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Efficient Use of Energy Resources on Malaysian Farms

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ABSTRACT

The purpose of this study is to discover an approach where the outputs of the farms are maximum at the minimal input. Malaysia is well known for its crop (such as rubber, rice, palm oil, tea). Prior studies show that due to the climate change, there are likely chances that the farms of Malaysia will go extinct. In this study, the main focus is to efficiently use the energy resources to save it for the future in a prolonged manner. The data was collected from the website of Department of Statistics Malaysia, Official Portal. The data was taken for rubber and crops category. In order to run the analysis, the non-parametric approach was used, which is also knows as data envelopment analysis. It is used to explore the efficient use of energy resources. The findings suggest that rubber farms are the most technical efficient as compared to other farms. Further, the results show that there are many factors that counts and sums up the efficiency of the farm. Whilst studying the technical efficiency, this study finds that the soil and climate conditions contributes to the efficiency and productivity of the farms.

Keywords: Technical Efficiency, Energy Resources, Palm Oil Farms, Crop Farms, Tea Farms, Rubber Farms, Malaysian Farms
JEL Classifications: Q2, Q4

1. INTRODUCTION

In 21st century, the most challenging job for the economist is to manage the sustainable agriculture growth and preserve the natural resources while minimizing the input and maximizing the output to the eco system. It is very important to integrate the natural resources and ecological services in the process of production (Brahimi and Bensaid, 2019). However, this integration has number of limitations, such as economic and ecological assessment. The monetary valuation and physical quantification of ecological assessment is very difficult, which makes it difficult to measure its effectiveness. Besides the fact that the integration of natural resources in the production function, which was started by Solow (1974) and Stiglitz (1979), only resources displaying economical attributes of a production factor can be incorporated into the production function. Along these lines, the estimation of natural resources proficiency stays challenging. Furthermore, some useful methodologies exist, at the farmer level, which evaluate whether farmers utilize natural resources to accomplish their economic objectives.

Climate change has been affecting both developed and developing countries and is causing problem in different sectors (Jermsittiparsert, 2019), especially in the agriculture sector. Due to the climate change, many natural resources are becoming obsolete or may become obsolete in the near future (Hussaini and Majid, 2015). It is the duty of the agriculturist and the economists to reduce the wastage of the natural resources, and make use of it in a prolong manner. According to surveys and reports, the climate changes happening in Malaysia are likely to cause problems for the farmers and decrease the yields of rice (main food of Malaysia) from 13% to 80%. As well as, the production of industrial crops i.e., oil, rubber, and cocoa are likely to drop by 10–30% due to the negative effects of the climate happening in Malaysia right now (Li et al., 2019).

With the growing population and climate changes happening right now, there are likely chances of Malaysia to face food crises in future due to less agriculture production. Consequently, this may increase the imports of agriculture products, which may negatively affect the Malaysian economy (Krömer and Gatzert, 2018). This paper explores different ways of increasing the production, while natural resources are saved from going extinct. This idea of connecting economical and natural resources is known as eco-proficiency (Rotzek et al., 2018).

This idea was additionally utilized by the Organization for Economic Cooperation and Development, which characterizes it as "the productivity with which natural resources are utilized to address human needs," and has been received and advanced by the World Business Council for Sustainable Development as an approach to urge organizations to accomplish more elevated amounts of intensity and ecological duty simultaneously (Saritas and Kuzminov, 2017). In practical terms, eco-efficiency is the capacity to acquire economical execution by utilizing natural resources and making insignificant degradation to the nature and environment. Eco-efficiency can be estimated utilizing proportions between the monetary estimation of merchandise or administrations created by any single substance (farm, organization, sector), and the ecological weights produced by the production procedure (Ghali et al., 2016).

This eco-efficiency improves when ecological effects reduce and the economical estimation of production is kept up or increased. The eco-efficiency idea was additionally adjusted for the examination of arrangement procedures and their possible macroeconomic results. It is utilized to think about efficiency of economical branches, or to associate individual organizations to the macroeconomic level.

