# Non-Parametric Approach to Measure Efficiency Level of Paddy Farmers in Kedah

Nerda Zura Zaibidi[1], Md Azizul Baten[2], Maznah Mat Kasim[1], Razamin Ramli[1]
[1]*Department of Decision Science, School of Quantitative Sciences,*
*Universiti Utara Malaysia, 06010 UUM Sintok, Kedah, Malaysia.*
[2]*Departement of Statistics, School of Physical Sciences,*
*Shahjalal University of Science and Technology, Sylhet, Bangladesh.*
*nerda@uum.edu.my*

***Abstract*—Rice is the basic food, most important source of employment and income as well as the main cultivation activity of paddy farmers in northern region of Malaysia. The efficiency of rice production has been of longstanding interest to the responsible organization in agriculture. This paper attempts to study the efficiency of paddy farmers in Kedah using Data Envelopment Analysis model. Four districts have been selected with the total respondents of 200. Overall average performance of paddy farmers is 0.787. The paddy farmers in Kepala Batas are the most efficient followed by Kubang Pasu, Kerpan and Kubang Pasu. Only few paddy farmers in Kubang Sepat, Kubang Pasu and Kerpan are showing very low relative performances,, on the other hand, not a single farmer in Kepala Batas district shows such low performance. By knowing the existing efficiency level of paddy farmers, the government can take viable plans or actions to increase the efficiency of paddy farmers in Kedah.**

***Index Terms*—Rice Production; Technical Efficiency; DEA.**

## I. INTRODUCTION

Growing rice is one of the main agriculture activities in most of Asian countries. In Malaysia, rice production and productivity increase each year, however, its yield per capita declines each year. From a high of 174.6 kg of rice per capita in 1974, rice yield per capita has since fallen steadily, falling to 86.0 kg of rice per capita in 2008 [1]. Due to food crisis in the midst of 2008, rice producer country such as Thailand and Vietnam has reduced their rice exports. Since then, Malaysia has raised awareness in achieving 100% self-sufficiency in rice production. Unfortunately, our self-sufficiency level of rice production does not comply with the current average rice yield of 3.7 tons per ha per season. It is stated that Malaysia is only able to achieve a 62% of self-sufficiency. Almost 40% of the local demand will still have to depend on rice imports. Under the Ninth Malaysia Plan (NMP) (2006 –2010), the government adopted a policy goal to increase self-sufficiency to 90% in rice production by 2010 and 100% by 2015. Padi Beras Nasional (Bernas) is given the responsibilities to manage the country's rice stockpile in Malaysia. Their responsibilities comprise purchase the rice from the farmer and distribute them to the rice retailers and also been the sole rice importer in Malaysia. Here comes their big challenge to ensure the national rice stockpile stays intact. Any potential disruptions such as supply shortage will seriously affect sustainable rice production. In regards to this scenario, the strategy must be planning in details to increase domestic rice production and cut rice imports, for the forthcoming years. It is believed that Bernas has planned many strategies and programs to overcome the existing problems in the rice production in Malaysia. However, all the strategies and programs are efficient if and only if the paddy farmers, the most important element in rice production system are efficient. Thus, how efficient are the paddy farmers?

Efficiency measures are important because of its vital role on productivity growth. Efficiency measurement has been the concern of researchers with an aim to investigate the efficiency levels of paddy farmers engaged in rice productivity activities. Identifying determinants of efficiency levels is a major task in efficiency analysis. Therefore, it is important to identify the socio-economic characteristics of the paddy farmers and their linkage with paddy production activities. Alam *et al.* [2] has identified several socio-economic and physical characteristics of farmers have significant impacts on paddy productivity. One characteristic in particular is race. The option of pursuing a secondary occupation for farmers, level of education and the ratio of non-agriculture to agricultural income have significant negative impacts while technology and geographical position are the farm characteristics that have significant positive impacts on paddy production. In contrast, Khai and Yabe [3] reveal that the level of education is a necessary element of technically efficiency increase for rice farmers. Farmers who have secondary school level or above produce rice more productive or better than those without education or with only primary study. A similar study by Mohd Mansor, Nurjihan and Behrooz [4] also shows the important of education which indicated that paddy farmers who absent from attending the seminar of paddy farming, perform less efficient compared to those who attend the seminar. In Malaysia seminar of paddy farming is usually held by the authorities and private companies. Seminar is held for the purpose to improve knowledge of paddy farmer, to expose latest technology, machinery or skill to the paddy farmers and also introduce new fertilizers or seeds. It is convinced that having a seminar is also a chance to have the paddy farmers gather for experience or knowledge sharing, hence, indirectly causing productivity of paddy yield to be improved. A study by Ramli *et al.* [5] investigates the impacts of changes in government intervention policy, namely the fertilizer subsidy on the Malaysian paddy

