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Estimation of Cost and Allocative Efficiencies under Smallholder Livestock-Oil Palm Integration Farms in Johor, Malaysia

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Abstract: An analysis of cost and allocative efficiencies are equally imperative in capturing the comprehensive picture of production efficiency. An analysis on 255 livestock-oil palm integrated farms was conducted in districts of Johor for that purpose. Data envelopment analysis was imposed on the data to provide the estimates. Although, the study shows that the livestock-oil palm farmers produce at high cost and allocative efficiencies but a room still exist for improvement in their efficiency scores. Similar, it is with the slack analyses indicating very little wastage in inputs and shortfall in output. To improve farmers' cost and allocative efficiencies, farmers should consider buying production inputs at cheaper rates and be judicious and timely in allocating farm inputs.

Key words: Allocative, frontier, slack, congestion, Johor

INTRODUCTION

Livestock-oil palm integration in the Malaysian context is a galvanization between two distinct and extreme players to her agricultural sector performance and the economy in totality. On one hand, the oil palm plays a significant role while livestock particularly the ruminant sub-sector exhibits an insignificant role to the economy.

This policy of integration (livestock-oil palm) offers an opportunity for mutual benefits of the two units being integrated. The role of efficiency measures in enhancing productivity in agriculture is indispensable. Despite the many success story about Malaysia and oil palm productivity and the numerous testing of models for various analyses in the Malaysia's oil palm sector, very little efficiency (particularly cost and allocative) measures had been used. This research is more encompassing for it analyzed efficiency in an integrated approach (livestock-oil palm) not ordinarily under its traditional sole production base.

MATERIALS AND METHODS

Sampling technique: A total of 255 independent smallholder oil palm-livestock (cattle and goats) farmers were randomly surveyed in the ten districts (Batu Pahat, Johor Bahru, Kluang, Kota Tinggi, Kulaijaya, Ledang, Mersing, Muar, Pontian and Segamat) of Johor, Malaysia. Structured questionnaire was the survey tool used for eliciting the data spanning from January to December, 2011 production year.

Estimation of cost efficiency: Given that cost minimization under DEA can be estimated as:

$$\min_{\lambda, X_i^*} W_{i2} X_i^*$$

$$\text{Subject to} \begin{Bmatrix} -y_i + Y\lambda \geq 0, \\ X_i^* - X\text{ë} \geq 0, \\ NI'\lambda = 1 \\ \lambda \geq 0 \end{Bmatrix}$$

Where:

W_i = Vector of inputs prices for ith firm
X_i^* = Cost minimization vector of inputs bundles for the ith firm, given prices of inputs W_i
y_i = Levels of outputs

Following the above cost minimization equation, the cost efficiency (economic efficiency) which is the ratio of minimum production cost to observed production cost for the ith firm can be estimated. In Farrel's concept, cost (economic) efficiency is technical efficiency multiplied by allocative efficiency. This have gained further support Adeniji (1988), defined economic efficiency as the ability of farms to maximize profit and is a product of technical efficiency and allocative efficiency.

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$$CE = \frac{W_{i2}X_i^*}{W_{i2}X_i}$$

Where, CE is cost efficiency and other variables as defined earlier.

Estimation of allocative efficiency: Allocative efficiency or price efficiency measures firms' success in choosing the optimal input proportions. In this study to estimate the allocative efficiency, reference is made to the relationship between the three existing measures of efficiency. Yotopoulos and Lau (1973), asserted that allocative and technical efficiencies are necessary and when they occur together are sufficient conditions for achieving economic efficiency. From the general relationship earlier stated, economic efficiency is the product of technical and allocative efficiencies. Having expressed the computation procedures for economic and technical efficiency above, simple change of subject formula can be applied to estimate the only unknown in the relationship (allocative efficiency). This can be expressed mathematically:

$$AE = \frac{CE}{TE}$$

Where:
AE = Allocative Efficiency of i DMU
CE = Cost Efficiency of i DMU
TE = Technical Efficiency of i DMU