2. METHODOLOGY

In economics we have concept of scarcity which means that the resources we have are limited. So, we can implement the concept of technical efficiency, which is to use the limited resources. It allows the firms to make decisions based on the existing technology and make the most out of it. The efficiency that the firms intend to use are scale efficiency and technical efficiency. Scale efficiency refers to the optimal usage of the farm and its size whereas, technical efficiency refers to the ability to make decision to reach the maximum units of production for a set of inputs despite f the price of the goods and factors. It will deliberate useful information that is relevant to managerial decision making and their practices. Also, it will deliver information related to the organizations' production of units.

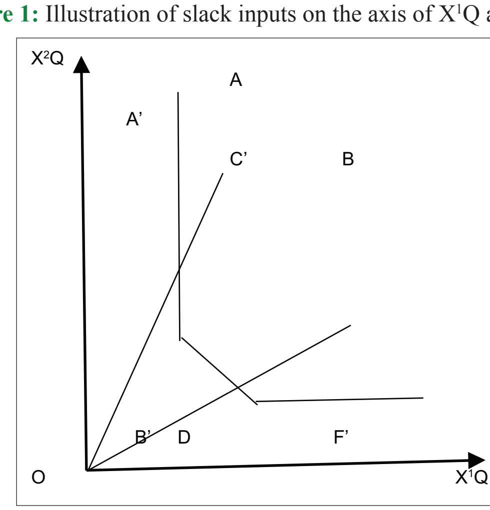
In this study we have sued two approaches i.e., parametric approach and non-parametric approach to formulate the production frontier and evaluate the technical efficiency. The parametric approach i.e., the stochastic parametric approach needs a functional form in order to specify the frontier of the production. To specify the frontier of the production it uses the econometric too in order to evaluate it. Furthermore, to separate the deviation from the production of frontier, it can be done between the random noise and inefficiency of the decision-making unit. However, the non-parametric approach i.e. data envelopment analysis (DEA), has its own origin of work. With the help of the inputs and outputs of the farm and its sample, it offers an estimate of efficient production. It was introduced by Farrell and Fieldhouse. This approach allows to eliminate the occurrence of the misspecification and also, it is not associated with the predetermined functional form. This method is widely popular in the agricultural sector, especially in the economic efficiency analysis of the energies. It also helps in studying the economic and environmental assessment.

In the DEA approach, the performance of each farm if compared with the best farm either, or with a hypothesized farm with the same number of inputs proportionally. Efficiency here can be explained by the distance of the farm (i.e., the production frontier). If the distance is higher it indicated low efficiency. Also, it helps to calculate the scale efficiency and technical efficiency both. When both of these are compiled together, it provides technical efficiency and it allows to obtain the input slacks. Therefore, the approach that we will use in this study is the non-parametric (i.e., DEA approach) to analyze the energy efficiency outputs.

Here, input slacks refers to the inputs that have been used in excess in this study. The excess in inputs in this study reflects potential increased reduction of an input along with the proportional elimination of all the inputs which are identified by the score of technical efficiency. In order to explain this concept, we have demonstrated a graph in Figure 1 which will illustrate the production frontier (denoted by FF') which are composed by the best performing decision making units (C and D). Here the frontier production demonstrated the minimal usage of the inputs (kept in mind X^1 and X^2) in order to produce the one unit of the output (denoted as Q). As we can see in the graph, farm A and farm B are not in the frontier. It makes them in-efficient.

As illustrated in this graph, farm A' technical efficiency is denoted by OA/OA, whereas the technical efficiency of farm B is denoted by OB/OB. Also, in this situation the hypothesized farms were denoted by farm A' and farm B'. For instance, the farm A can minimize the usage of input along the ray i.e. OA and

Figure 1: Illustration of slack inputs on the axis of X^1Q and X^2Q



Source: Adapted from Ghali et al. (2016)

the production could be as much as the farm A', this concept here is what we refer to technical efficiency concept. But, A' lacks efficiency as much as C has and therefore A' could minimize further the usage of the factor X^2 by the amount of CA' in order to continue the production of the same amount of the output.