and rice industry using simulation approach. It indicates that fertilizer subsidy does give a significant impact to the paddy and rice industry. Another study by Taraka, Latif and Shamsudin [6] reveals that there is a positive relationship between farm efficiency and family labor, extension officer's service, certified seed use and pest control on weedy rice and insect. The empirical finding reveals that farming experiences, family members and labors, farm size and land tenureship of demographic and farm characteristics have statistically significant relationship on technical inefficiency, while attendance in IPM training program, farm visit as best practices, extension services by extension officers and certified seed used are the variable influencing to farms technical inefficiency.

Measures of efficiency indicate the possibility of improvement in total productivity. In recent years much attention has been focused on data envelopment analysis to measure efficiency of paddy farmers of the farm families in Malaysia by Zaibidi et al. [7], Ghee-Thean et al. [8] and also in small holder agriculture in developing countries such Southern Ethiopia by Alene et al. [9], Nigeria by Tijani [10] and Bangladesh by Coelli and Thirtle [11]. Study by Nguyen et al. [12] measured efficiency of rice farms in South Korea and exposed that without major policy interventions, rice farms could increase economic and environmental performance by being more technically efficient. In order to measure the efficiency of the whole, it is more appropriate to also study the efficiency of the elements in the system. Thus, this study attempts to measure technical efficiency of paddy farmers in Kedah, the northern region of Malaysia. The paddy farmers are one of the vital elements in the rice production system. This paper consists of four sections; the next section will discuss the materials and methods used in the study followed by results and discussions, and finally conclusion.

## II. Materials and Methodology

Measuring technical efficiency expresses a functional relationship between the selection of inputs and outputs. It shows how and to what extent output changes with variation in inputs during a specified period of time. Productivity is generally measured in terms of the efficiency with which factor inputs, such as land, labor, fertilizer, herbicides, tools, seeds and equipment are converted to output within the production process.

### A. Data Collection Procedure

The data collection is done with a primary objective targeted to meet the objectives of this study using a structured questionnaire. The questionnaire includes sections on:

- background characteristics of the paddy farmers or farm families': age, education level, race, household size, gender, training attended and the size of family.
- technical indicator such as information regarding to seed, fertilizer and pesticide used.
- economic information: cost consumption, yield of rice and profit gained.
- knowledge: experience and training attended.

### B. Sample Size and Sampling Design

This study was conducted in the area under MADA region in Kedah, Malaysia. It covers about 125,155 ha in which about 76 per cent of the land is under rice cultivation (96,558 ha) with approximately 55000 residents of farm families. Under MADA there are 27 paddy farmer organizations known as Pertubuhan Peladang Kawasan (PPK) in 4 districts. For each district, 1 PPK is selected randomly with 50 paddy farmers are randomly chosen as respondents. Hence the sample total size for this study is 200. The data is collected through interviews with heads of households who all worked as paddy farmers in the village. The sample size is calculated using the following formula:

$$n = z2\ [P(1-P)/d2]*Deff \quad (1)$$

where: n = sample size
z = two-sided normal variate at 95% confidence level (1.96)
P = indicator percentage
d = precision
Deff = design effect

