An Economic Study on Technical Efficiency among Independent Oil Palm Smallholders in Sabah and Sarawak

Ali Zulhusni Ali Nordin*; Siti Mashani Ahmad*; Ainul Shazwin Sahidan*; Norhidayu Abdullah* and Ain, H*

Article history:
Received: 2 Jan. 2017
Accepted: 24 Feb. 2017
Available online: 3 March 2017

ABSTRACT

Malaysia was once known as the largest producer and exporter of palm oil until its position was taken over by Indonesia. The limitation in Malaysia in terms of land availability for new planting of oil palm has pushed the focus on technology and resources to efficiency and productivity in oil palm cultivation. At present, Malaysia is the second largest palm oil producer in the world, and may well be the third in future if no holistic strategy is charted to maintain her premier position in the industry. Rapid development and the increasing trend in the number of smallholders planting oil palm have posed another challenge to maintaining high productivity of fresh fruit bunch (FFB) production. Therefore, studies on social perception and factors affecting efficiency among the independent oil palm smallholders are deemed important. The present study found that the FFB yield achieved by independent smallholders in Sabah and Sarawak can be further improved. Among the factors that contributed to inefficiency among these independent smallholders are inadequate fertiliser application, Ganoderma *disease, high pest infestation, deficiency of nutrients in the oil palm, increasing cost of production and the unpredictable extreme weather conditions. The study focused only on Sabah and Sarawak as it is an extension of a previous study which had been carried out on smallholders in Peninsular Malaysia. It is recommended that the government continues its policy of assisting independent oil palm smallholders in order to maintain or increase their productivity.*

Keywords: technical efficiency, independent oil palm smallholders, productivity.

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

INTRODUCTION

Malaysia was well-known as the biggest palm oil producer and exporter in the world since 1970s before being overtaken by Indonesia. Oil palm has been dominating the Malaysian agricultural scene, having a supply chain with two levels of activities, namely, 'upstream' and 'downstream'. While the 'downstream' has been commonly referred to as the processing sector, encompassing mills and refineries, the 'upstream' sector consists of nursery operators, input suppliers, fresh fruit dealers, smallholders and estates. The smallholder sector includes both the organised and the unorganised smallholders, and, together with the estates, they are the backbone of the oil palm industry in the country. The organised smallholders are represented by participants in the Federal Land Development Authority (Felda), the Federal Land Consolidation and Rehabilitation Authority (Felcra), the Rubber Industry Smallholders Development Authority (RISDA), and various state schemes. The unorganised smallholders are those who are independent of such schemes.

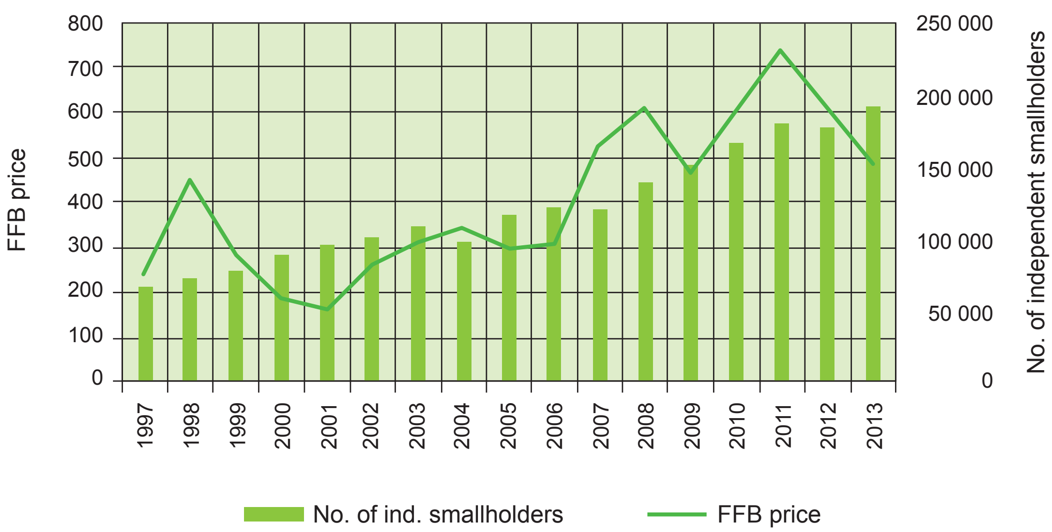
Independent smallholders (ISH) in Malaysia have generally increased in number in the recent past. From 67 208 ISH in 1997, their number rose to 120 341 in 2007, and to 177 046 and 192 198 in 2012 and 2013, respectively (*Figure 1*). The increase in the number of ISH was driven mainly by the lucrative fresh fruit bunch (FFB) price that attracted many of them to venture into the business and thus increase their oil palm areas (*Figure 1*).

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

ISH, however, face a number of problems, such as smallholding size (Koczberski *et al.*, 2001), low yield (Ayat *et al.*, 2008), inadequate uptake of oil palm technologies, and being unorganised. According to data from MPOB (2013), 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 largest number of ISH, with the largest total area under ISH and an average holding size of about 3 ha.

Perlis, by contrast, had the smallest area under ISH and the smallest number of ISH, but with the largest average holding size of 7-9 ha. With reference to low productivity, Azman *et al.* (2003) found that the main reason for low productivity was that ISH were not applying enough fertiliser; 14% of ISH surveyed in Johor in 2000 did not apply fertiliser which might have been due to the lack of funds for purchasing fertiliser arising from the low FFB price prevailing that year.

Another study by Ayat *et al.* (2008) showed that smallholders' FFB yield was low at around 18.82 t/ha in 2007, lower than the average yield of the country, which was 19.03 t/ha (MPOB 2012). However, according to Ishola *et al.* (2012), the soaring price of fertiliser



Source: MPOB (2012; 2013; 2014).

Figure 1. Number of independent smallholders and fresh fruit bunch (FFB) price (1997-2013).

TABLE 1. OIL PALM AREAS BY CATEGORY OF GROWERS (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	5 000 109	100	5 076 929	100	3.5

Note: Felda - Federal Land Development Authority.
Felcra - Federal Land Consolidation and Rehabilitation Authority.
RISDA - Rubber Industry Smalholders Development Authority.
CAGR - Compound Annual Growth Rate.
Source: MPOB (2012; 2013; 2014).

TABLE 2. INDEPENDENT SMALLHOLDER OWNERSHIP BY STATE, 2007 AND 2013

State	2007			2013		
	Number	Area (ha)	Average holding size (ha)	Number	Area (ha)	Average holding size (ha)
Johor	47 783	150 809	3.16	65 797	196 865.2	2.99
Perak	23 512	72 244	3.07	34 195	99 789.63	2.92
Sabah	15 689	106 157	6.77	29 685	198 632	6.69
Selangor	13 593	32 619	2.40	19 062	42 097.29	2.21
Pahang	6 319	29 213	4.60	8 967	40 585.27	4.53
Sarawak	4 620	29 214	6.32	18 234	93 332.38	5.12
Kedah	2 797	15 664	5.60	4 646	22 562.01	4.86
N. Sembilan	2 326	15 230	6.55	4 325	21 361.31	4.94
Melaka	1 240	6 419	5.18	2 166	10 289.45	4.75
P. Pinang	1 218	7 054	5.79	1 682	8 677.46	5.16
Terengganu	884	5 435	6.15	2 407	9 908.95	4.12
Kelantan	353	1 873	5.31	1 025	4 133.97	4.03
Perlis	7	61	8.67	8	57.65	7.21
Total	120 341	471 991	3.92	192 199	748 292.51	3.89

Source: MPOB (2012; 2013; 2014).

had prompted some of the oil palm planters to withdraw fertiliser usage as a measure to break even. Nevertheless, it should be noted that for sustaining good yields, fertiliser inputs are necessary and typically constitute 40%-50% of total field upkeep cost (Ng, 2001). In addition to the above problems, ISH also established their oil palm holdings by themselves with minimal government assistance (Azman *et al.*, 2003), and are normally less efficient compared with the estates.