However, there is slight difference or argument amongst the researchers. According to Koopman, the technical efficiency can be defined as when the decision making unit is supposedly technical efficient if the operation on the frontier and all the slack are related to the inputs are zero. It means that farm A will have to decrease its two units (to be specific by number of percentage that equals to 1 subtracted the score of technical efficiency) and further decrease the X^2 by CA'. This amount of CA' is known as slack of input X^2.

The objective of this study is to evaluate the slacks of the input considered the usage of energy resource and to discover and explore the determining factors in the Malaysian farms. In order to make the analysis, slacks of input are measured by the DEA (non-parametric approach. These determinants in the first stage are regressed towards the potential determinants in the second stage. To make analysis in the second stage we have used Tobit model due to censorship of the characters at score zero of the dependent variables. However, studies have suggested that some farms show no score for some of the inputs of slack.

3. SPECIFICATION OF MODEL AND DATA

3.1. DEA

In this study, two farms from Malaysia have been explored. The reason why these two have been chosen is due to the specialization of the production. Also, for each sample separate frontier is constructed. Technical efficiency and input of slack is computed in two ways which is in accordance with the specification of the technology.

First of all, we use reference technology (denoted by T1), which is a composition of three outputs and four inputs. Lastly, the inputs that are being used is for calculating technical efficiency of the farms. For instance, land, labor, capital, intermediate consumption.

Moreover, in second step the energy resources are separated from the intermediate consumption in order to retain the three outputs on the basis of technology T1. However, it consists of five inputs i.e., land, labor, capital (technology T1), intermediate consumption and energy resources.

Table 1 concludes the inputs and outputs for the two technology. The three outputs illustrated are outputs from harvest/crops practices, outputs from rubber farms and output from different practices, all expressed in Ringgit. With respect to the input, land is calculated by the Utilized Agriculture Area (UAA) in hectares (ha); labor is calculated in Annual Working Units, in other words in full-time reciprocals; farm capital is calculated in Ringgit; intermediate consumption incorporates fertilizers, pesticides, seeds, feed, soil alterations, fuel, water, power and support costs, and is expressed in Ringgit; energy resources, which is a composition of intermediate consumption, are additionally expressed in Ringgit and incorporate direct utilization of energy as fuel, just as indirect utilization through manures and soil changes.

3.1.1. Model specification for the determining factors of input slacks

After the DEA analysis, the second step is to explore the determining factors of non-proportional and use of inputs (slacks) on excessive amount. For each individual slack we will perform three separate regression tests (Tobit Regression Tests). In the first test, intermediate consumption will be used as the dependent variable which were measured under the Technology 1 (T1). Whereas, in the second regression test, the dependent variable is energy resources that fell under the technology 2 (T2). Furthermore, in the third regression test we will be using the remaining from the slack of intermediate consumption which was also measured under the technology 2 (T2). The variables that we are going to use as the determining factors of the input slack will be demonstrated in Table 2. The reason why these variables were chosen for this analysis is purely based on the key determining factors that were found in the farm technical efficiency practices and literatures as suggested by the Latruffe (2010). Furthermore, to perform the analysis only those variables were selected that is uncorrelated to each other.

Considering all other variables, the proxy of dependence of subsidies is based on the proportion of subsidies which are received by the farms (which is associated with the total output that has been produced as a result of the input). The subsidies that we are talking about here are the ones that the farmers receive from the Ministry of Agriculture and Agro of Malaysia. It also includes the amount of money and decoupled subsidies, direct or indirect payments granted to those who are located in a disadvantaged are or location. It is granted on the basis of the hectares covering the specific covering and granted in the form of lump sum amounts to the farms. Furthermore, to incorporate proxy at farmer's age we use human capital as the proxy. In order to do so, two variables are used. The first location is used to analyze the environment of the farm, if it is as per the standard suggested by the Ministry of Agriculture or not. It defines if there is any constraint in the environment. The objective of the second one is to test the soil and discover the percentage of sand-clay in it and testify it is acceptable for the farms or not. If it has a balance share of sand and clay, then it is good to go. Because that texture is affirmative for the rainy seasons as well.

