Technical Efficiency of Independent Oil Palm Smallholders (ISH) in Peninsular Malaysia with Respect to Fertiliser and Land Size

Ramli Abdullah*

ABSTRACT

Productivity of independent smallholders (ISH) is said to be low. This is partly due to, among others, their lower efficiency level compared to the estates. Although this is a known fact, there is no literature available which measures their efficiency level in producing their fresh fruit bunch (FFB). Hence, this study was carried out on the ISH to assess and determine their technical efficiency (TE) level by considering their effectiveness on using inputs, such as fertilisers and size of their holdings. The results of the study can be used to fill up the missing information pertaining to their level of efficiency. The study used Stochastic Frontier Analysis approach to see the effects of the two inputs. The ISH from Pahang, Perak and Johor were included in this study to represent Peninsular Malaysia region. The two variables, i.e. *fertiliser application and size of their holdings had a positive relationship with FFB yield. The study revealed that the estimated average level of TE for the ISH is 0.70 while the maximum and minimum TE are 0.94 and 0.23, respectively. This indicates that the ISH in Peninsular Malaysia are generally inefficient and supports the claim to statement made by various authors on the level of their efficiency. The big difference in TE among ISH in the sample suggests that there is a potential to increase their output or yield by using inputs more efficiently. This can also be inferred that there is an opportunity to improve the ISH productivity, especially the Malays and Indian ethnic groups whose efficiency levels are lower than the Chinese ethnic group.*

INTRODUCTION

Oil palm has been dominating the Malaysian agricultural system since the early 1960s and having a supply chain with two levels of activities namely 'upstream' and 'downstream'. While the 'downstream' side has been commonly referred to as the processing sector such as mill and refinery, the 'upstream'

* Malaysian Palm Oil Board,
6 Persiaran Institusi, Bandar Baru Bangi,
43000 Kajang, Selangor, Malaysia.
E-mail: ramlia@mpob.gov.my

sector consists of nursery operators, input suppliers, fresh fruit dealers, smallholders, and estates. Smallholder sector involves the organised and the unorganised smallholders and together with the estates, they are the backbone of the oil palm industry, producing fresh fruit bunches (FFB) in the country. The organised smallholders are being represented by participants under the Federal Land Development Authority (FELDA), Federal Land Consolidation and Rehabilitation Authority (FELCRA), and Rubber Industry Smallholders' Development Authority (RISDA) and various state schemes. The unorganised smallholders are those from the independent ones.

Independent smallholders (ISH) in Malaysia have generally increased in number over the years. From 67 208 ISH in 1997, their number rose to 120 341 in 2007 and to 179 350 and 177 046 in 2011 and 2012, respectively (*Figure 1*). The area of their holdings had similarly increased from 0.32 million hectares in 2000 (*Table 1*) to 0.45 and 0.47 million hectares in 2006 and in 2007, respectively. The areas kept on increasing in 2011 to reach 0.70 million hectares and more or less maintained in 2012 at 0.69 million hectares (MPOB, 2013) (*Table 1*). The increase in the number of ISH was driven mainly by the lucrative FFB price that attracted many of them to venture into the business and thus increases their total areas (*Figure 1*).

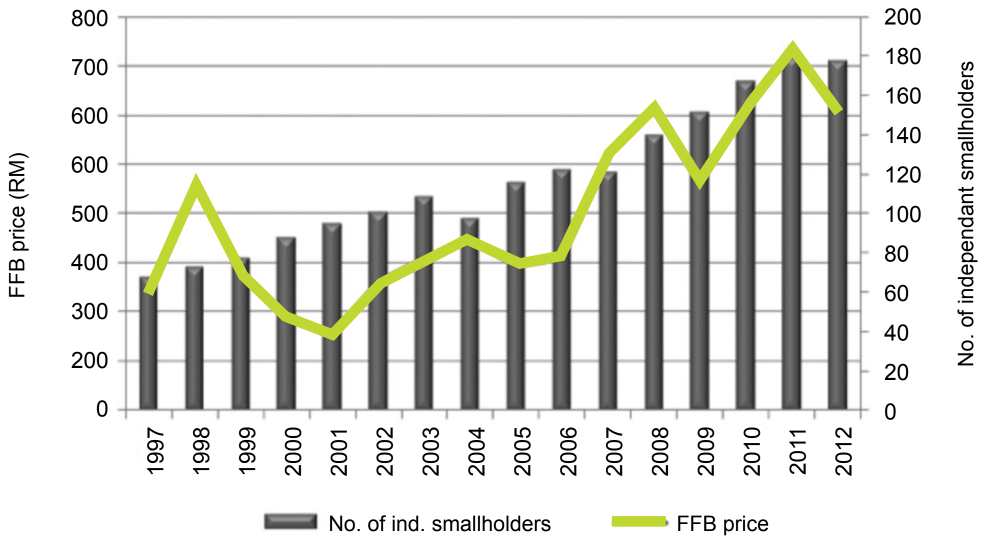
The contribution of ISH to the Malaysian economy has gradually improved. This is based on the fact that their share in total oil palm planted area has improved over the years. In 2000, their share was 9.5% and increased to 14% in 2011 (*Table 1*). In 2012, the share dropped slightly to 13.6%, but it was almost as big as FELDA group. Such a big increase in share was mainly due to the rate at which the areas were expanding. ISH areas expanded at the fastest rate of 6.6% per annum since 2000 compared to the organised smallholders, such as FELDA, FELCRA, RISDA, and government and state agencies. The share of areas for the estates, however, recorded a slight increase from the year 2000 to the year 2012.

