181, 2013.

[17] N. N. Ifeanyi and C. E. Onyenweaku, "Economic efficiency of Fadama telfairia production in Imo State Nigeria: A translog profit function approach." Available Http://mpra.ub.uni-muenchen.de/13469, 2007.

[18] S. K. Nganga, J. Kungu, N. De Ridder, and M. Herrero, "Profit efficiency among Kenyan smallholders milk producers : A case study of Meru-South District , Kenya," *African Journal of Agricultural Research,* vol. 5, pp. 332–337, 2010.

[19] L. T. Ogunniyi, "Profit efficiency among maize producers in Oyo State, Nigeria," *ARPN Journal of Agricultural and Biological Science,* vol. 6, pp. 11–17, 2011.

[20] D. A. Kodde and F. C. Palm, "Wald criteria for jointly testing equality and inequality restrictions," *Econometrica,* vol. 54, pp. 1243–1248, 1986.

[21] J. O. Oladeebo and A. S. Oluwaranti, "Profit efficiency among Cassava producers: Empirical evidence from South Western Nigeria," *Journal of Agricultural Economics and Development,* vol. 1, pp. 46–52, 2012.

[22] H. E. Wallace, "Farm and off-farm work decisions: The role of human capital," *Review of Economics and Statistics,* vol. 62, pp. 14–23, 1980.

APPENDIX

Frontier-4.1. Result of Cobb-Douglass Stochastic Frontier Profit Function and Profit Inefficiency effects

the final mle estimates are :			
coefficient	**standard-error**	**t-ratio**	
beta 0	0.38798565E+00	0.11110147E+00	0.34921739E+01
beta 1	0.64215212E+00	0.34450018E+00	0.18640110E+01
beta 2	0.89630295E+00	0.53383110E+00	0.16790010E+01
beta 3	0.33897919E+00	0.16881324E+00	0.20080131E+01
beta 4	-0.52117611E+00	0.81173161E+00	-0.64205473E+00
beta 5	0.13457565E+00	0.06055013E+00	0.22225493E+01
delta 0	0.10662854E+01	0.39046943E+00	0.27316443E+01
delta 1	0.09906032E+00	0.28274516E-02	0.35035195E+00
delta 2	-0.57492215E+00	0.32391515E+00	-0.17749159E+01
delta 3	0.06833029E+00	0.68985809E+00	0.09904979E+00
delta 4	0.00452043E+00	0.00376046E+00	0.12020958E+01
delta 5	-0.02842653E+00	0.01423433E+00	-0.19970404E+01
delta 6	-0.51146022E+00	0.14269038E+00	-0.35844058E+01
delta 7	-0.43315978E+00	0.65312674E+00	-0.66312674E+00
delta 8	0.00791798E+00	0.01741443E+00	0.45467929E+00
delta 9	-0.35118395E+00	0.68764513E+00	-0.51070521E+00
delta10	-0.74269849E+00	0.38339227E+00	-0.19371765E+01
delta11	-0.00529086E+00	0.01619542E+00	-0.32668871E+00
delta12	-0.14225543E+01	0.52668223E+00	-0.27009727E+01
delta13	-0.00237205E+00	0.00138357E+00	-0.17144488E+01
delta14	-0.86411189E+00	0.10101243E+00	-0.85545105E+01
delta15	-0.01056429E+00	0.00808168E+00	-0.13071905E+01
sigma-squared	0.77214750E+00	0.08828364E+00	0.87462128E+01
gamma	0.93328448E+00	0.07959502E+00	0.11725413E+02
log likelihood function = - 0.12114309E+03			
LR test of the one-sided error = 0.10804239E+03			