3.2. Data

The data was collected from the website of Department of Statistics Malaysia, Official Portal. In order to run the analysis, three categories of firms were chosen i.e. tea farms, palm oil firms, rubber farms and mixed farms. The reason why these categories were chosen is because Malaysia does massive production of these and is specialized in their production. The total sample size was 1500, 500 rubber farms, 500 palm oil farms, 200 tea farms and 300 mixed farms were used in this study to run the analysis.

Below we have Tables 3 and 4 which explain the descriptive statistics of variables that were used to measure the technical

Table 1: Description of input and output variables used to measure the slacks and technical efficiency

Variable names	Variable description	Incorporated in technology T1	Incorporated in technology T2
Inputs			
UAA	Utilized agriculture area (hectares)	Yes	Yes
LAB	Labor (AWU)	Yes	Yes
F-CAP	Farm capital (Ringgit)	Yes	Yes
IC	Intermediate consumption (Ringgit)	Yes	-
ER	Energy resources (Incorporating soil, fertilizers, fuel etc.) (in Ringgit)	-	Yes
R-IC	Rest of the intermediate consumption i.e., intermediate consumption without energy resources	-	Yes
Output			
CR-OUT	Crop output (Ringgit)	Yes	Yes
RB-OUT	Rubber output (Ringgit)	Yes	Yes
OF-OUT	Other farm outputs (Ringgit)	Yes	Yes

Table 2: Explanation of variables related to input slacks

Variable name	Variable description
UAA	Utilized agriculture area (UAA, hectares)
CAP/UAA	Ratio of capital (Technology) to UAA (Ringgit per hectares)
DEBT	The ratio of indebtedness explained as ratio of the capital
Unpaid/LAB	Ratio of the un-paid labor to the labor
SH-CRP	Share of rubber, rice, and oilseed in the farms UAA (in percentage %)
SH-LG	Shared of legumes in the farms UAA (in percentage %)
SUB/OTP	The ratio of subsidies to the total output
Age	Age of farmers
ENVR	ENVI is a dummy variable. ENVI = 0 if the farm is not in Ministry of agriculture and agro based industry Malaysia area; ENVI = 1 if the farm is in Ministry of agriculture and agro based industry Malaysia area
SH-TEX	Percentage of the clay-sand soil texture in the area of the farm (in %)

Table 3: Descriptive statistics of the variables used to calculate technical efficiency and slacks (AVG)

Variables	All farms	Palm oil and tea	Rubber farms	Mixed farms
No. of farms	1500	700	500	300
Inputs				
UAA (hectares)	125	140	99	147
LABR (AWU)	1.7	1.2	1.5	2.1
CAPTL (RM/hectare)	1678	943	2577	1891
IC (RM/hectare)	852	666	1111	1011
ER (RM/hectare)	189	223	159	190
R-IC (RM/hectare)	703	456	977	813
FUEL (RM/hectare)	55	53	65	66
FERT (RM/hectare)	136	159	89	119
Outputs				
OUT-PC (RM/hectare)	778	1128	239	773
OUT-PL (RM/hectare)	674	36	1516	802
OUT-PO (RM/hectare)	81	60	67	123

Table 4: Descriptive Stats (Avg.)

Variables	All farms	Palm oil and tea	Rubber farms	Mixed farms
No. of farms	1500	700	500	300
CAPTL/UAA (RM/hectare)	1968	973	2743	2343
DEBT	0.542	0.443	0.447	0.458
UN-PAID/LABR	0.89	0.91	0.76	0.95
SH-CRP (%)	53	89	25	55
SH-LG (%)	2.4	4.1	0.34	2.5
SUBS/OTP	0.29	0.28	0.245	0.26
Age (years)	47.8	52.1	44.8	47.9
ENVR (HYP)	0.045	0.023	0.09	0.087
SH-TXT (%)	53.7	55.1	56.5	52.3

efficiency and slack. Further, it helps to determine the potential key drivers for the slack. Table 3 illustrates that the crops farm (palm oil, tea) are larger in term of land in average (UAA average of 138 hectares) than the rubber and mixed farms. The degree of the labor used and capital required in farms with livestock practices are slightly higher than the rest. Whereas, the energy resources used in the crops farm i.e., tea farms palm oil farm is higher per hectares than the mixed farms or the rubber farms. Also, the proportion of energy resource expenses in total intermediate consumption is greater on the end of crops firm than the rubber farms or mixed farms. To be more specific, if we look at the costs of the fertilizers they can be seen as illustrated in the Table 3. 23% on average alone depicts the cost of fertilizers of the crops i.e., tea farms and palm oil. Whereas, the cost of fertilizers for rubber farms and mixed farms resulted to be 7.5% and 12%. The fuel cost on these farms have resulted to be 7.9%, 6.3% and 5.5% for crops farm, mixed farms and rubber farms.

