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# Resource-Use and Allocative Efficiency of Paddy Rice Production in Mada, Malaysia

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**Abstract**
The study examined resource-use and allocative efficiency of paddy rice production in the MADA, Malaysia. A total sampling size of 396 rice farmers were selected using a multistage random sampling through a well-structured questionnaire. The independent samples F-tests, Ordinary Least Square analyses techniques, descriptive statistics, Gross margin analysis and Cobb-Douglas production function analysis that combines the conventional neoclassical test of economic and technical efficiencies was employed in the study. Findings revealed that all inputs used were positively significant. Rice production was found to be profitable as farmers realized RM2,054.03 per ha as Gross Margin in the study area. Result of the allocative efficiency of inputs confirmed that rice producers in the area did not attain optimal allocative efficiency, seed input (0.29) had the highest allocative efficiency while fertilizer input (0.06) showed the least allocative efficient input. The findings of the study emphasized the need to improve farm efficiency at all levels. It is therefore, recommend that the rice farmers be encouraged to use their inputs up to the point the values of the marginal products (MVPs) equates their factor prices (i.e. MVPs = PXs).
**Keywords:** Resource -Use: Allocative Efficiency, Paddy Rice, MADA, and Malaysia.

## 1.0 Introduction

As an important staple crop and a strategically agricultural commodity for food security, rice has always been given a special treatment by the Malaysian government in order to improve its production. The shifting from transplanting to direct seeding technology of planting of rice has been reported to increased weedy rice infestations resulting to crop loss per year at RM 180 million (Angin, 2004) causing no significant growth in yield as the mean yield is at 3.9 tons per hectare while the actual paddy farm yields varies from 3-5 tons per hectare below the neighbouring countries such as Vietnam and Indonesian at 5.5 tons per hectare and 4.9 tons per hectare respectively (Dos, 2013). Even with the vital use of rice, the increase in paddy production threatened by the land expansion is quite challenging presently due to constraints of suitable soil fertility, competition with industrial and domestic needs. A lots of problems arising in paddy farming, resulting out in excessive use of inputs such as chemical fertilizers, insecticides and pesticides, above a given recommendations. This has caused soil degradation, water pollution and an increased number of pests, which are resistant against the application of pesticides. About 0.7millions hectares with average growth of about 0.27% per year remain a constant cultivable land (Wong *et al*., 2010). Further, Financial constraint of farmers in using sophisticated machinery that can help in boosting the yield of rice production is hampered. All these circumstances have a negative effect by threaten level of productivity, process of technology transfer and cannot guarantee self-sufficiency. This study aims to contribute to the literature by providing a micro perspective on measuring farm efficiency level. It will also serve as a guideline to all the researchers', extension agents, policy maker and farmers involved in paddy rice production. Efficiency has been an area of concentration in the investigation of farm operations. According to (Sadoulet & Janvy, 1995), efficiency of a farm is defined as how available resources are effectively used for the purpose of profit maximization at given technology, available fixed factor and factor. It also means how a firm is being successful in producing as large as possible output from a given set of inputs when both the inputs and output are measured accurately.

Economic efficiency can be decomposed into two parts namely; technical and allocative efficiency and when they occur jointly are referred to as economic efficiency (Yotopoulus and Nugent, 1976). Its aims in maximizing profit while minimizing costs. A farm is said to be allocative or price efficient if it maximize profit by equating marginal value of product (MVP) of each variable input to its price. However, a farm is technically efficient if it produces a higher level of output from the same level of inputs as compared to another farm. Even, if the farmers are allocatively efficient, they may not be actualizing the technically feasible maximum production as a result of inefficient management of the resources. In such manner, a comparison of output in relation to inputs level used will reveal the main efficiency which is technical efficiency. Nicholson (1978) stated that economic efficiency is the same as Pareto efficiency. An allocation of resources is Pareto efficient if no one individual (or activity) can be made better – off without making someone else (or another activity) worse-off. The concept of Pareto efficiency can be employ to evaluate different ways of allocating resources (Hardwick *et. al*. 1988). Also, in agriculture, productivity is majorly measured in terms of the efficiency with which factor inputs, such as land, labour, fertilizer, weedicides, tools, and seeds etc are changed to output within the production process (Umoh and Yusuf, 1999). Resource use is a concept to designate the allocation of resources such as land, labor, capital and management in their various forms between competing alternatives (Olayide and Heady, 1982). They further defined agricultural productivity as an index of the ratio of farm output to the value of the total inputs used in producing the output. They also agreed that resource productivity is definable in terms of individual inputs or a combination of them. They opined that maximum resource productivity would imply obtaining the maximum possible output from minimum possible set of inputs. Thus optimal productivity of resources implies an efficient utilization of resources in production process. This implies that productivity and technical efficiency are synonymous.