Despite the problems that they face, ISH do play an important role in the Malaysian economy, especially in terms of employment and production of FFB. Based on the area in 2013 of 748 292 ha (MPOB, 2014), we estimate that a total of nearly 12 million tonnes of FFB were produced by them. The Malaysian government also has a plan to improve their income so that it is in line with the aspiration to make the country a developed nation by 2020. In view of this, one of the strategies by the government through MPOB to improve income of ISH was by introducing an oil palm replanting scheme called *Skim Tanam Semula Sawit* (SITS) in 2001 and 2008.

The main ideas of the scheme were to address the declining crude palm oil (CPO) price during those years as well as to replace the older varieties of oil palm that were more than 25 years of age with new planting materials. By replanting oil palm using these new improved materials, it was expected that they would be able to produce more output. Under SITS 2001, a total of 46 828 ha of oil palm owned by smallholders (both ISH and organised) were replanted in 2002 and 2003 (Dayang *et al*., 2017).

The second scheme SITS 2008 recorded a larger replanted area by the smallholders. The area replanted under ISH was 48 256 ha while 20 298 ha were by organised smallholders, bringing the total to 68 554 ha.

It is expected that replanting will help to curtail under-production because production from old palms will be reduced. Quality planting materials will be used for replanting, and production of FFB from the smallholders can be expected to increase when the palms mature. However, replanting alone cannot ensure high productivity of the smallholdings which is normally measured by FFB yield. This is because there exist a few factors contributing to FFB yield, such as quality of the planting materials, field maintenance (especially during the immature period when palms are less than three years old), fertiliser application and field upkeep. In this respect, 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 system should include correct timing, placement and methods of fertiliser application, the right source of fertiliser, and recommendations on optimum growing conditions for the oil palm to maximise nutrient uptake, and should be accompanied by monitoring of growth, nutrition and yield targets (Ng, 2001).

The use of fertilisers, however, is dependent on the price of palm oil; more fertilisers will be used during higher prices than during low prices. Due to the lack of funds to purchase fertilisers, as in the case Johor ISH in 2000, 14% of them did not apply any (Azman *et al*., 2003).

Therefore, efficiency of smallholders should not be judged only by the amount of FFB produced but also by how inputs are being used efficiently, in this case the fertiliser. Efficiency in using inputs means less wastage so that the amount of fertiliser used can be reduced compared with normal usage. This simply means that cost can be reduced, and, at the same time, indirectly the net income of the smallholder can be increased.

Stochastic Production Function and Technical Efficiency

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

The value of TE ranges between 0 and 1, which represents the degree of TE. If TE is equal to 1, it means the firm is producing at full TE; however, if it is 0, it 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 such information is important for policy purposes.

To study efficiency, most researchers adopt either one of the other of the competing methodologies, *i.e.* Stochastic Frontier Analysis (SFA) or data envelopment analysis (DEA). The initial concept of the former method was proposed by Farrell in 1957 (cited by Amos, 2007) and later by Aigner and van de Broeck (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 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).

LITERATURE REVIEW

There are two methods which are widely used for estimating TE, namely, the econometric approach which aims to develop Stochastic models, and the non-parametric approach or mathematical programming (Huynh and Mitsuyasu, 2011). The former is normally known as the Stochastic Frontier model while the latter is DEA. Both have 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 new technology. Estimates of the extent of inefficiency also help in deciding whether to improve efficiency or to develop new technologies to raise 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) and Raziah (2006). A study by Nik Hashim (2011) involved 35 rubber smallholders in Besut, Terengganu, who were under the supervision of RISDA personnel. Variables used in estimating the Frontier model were rubber production as the 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 smallholders achieved a 0.95 to 1.00 TE score. The score for TE ranges from 0.00 to 1.00 where 1.00 indicates maximum efficiency.

In the aquaculture sector, Lim *et al*. (2011) studied the efficiency of sampled trawling vessels in Pulau Pinang because annual landings had declined by almost 23% in the past 17 years. Data envelopment analysis was applied using 69 selected vessels and the TE scores 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 landings per trip while the independent variables or inputs were number of workers, fishing effort (fishing days per trip), diesel consumption per trip (in litres), vessel capacity (GRT) and engine horsepower (hp) of each vessel.

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

For non-seasonal fruits such as water melon, a study was carried out by Raziah in 2006 on 49 selected farms in the 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 the costs of capital, labour and 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 farms having an efficiency level below the average.

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

METHODOLOGY

Data were collected from independent smallholders in Sabah and Sarawak. There were 39 725 ISH in Sabah and Sarawak, with their smallholdings amounting to 248 733.77 ha, planted in 35 different districts (*Table 3*).

To determine the minimum sample size requirement to undertake the study, the sampling size formula by Morris Hamburg (1985) was utilised, and the sample number was distributed based on the percentage of ISH numbers in Sabah and Sarawak (*Tables 4* and *5*). The total sample size determined for this study was 381 ISH. Data collected were analysed using the SFA production function. The total number of respondents surveyed in Sabah was 331 smallholders and 145 in Sarawak.

Frontier Model

The Stochastic Frontier Production Function that is based on an econometric specification of a production frontier was developed by Aigner *et al.* (1977) and W Meeusen and J Van den Broeck (1977). Later in 1995, Battese and Coelli extended the earlier work and defined the Stochastic Production Function as follows:

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

where Y_i is the output vector for the i^{th} firm, X_i is a vector of inputs, β is a vector of parameter and $e^{\varepsilon i}$ is an error term. In this model, a production frontier defines output as a function of a given set of inputs.

TE was estimated by finding the ratio of the observed output (Y_i) to the corresponding frontier output (Yi^*) 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 the subscript *i* refers to the observation of the i^{th} farmer and *j* refers to FFB production.

Y = total FFB produced in a month (t/month)
X_1 = farm size (ha)
X_2 = number of fertiliser bags used in the previous year (each bag of 50 kg)
e = error term
ln = natural logarithm

The β is a scalar parameter estimated by the method of maximum likelihood, while estimates for parameters of the Stochastic Frontier Production Function are obtained using the program Frontier version 4.1.

RESULTS AND DISCUSSION

Productivity indicators show an improvement or reduction in performance, and the information obtained from productivity sub-indicators are used to identify the problems and define the strategies. This study was mainly carried out through a survey by questionnaires to assess the key factors that affect the productivity of FFB in Sabah and Sarawak. The 476 respondents in Sabah and Sarawak were interviewed, the questionnaires were properly filled and the required data collected. The minimum sample size needed for the study was 360 respondents.

TABLE 3. NUMBER OF INDEPENDENT SMALLHOLDERS (ISH) IN SABAH AND SARAWAK

State	Number of districts	Number of ISH	Oil palm area (ha)
Sabah	24	25 922	176 858.36
Sarawak	11	13 353	71 875.41

Source: MPOB (2012; 2013; 2014).