Moreover, Table 4 shows that the livestock farms resulted to be more intensive capital than the crops farms. However, the degree of indebtedness is not different. Whereas, the ratio for subsidy to the output have also resulted to be same and not changes. It resulted to be 0.7 on average for all farms. It means that all the farms receive subsidy of 0.27 Ringgit for every Ringgit of output that is produced.

4. RESULTS

4.1. Technical Efficiency Results

The results from Table 5 shows that the rubber farms are more effective and efficient as compared to the crops farms and the mixed farms. According to this result, the soil used in these livestock farms is greater than those used in the crop farms and their average production is also greater. Also, climate is another condition for greater condition. Hence, the results in Table 5 suggests that livestock farms are technically more efficient than those of crop farms. However, there were two types of technology used to test the results and see if there are any variations. The results from Table 6 as per technology showed same response and there was very slight variation found in it. It proves that the technical efficiency is greater in the livestock farms than the crop farms. Our results support the literature and studies done by Bravo-Ureta et al. (2007). Besides the soil condition and climate conditions, on an average level of production rubber farms have been proven to be the most efficient technically amongst all other farms. Also, according to the other technology i.e., T2, we have come to analyze that there is slight variation in the results and rubber farms have resulted as the most efficient on the basis of technical efficiency and their level of production is highest amongst all the other farms that we have studied.

Tables 6-8 has resulted that the size of the farm has relationship with the wastage generated by the farms whilst using the energy resources. The larger the farm is, there is less chances to generate wastage. Another finding was regarding the indebtedness against slack of energy resources. It resulted that if there is indebtedness against slack of energy resources, the more likely the farms are to be technically efficient. They make necessary adjustments to be efficient. It was also in support and confirming the study that was done by Zhu and Lansink (2010). Furthermore, another key

Table 5: Table of technical efficiency of the farms under technology 1 and technology 2 (T1 and T2)

Name of variables	Crop farms		Rubber farms		Mixed farms	
No.of farms	700		500		300	
Technology 1 (T1)						
Total and pure technical efficiency output	TE	PTE	TE	PTE	TE	PTE
Avg.	0.67	0.89	0.75	0.65	0.89	0.91
SD	0.18	0.113	0.18	0.19	0.26	0.13
Min.	0.113	0.397	0.45	0.19	0.43	0.41
Max.	1	1	1	1	1	1
No. of efficient farms (in %)	3.9	7.9	5.5	6.5	30.35	34.5
Technology 2 (T2)						
Total and pure technical efficiency output						
Avg.	0.67	0.89	0.75	0.65	0.89	0.91
SD	0.18	0.113	0.18	0.19	0.26	0.13
Min.	0.113	0.397	0.45	0.19	0.43	0.41
Max.	1`	1	1	1	1	1
No. of efficient farms (in %)	3.45	7.98	5.43	6.01	32.35	35.5

Table 6: Key determining factors of minimal input for crop farms (palm oil and tea farms)

Variable name	Technology T1		Technology T2
DV	Slack of IC	Slack of Eng Res	Slack of R-IC
Determining factors	Co-efficient and Sig.	Co-efficient and Sig.	Co-efficient and Sig.
UAA	−0.021	−0.055***	−0.033**
CAPT/UAA	0.0012	−0.004***	0.003**
DEBT	−0.015	−0.089**	0.051
UNPAID/LABR	4.056	22.1433***	−7.66
SH−CRP	−22.333***	4.356	−25.005***
SH−LG	−51.167**	−0.245***	−63.778***
SUBS/PROX	−13.564	1.367	5.665
Age	−0.175	−0.145***	−0.152
ENVR	−1.452	1.345	3.555
SH−TXT	0.021	−0.166***	0.078
Log−Likelihood	−598.32	−2067.66	−740.89