RESULTS AND DISCUSSION

Results of costs and allocative efficiencies based on DEA estimator: Table 1 and 2 portray the cost and allocative efficiency estimates based on VRS assumption for goat-oil palm and cattle-oil palm integration, respectively. Both cost and allocative efficiency vary widely but none of the plantations operate under CE or AE <0.50. In other words, all plantations operate above 0.50 costs and allocative efficiency. In Table 1 while the CE report 0.588, 1.000 and 0.867 as minimum, maximum and average cost efficiency, respectively. The AE show 0.590, 1.000 and 0.869 as minimum, maximum and average allocative efficiency, respectively. While the AE captures farmers' ability to produce an output bundle given cost minimizing inputs, the CE handles farmers' ability to produce an output bundle in the presence of a particular technology at minimum cost (Asogwa *et al*., 2011; Avkiran, 2006; Cooper *et al*., 2006; Ramanathan, 2003).

By implication, plantations producing at low level of AE are surrounded by input congestion, resulting in high cost of input bundles and eventually lower the farmer's return. Plantations producing at low levels of CE experience output production at higher cost per unit and consequently lower the chances of such farmers from attaining profit maximization. These forgoing facts agrees with the findings of Asogwa *et al.* (2011) that allocative inefficiency prevent farmers from equating the marginal value product of the factor to the factor price and cost inefficiency and cost efficiency is viewed as farmers' ability to maximize profit. Similarly, result in Table 2 indicates that both AE and CE estimates under cattle-oil palm integration enjoy common estimates. The estimates were 0.690, 1.000 and 0.865 for minimum, maximum and average AE and CE, respectively. It can also be seen that under both goat and cattle integrated systems, the AE and CE estimates seems to be uniform in value.

Table 1: Cost and allocative efficiency estimates based on VRS assumption for goat-oil palm integration

Efficiency range	TE_{VRS} (PTE)	CE_{VRS}	AE_{VRS}
Goat-oil palm integration (N = 65)			
<0.50	0.000	0.000	0.000
0.51-0.60	0.000	3 (4.620)	1 (1.540)
0.61-0.70	0.000	4 (6.150)	6 (9.230)
0.71-0.80	0.000	7 (10.770)	7 (10.770)
0.81-0.90	0.000	20 (30.770)	20 (30.760)
0.91-0.99	10 (15.380)	17 (26.150)	17 (26.150)
1.00	55 (84.620)	14 (21.540)	14 (21.540)
Summary			
Min.	0.958	0.588	0.590
Max.	1.000	1.000	1.000
Mean	0.997	0.867	0.869
SD	0.009	0.120	0.118

Table 2: Cost and allocative efficiency estimates based on VRS assumption for cattle-oil palm integration

Efficiency range	TE_{VRS} (PTE)	CE_{VRS}	AE_{VRS}
Cattle-oil palm integration (N = 190)			
<0.50	0.00	0.000	0.000
0.51-0.60	0.00	0.000	0.000
0.61-0.70	0.00	2 (1.050)	1 (0.530)
0.71-0.80	0.00	41 (21.580)	42 (22.110)
0.81-0.90	0.00	84 (44.210)	84 (44.210)
0.91-0.99	0.00	53 (27.890)	53 (27.890)
1.00	190 (100.00)	10 (5.260)	10 (1.050)
Summary			
Min.	1.00	0.690	0.690
Max.	1.00	1.000	1.000
Mean	1.00	0.865	0.865
SD	0.00	0.076	0.076

Field Survey (2012)

Analyses of both CE and AE under both systems of integration reveal high estimates, the numerous government efforts on subsidies of inputs explain the rationale behind the high CE. Similarly, the numerous enlightenment programs vis-a-vis the high years of production experience of the farmers explains their high level of AE. In both integration systems, the mean AE scores are lower than mean TE scores, this scenario infers that rather than TE, AE is the primary source of CE. Table 3 and 4 shows the CE and AE estimates based on CRS assumption for goat and cattle oil palm integration, respectively. Accordingly, the estimates are lower than those estimated under VRS assumption.

Results of input and output slacks based on DEA estimator: Table 5 summarizes the results of input and output slacks for both goat and cattle-oil palm integration.