The ISH, however, face a number of problems, such as small land holding size (Koczberski *et al.*, 2001) and low FFB yield (Ayat *et al.*, 2008). Other problems include oil palm technologies not reaching them and disorganised. According to the data (2013) from the Malaysian Palm Oil Board (MPOB), the average holding size was about 3.9 ha per ISH in 2007 and in 2012 (*Table 2*). Johor appears to be the state with the highest number of ISH, with the largest area size under ISH, and with an average holding size of about 3 ha. Perlis, in contrast, has the smallest area size under ISH and the smallest number of ISH but with the highest average holding size of 7 – 9 ha. On the ISH's low productivity, Azman *et al.* (2003) found that 14% of their surveyed ISH in Johor in 2000 did not apply enough fertiliser which could be due to the lack of funds for the purchase arising from low FFB

TABLE 1. OIL PALM AREAS BY CATEGORY (ha)

Category	2000		2011		2012		CAGR* (2001-2012)
	Area	%	Area	%	Area	%	
Private estates	2 024 286	60.0	3 037 468	60.8	3 126 990	61.6	3.7
FELDA	598 190	17.7	703 027	14.1	706 069	13.9	1.4
FELCRA	154 357	4.57	162 027	3.2	167 361	3.3	0.07
RISDA	37 011	1.10	79 743	1.6	78 634	1.5	6.5
Govt./state agencies	242 002	7.17	319 786	6.4	306 187	6.0	2.0
Independent smallholders	320 818	9.50	697 826	14.0	691 688	13.6	6.6
Malaysia	3 376 664	100.0	5 000 109	100.0	5 076 929	100.0	3.5

Note: * Compounded annual growth rate.
FELDA - Federal Land Development Authority.
FELCRA - Federal Land Consolidation and Rehabilitation Authority.
RISDA - Rubber Industry Smallholders' Development Authority.
Source: MPOB (2012; 2013).



Source: MPOB (2012; 2013).

Figure 1. Number of independent smallholders and fresh fruit bunch (FFB) price.

price during the year. In another study by Ayat *et al.* (2008), the smallholders' FFB yield was shown to be low at around 18.82 t/ha in 2007, lower than the average yield of the country at 19.03 t/ha (MPOB 2012). According to Ishola *et al.* (2011), soaring price of fertiliser has caused some of the oil palm planters to withhold fertiliser usage in order to break even. Nevertheless, it should be noted that for sustaining good yields, fertiliser inputs are necessary and typically constitute 40%-50% of total cost for field upkeep (Ng, 2001). In addition to the above problems, the ISH also established their oil palm holdings by themselves with minimal government assistance (Azman *et al.*, 2003), and are normally inefficient compared to the estates. In this respect, the inefficient ISH

TABLE 2. INDEPENDENT SMALLHOLDERS OWNERSHIPS BY STATES, 2007 AND 2012

States	2007			2012		
	Number	Area (ha)	Average holding size (ha)	Number	Area (ha)	Average holding size (ha)
Johor	47 783	150 809	3.16	60 991	183 653	3.01
Perak	23 512	72 244	3.07	31 403	93 058	2.96
Sabah	15 689	106 157	6.77	26 660	180 955	6.79
Selangor	13 593	32 619	2.40	18 597	40 617	2.18
Pahang	6 319	29 213	4.60	8 391	38 486	4.59
Sarawak	4 620	29 214	6.32	15 700	81 292	5.18
Kedah	2 797	15 664	5.60	4 363	21 549	4.94
N. Sembilan	2 326	15 230	6.55	4 109	20 620	5.02
Melaka	1 240	6 419	5.18	2 060	9 924	4.82
Pulau Pinang	1 218	7 054	5.79	1 612	8 456	5.25
Terengganu	884	5 435	6.15	2 291	9 416	4.11
Kelantan	353	1 873	5.31	861	3 605	4.19
Perlis	7	61	8.67	8	57	7.13
Total	120 341	471 991	3.92	177 046	691 688	3.91

Source: MPOB, various sources.

should emulate the efficient ones or estates in choosing the types of fertiliser to be used in addition to the techniques in applying them.