TABLE 4. NUMBER OF INDEPENDENT SMALLHOLDERS (ISH) IN SABAH

District	Number of ISH	Sample distribution	Respondents surveyed
Kinabatangan	5 486	60	70
Labuk/Sugut	4 949	54	64
Lahad Datu	3 137	35	45
Tawau	2 553	28	38
Sandakan	1 978	22	28
Beaufort	1 665	18	25
Samporna	1 254	14	20
Keningau	1 175	13	23
Kunak	948	10	10
Kudat	740	8	8
Total	23 885	262	331

TABLE 5. NUMBER OF INDEPENDENT SMALLHOLDERS (ISH) IN SARAWAK

District	Number of ISH	Sample distribution	Respondents surveyed
Miri	6 428	71	74
Bintulu	1 252	14	20
Samarahan	1 128	12	15
Betong	1 053	12	21
Sri Aman	852	9	15
Total	10 713	118	145

As can be seen from *Table 6*, the majority of the respondents (48.9%) were above the age of 50 years, followed by those in the category of 41-30 years (28.7%). In terms of educational level, most of them had qualifications up to secondary school (48.5%), followed by those who completed primary school (30.8%). There was also a small percentage of respondents who had a basic degree and above (7.3%). The majority of the respondents were married (90.3%). Only 3.7% were single and the same number were widowed. The remaining 2.2% of the respondents were divorced. Most of the respondents (51.6%) had a family of one to four members, while 31.5% had a family of 5 to 7. Only 5.0% respondents had a family size greater than 10.

From *Figure 2*, it appears that the majority of the independent oil palm smallholders earned around RM 1000 to RM 2500 per month, *i.e.* 37.8% out of the total. Only 9% of the smallholders earned more than RM 4500 per month, followed by 8.8% who earned from RM 3501 to RM 4500 a month, while 19.3% earned around RM 2501 to RM 3500 a month. About 25.3% of the respondents were in the lowest income category, earning less than RM 1000 a month.

With regard to the experience of the respondents, *Figure 3* shows that the majority of them (55%) had 1-10 years' experience in managing oil palm. It is also clear that only 2.5% of the respondents had experience less than one year or more than 30 years.

Farm Information

The area of a farm dictates the scale of production. As farm size increases, the level of output increases as well. The distribution of farm size of the sampled ISH in the study area is given in *Figure 4*. About 46% of the respondents had

TABLE 6. DEMOGRAPHIC PROFILE OF THE RESPONDENTS

Profile	Category	%
Age	Below 20	0.5
	20-30	5.5
	31-40	16.5
	41-50	28.7
	Above 50	48.9
Educational level	Did not attend school	13.5
	Primary school	30.8
	Secondary school	48.5
	College/university	7.3
Marital status	Single	3.7
	Married	90.3
	Widowed	3.7
	Divorced	2.2
Family size	No family	2.2
	1 to 4	51.6
	5 to 7	31.5
	8 to 10	9.7
	More than 10	5.0

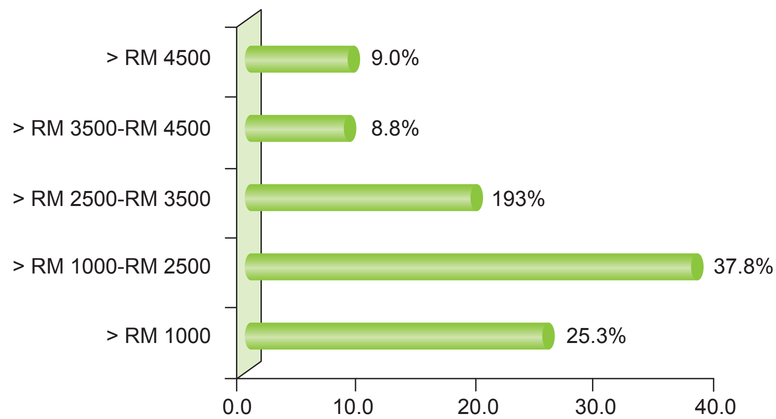


Figure 2. Monthly income.

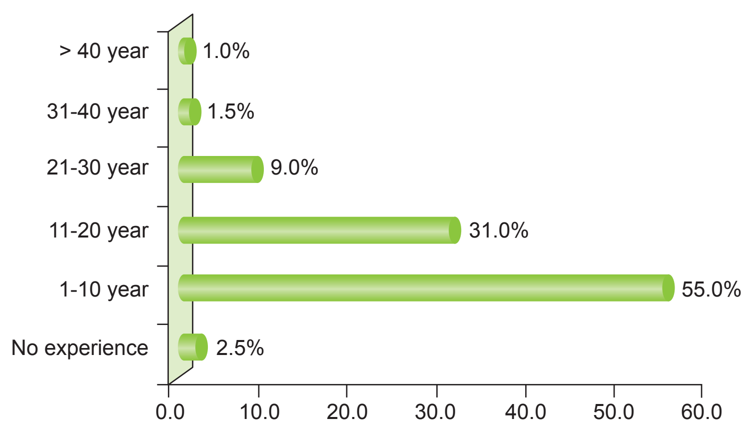


Figure 3. Experience in managing oil palm.

holdings of less than 4 ha, while 45% of them operated on a small scale level of 4 to 10 ha. Only 6% of them operated on a medium scale (10 to 20 ha), reconfirming that ISH farmed mostly on a small scale.

For age of the palms (*Figure 5*), most of the respondents owned palms ranging from 9 to 15 years in age (approximately 34%), followed by those owning palms in the range of 16-20 years (about 20%) and in the range of five to eight years (29%). Less than 7% of the respondents had palms below the age of four years, while approximately 2% had palms above 25 years old.

For FFB yield from smallholdings in Sabah and Sarawak, *Figure 6* shows that only 2% of them produced FFB yields greater than 30 t/ha/yr. Another 21% produced around 20 to 30 t of FFB per year. The majority of the respondents (43%) achieved 10 to 20 t/yr, while 34% were the low performers producing less than 10 t of FFB per year.

Type of soil and topography are two important parameters of site quality to conserve soil moisture for use by the planted palms. For soil type, 82.3% of the holdings of the respondents had the hinterland type, 10.8% were on peat soil and the rest had alluvial coastal soil (*Figure 7*). In terms of topography, 41.7% of the holdings were on flat land which is between 0° and 2° gradient, while 36.8% had undulating topography (between 2° and 6°) (*Figure 8*). Only 21.5% of respondents had holdings on hilly topography.

From *Figure 9*, it may be seen that 65.0% of the respondents practised a lower planting density (which is 136 palms per hectare), while 25.6% had 148 palms per hectare and 4.2% planted 160 palms per hectare. *Figure 10* also shows that 88.2% of the respondents used the equilateral triangle planting

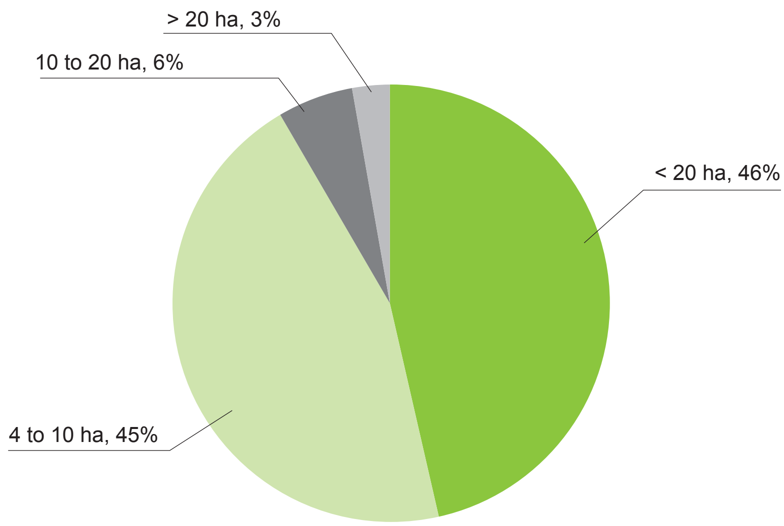


Figure 4. Size distribution of oil palm holdings.