Table 3: Cost and allocative efficiency estimates based on CRS assumption for goat-oil palm integration

Efficiency range	TE_{-CRS} (PTE)	CE_{-CRS}	AE_{-CRS}
Goat-oil palm integration (N = 65)			
<0.50	0.000	8 (12.310)	4 (6.150)
0.51-0.60	0.000	8 (12.310)	9 (13.850)
0.61-0.70	0.000	5 (7.690)	7 (10.770)
0.71-0.80	0.000	11 (16.920)	12 (18.460)
0.81-0.90	4 (6.150)	21 (32.310)	21 (32.310)
0.91-0.99	26 (40.000)	7 (10.770)	7 (10.770)
1.00	35 (53.850)	5 (7.690)	5 (7.690)
Summary			
Min.	0.802	0.395	0.433
Max.	1.000	1.000	1.000
Mean	0.977	0.755	0.769
SD	0.039	0.168	0.154

Table 4: Cost and allocative efficiency estimates based on CRS assumption for cattle-oil palm integration

Efficiency range	TE_{-CRS} (PTE)	CE_{-CRS}	AE_{-CRS}
Cattle-oil palm integration (N = 190)			
<0.50	0.00	0.000	0.000
0.51-0.60	0.00	0.000	0.000
0.61-0.70	0.00	19 (10.000)	19 (10.000)
0.71-0.80	0.00	73 (38.420)	73 (38.420)
0.81-0.90	0.00	67 (35.260)	67 (35.260)
0.91-0.99	0.00	26 (13.680)	26 (13.680)
1.00	190 (100.00)	5 (2.630)	5 (2.630)
Summary			
Min.	1.00	0.611	0.611
Max.	1.00	1.000	1.000
Mean	1.00	0.811	0.811
SD	0.00	0.089	0.089

In terms of input slacks under goat system, the mean slacks for each input shows the quantity by which on average, the input was excessively used relative to best performing plantations. Capital with RM 99.852 and land with 0.141 ha are, respectively the highest and lowest mean slacks of the factors of production considered. This implies that on average and relative to best practice, farmers had over-utilized resources (over expended) on capital by RM 99.852 and land by 0.141 ha. This shows the degree of input congestion or wastage of resources which its withdrawal (reduction) would not have any in any influence on the output bundles and which would have been used channeled to a more productive course. To attain 100% efficiency, farmers should withdraw the supply of the following important factors by their corresponding percentages parenthesis, general farm maintenance (3.12%), fertilizer (2.05%), capital (4.91%), family labor (3.74%), hired labor (0.02%) and othercosts (0.24%). The result also shows maximum FFB yield of 0.016 metric ton year and number of goats reared 6.030 stocks year, affecting only one plantation. This result suggest that relative to the best performing plantations, the affected plantation experienced only a shortfall of 0.016 mt for the year and 6 stocks of goats. In other words, the affected plantations had the potential of tapping more outputs of FFB and raising more goats to the limit of 0.016 mt and 6 stocks, respectively. The mean of 0.000 and 0.093 for FFB yield and number of goats shows that on average, the goat-oil palm integrated plantations operates without any output shortfall (Table 5).

Table 5: Analyses of input and output slacks for goat and cattle-oil palm integration