Despite these problems, the ISH do play an important role in the Malaysian economy especially in terms of employment and production of FFB. Based on the area planted in 2012 at 691 688 ha (MPOB, 2013), it was estimated that the ISH produced a total of 11 million tonnes of FFB in that year (authors' calculation). The Malaysian government also has a plan to improve the income of the ISH so that it will be in line with the country's aspiration to be a developed nation by 2020. In view of this, one of the strategies by the government, channeled through MPOB, is by introducing replanting scheme called *Skim Tanam Semula Sawit* (SITS) in 2001 and 2008. The main ideas of the scheme are to tackle the declining crude palm oil (CPO) price during those years as well as to replace old, low yielding palms of more than 25 years with high yielding new materials. By replanting with new improved seedlings, it is expected that the ISH can produce more output. Under SITS 2001, a total of 46 828 ha of oil palms owned by smallholders (ISH and organised) was replanted in 2002 and 2003 (Dayang *et al.*, 2013; MPOB, in press). The second scheme, SITS 2008, recorded larger replanted area by the smallholders. The area replanted under independent smallholders was 48 256 ha while 20 298 ha was under organised smallholders bringing to a total of 68 554 ha for the two groups.

Replanting will help to reduce production as old trees are felled. Quality seeds are then used during this activity, and thus can increase the ISH's production of FFB when the palms mature. However, replanting alone cannot ensure high productivity of the smallholders which is normally being measured by FFB yield. This is because there exist other contributing factors to the FFB yield, such as quality of the seeds, field maintenance especially during immature period (age of palm below three years), and fertiliser application. In this respect, the ISH should have a proper fertiliser management system. According to Goh (2004), the fertiliser management system constitutes the largest field cost item in well-run oil palm plantations in Malaysia. Fertiliser is also considered as one of the most important inputs in the production of palm oil, accounting for about 24% of the production costs of palm oil (Mohd Nasir *et al.,* 2005). The fertiliser management system should include correct timing, placement and methods of fertiliser application, the right source of fertiliser, monitoring of growth, nutrition and yield targets (Ng, 2001). The use of fertilisers, however, is often influenced by the price of palm oil; more fertilisers will be used during higher price of palm oil compared to low price. However, due to poor attitude about spending money on inputs, they sometimes did not apply fertilisers even during high price.

Therefore, efficiency of smallholders should not be judged only by the amount of FFB produced but also on whether inputs are being used efficiently, in this case, the fertiliser. Efficient application techniques can reduce wastage and increase yield and net income.

STOCHASTIC PRODUCTION FUNCTION AND TECHNICAL EFFICIENCY

Efficiency is an important factor of productivity. In a growing economy, like Malaysia, there are dwindling resources for adoption of improved technologies for increased production (Iwala *et al*., 2006). For technical efficiency (TE), it is the effectiveness with which a given set of inputs is used to produce an output with given and obtainable technology. Measuring it is to use input and output quantity without introducing the prices. Thus, a firm is said to be TE if it is producing the maximum output from the minimum quantity of inputs, such as labour, capital and technology (Economicshelp, 2013). TE can be decomposed into three components, such as scale efficiency (the potential productivity gain from achieving optimal size of a firm), congestion (increase in some inputs could decrease output), and a pure TE (Farrell, 1957). It is usually expressed in percentage term which represents the percentage by which all inputs need to reduce to achieve TE production.

The value of TE ranges between 0 and 1, and represents the degree of TE. If TE is equal to 1, it tells that the firm produces with full TE; otherwise, if it is 0, then the firm is fully technically inefficient (Huynh and Mitsuyasu, 2011). As cited by Tijani (2006), numerous studies (*e.g.* Obwona, 2000; Son *et al.*, 1993) have attempted to determine technical efficiencies of farmers in developing countries because it is important for policy purposes.

To study efficiency, most researchers would adopt either one of the competing methodologies, *i.e.* stochastic frontier analysis (SFA) or data envelopment analysis (DEA) methods. Initial concept of the former was proposed by Farrell in 1957 (cited by Amos, 2007) and later by Aigner *et al.* (1977) (cited by Iwala *et al.*, 2006) and Coelli in 1995 (cited by Lim *et al.,* 2012). The SFA model uses stochastic production where the output of a firm is a function of a set of inputs, inefficiency and random error. The estimation techniques utilise extreme observations from data to determine the best practice production frontier where the relative measure of the TE can be derived. TE of a firm is then characterised by the relationship between observed production and some ideal or potential production. It is just one component of overall economic efficiency. However, a firm must be technically efficient in order to be economically efficient. Profit maximisation requires a firm to produce the maximum output given the level of inputs employed (*i.e.* be technically efficient).

OBJECTIVE

The objective of the study is to estimate the level of TE of Malaysian ISH, particularly those in Peninsular Malaysia, as a consequence of low FFB yield obtained per hectare as compared to average national FFB yield using SFA.

LITERATURE REVIEW

There are two methods which are widely used in estimating TE, namely econometric approach which aims to develop stochastic models and non-parametric approach or mathematical programming (Huynh and Mitsuyasu, 2011). The former is normally known as stochastic frontier model while the latter is the DEA. Both had their own strengths and weaknesses.

According to Tijani (2006), efficiency is an important factor in productivity growth. In an economy where resources are scarce and opportunities for new technologies are lacking, inefficiency studies will be able to show that it is possible to raise productivity by improving efficiency without increasing the resource base or developing a new technology. Estimates of the extent of inefficiency also help in deciding whether to improve efficiency or to develop new technologies to raise agricultural productivity.