The objectives of the study include to:

i) Examine the socio-economic characteristics of rice farmers in the region;
ii) Determine the costs and return associated with rice production systems;
iii) Measure the allocative efficiency of resource-use in rice production in the study area.

## 2.0 Methodology

The study was carried out in MADA (Muda Agricultural Development Authority) in Malaysia. It is an area established to increase paddy production for the Malaysian community. It is the largest and the most vital "granary area" in Peninsular Malaysia with the Muda Irrigation Scheme that covers about 125,155 hectares of which 105,851 hectares are in the north-western part of Kedah State and 20,304 ha are in the southern part of Perlis State. There are two states in MADA namely Kedah and Perlis with four regions, namely Kangar region, Jitra region, Pendang region and Kota Sarang Semut region. MADA is located in northwest Peninsular Malaysia, situated at latitudes 5° 5' to 6° 40' and longitudes 100° 05' to 101° 08' with average percentage in temperature of 27.4°C to 30.5°C. MADA provides 40 per cent of national rice production and 22 per cent of rice cultivation area with an average yield of 5 tonnes per hectare per season, higher than the national average of 3.74 (MADA, 2010).

### 2.1 Data Collection and Sampling Method

To achieve the study objectives, data were obtained from primary and secondary source with the aid of a structured questionnaire with interview. Secondary source of information comprises of journals, text books, internet search, websites, published and unpublished materials relevant to the study. The study used multistage random sampling technique to select the sample respondents of 396 paddy farmers. In the first stage, four regions were selected; Kangar region, Jitra region, Pendang region and Kota Sarang Semut region. In the second stage, 25 localities were randomly selected from 27 localities in each region. A total number of 396 paddy farmers in each locality were randomly selected at the last stage as the sample size for the research.

### 2.2 Method of Data Analysis

The analytical tools that were employed for this study include descriptive statistics, gross margin analysis, production functions, regression analysis, and marginal value product (MVP) with the use of APP, MPP, and MFC. Descriptive statistics such as frequency, percentage and rank order was used. This technique was used to assess the socio-economic characteristics of rice farmers in the study area. Gross margin analysis was used to capture the second objective while MVP to MFC ratio was used to determine the economic efficiency of the resource used in paddy production. The study adopted the method used by (Oniah *et al*, 2008; Sani *et al*, 2010; Idumah *et al*, 2014 and Sadiq *et al*, 2015). The output elasticity of each production input was determined from the Cobb-Douglas production function. Marginal value productivities (MVPs) for each resource is computed and compared with their respective acquisition cost and marginal factor cost (MFC). The mean estimates (output and input costs) of the log-linearized Cobb-Douglas production function were used in the calculation of MVPs of each of the production (inputs) with its MFCs. The Cobb-Douglas production function was easy and fitted for calculating the ratio especially when the variables are measured in value terms (Olarinde and Ajetomobi, 2000).Cobb-Douglas functional form was used based on economic, econometric and statistical criteria including the signs and magnitude of the coefficient, the magnitude of $R^2$, F-statistics (Umoh and Yusuf, 1999; Gujarati, 1999). Based on the above reviews, the following production function was employed;

Gross return = Yield in Kg/ha × rice price per kg (Spoor, 2010). The gross margin was represented by

G.M = G.I – TVC …………………………………………………………………….. (1)

Where G.M = Gross margin

G.I = Gross sales/income TVC = Total variable cost

In general the Cobb-Douglas production function can be specified as follows:

$$Y = b\, X_1^{b1}\ X_2^{b2}\ X_3^{b3}\, X_4^{b4}\ X_5^{b5}\ \ u \quad \ldots \ldots \ldots \ldots \quad (2)$$

The form can be converted to linear form by taking the logarithms;

$$Ln\, Y = Lnb_0 + b_1 LnX_{1i} + b_2 LnX_{2i} + b_3 LnX_{3i} + b_4 LnX_{4i} + b_5 LnX_{5i} + u \ldots . . (3)$$