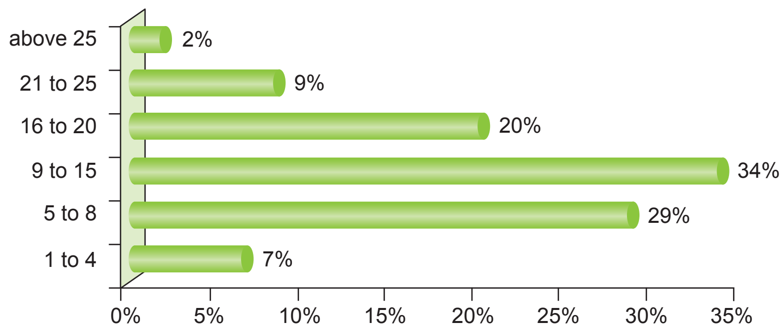


Figure 5. Age of palms.

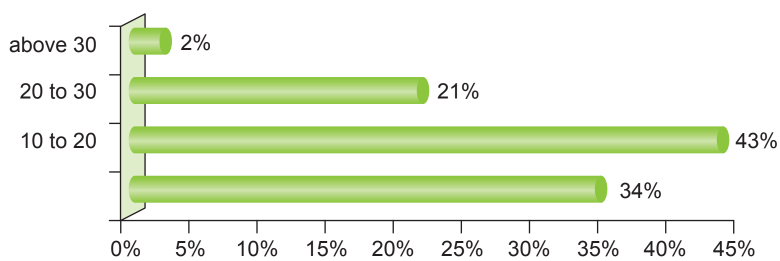


Figure 6. Fresh fruit bunch yield.

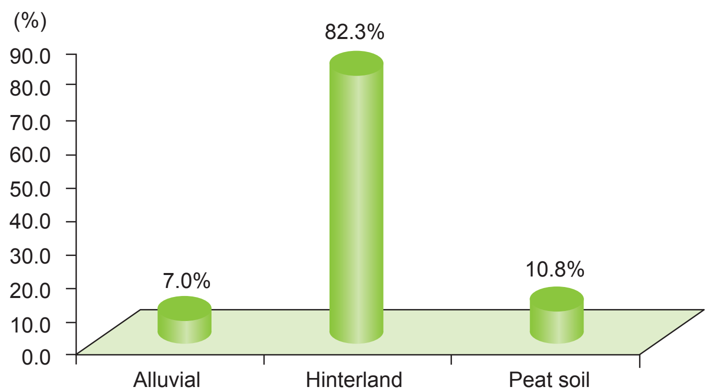


Figure 7. Types of soil.

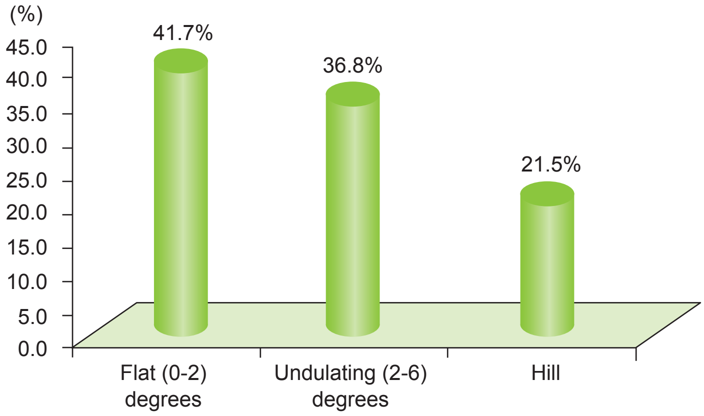


Figure 8. Types of topography.

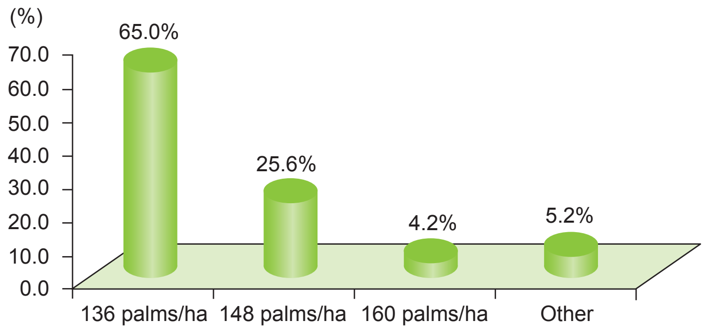


Figure 9. Oil palm planting density.

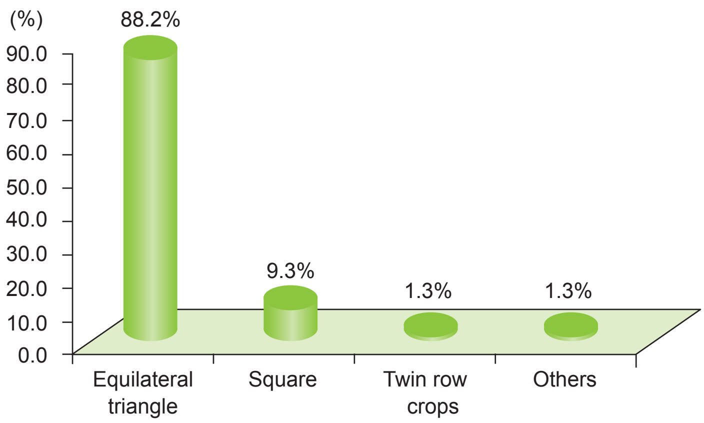


Figure 10. Oil palm planting system.

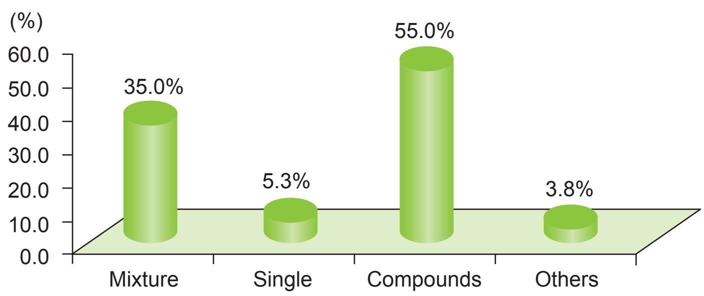


Figure 11. Types of fertiliser used.

system, while only 9.3% of them used the square system.

Farming Practices

As the cost of fertilisers is the major component of field upkeep expenditure, it is important to determine the appropriate types of fertilisers required and the methods used to ensure optimal palm development and production. Respondents were asked directly the types of fertiliser that had been used in their holdings. Approximately 55% replied that they used compound fertilisers, while 35.9% used mixtures of fertiliser (*Figure 11*).