### C. Data Envelopment Analysis Model

Data Envelopment Analysis (DEA) is a non-parametric technique based on linear programming approach that can be used to measure the relative efficiency of operating units with the same general goals and objectives [13]. DEA evaluates the performance regarding a number of inputs and outputs simultaneously without considering any assumption about the functional form of the frontier. DEA may be cast in either an output-maximizing or an input-minimizing role. DEA also does not require pre-described structure of the relationship between the input and output variables. One of the advantages of DEA is it can accommodates more than one output into the analysis. The value of DEA is capable in relatively evaluating the individual decision making unit (DMU) within a target interest group. The general form of the model is:

Efficiency = weighted sum of outputs/weighted sum of inputs

Consider n DMUs (decision making unit) or paddy farmers of the farm families with m inputs and k outputs each one producing different output (y) and using different inputs (x). The efficiency of the Paddy farmers of the farm families (Constant Return to Scale) is measured as follows:

$$\mathrm{Max}_{\theta,\lambda}\theta \quad (2)$$

subject to:

$$\theta y_r - \sum_{j=1}^{n} \lambda_j y_{rj} \geq 0 \quad (3)$$

$$-x_i + \sum_{j=1}^{n} \lambda_j x_{jj} \geq 0 \quad (4)$$

$$\lambda_j \geq 0,\ j = 1..n, \qquad i = 1..m, \qquad r = 1..k \quad (5)$$

where, θ indicates the efficiency score of DMUs, and it will satisfy θ≤1, with a value of 1 indicating a point on the frontier,

Xij indicates the i-th input of the j-th DMU or paddy farmers of the farm families, Yrj indicates the r-th output of the j-th DMU or paddy farmers of the farm families, λj indicates the weight of the j-th DMU or paddy farmers of the farm families.

## III. RESULTS AND DISCUSSIONS

### *A. Profile Analysis of Paddy Farmers*

Table 1 presents the frequency distribution of background characteristics of paddy farmers in Kedah. As can be seen from the Table 1, more than 90% of the farmers are over aged that is their age is more than 40 years. Hence, it can be assumed that the paddy farmers have rich experience in paddy farming. Their education level also is not too low as most of the farmers (about 80%) have education up to SPM, 5.5% farmers have education more than SPM, and only, about 15% farmers are illiterate. Most of the paddy farmers are Malay (97.5%) and only 2.5% farmers are from other race. It is quite surprising to find that more than 75% of paddy farmers did not participated in any course or training on technology in the last five years. It is whether they did not bother to attend the course or MADA did not organize any training or workshop in which it is believed the former is the cause. Only 30% of the paddy farmers need financial help to do their farming while the rest (70%) can afford by their own. Every three out of five farmers have regularly kept in touch with agriculture extension officer. It is believed the meeting is due to deal with the subsidies provided by the government authority to the paddy farmers and also other reasons such as seeking advice and guidance. The geographic locations of farming are believed in good condition as according to majority of the farmers the soil condition for cultivation of paddy is very good while only 2.5% farmers rated it very bad or damaged. As expected, more than 87% farmers are found to be living primarily on farming. Somehow, it can be concluded that paddy farming is their job tradition and inherited as almost half of the farmers do farming on their firms.

Table 1
Frequency distribution of paddy farmers

| | Frequency | Percentage |
|---|---|---|
| Age distribution of the respondents | | |
| <30 | 5 | 2.5 |
| 30-39 | 12 | 6.0 |
| 40-49 | 40 | 20.0 |
| 50-59 | 54 | 27.0 |
| 59< | 89 | 44.5 |
| Educational background of the farmers | | |
| No education | 31 | 15.5 |
| Upto SPM | 158 | 79.0 |
| More than SPM | 11 | 5.5 |
| Race of the respondent | | |
| Malay | 195 | 97.5 |
| Others | 5 | 2.5 |
| Got training on technology or attain in courses in 5 years | | |
| Yes | 47 | 23.5 |
| No | 153 | 76.5 |
| Take loan for cultivation | | |
| Yes | 56 | 28.0 |
| No | 139 | 69.5 |
| Contact with Agricultural Officer | | |
| No | 85 | 42.5 |
| Yes | 115 | 57.5 |
| Soil condition of paddy field | | |
| Very good | 104 | 52.0 |
| Moderate | 88 | 44.0 |
| Damaged | 5 | 2.5 |
| Cultivation of paddy as primary work | | |
| Yes | 175 | 87.5 |
| No | 25 | 12.5 |
| Farming system | | |
| Individual | 94 | 47.0 |
| Mini state | 13 | 6.5 |
| Estate | 93 | 46.5 |