Where;
Y = Rice yield (kg/ha$^{-1}$)
$X_1$= seed (kg/ ha$^{-1}$)
$X_2$ = fertilizer (kg/ ha$^{-1}$)
$X_3$ = labour (man-hr/ hr)
$X_4$ = Pesticides (L/ha)
$X_5$ = Herbicides (L/ha)
$b_0$= Intercept term (scale parameter)
$b_1, b_2, b_3, b_4, and\ b_n$ are the regression coefficients with respect to $X_1$, $X_2$, $X_3$, and $X_4$ inputs respectively.
$U$= error term independently distributed with zero mean and finite variance.

**Determining Technical Efficiency of Resource use**
To calculate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of inputs (Farell,1957; Coeilli and Battesse, 1996). The elasticity of production was used which is the percentage change in output as a ratio of a percentage change in input use.
EP= MPP/APP
Where:
EP = Elasticity of production
MPP = Marginal physical product
APP = Average Physical product
If
EP = 1: Constant return to scale
EP = <1: Decreasing return to scale
EP = >1: Increasing return to scale.
**Determining Economic Efficiency of Resources Use**
The average physical product APP is calculated by;

$$\text{APPi} = \frac{Y}{X}$$

where Y and X are the mean of the output and inputs respectively .............................. (4)
The marginal physical product MPP was given as;
MPPxi = bi. APPi  where bi is the elasticity of the various inputs used………………. (5)
The Marginal value product (MVP) of production is given as:
MVP = MPPxi. PYi……..……………………………………….………….................... (6)
$P_Y$ is the output (paddy) price
$P_{xi}$ is the price per unit of resource input used
Marginal factor cost (MFC) is the price for each inputs used estimated as average acquisition cost.

$$\text{r} = \frac{MVP}{MFC} \quad \text{………..…………………………………... …........................................... (7)}$$

Where:
MVP = marginal value product
MFC = marginal factor cost
R= numerical constant
In a way to substitute the efficiency hypothesis, focus was based on the estimated value of R and its closeness to unity. Efficiency is attained if:
MVP = MFC ………………………………………..…………………………….. (8)
Decision rule: Efficiency (r) =1, resources are economically utilized,
When r < 1 resources are over utilized, When r > 1, resources are underutilized.
The relative percentage change in MVP (Marginal value product adjustment) of each resource required in order to obtain optimal allocation of resources. i.e. r = 1 or MVP =MFC which was estimated using equation below:

$$D = \left(1 - \frac{MFC}{MVP}\right) X\ 100 \quad \text{………………………………………………………. (9)}$$

Where:
D = absolute value of percentage change in MVP of each resource.
Economic optimum occurs where MVP-MFC if r ≠ 1, it suggests that resources are not efficiently utilized. Adjustments could therefore be done in the quantity of inputs employed and costs in the production process to restore
r = 1.

 

## 3. Results and Discussion

### 3.1 Socio-economic Characteristic of Respondents

Table 1 present the farmer socio-economic characteristics and production inputs used for the analysis. This analysis was estimated to give an account of mean, percentage frequency distribution and standard deviations of the variables employed. The farmer socio-characteristics discussed were age, household size, farm size, education level and farming experience. This study shows that the farmers' average age is 54 years. It implies that the paddy productions are managed by elderly farmers as youth outmigration increases in agricultural sector due to the lack of interest. The most common age range for the farmers is 51 – 60 years. This study is in tandem with the findings of Fauzi, [13] (p.86), Mohd *et al, [*13] (p.64) and Lira *et al*. [14] (p. 6) who found that the average age of the paddy farmers in MADA was 50.0, 51.8 and 53.53 years respectively.

**Table 1: Summary of farmers' production inputs and socio-economic profile, MADA, Malaysia, 2013**

| Variable | Average | Minimum | Maximum | Standard Deviation | Units |
|---|---|---|---|---|---|
| Age | 54.00 | 24 | 79 | 11.21 | Years |
| Household size | 5.07 | 1 | 13 | 2.21 | Person |
| Farm Size | 2.53 | 0.29 | 6 | 1.32 | Hectare |
| Education | 9.26 | 0 | 13 | 2.83 | Years |
| Farming Experience | 26.87 | 2 | 70 | 13.05 | Years |