It is also important to determine the appropriate method of fertiliser application used for optimal palm development and production. Respondents were directly asked how they applied the fertiliser used in their holdings. *Figure 12* shows that most of the respondents spread the fertiliser around the palms (66.1%), followed by those who spread the fertiliser between the palms (29.9%).

The majority of the respondents (81.9%) hired one to two workers for fertiliser application, while only 14% hired three to four workers for the job (*Figure 13*). The source of the workers for fertiliser application was mostly local (34.4%), while others (42.9%) included the owner himself performing the job or sharing labour with other smallholders.

For the frequency of fertiliser application, 56% of the respondents fertilised the immature palms three to four times per year, while 35% of them fertilised less than three times a year. For the mature palms, 57% of the respondents applied fertiliser two to three times per year, while 30% of them applied fertiliser less than twice per year.

Most of ISH did not apply fertiliser according to the

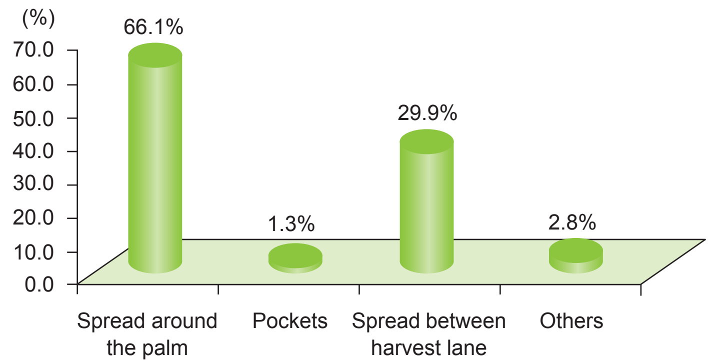


Figure 12. Fertiliser application method.

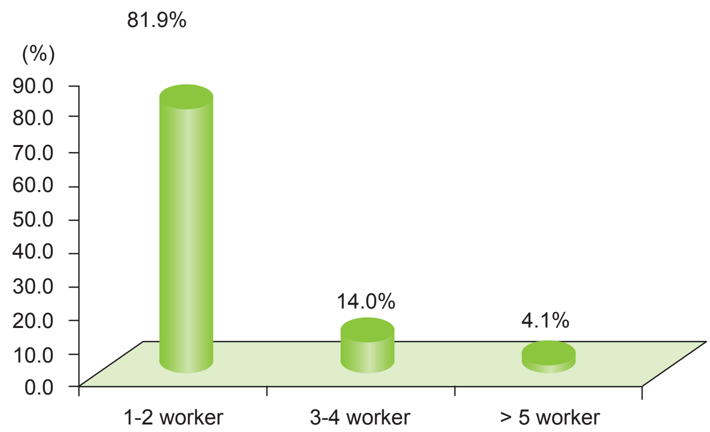


Figure 13. Manpower employed for fertiliser application.

recommendations. As we can see from *Figure 14*, the majority of the respondents used less than 2 kg per palm per year for both immature and mature palms. Only some of the smallholders (19%) applied more than 4 kg per immature palm and about 3% applied more than 7 kg per mature palm (*Figure 15*). The major reasons given by the smallholders were the belief that the soil was fertile enough, and that chemical fertiliser was too costly for them.

The respondents were asked whether weed control was carried out or not, and 96% of them replied 'Yes'. *Figure 16* shows that the main method used by those practicing weed controls was chemical (67.8%), *i.e.* applying herbicides, followed by mechanical (27.5%) which used a hoe, sickle or lawn mower.

The majority of the respondents hired one to two workers for weeding (84.8%), while only 12.9% of them hired three to four workers

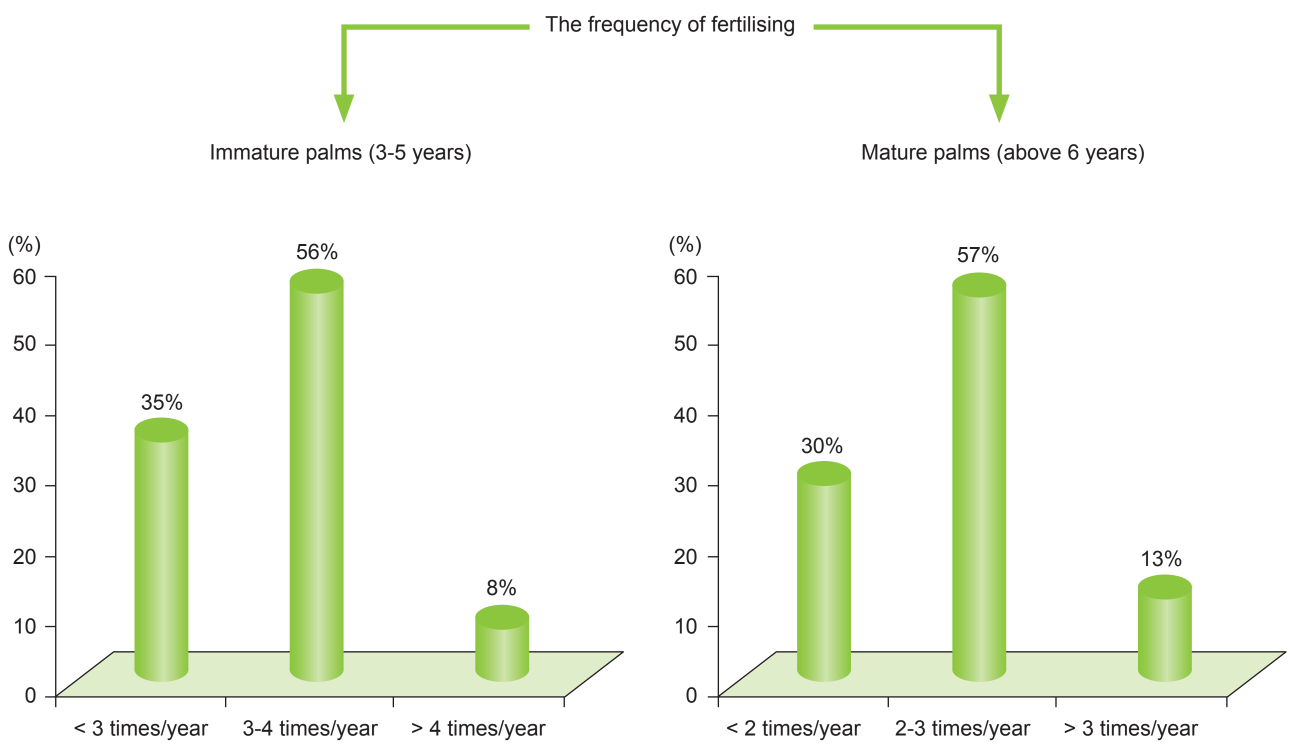


Figure 14. Fertiliser application frequency.

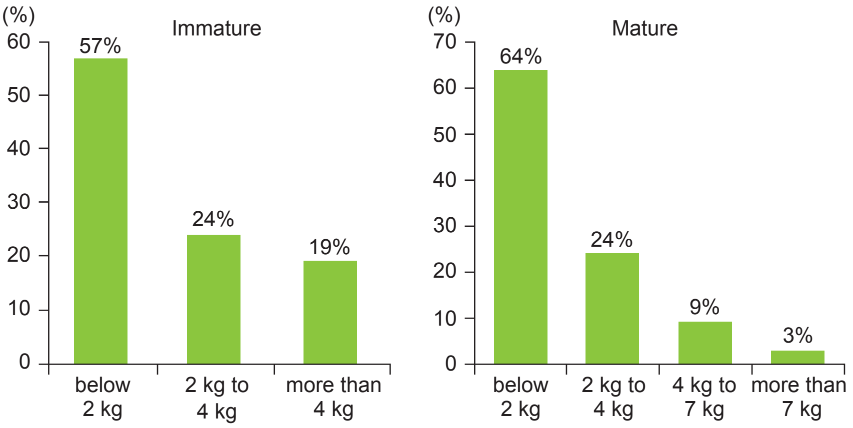


Figure 15. Amount of fertiliser applied.

