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Technical Efficiency of Pepper Farms in Sarawak

Abdul Hamid Jaafar
Mansor Jusoh

ABSTRACT

Pepper is an important crop in Sarawak. This is especially so for the interior population as the crop can be stored for a long period of time without any treatment. Pepper in Sarawak are cultivated by bumiputeras and non-bumiputeras. This paper has two objectives; the first is to determine the overall technical efficiency of the pepper cultivation industry in Sarawak and the second is to ascertain whether there is any difference in the technical efficiency of the bumiputera and non-bumiputera pepper farms. The method of technical efficiency measurement is calculated based on the Kopp technical efficiency measure while for the comparison of technical efficiency between ethnic groups, the method as suggested in Mansor Jusoh and Hamid Jaafar (1989) was utilized. The results indicate that the overall technical efficiency of pepper cultivation industry in Sarawak is very low. This implies that a greater output can be achieved with the present level of input usage. Further the results also indicate that the bumiputera farms are relatively less technically efficient than the non-bumiputera farms. Thus, appropriate measures must be taken so that scarce factors of production are used optimally.

ABSTRAK

Lada merupakan tanaman yang penting kepada ekonomi Sarawak, terutamanya bagi penduduk pendalaman kerana hasil tanaman ini tahan disimpan lama. Tanaman lada di Sarawak diusahakan oleh kaum bumiputera dan bukan bumiputera. Objektif kertas ini ada dua; pertama ialah untuk menentukan secara keseluruhan kecekapan teknik industri penanaman lada Sarawak dan kedua ialah menentukan sama ada terdapat perbezaan dalam kecekapan teknik antara ladang yang diusaha oleh bumiputera dengan bukan bumiputera. Kaedah penentuan kecekapan teknik adalah berdasarkan ukuran

kecekapan teknik Kopp, manakala kaedah perbandingan kecekapan teknik antara kumpulan etnik dibuat berdasarkan kaedah yang disyorkan oleh Mansor Jusoh dan Hamid Jaafar (1989). Keputusan kajian ini mendapati bahawa secara keseluruhan, industri penanaman lada Sarawak mempunyai indeks kecekapan teknik yang amat rendah. Ini bermakna output industri ini dapat dipertingkatkan lagi dengan menggunakan tahap input yang digunakan sekarang. Secara perbandingan, didapati bahawa ladang kumpulan bumiputera lebih tidak cekap teknik daripada ladang yang diusahakan oleh kumpulan bukan bumiputera. Usaha-usaha yang sewajarnya harus dilaksana agar kecekapan industri tanaman lada Sarawak dapat dipertingkatkan agar sumber pengeluaran yang terhad digunakan dengan optimum.

INTRODUCTION

Pepper (Piper spp.) was brought into Sarawak in 1856. In spite of its declining output, pepper is still one of the important perennial crops in the Sarawak economy. The state produces about 28 thousand tones of black and white pepper, of which more than 85 per cent is exported. In terms of the economic contributions of pepper, there are approximately 45,000 small farmers and it is roughly estimated that the pepper industry in Sarawak provides a livelihood that contributes about 10 per cent toward the state's Gross National Product (GNP).

The pepper industry demonstrated a declining trend from 1980 through 1985 due to the continuous decrease in pepper price since 1977. For example, the output of black and white pepper decreased from 36 thousand tones in 1979 to 31 thousand tones in 1980. By 1985, the output of black and white pepper has dropped to only 15 thousand tones.

For the period between 1983 and 1987, pepper price rebounded; reaching a peak of RM9,400 per ton for black pepper and RM12,200 per ton for white pepper. The increase in pepper prices during this period was met by a gradual increase in output from 1985 through the early 1990's. However, with the downward cycle in the price movement after 1987, it is expected that production will follow suit at least for the first half of the nineties.

The objectives of this paper are two folds. One is to determine the overall level of technical efficiency for pepper cultivation in Sarawak and the other is to determine whether there exist any technical efficiency differential between bumiputera and non-bumiputera pepper cultivators. The results of this study will no doubt enable policy makers to prescribe suitable policy options for this sub-sector of agriculture.

There are five sections in this paper. After the introduction, the discussion in the next section will focus on the theoretical aspects of technical efficiency and its measurement. Section III presents the estimation and results of the measurement of technical efficiency for the pepper farms in Sarawak. The result consists of two parts; the first is for the general technical efficiency level of pepper farms while the other is the result of efficiency differential between bumiputera and non-bumiputera pepper farms. Section IV offers some insight into the possible factors that may contribute to the technical efficiency differential between the two groups of cultivators. Some concluding remarks are given in the final section.