*, **, ***Significance level at 10%, 5%, 1%

Table 7: Key determining factors of minimal input for rubber farms

Variable name	Technology T1		Technology T2
DV	Slack of IC	Slack of Eng. Res	Slack of R-IC
Determining factors	Co-efficient and Sig.	Co-efficient and Sig.	Co-efficient and Sig.
UAA	−0.114***	−0.019	−0.163***
CAPT/UAA	−0.005***	−0.0023***	−0.002***
DEBT	0.043	−0.199***	0.171**
UNPAID/LABR	−12.987*	17.1433***	−0.334
SH-CRP	19.765**	4.359	−2.465
SH-LG	55.16	18.811***	98.547
SUBS/PROX	−8.564	−14.897	−10.678
Age	−0.185	37.854***	−0.214
ENVR	−0.452	−0.176	−3.456
SH-TXT	0.029	−2.166	−0.197**
R^2	0.98	0.96	0.95
Log-Likelihood	−655.32	−2967.66	−635.89

*, **, ***Significance level at 10%, 5%, 1%

Table 8: Key determining factors of minimal input for mixed farms

Variable name	Technology T1		Technology T2
DV	Slack of IC	Slack of Eng Res	Slack of R-IC
Determining factors	Co-efficient and Sig.	Co-efficient and Sig.	Co-efficient and Sig.
UAA	−0.0381**	−0.181**	−0.233
CAPT/UAA	−0.041	−0.213***	0.029
DEBT	−14.181**	7.089**	−12.990
UNPAID/LABR	−3.789	−2.887	5.897
SH-CRP	−0.0021*	−0.001***	−0.0045**
SH-LG	−0.078	−0.134	−0.216**
SUBS/PROX	23.564***	9.875**	19.876**
Age	−0.121***	0.545***	−0.198***
ENVR	−21.765	−2.345	−29.543
SH-TXT	16.533**	17.166***	36.989***
Log-Likelihood	−454.32	−2167.66	−560.89

determining factor is the level of subsidy. According to our results, the firms that are likely supposed to get higher subsidy have less technical efficiency than those who are expected to receive low subsidy. Moreover, farms who produce their forage are likely to be less efficient in the context of using the energy resources efficiently.

5. CONCLUSION AN RECOMMENDATIONS

5.1. Discussion

The purpose of this study was to find different ways of using resources efficiently with maximum output. It can be done through the non-parametric approach or the DEA analysis. Three types of categories were chosen to run the analysis, and these categories were discussed and cross-studied to evaluate their results and establish the idea, which farm is more efficient technical and using minimal sources of energy. The best part of these farms is that these are renewable sources, which means they can be produced over time. Unlike oil and gas reserves, these when used to their maximum limit will lead towards extinction in future. However, in today's world where the completion has rose and we are well aware with the climate change which is again affected by the technology and industrial evolution. It has made a lot of economists to worry about the future. As these farms are not only energy resources but also source of income and contributes a lot in the GDP of the country.

5.2. Conclusion

This study finds that palm oil, tea, rubber farms, and mixed farms are the most efficient farms. It means that rubber production can stay in the country for a longer run. Also, the texture of the soil which is the balanced composition of cay and sand has turned out to be highest in rubber farms. We considered hypothesized farms and discover how can the farms utilized to be efficient. We understood that, it can happen by introducing technology into it. There were two types of technology introduced in this study. Both of these studies resulted in favor of rubber farms.

There were basic steps used to compare the current usage and hypothesized usage (results that we want) of the energy resources in the farms. First step is to find out the current production of the farms and only then when we find out we can introduce the technology element into it and expand the production to the level we opt for. To do so, Energy Conservative Measures or ECM technique is introduced which recommends to use energy resources minimally and make the most out of it for the production procedures. The idea of these measures are not to diminish the performance of the farmers and decrease the productivity of the farms but to offer solutions for optimization. However, if these measures reduce the performance than before, then it should be certainly not considered and look out for other options.