Studies on TE and productivity in the Malaysian agriculture sector have been carried out by researchers such as Nik Hashim (2011), Lim *et al.* (2011), Lim (2012), Raziah (2006) and Mad Nasir *et al.* (1996). A study by Nik Hashim (2011) involved 35 rubber smallholders in Besut, Terengganu under the supervision of the RISDA personnel. Variables used in estimating the frontier model were rubber production as dependent variable (y), and cultivated area ($x1$) measured in hectares, and tapping intensity ($x2$) measured in number of tapping days, as independent variables. It was found that 23% of the total cultivators achieved 0.95 to 1.00 TE score. The score for TE ranges from 0.00 to 1.00 where 1.00 indicates maximum efficiency.

On aquaculture sector, Lim *et al.* (2011) studied the efficiency of sampled trawl vessels in Pulau Pinang because annual landings had declined by almost 23% in the previous 17 years. Data envelopment analysis was applied using 69 selected vessels and the TE values obtained were between 0.123 and 1.00 with an average TE of 0.566. The dependent variable or output used in this study was landing per trip while the independent variables or inputs were number of workers, fishing effort (fishing days per trip), diesel consumption per trip (litre), vessels capacity (GRT), and engine horsepower (hp) of each vessel.

Lim *et al.*(2012) studied paddy farming which was one of the important activities in the Malaysian agriculture sector. This study involved a sample of 230 paddy farmers operating in Peninsular Malaysia. Data on output was paddy yield per hectare while inputs data were total size of farmers' paddy field, expenditure on seeds, expenditure on fertiliser, and number of workers engaged in paddy farming. The mean TE for the sampled paddy farmers was 0.85 which indicates that utilisation rate on existing inputs (size of paddy field, expenditure on seeds, expenditure on fertiliser and number of workers) was almost optimum.

On non-seasonal fruit such as watermelon, a study was carried out by Raziah in 2006 on selected 49 farms in districts of Kluang, Kota Tinggi, Muar and Pasir Putih. In the study, the variable used as the output was gross income while the input variables were cost of capital, cost of labour, and cost of other inputs (seeds, fertiliser, insecticides, herbicides and plastic covers). The mean efficiency of the sample farms was found to be 0.46 with 55% of the sample farms were having efficiency level below the average.

On a larger perspective, such as involving firms or companies, TE method can also be applied to determine their efficiency. A study by Alias *et al.* (2008a) which involved 7360 small and medium enterprises using data collected in 2004 found that only 3.06% (16 firms) of the total firms can be considered technically efficient (TE) (ratio above 0.82). Another study, also done by Alias *et al.* (2008b), was in relation to food industry in Malaysia. The study, designed to measure the TE using data collected in 2004, found that the average TE was 0.688. Again, based on TE ratio above 0.82 as technically efficient measurement, the result concluded that Malaysian food industry was highly inefficient.

METHODOLOGY

Study Area

The project covered ISH in Peninsular Malaysia from six districts located in three states in Peninsular Malaysia. The districts were Kluang and Batu Pahat for

Johor, Teluk Intan and Manjung for Perak, and Temerloh and Pekan for Pahang. Johor and Perak were selected as they are the two states with the largest number of ISH. The former and the latter had the largest and the second largest area under ISH respectively (based on data from *Table 2*). They also represented the states with holding size almost equivalent to the national holding size. Another state (Pahang) was selected on random basis from among the rest of the states in Peninsular Malaysia. The selection of the districts in these three states was based on the advice by MPOB *Tunjuk Ajar Sawit* (TUNAS) officers in the respective states.

Data Collection

Primary survey using enumerators was adopted to gather data for the study. The survey was carried out in September 2012. The target sample size for every state was 100 respondents bringing the total sample size to 300 for the three states. The respondents were then interviewed with the cooperation of the TUNAS officers. The data collected included the followings: ISH background, FFB obtained by the ISH in the previous month (August 2012), the number of fertiliser bags used in 2011, and the holding size. Fertiliser applied in 2011 was required in the survey as it could give an impact on the yield in the following year. Hence, the FFB obtained in August 2012 was considered.

Frontier Model

The stochastic frontier production function that was based on an econometric specification of a production frontier was developed by Aigner and Meeusen and Van den Broeck back in early 1980s. Later in 1992, Battese and Coelli extended the earlier work and defined stochastic production function as follows:

$$Y_i = f(X_b, \beta)\, e^{\varepsilon i}$$

Y_i is output vector for the i[th] firm, X_i is vector of inputs, β is a vector of parameter and ε_i is an error term. In this model, a production frontier defines output as a function of a given set of inputs.

The TE was estimated by finding the ratio of the observed output (Y_i) to the corresponding frontier output (Y_i^*) given the available inputs (X_i).

$$TE = Y_i / Y_i^*$$

For this study, a general model specified by a Cobb-Douglas function was assumed and was defined as:

$$\ln Y_{ij} = \beta_0 + \beta_1 \ln X_{ij} + e$$

where subscript *i* refers to the observation of the ith farmer and *j* refers to FFB production.