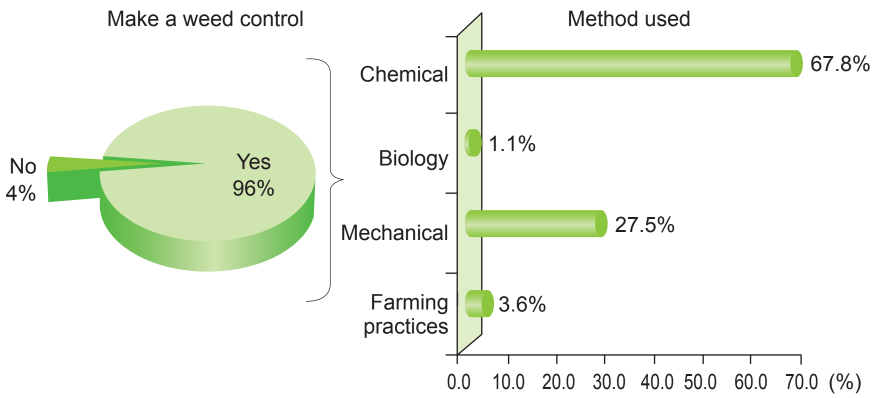


Figure 16. Weed control.

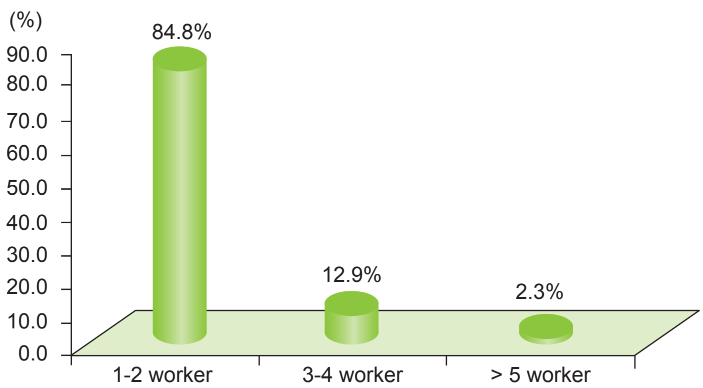


Figure 17. Manpower employed for weeding.

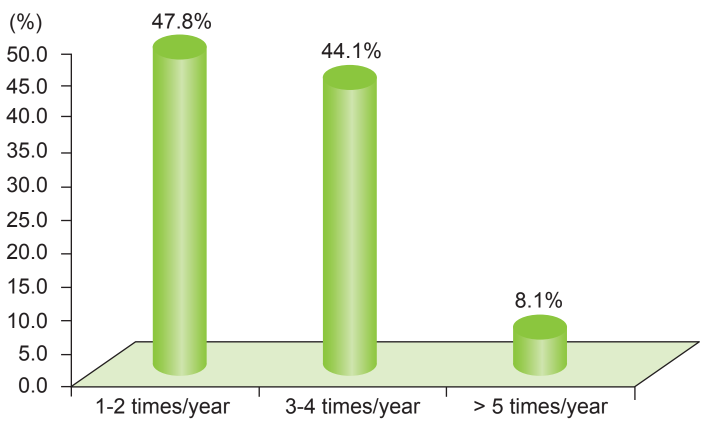


Figure 18. Weeding frequency.

(*Figure 17*). Most of the workers were local. Of the respondents who practiced weeding, 47.8 % of them weeded the palms one to two times per year, while 44.1% weeded three to four times per year (*Figure 18*).

The respondents were also asked whether they observed any signs of pest infestation, and 47% replied 'Yes' (*Figure 19*). Of the main pests observed, 40.6% comprised rats, 32.5% were rhinoceros beetles and 12.9% were bagworms (*Figure 19*).

For signs of disease infection, 29% of the respondents replied 'Yes' to noticing signs, and 79% of them identified the disease as *Ganoderma* (*Figure 20*).

Those whose palms were infected by *Ganoderma* disease were asked what steps were taken to control the disease. About 43.5% of them did not do anything to mitigate the *Ganoderma* infection, while 17.6% said that they carried out trunk injection with fungicides on the infected palms. About 18.8% of the respondents used sanitation methods, while 15.6% of them covered the trunks of sick palms with soil (*Figure 21*).

The respondents were also asked whether their palms had unhealthy symptoms, and 49% replied 'Yes'. Unhealthy signs included yellowish leaves (39.3%), orange leaf spots (19.5%), yellow and dry leaf margins (16.7%), stunted palms (13.6%), and wrinkled leaves (11%) (*Figure 22*).

The majority of the respondents (87.9%) harvested their palms twice a month, or every cycle of 15 days (*Figure 23*). About 98.2% of the respondents cut the bunch stalks short, and 97.2% of them also collected all the loose fruits that fell off the bunches. This shows that the respondents adopted the right practices in order to get maximum output.

A number of challenges affect ISH in FFB production, and these are associated with different factors.

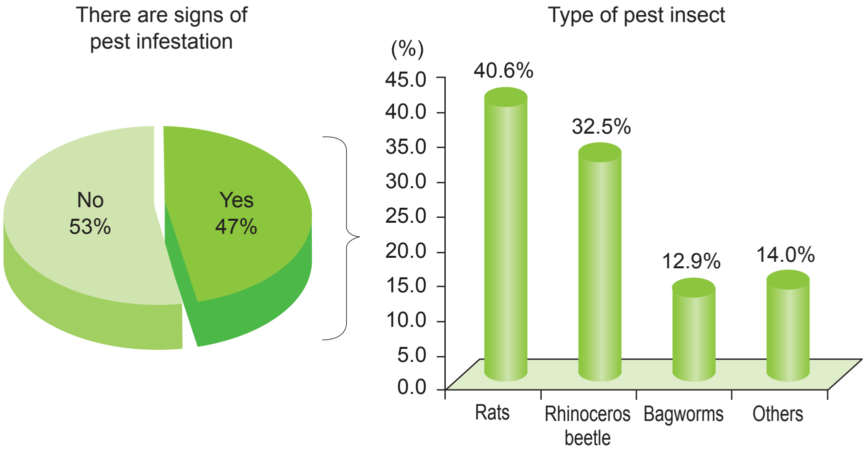


Figure 19. Signs of pest infestation and type.

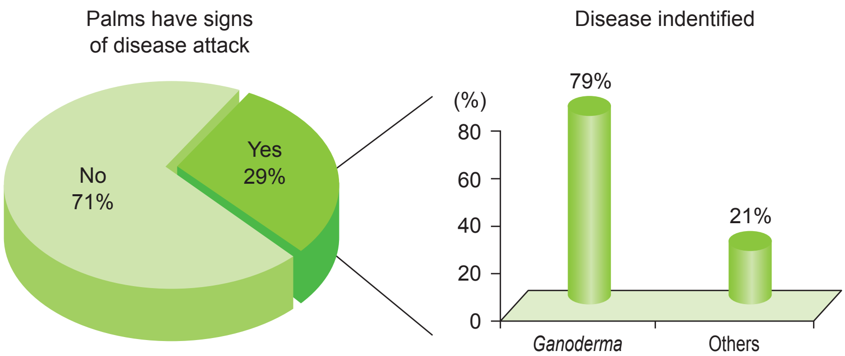


Figure 20. Signs of disease attack on palms and type.