The idea of these measures is also not to save the money or to make more profits. But the idea is to make the production optimal. Energy is the mean of production in the agriculture and the task is to reach the optimum yields through the production. However, the focus should not only be on the production but on the direct and indirect energy resources as well. On farms the direct energy resources are oil, gas, electricity etc. In the ear of 21st century we have come across so many alternatives. The cost of petroleum and oil is increasing day by day and the demand is also increasing simultaneously.

According to our studies, the rubber farm has resulted amongst the most efficient user of the energy resources. They have proven to be the optimum users. Energy resources will not stay forever with us. And people already are working on what to do when these emery resources will go extinct. We are already familiar that in future we will have robotics and hybrid cars that will not need petroleum an oil. To cope up with the electricity issues, industries are switching towards solar energy resources to produce electricity. The reason why we chose these category of farms was because these farms have shown decline in their production and the idea was to figure out how well they are using the energy resources to increase their production.

5.3. Recommendations

For future studies, more industries and more agriculture farms should be considered to study how well they use energy resources as per the technical efficiency. Moreover, the sample size could be extended too to have more certainty of the data. This study will help the agriculturists and economists to work more on the technical efficiency part for the use of energy resources. Also, the farms have significantly dropped (Appendix 1) on the production procedures which should be increased with the help of technical efficiencies and technologies. Furthermore, Malaysia is a developing country and still behind the countries such as US, UK and European countries. The studied that they have done should be kept in mind and contrasted with the findings of our study. There should be a cross study in order to seek where we stand and where we want to stand on the basis of their production and how efficiently they use technology for using the energy resources.

REFERENCES

Brahimi, T., Bensaid, B. (2019), Smart Villages and the GCC Countries: Policies, Strategies, and Implications. In: Visvizi, A., Lytras, M., Mudri, G., editors. Smart Villages in the EU and Beyond (Emerald Studies in Politics and Technology). Bingley: Emerald Publishing Limited. p155-171. Available from: https://www.doi.org/10.1108/978-1-78769-845-120191015.

Bravo-Ureta, B.E., Solis, D., Lopez, V.H.M., Maripani, J.F., Thiam, A., Rivas, T. (2007), Technical efficiency in farming: A meta-regression analysis. Journal of Productivity Analysis, 27, 57-72.

Ghali, M., Latruffe, L., Daniel, K. (2016), Efficient use of energy resources on French farms: An analysis through technical efficiency. Energies, 9(8), 601.

Hussaini, I., Majid, N.A. (2015), Energy development in Nigeria and the need for strategic energy efficiency practice scheme for the residential building sector. Management of Environmental Quality, 26, 21-36.

Jermsittiparsert, K. (2019), Climate Change, Growth Determinants and Tourism Industry: Time Series Analysis from Malaysia. Indonesia: A paper presented at the International Conference on Environment and Sustainability Issues. Noormans Hotel Semarang.

Krömer, S., Gatzert, N. (2018), Renewable energy investments with storage: A risk-return analysis. International Journal of Energy Sector Management, 12, 714-736.

Latruffe, L. (2010), Competitiveness, Productivity and Efficiency in the Agricultural and Agri-food Sectors. Ukraine: OECD Food, Agriculture and Fisheries Papers 30, OECD Publishing.

Li, Z., Gong, Y., Chen, K. (2019), Energy use and rural poverty: Empirical evidence from potato farmers in northern China. China Agricultural Economic Review, 11, 280-298.

Rotzek, J., Scope, C., Günther, E. (2018), What energy management practice can learn from research on energy culture? Sustainability Accounting, Management and Policy Journal, 9, 515-551.

Saritas, O., Kuzminov, I. (2017), Global challenges and trends in agriculture: Impacts on Russia and possible strategies for adaptation. Foresight, 19, 218-250.