Y = total FFB produced in a month (tonnes per month)

X_1 = farm size (ha)

X_2 = number of fertiliser bags used in 2011 (bag of 50 kg)

e = error term

ln = natural logarithm

The β is scalar parameter estimated by the method of maximum likelihood while estimates for parameters of the stochastic frontier production function is obtained using the program Frontier version 4.1.

RESULTS

Descriptive Statistics from the Survey

Table 3 relates to the background of the respondents. The total number of respondents attending the interview sessions were 145; 70 were from Johor, 36 from Perak and 39 from Pahang. In terms of the ethnic groups, 61.1% of the respondents were Malays, 26.9% Chinese, 11% Indian, and 0.01% others. In terms of distribution between states, the Malay respondents were distributed evenly between Johor, Perak and Selangor while the Chinese and Indian respondents were mainly from Johor.

The summary of farm holding size is presented in *Figure 2*. Majority of the respondents (48 or 32.4%) owned an area of between 1.6 to 4 ha. About 24.8% or 36 respondents owned less than 1.5 ha. Combination of these two groups with holding size of less than 4 ha was about 58%; there were some smallholders (about 10%) with holding size of more than 8 ha. In terms of states comparison, the majority of ISH in Johor and Pahang had a farm size of between 1.6 ha to 4 ha but for Perak, the majority had less than 1.5 ha.

Figure 3 indicates the average FFB yield obtained by the ISH in August 2012 and the number of bags (50 kg bag) of fertiliser applied the previous year (2011). On average, ISH in Johor obtained 10 t of FFB in August 2012 (regardless of holding size) while ISH in Perak obtained 7 t of FFB and those in Pahang,11 t of FFB.

In terms of the number of bags of fertiliser applied in 2011, the study found that ISH in Johor applied an average of 44 bags of fertiliser or equivalent to 2200 kg (*Figure 3*). The study also found that ISH in Perak, on average, applied 31 bags or 1550 kg of fertiliser while ISH in Pahang utilised 58 bags or 2900 kg of fertiliser. In terms of the relationship between the amount of fertiliser applied and the FFB output, ISH in Johor who applied 44 bags of fertiliser obtained 10 t of FFB in the month of August 2012. ISH in Perak who applied lesser fertiliser (31 bags) obtained only 7 t of FFB while ISH in Pahang

TABLE 3. DISTRIBUTION OF RESPONDENTS BY STATE AND RACE

Race	Johor	Perak	Pahang	Total
Malay	26	33	30	89 (61.1%)
Chinese	28	3	8	39 (26.9%)
Indian	16	0	0	16 (11.0%)
Others	0	0	1	1 (0.01%)
Total	70 (48.2%)	36 (24.8%)	39 (27.0%)	145 (100%)

who applied the most fertiliser (58 bags) obtained 11 t of FFB.

Based on the ethnic categories, the study found that the Chinese ISH obtained the highest FFB output at 11 t in the month of August 2012 and they applied 50 bags of fertiliser in the previous year (2011) (*Figure 4*). Indian ISH obtained 10 t of FFB, which is second after the Chinese, but they applied 55 bags of fertiliser which is the highest compared to others. Malay ISH was the lowest in terms of FFB output where they only obtained 9 t in the month of August 2012 and they applied 41 bags of fertiliser in 2011.

Output from Frontier 4.1

Stochastic production frontier analysis. The statistics obtained through the survey and described in the above section is important and become the input for the stochastic production frontier analysis using Frontier 4.1. The analysis produced outputs on TE of the ISH as shown in *Table 4*. All coefficients of X's based on the maximum likelihood estimates for the stochastic production function model of the Cobb-Douglas function are significantly different from zero at a very high probability levels of 0.05. With reference to production elasticity of fertiliser and area, 1% increase in the fertiliser applied, keeping area at *ceteris paribus*, the yield of ISH could increase by 0.42% and 1% increase in the area, keeping fertiliser at *ceteris paribus*, the yield of ISH could increase by 0.54%. Hence, there is a positive impact of fertiliser and area on the yield of the ISH.

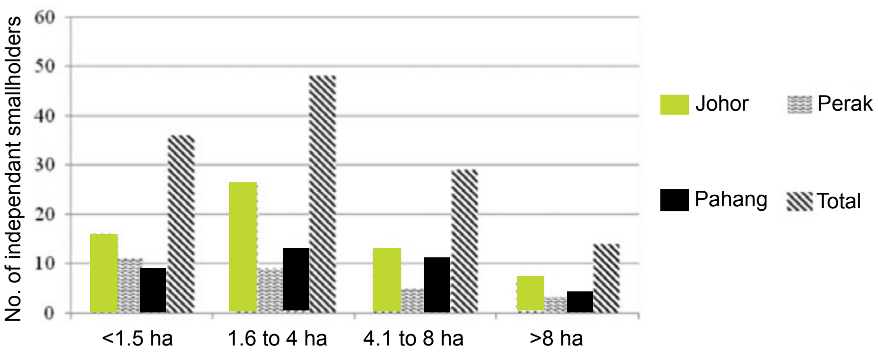


Figure 2. Farm holding size by states.