### *B. Efficiency Level of Paddy Farmers*

Table 2 presents the descriptive statistics of relative performance of the selected PPKs. DEA provides relative efficiency. For this study, relative performances of all paddy farmers for the selected PPKs are estimated. Technical efficiency represents the effectiveness of producing maximum output using a given set of inputs. The efficiency scores range from 0 to 1 (i.e. 0% to 100%). A paddy farmer is said to be efficient if the score is 1 (i.e 100%) and not efficient if the score is less than 1. The efficiency scores are calculated using DEA by applying constant return to scale method. In order to be efficient, this study is looking for the level of input to be improved. For both Kubang Sepat PPK and Kepala Batas PPK, relative performance one is not observed for any farmers but the exception to Kubang Pasu and Kerpan PPKs. Minimum relative performance of a farmer for Kubang Sepat PPK,

Kubang Pasu PPK and Kerpan PPK are found 0.001 however; minimum performance of a farmer of Kepala Batas PPK is found 0.70. Overall average performance of farmers is 0.787. It shows that the farmers in Kedah can increase their efficiency by reducing the input in average 21.3%. Average relative performance of the farmers of Kubang Pasu PPK is only 0.632 whereas for Kepala Batas PPK is 0.937. The farmers in Kubang Pasu should reducing their input by 36.8% more than the farmers in Kepala Batas do, which only 6.3%. The farmers in both Kubang Sepat and Kerpan are quite in the same level performance which the input that should be reduced is around 21%.

Table 2
Descriptive Statistics of Performance of Selected PPKs

| | Minimum | Maximum | Mean |
|---|---|---|---|
| Kubang Sepat | 0.001 | 0.996 | 0.794 |
| Kubang Pasu | 0.001 | 1 | 0.632 |
| Kepala Batas | 0.7 | 0.998 | 0.937 |
| Kerpan | 0.001 | 1 | 0.783 |
| Overall | 0.001 | 1 | 0.787 |

Figure 1 is showing the efficiency level of each paddy farmer (*x-axis*) in the selected PPKs by using DEA. In term of performance, Kubang Pasu is found minimum while Kepala Batas has higher relative performance. Few paddy farmers of Kubang Sepat, Kubang Pasu and Kerpan are showing very low relative performances which are nearly zero; on the other hand, not a single farmer is in Kepala Batas has such a low performance.

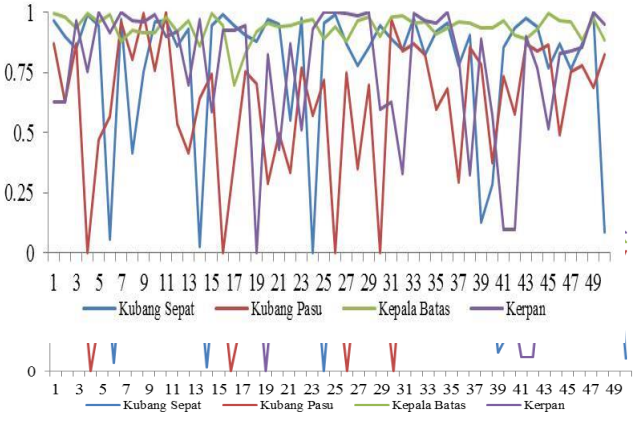


Figure 1: Performance of Selected PPKs using DEA

Overall it can be seen the paddy farmers in Kepala Batas are consistently efficient as the lowest level is 0.7 while the highest is 0.998. While for the other PPK, there are some farmers are nearly inefficient with the level obtained is 0.001. On the other hand, some of them are impeccably efficient. The paddy farmers in Kubang Pasu are below the average level of efficiency. Relatively, they need to increase their efficiency by 30% with the same resources.