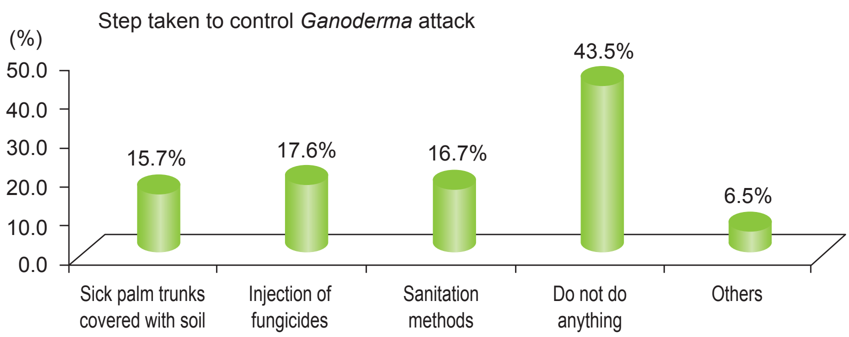


Figure 21. Mitigation measures for Ganoderma *disease.*

From *Figure 24*, it is apparent that the cost of production was the main challenge faced by ISH, far more important than weather. The average mean score of 4.03 for high cost of production corresponds to the response 'Agree'. The result also shows that ISH needed more training and knowledge-sharing from Extension Officer in order to help them increase productivity of FFB. This can be seen from the highest mean score (4.29) for field management.

Efficiency Score of Independent Smallholders in Sabah and Sarawak

The Stochastic Frontier Production Function analysis was used to determine the efficiency of the oil palm ISH in Sabah and Sarawak. The analysis was divided into two: TE for immature palms, and TE for mature palms.

The model specification for immature palms was: lnYield = 2.8647 + 0.2543 lnHolding - 0.0186 lnAge + 0.0393 lnFertiliser, while the model specification for mature palms was: lnYield = 3.1840 + 0.0942 lnHolding - 0.0597 lnAge + 0.0241 lnFertiliser (*Table 7*).

The analysis results are shown in *Table 8* as a distribution of TE scores obtained for the independent oil palm smallholders. The smallholders are deemed efficient if the score is 1, while lower scores indicate inefficiency.

TABLE 7. MAXIMUM LIKELIHOOD ESTIMATES (MLE) FOR IMMATURE PALMS AND MATURE PALMS (Sabah and Sarawak)

	Immature palms			Mature palms		
	Coefficient	Standard error	t-ratio	Coefficient	Standard error	t-ratio
Beta 0	2.8647	1.0604	2.7016	3.1840	0.3832	8.3082
Beta 1	0.2543	0.2157	-1.1790	0.0942	0.0684	1.3778
Beta 2	-0.0186	0.3073	0.0605	-0.0597	0.0807	-0.7398
Beta 3	0.0393	0.1370	0.2870	0.0241	0.0544	0.4439

Note: ** Significance at 95%.

TABLE 8. DISTRIBUTION OF TECHNICAL EFFICIENCY (TE) SCORES

Efficiency	Immature OP		Mature OP	
	No. of ISH	% of ISH	No. of ISH	% of ISH
> 0.90	4	4.50	5	1.30
0.80-0.89	13	15.90	50	12.70
0.70-0.79	16	20.50	71	18.00
0.60-0.69	13	20.50	59	14.90
0.50-0.59	31	38.60	38	9.60
< 0.49	4	4.50	172	43.40
Mean TE	0.5245		0.5517	
Minimum TE	0.1369		0.1008	
Maximum TE	0.8429		0.9113	

Note: OP - oil palm.
ISH - independent smallholders.

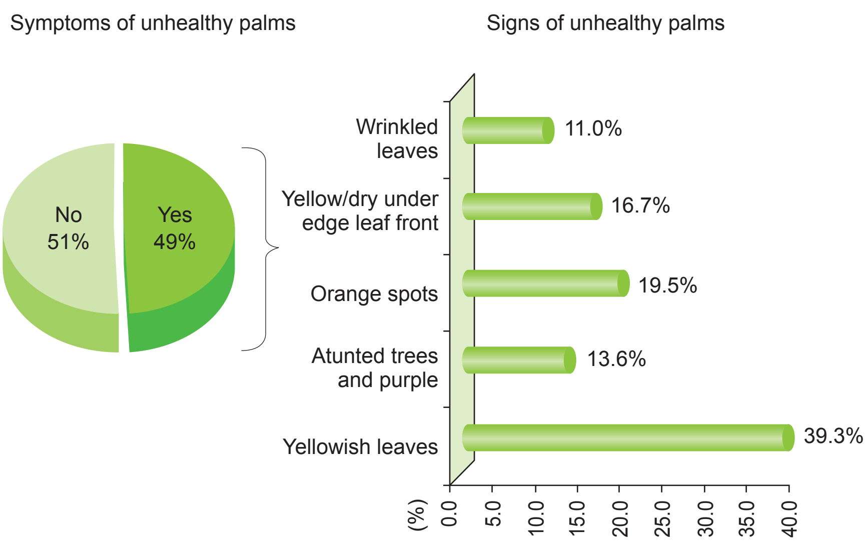


Figure 22. Signs of unhealthy palms and symptoms.

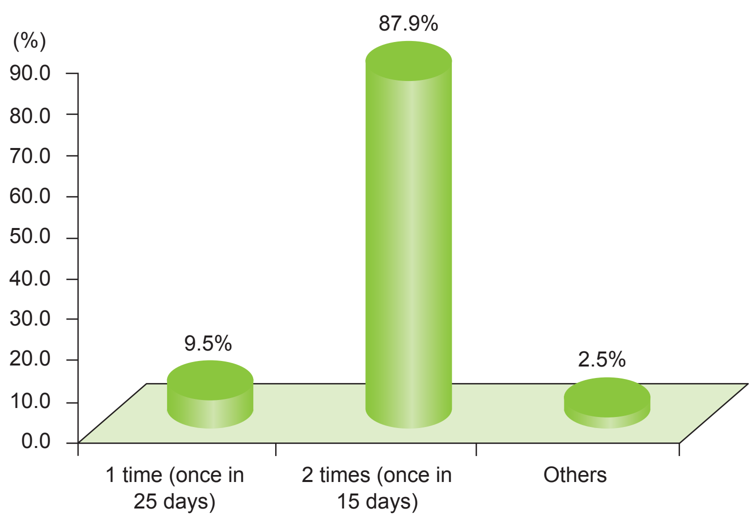


Figure 23. Harvesting frequency.

For immature oil palm, only 4.5% of the smallholders scored above 0.90, which is the very efficient. This is followed by 15.90% of the smallholders having scores between 0.80 and 0.89, 20.50% with scores between 0.70 and 0.79, and another 20.50% scoring between 0.60 and 0.69. Among the rest, 38.60% of the smallholders scored between 0.50 and 0.59, while 4.50% scored the lowest, which was less than 0.49.