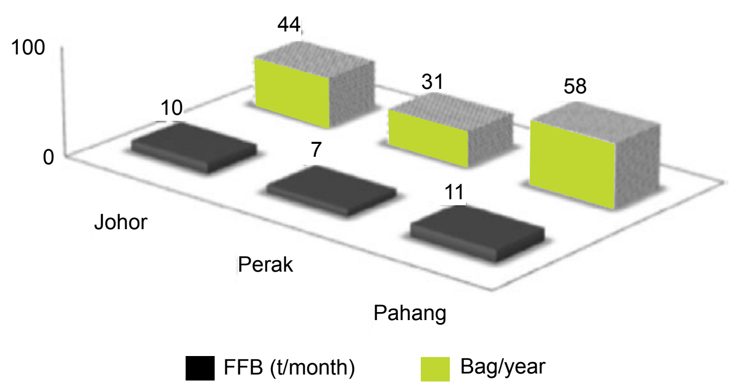


Figure 3. Fresh fruit bunch (FFB) yield and amount of fertiliser applied by independant smallholders by states.

Technical efficiency score. TE is the effectiveness with which a given set of inputs is used to produce an output. A firm is said to be technically efficient if a firm is producing the maximum output from the minimum quantity of inputs. As illustrated by *Figure 5*, in the Frontier analysis, TE was calculated by dividing actual production (q) with potential production (q^*) using the same input value (x). The TE value will be 1 if actual production can match the potential production.

Table 5 shows the frequency of TE for 145 ISH scores using Cobb-Douglas stochastic frontier estimates. The average TE score is 0.70 which was obtained using Frontier 4.1. This means that the ISH in Peninsular Malaysia is generally inefficient.

Table 5 shows that eight (5.5%) ISH obtained TE above 0.90 and 34 (23.4%) scored a TE between 0.80 and 0.89. These two groups with the score of TE above 0.80 can be considered as efficient ISH. The majority of the ISH (86 or 59.3%) achieved TE of between 0.50 to 0.79, while 17 ISH (11.7%) scored less than 0.49 TE. The minimum TE score by the ISH is 0.23 while the highest score is 0.94.

Comparing the TE score between the ISH on the three states, it is noted that the ISH in Johor scored the highest TE with 0.723 while the ISH in Pahang and Perak, their TE scores were about the same at 0.687 and 0.686, respectively (*Table 6*). In terms of the number of fertiliser bags applied in a year the ISH in Johor, on average, applied 44 bags while ISH in Perak and Pahang applied 31 and 59 bags, respectively even though both states (Perak and Pahang) having equal TE scores. In terms of FFB obtained in a month, ISH in Pahang scored the highest with 11 t, followed by ISH in Johor with 10 t and ISH in Perak with 7 t per month.

Table 7 shows the relationship between TE and FFB yield by ethnic categories. The results indicate that the average TE for Chinese ethnic was the highest (0.730) as compared to Malay and Indian owners with 0.696 and 0.702, respectively. The Chinese also obtained the highest FFB yield with 11 t a month as compared to 10 t for Indian ISH and 9 t for Malay ISH. Nevertheless, if the TE score by each ethic group were compared to the amount of bags of fertiliser applied (*Figure 5*), we noticed that the Chinese ISH used 50 bags of fertiliser in 2011, compared to only 41 bags by Malay ISH. For the Indian ISH, even though they scored 0.702 on the TE, they actually applied 55 bags in 2011 and the FFB yield obtained by them was not as good as the yield obtained by the Chinese ISH.

CONCLUSION

There were comments or studies by authors [*e.g.* Ayat *et al.*(2008), Azman *et al.* (2003) and others] which indicated that productivity

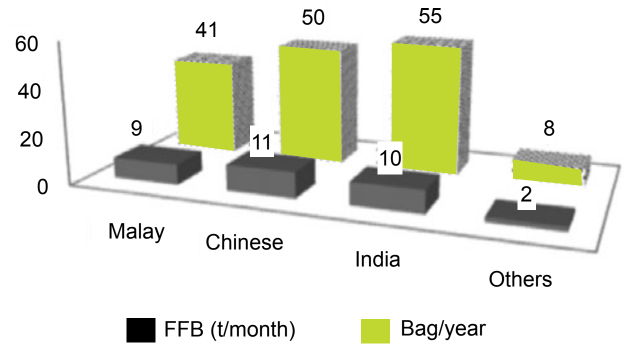
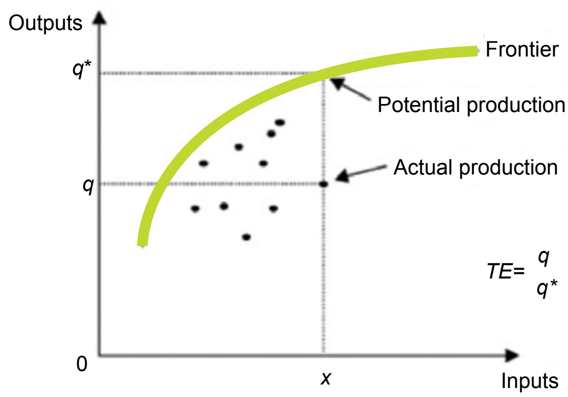


Figure 4. Fresh fruit bunch (FFB) yield and amount of fertiliser applied by different ethnic groups.