Source: Field Survey, 2013

The study also found out that the average household size of the farmers was 5.07 per home which was consistent with the findings of Lira *et al*. [14] (p. 6), Mohd *et al, [*13] (p.64) that had an average of 5.15 and 5 people per family size respectively and also consistent with the family size number reported in agricultural sector 2005; the mean farm size reported by the farmers was 2.53ha.This implies that larger percentage of paddy farmers in Mada were cultivating on a small farm size and their productivity will not be much higher as more size of land tends to increase productivity. In support, the findings of [13] (p.64) showed that the average farm size of the farmers in MADA was 2.21 ha while the findings was not in line with [14] (p. 6) that reported 4.25 ha. The most common educational level attained by the respondents, is high school with 65.90%. Most of the farmers attained education level at 9 years or level. This result is also in line with Lira *et al*. [14] (p.6) that found the same 9 years of attaining education level. Majority of the farmers had 21 – 30 years farming experience with averages of 26.87.This indicates that paddy farmers have more than 20 years of experience. This finding is similar with the findings of Mohd *et al, [*13] (p.64) that recorded 25.2.

### 3.2 Production Cost and Revenue

The average production obtained by sample farmers was about 2.0mt/ha and farmers received paddy price of RM1.42/kg. The total variable cost was RM840.34 per hectare. Farmers received gross income of RM2, 054.03 per hectare. Fertilizer inputs cost was dominated most among the inputs used by paddy farmers with RM282.10, followed by labour and seed cost respectively.

**Table 2: Production Cost and Revenue of rice production per hectare in MADA, Malaysia**

| Items | RM |
|---|---|
| Gross Return | 2894.37 |
| Yield in Kg/ha(2038.29) × rice price per kg(1.42kg) | |
| Variable Cost (RM/HA) | |
| Cost of Seed | 140.50 |
| Cost of Fertilizer | 282.10 |
| Cost of Labour | 200.54 |
| Cost of Pesticides | 125.00 |
| Cost of Herbicides | 92.20 |
| Total Variable Cost | 840.34 |
| Gross Income | 2054.03 |

Source: Field Survey, 2013

This result is a bit tandem with the findings of Lira *et al*, (2014) who found that farmers receive a gross income of RM2, 494. 94 in MADA. The positive gross margin showed that rice farm is profitable. This result revealed that rice production is highly profitable if the farm is well managed.

### 3.3 Production Function

Table 3 present the result of Cobb-Douglass production analysis using Ordinary Least Square (OLS) method. The $R^2$ estimated shows that 89% of variations in total rice yield were explained by the explanatory variables with the remaining 11% due to error term or uncontrollable factors in the model. The estimated $R^2$with 89% gives a better fit for the model as the closer to 1 shows the goodness of the model. Gujarati (2004) further recommends that the relevancy of a model should be judged in the light of correct specification, correct expected signs of the regressors, and statistical significance of the regression coefficient. Accordingly, these conditions have been satisfied in this study.

The production estimates had positive signs and conformed to the aprior expectation. All the five inputs used seed, fertilizer, labour, herbicides and pesticides influence rice yield in MADA, Malaysia. Even their rice output was elastic to the changes of those inputs as the farm exhibit an increasing return to scale (1.05). This implies that on average the rice farms has increasing return to scale which is the characteristics of stage one of the production function. It means if the rice farm increased all inputs by 1%, production will give 1.05%. This result obtained suggested that there is every possibility to increase production by improving the use of those inputs. Lira *et al*, (2014) also reported production elasticities of 1.28.

**Table 3: Estimated Results for Rice Production Function**

| Variables | Parameters | Coefficient | Standard Error | T-value |
|---|---|---|---|---|
| Constant | $\beta_0$ | 3.300588 | 0.186878 | 17.66169*** |
| Ln Seed (kg/ha) | $\beta_1$ | 0.266421 | 0.039383 | 6.764810*** |
| Ln Fertilizer(kg/ha) | $\beta_2$ | 0.503332 | 0.038496 | 13.07507*** |
| Ln Labour (man-hr/ha) | $\beta_3$ | 0.140334 | 0.043692 | 3.211894*** |
| Ln Pesticides(L/ha) | $\beta_4$ | 0.067790 | 0.017511 | 3.871295*** |
| Ln Herbicides(L/ha) | $\beta_5$ | 0.094587 | 0.033428 | 2.829603** |
| $R^2$ | | 0.896668 | | |
| F-Statistics | | 444.001*** | | |