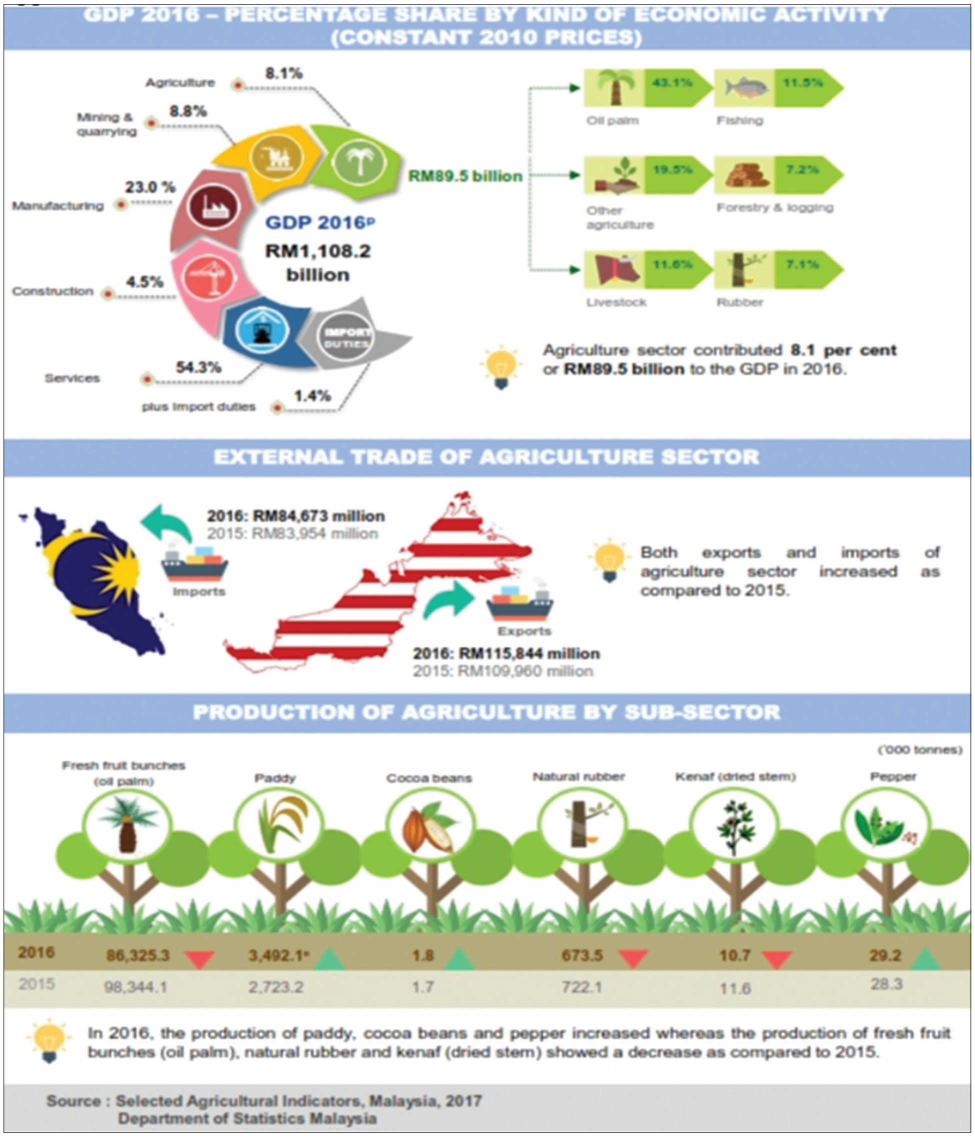
Solow, R.M. (1974), The economics of resources or the resources of economics. The American Economic Review, 64, 1-14.

Stiglitz, J.E. (1979), A neoclassical analysis of the economics of natural resources. In: Smith, V.K., editor. Scarcity and Growth Reconsidered. New York, USA, London, UK: RFF Press, Johns Hopkins University Press. p36-66.

Zhu, X., Lansink, A.O. (2010), Impact of CAP subsidies on technical efficiency of crop farms in Germany, the Netherlands and Sweden. Journal of Agricultural Economics, 61, 545-564.

APPENDIX

Appendix 1: GDP share by sector in Malaysia (Constant 2010 prices)



Source: Selected Agricultural indicators, Malaysia, 2017 (Department of Statistics Malaysia)