Source: Sean Pascoea and Louisa Coglan (2000).

Figure 5. Concept of technical efficiency (TE).

TABLE 4. MAXIMUM LIKELIHOOD ESTIMATES OF STOCHASTIC FRONTIER OF INDEPENDENT SMALLHOLDERS			
	Coefficient	Standard-error	t-ratio
Beta	-0.1811	0.1082	-1.673
InFertilizer	0.4214	0.0633	6.656**
InArea	0.5398	0.0803	6.715**

Note: ** Significant at 0.05 probability level.

TABLE 5. FREQUENCY AND DISTRIBUTION OF TECHNICAL EFFICIENCY OF ISH BY STATES

Efficiency	Johor	Perak	Pahang	Total
Above 0.90	4 (2.7%)	1 (2.7%)	3 (7.7%)	8 (5.5%)
0.80-0.89	21 (14.5%)	6 (16.6%)	7 (17.9%)	34 (23.4%)
0.70-0.79	24 (16.5%)	12 (33.3%)	9 (23.1%)	45 (31.0%)
0.60-0.69	6 (4.1%)	8 (22.2%)	8 (20.5%)	22 (15.2%)
0.50-0.59	8 (5.5%)	4 (11.1%)	7 (17.9%)	19 (13.1%)
Less than 0.49	7 (4.8%)	5 (13.9%)	5 (12.8%)	17 (11.7%)
Mean TE	-	-	-	0.70
Min TE	-	-	-	0.23
Max TE	-	-	-	0.94

TABLE 6. TECHNICAL EFFICIENCY (TE), AVERAGE FERTILISER APPLIED AND FRESH FRUIT BUNCH (FFB) YIELD BY STATES

State	TE score	Fertiliser (bag)	FFB yield (t per month)
Johor	0.723	44	10
Perak	0.686	31	7
Pahang	0.687	59	11

TABLE 7. AVERAGE TECHNICAL EFFICIENCY (TE) AND FRESH FRUIT BUNCH (FFB) YIELD BY ETHNICS

Race	Mean TE	FFB yield (t per month)
Malay	0.696	9
Chinese	0.730	11
Indian	0.702	10
Others	0.416	2

of smallholders is very low. No measurement had been made on the efficiency of the ISH which can qualify the authors' statements. This study, however, attempted to assess the level of efficiency of the ISH. It used fertiliser applied and holding size as its explanatory variables for the ISH yield. These explanatory variables are positively correlated with the yield. The study estimated TE of ISH in Peninsular Malaysia, emphasising only in the three states, namely Johor, Perak and Pahang to represent the whole region. The analysis estimated the average level of TE is 0.70 while the maximum and minimum TE are at 0.94 and 0.23, respectively. These TE values indicate that the ISH in Peninsular Malaysia are generally inefficient and support statement made by various authors on the efficiency of ISH. The big difference in TE among ISH in the sample suggests that there is a potential to increase output or yield by using inputs more efficiently. This can also be inferred that there is an opportunity to improve the ISH productivity.

To gain the TE score of ISH, one of the suggestions is to educate ISH in using fertiliser more efficiently, for example using correct technique when applying fertiliser. There were 17 ISH which obtained TE less than 0.50 and focus can be given to educate them in improving their fertiliser application technique. In addition, ISH knowledge needs to be updated especially in choosing the types of fertiliser to be used. It is suggested that successful ISH should become a model for other ISH to emulate. The successful ones probably have better fertiliser management which includes the usage of different types of fertiliser and their technique in applying their fertiliser.

REFERENCES

AIGNER, D L and VAN DE BROECK (1977). Formulation and estimation of stochastic frontier production models. *J. Econometrics, 6*: 21-37.

ALIAS, R; MIMI, L A and AMIN, M A (2008a). Technical efficiency of small and medium enterprise in Malaysia: a stochastic frontier production model. *International Journal of Economic and Management, 2(2)*: 395-408.

ALIAS, R; MOHD RUSLI, Y and SAIDATUL ASIMA, K S (2008b). The technical efficiency of food industry in Malaysia: an application of stochastic frontier model. *International Applied Economics and Management Letters, 1(1)*: 19-23.

AMOS, T T (2007). An analysis of productivity and technical efficiency of smallholders cocoa farmers in Nigeria. *J. Social Science, 15(2)*: 127-133.

AYAT, K A R; RAMLI, A; FAIZAH, M S and MOHD ARIF, S (2008). The Malaysian palm oil supply chain: the role of the independent smallholders. *Oil Palm Industry Economic Journal Vol. 8 No. 2*: 17-27.