Note: Numbers in Parenthesis are t-ratios
** Significant at 5% ($\alpha = 0.05$)
*** Significant at 1% ($\alpha = 0.01$)

Table 4 illustrated the level of efficiency of paddy farmers in the study area. MPP is used to measure how farm can decide on what resources to be used. From the estimated results, the values of the MPP show that the farmers were efficient in the use of labour, more efficient in the use of herbicides and most efficient in the use of pesticides as they have higher MPP value. This suggests that if additional units of labour, herbicides and pesticides were available and accessible, it would lead to an increase in rice yield per hectare by 21.39 man-hour of labour, 62.19litres of herbicides and 77.90 litres of pesticides among the farmer respectively.

**Table 4: Estimates of Efficiency Parameters in Rice Production in MADA, Malaysia, 2013.**

| Variables | App | Mpp | Mvp(MPP*PY) | Mfc(Px) | MVP/MFC=r | Efficiency Gap | Divergence % |
|---|---|---|---|---|---|---|---|
| Seed | 40.76 | 10.60 | 15.05 | 51.55 | 0.29 | -36.5 | -242.52 |
| Fertilizer | 9.29 | 4.65 | 6.60 | 115.62 | 0.06 | -109.02 | -1651.82 |
| Labour | 152.80 | 21.39 | 30.37 | 124.43 | 0.24 | -94.06 | -309.71 |
| Pesticides | 1298.27 | 77.90 | 110.62 | 98.87 | 1.12 | 11.75 | 10.62 |
| Herbicides | 690.95 | 62.19 | 88.31 | 57.60 | 1.53 | 30.71 | 34.78 |

Note: Px = Input unit prices, Py= output selling price (RM 1.42/kg), MVP= Marginal value product, r= Economic Efficiency level.

This implies that the farmers were technically efficient in the use of labour, more technically efficient in the use of herbicides and most technically efficient in the use of pesticides. Of all the resources used, fertilizer had the least MPP 4.65 kg. This shows inefficiency in the use of fertilizer given the level of technology and prices of the inputs. Table 4 further reveals that the ratios of the MVP to the MFC were greater than unity (1) for pesticide and herbicides. This implies that pesticide and herbicides were under-utilized while seed, fertilizer and labour were over- utilized (less than one). This means that paddy output was likely to increase and hence revenue if more of such inputs (pesticide and herbicides) had been used. The adjustment in the MVPs for optimal resource used indicated that for optimum allocation of resources requires pesticides to be adjusted with 10.62 per cent and herbicides with 34.78 per cent adjustment. Conversely, seed, fertilizer and labour inputs were over-utilized and required approximately 242 per cent, 1651 per cent and 309 per cent reduction respectively. Hence, since the use of pesticides and herbicides were under-utilized, farmers could increase their utilization in order to improve their economic efficiency.

It should be noted that the MVPs of the inputs were not negative indicating that rice farmers still use these resources within the economically rational range even though they were not optimally used. A similar study conducted by Alias *et al*., (2006) on rice production in Malaysia, revealed that farmers are economically inefficient with a mean efficiency ratio of 0.5509 and only 1.1 percent of the farmers are at least 80 percent efficient in terms of economic efficiency. Similarly, a study by Lira *et al*., (2014) on optimality of input used, input demand and supply response of rice production in Mada, Malaysia found that rice farmers were economically inefficient and there is need to increase chemicals and pesticides utilization for paddy production in order to improve their economic efficiency.

 

## 5. Conclusion and Recommendations

The rice farmers in the area were technically inefficient in the use of farm resources most especially in fertilizer input. The inefficiency of the farmers may be directly or indirectly linked to less concerted efforts by the extension service in the use of recommended rate of applications of inputs. Maximum profit achievement is possible by re-organizing input utilization allocation in farming such as by increasing the amount of pesticides and herbicides. Government agencies in charge with the agricultural sectors in the area should encourage the inputs utilization at a recommended rate so as to improve their economic efficiency. The findings of the study emphasized the need to improve farm efficiency at all levels. It is therefore, recommend that the rice farmers be encouraged to use their inputs up to the point the values of the marginal products (MVPs) equates their factor prices (i.e. MVPs = PXs).

**Author Contributions**
All authors contributed to this paper

**Conflicts of interests**
The author declares no conflicts of interest.

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