## IV. Conclusion and Recommendations

This paper has discussed the technical efficiency of paddy farmers in Kedah, the northern area of Malaysia. DEA has been applied to measure the efficiency of rice farmers and the empirical results provide evidence that the efficiency level for each region in Kedah. The farmers in Kepala Batas show consistency in rice farming as the lowest efficient level obtained is near to the average level of efficiency which is 0.787. However there are some rooms for improvement in order to increase the efficiency level. By knowing the existing efficiency level of paddy farmers in using the inputs for rice production, the government can take viable plans or actions to increase the rice production up to the maximum level. If paddy farmers are technically efficient, then the government has to increase investment and has to adopt new technology in order to increase production to meet its consumption needs. The internal productivity of the country can be increased by improving the technical efficiency of the paddy farmers. This study will help explore the existing rice production systems and measure technical efficiency of paddy farmers in northern region of Malaysia.

## Acknowledgement

The research was funded by Exploratory Research Grant Scheme with S/O Code 12825, 2012-2015.

## References

[1] Hoh, R. 2012. Malaysia Grain and Feed Annual.*GAIN Report*, MY2001. Retrieved 11 March 2013 from http://www.thecropsite.com/reports/?country=MY&id=135.

[2] Alam, M.M., Chamhuri Siwar, Basri Talib and M.E. Toriman. "The relationships between the socio-economic profile of farmers and paddy productivity in North West, Selangor, Malaysia". *Asia-Pacific Development Journal.* Vol. 18 (1), pp. 161-173, 2011.

[3] Khai and Yabe, "Technical efficiency analysis of rice production in Vietnam". *Journal ISSAAS. Vol.* 17(1), pp. 135-146, 2011.

[4] Ismail, Mohd Mansor and Idris, Nurjihan and Hassanpour, Behrooz. 2013. Technical efficiency estimates of paddy farming in peninsular Malaysia : a comparative analysis". *Annals of Biological Research*. Vol. 4(5), pp. 114-118, 2013.

[5] Ramli, N. N.,Shamsudin, M. N., Mohamed, Z. and Radam, A. "The Impact of Fertilizer Subsidy on Malaysia Paddy/Rice Industry Using a System Dynamics Approach". *International Journal of Social Science and Humanity. Vol.* 2(3), pp. 213-219, 2012.

[6] Taraka, K., Latif, I. A., & Shamsudin, M. N. A. "Nonparametric Approach to Evaluate Technical Efficiency of Rice Farms in Central Thailand". *Chulalongkorn Journal of Economics. Vol.* 22, pp. 1-14, 2010.

[7] Zaibidi, N. Z., Kasim, M. M., Ramli, R., Baten, M. A. and Nadhar Khan, S. A. "Measuring efficiency of rice growing farmers using data envelopment analysis." *AIP Conf. Proc. Vol. 169*; 2015. doi: 10.1063/1.4937049

[8] Ghee-Thean, L., Ismail, M. M. and Harron, M. "Measuring Technical Efficiency of Malaysian Paddy Farming: An Application of Stochastic Production Frontier Approach". *Journal of Applied Science. Vol.* 12. pp. 1602-1607, 2012.

[9] Alene, A.D., Manyong, V. M. and Gockowski, J. "The production efficiency of intercropping systems of annual and perennial crops production in southern Ethiopia: a comparison of distance functions and production frontiers". *Agricultural Systems.* Vol. 91, pp. 51–70, 2006.

[10] Tijani, A. A. "Analysis of the technical efficiency of rice farms in Ijesha Land of Osun State, Nigeria". *Agrekon: Agricultural Economics Research, Policy and Practice in Southern Africa*. Vol. 45(2), pp. 126-135, 2006.

[11] Coelli, T., Rahman, S. and Thirtle, C. 2002. Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-parametric Approach". *Journal of Agricultural Economics. Vol*. 53(3), pp. 607-626. 2002.

[12] Thanh Nguyen, T., Hoang, V.-N. and Seo, B. "Cost and environmental efficiency of rice farms in South Korea". *Agricultural Economics*. Vol. 43, pp. 369–378, 2012.

[13] Charnes, A.C., Cooper, W.W. and E. Rhodes. "Measuring the efficiency of decision making units". *European Journal of Operational Research*, vol. 2(6), pp. 429 - 444, 1978