Input/output	No. of plantations	Min. slack	Max. slack	Mean slack	SD	Mean input used/output obtained	Excess input used/ output shortfall obtained (%)
Goat-oil palm integration (N = 65)							
Output							
Y1 (FFB in MT)	1 (1.54)	0.000	0.016	0.000	0.002	66.81	0.00
Y2 (Total animal stock)	1 (1.54)	0.000	6.030	0.093	0.748	27.00	0.34
Inputs							
X1 (Land in ha)	5 (7.69)	0.000	3.550	0.141	0.635	3.64	3.87
X2 (GFM in RM)	7 (10.77)	0.000	286.263	15.921	53.347	510.30	3.12
X3 (Fert in kg)	10 (15.38)	0.000	599.886	50.945	140.752	2480.00	2.05
X4 (Capital in RM)	11 (16.92)	0.000	1228.211	99.852	291.301	2034.00	4.91
X5 (FML in M/H)	9 (13.85)	0.000	1045.595	90.153	249.093	2412.00	3.74
X6 (Hired labour in RM)	1 (1.54)	0.000	31.590	0.486	3.918	2135.00	0.02
X7 (Other costs in RM)	1 (1.54)	0.000	50.442	0.776	6.257	318.11	0.24
Cattle-oil palm integration (N = 190)							
Output							
Y1 (FFB in MT)	0 (0.00)	0.000	0.000	0.000	0.000	88.58	0.00
Y2 (Total animal stock)	49 (25.79)	0.000	23.072	1.885	4.874	40.00	4.71
Inputs							
X1 (Land in ha)	9 (4.74)	0.000	3.000	0.041	0.273	4.05	1.01
X2 (GFM in RM)	119 (62.63)	0.000	491.775	152.028	144.849	624.70	24.34
X3 (Fert in kg)	118 (62.11)	0.000	499.392	103.223	115.715	2293.00	4.50
X4 (Capital in RM)	77 (40.53)	0.000	1453.467	293.856	380.131	2414.00	12.17
X5 (FML in M/H)	114 (60.00)	0.000	3831.429	625.130	780.302	3954.00	15.81
X6 (Hired labour in RM)	0 (0.00)	0.000	0.000	0.000	0.000	2658.00	0.00
X7 (Other costs in RM)	38 (20.00)	0.000	1019.947	83.898	209.602	1519.00	5.52

Field Survey (2012)

Similarly, also reveals the input and output slacks for cattle-oil palm integration. The input slacks reveal family labor and hired labor with 625.13 and 0.000 as the highest and lowest mean slacks, respectively. This means that relative to best practice on average plantations under cattle-oil palm system spent excess man-hour of labor as high as 625 man-hours per year, as against efficient utilization of hired labor. In other words, farmers do not over-utilized hired labor but they over-utilized their family labor up to 625 man-hours per year. The rationale may be that farmers are careful of their hired labor due it the involvement of cash payment but are unmindful of excess family labor which is not accompanied by any cash payment. Looking at opportunity cost theory, the excess man-hours could have been used for more productive venture that could have earned the farmers more income or could have also been used for leisure. To attain 100% efficiency, farmers should withdraw the supply of the following important factors by its corresponding percentage in parenthesis: General farm maintenance (24.34%), fertilizer (4.50%), capital (12.17%), family labor (15.81%) and other costs (5.52%). Next, the mean slacks for FFB of 0.000 and number of cattle 1.885 suggested that on average and relative to best practice, the cattle-integrated plantations do not have shortfall in FFB yield but have shortfall of up to 2 cattle with respect to animal stock. In order words, 2 more cattle could have been raised under the cattle-oil palm integrated system.

CONCLUSION

Across assumption technique of estimation and across livestock type for the integration, high cost and allocative efficiencies result. This implies that farmers in the Malaysia's livestock-oil palm integration produce at high cost and allocative efficiency and still suggesting a vacuum for improvement in these efficiency estimates. Similarly, the farmers also produce with minimal input waste and output shortfall. Future purchase of inputs at cheaper rates, timeliness and judicious use of the input are avenues that will lead farmers to produce at the frontier of both cost and allocative efficiencies.

REFERENCES

Adeniji, J.P., 1988. Farm size and resource use efficiency in small-scale agricultural production: The case of rice farms in kwara state of Nigeria. Nigerian Agric. J., 23: 51-62.

Asogwa, B.C., S.T. Penda and L.W. Lawal, 2011. Application of data envelopment analysis to evaluate farm resource management of nigerian farmers. J. Agric. Sci., 2: 9-15.

Avkiran, N.K., 2006. Productivity Analysis in the Service Sector with Data Envelopment Analysis. 3rd Edn., Avkiran, Ipswich Australia.

Cooper, W.W., L.M. Seiford and K. Tone, 2006. Introduction to DEA and its Uses with DEA Solver Software and References. Springer, New York.

Ramanathan, R., 2003. An Introduction to DEA: A Tool for Performance Measurement. Sage Publications, India, New Delhi.

Yotopoulos, P.A. and L.J. Lau, 1973. Test of relative economic efficiency: Some further results. Am. J. Econ. Rev., 63: 214-223.