AZMAN, I; MOHD ARIF, S and MOHD NOOR, M (2003). The production cost of oil palm fresh fruit bunches: the case of independent smallholders in Johor. *Oil Palm Industry Economic Journal Vol. 3 No. 1*: 1 and 4.

COELLI, T J (1995). Estimators and hypothesis tests for a stochastic: a Monte Carlo analysis. *J. Productivity Analysis, 6*: 247-268.

DAYANG NAZRIMA, S; ABD RAHIM, A S; JUSOH, L and AHMAD BORHAN, A N (2013). Chapter 2: Overview of oil palm replanting in Malaysia. *Oil Palm Replanting – Little Steps to a Giant Leap*. MPOB, Bangi. In press.

ECONOMICSHELP (2013). Internet extraction: www.economicshelp.org/blog/glossary/TechnicalEfficiency.

FARELL, M J (1957). The measurement of productive efficiency. *J. Royal Statistician Society Series A (General), 120*: 2503-287.

GOH, K J (2004). Fertilizer recommendation systems for oil palm: estimating the fertilizer rates. *Proc. of the MOSTA Best Practices Workshop – Agronomy and Crop Management.* Malaysian Oil Scientists and Technologies Association (MOSTA), Kuala Lumpur. p. 235-268.

HUYNH, V K and MITSUYASU, Y (2011). Technical efficiency analysis of rice production in Vietnam. *J. ISSASS Vol. 17 No. 1*: 135-146.

ISHOLA, T A; YAHYA, A; SHARIFF, A R M and ABD AZIZ, S (2011). A new concept of variable rate technology fertilizer applicator for oil palm. *International Journal of Agronomy and Plant Production Vol. 2 (5)*: 181-186. Available online at http:// www.victorquestpub.com.

IWALA, O S; OKUNLOLA, J O and IMOUDU, P B (2006). Productivity and technical efficiency of oil palm production in Nigeria. *J. Food, Agriculture and Environment. Vol. 3*: 181-185.

KOCZBERSKI, E; CURRY, G and GIBSON, K (2001). *Improving Productivity of the Smallholders Oil Palm Sector in Papua New Guinea: A Socio Economic Study of the Hoskins and Popondetta Schemes*. Oil Palm Research Association (OPRA) of Papua New Guinea – OPRA Annual Report Supplement.

LIM, G T; ISMAIL, A L and ARIFF HUSSEIN, M D (2011). Technical efficiency analysis for Penang trawl fishery, Malaysia: applying DEA approach. *Australian Journal of Basic and Applied Sciences, 5 (12)*: 1518-1523.

LIM, G T; ISMAIL, M M and HARRON, M (2012). Measuring technical efficiency of Malaysian paddy farming: an application of stochastic production frontier approach. *J. Applied Sciences, 12(15)*: 1602-1607.

MAD NASIR, S; ALIAS, R and ISMAIL, A L (1996). *Productivity in the Malaysian Agriculture Sector: Status and Policy Options to Increase Productivity*.

MOHD NASIR, A; ZIN, Z and HASIAH, E (2005). Market evaluation of phosphate fertilizers from various sources for matured oil palm in Malaysia. *Oil Palm Industry Economic Journal Vol. 5 No. 1*: 28.

MPOB (2012). *Malaysian Oil Palm Statistics 2011*. 31st Edition. MPOB, Bangi.

MPOB (2013). *Malaysian Oil Palm Statistics 2012*. 32nd Edition. MPOB, Bangi.

NG, S K (2001). Nutrition and nutrient management of the oil palm – new thrust for the future perspective. A paper presented at IPI PRII K in Nutrient Management for Sustainable Crop Production in India, New Delhi, India. Extracted from http://www.ipipotash.org/udocs/Nutrition%20and%20Nutrient%20Management%20of%20the%20Oil%20Palm.pdf.

NIK HASHIM, N M (2011). Technical efficiency for rubber smallholders under RISDA's supervisory system using stochastic frontier analysis. *J. Sustainability and Management Vol. 6 No. 1*: 156-168.

OBWONA, M (2000). *Determinants of Technical Efficiency Differentials Amongst Small and Medium Scale Farmers in Uganda: A Case of Tobacco Growers*. A Final Research Report presented at the Biennial AERC Workshop, Nairobi, Kenya.

RAZIAH, M L (2006). Total productivity and technical efficiency of watermelon at farm level. *Economic and Technology Management Review Vol. 1 No. 1*: 13-28.

SEAN, P and LOUISA, C (2000). Implications of differences in technical efficiency of fishing boats for capacity measurement and reduction. *Marine Policy, Vol. 24 Issue 4*: 301-307.

SON, T V H; COELLI, T and FLEMING, E (1993). An analysis of the technical efficiency of state rubber farm in Vietnam. *J. Agricultural Economics 9*: 183-201.

TIJANI, A A (2006). Analysis of the technical efficiency of rice farms in Ijesha land of osun state, Nigeria. *Agrekon Vol. 45, No. 2.*