For the efficiency scores achieved by smallholders having mature palms, only 1.30% of them scored above 0.90, which is the most efficient. This is followed by 12.70% with scores between 0.80 and 0.89, 18.00% scoring between 0.70 and 0.79 and another 14.90% scoring between 0.60 and 0.69. Among the rest, 9.60% of the smallholders scored between 0.50 and 0.59, while the majority of 43.40% of the smallholders scored the lowest, *i.e.* less than 0.49.

CONCLUSION

The study found that FFB yields achieved by ISH in Sabah and Sarawak can be further improved. The main factor that affected the efficiency of the smallholders was inadequate fertiliser application. The recommended rate of fertiliser for immature palms is 3.6 to 6.9 kg/palm/yr, while for mature palms it is 7.0 to 9.0 kg/palm/yr. This was not practiced by the smallholders, the majority of whom applied less than 4 kg/palm/year for both mature and immature palms, thus affecting the growth of the palms and FFB development. Another factor that affected FFB yield was *Ganoderma* infection. Although only 29% of the respondents reported observing *Ganoderma* disease in their oil palm holdings, the rate of infection is expected to escalate if no proper mitigating

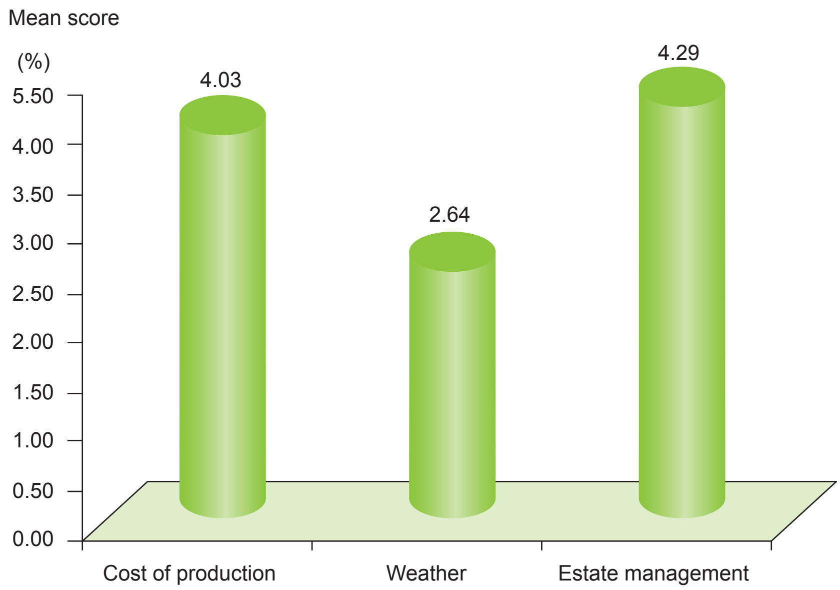


Figure 24. Challenges or constraints faced by smallholders.

action is taken. The high number of pest infestations in their holdings also contributed to the low FFB yield among smallholders in Sabah and Sarawak. A total of 47% of the respondents reported pest infestations with rats having the highest occurrence, followed by rhinoceros beetles and also bagworms. In addition to this, yellowish leaves, orange leaf spots and yellowish/dried palm fronds, which are mostly signs of insufficient nutrients, also contributed to low FFB yield among smallholders. Finally, almost all of the respondents strongly agreed that the increasing cost of production and unpredictable extreme weather conditions were the biggest challenges to the smallholders nowadays.

RECOMMENDATION

From the above discussion, it is recommended that the government continue to assist the smallholders so that they will stay competitive and efficient. Although the implementation of the National Key Economic Areas (NKEA) covers smallholders' interests, the amount of allocation needs to be increased as the trend shows that the number of independent smallholders is increasing as well as their oil palm area. In addition to this, empowerment of extension officers seems to give direct positive effects to the coverage of advisory services to the smallholders. It is proposed that Certification of Good Agricultural Practices (GAP) courses be made mandatory for all smallholders to provide them with knowledge and information on recommended technologies. Other than the experienced planters, it is also helpful to enforce GAP certification on all smallholders. This will ensure that the ISH in Malaysia are well equipped with the necessary knowledge on oil palm cultivation technologies and guidelines to produce higher FFB yield.

REFERENCES

AIGNER, D J; LOVELL, C A K and SCHMIDT, P (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 enterprises in Malaysia: a Stochastic Frontier Production Model. *International J. Economic and Management, 2(2)*: 395-408.

ALIAS, R; MOHD RUSLI, Y and SAIDATUL ASIMA, K S (2008b). The technical efficiency of the food industry in Malaysia: an application of

Stochastic Frontier Model. *International Applied Economics and Management Letters, 1(1)*: 19-23.

AMOS, T (2007). An analysis of productivity and technical efficiency of smallholder 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 (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 (1)*: 1-4.

BATTESE, G E and COELLI, T J (1995). A model for technical inefficiency effects in a Stochastic Frontier Production Function for panel data. *Empirical Economics, 20 (2)*: 325-332.

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 (2017). Chapter 2: Overview of oil palm replanting in Malaysia. *Oil Palm Replanting – Little Steps to a Giant Leap*. MPOB, Bangi.

ECONOMICSHELP (2013). www.economicshelp.org/blog/glossary/TechnicalEfficiency. accessed in January 2017.

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.

HAMBURG, MORRIS (1985). *Basics Statistic: A Modern Approach*. San Diego: Harcourt Brace Jovanovich (HBJ).

HUYNH, V K and MITSUYASU, Y (2011). Technical efficiency analysis of rice production in Vietnam. *J. ISSASS, 17 (1)*: 135-146.

ISHOLA, TAJUDEEN ABIODUN; YAHYA AZMI; MOHAMED SHARIF; ABDUL RASHID, ABD AZIZ and SAMSUZANA (2012). Variable rate technology fertiliser applicator for oil palm plantation. Paper presented at the International Conference on Agricultural and Food Engineering for Life (Cafei2012), 26-28 November 2012, Palm Garden Hotel, Putrajaya. p. 520-534.

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, 3 (3 & 4)*: 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 J.f 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.

MEEUSEN, W and VAN DEN BROECK, J (1977). Efficiency estimation from Cobb-Douglas Production Functions with composed error. *International Economic Review, 18 (2)*: 435-444.

MOHD NASIR AMIRUDDIN; AYAT K AB RAHMAN and FAIZAH SHARIFF (2005). Market potential and challenges for the Malaysian palm oil industry in facing competition from other vegetable oils. *Oil Palm Industry Economic Journal Vol. 5(1)*.

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

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

MPOB (2014). *Malaysian Oil Palm Statistics 2013*. 33rd 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 the IPI PRII K in Nutrient Management for Sustainable Crop Production in New Delhi, India. Extracted from http://www.ipipotash.org/udocs/NutritionandNutrientManagementoftheOilPalm.pdf, accessed in January 2017.

NIK HASHIM, N M (2011). Technical efficiency for rubber smallholders under RISDA's supervisory system using Stochastic Frontier Analysis. *J. Sustainability and Management, 6 (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, 1 (1)*: 13-28.

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

ISHOLA, TAJUDEEN ABIODUN; YAHYA AZMI; MOHAMED SHARIFF; ABDUL RASHID, ABD AZIZ and SAMSUZANA (2012). Variable rate technology fertilizer applicator for oil palm plantation. Paper presented at the International Conference on Agricultural and Food Engineering for Life (Cafei2012), 26-28 Nov. 2012, Palm Garden Hotel, Putrajaya. p. 520-534.