THE CONCEPT AND MEASUREMENT OF EFFICIENCY AND EFFICIENCY DIFFERENTIAL

In this paper, the method of technical efficiency measurement is calculated based on the Kopp's technical efficiency measure. For the comparison of efficiency differential between two groups of producers, the methodology will draw heavily upon the extension made by Mansor Jusoh and Hamid Jaafar (1989) based on Kopp's idea (1981).

The basic idea underlying Kopp's approach to efficiency measurement can best be illustrated using Figure 1. This figure depicts the frontier surface 0XYZ with qq′ as the efficient isoquant. Consider a firm (or farm) denoted by point R, with OQ′ amount of output, in the three dimensional space. R is inefficient since it lies below the frontier surface 0XYZ. If the input set of the firm is shown by point R, the input set of the efficient firm will be the point B on the isoquant qq′. In the input plane, R′ or the input combination (C′, A′) denotes the input combination of the firm to produce output 0Q′. Similarly, B′ or input combination (C, A) denote the efficient input combination to produce the same amount of output. The ratio of these two points, that is B′ and R′, constitute a measure of relative input usage for firm R. If R′ is described by its input vector r and point B′ by its input vector b, this ratio can then be express in terms of r and b. Kopp defined the ratio of vector norms $||b||/||r||$ as an index for technical efficiency.

The index, denoted as KTE in the remainder of this paper, is bound between zero and one and can be interpreted in terms of cost savings associated with technical inefficiency. In particular, (1-KTE) indicates the fraction of total cost a firm can reduce if it eliminates the extra inputs associated with technical inefficiency.[1]

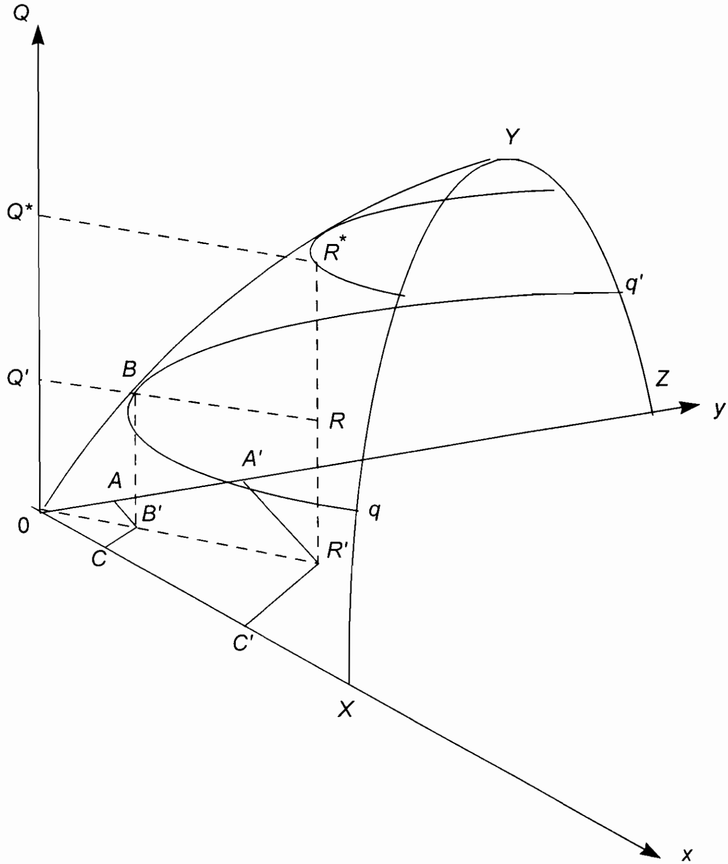

Figure 1. Kopp's efficiency measure

In order to utilize the efficient index to estimate efficiency differential, it is assumed that each firm in an industry of several firms can be classified into two well-defined groups. Further, it is assumed that all firms in the industry are competitive and adopt identical ex-ante technology. These assumptions show a slight deviation from the usual textbook treatment of firms but they are closer to the real life situation. The assumption of a competitive environment requires firms in the industry to have some degree of competitiveness and this may come from the technology firms adopted. Given various production techniques, firms within the industry will undoubtedly choose the best. Hence, the assumption of identical ex-ante technology seems plausible.

It is also assumed that for the industry, there exist an efficiency standard characterized by a production frontier common to every firm in the industry. The function is a well-behaved neoclassical function and is of a full frontier type.[2] Restrictions on the nature of the frontier function ensure that firms within the industry, regardless of groups, are necessarily no more efficient than the frontier firm. Consequently, each firm can thus be distinguished by their respective KTE index and since the efficiency standard is identical to every group within the industry, the efficiency index of a firm in any particular group is comparable to that of the other group.

Subsequently, consider firms in one of the groups, say A, within the industry and denote X as a real-valued function associating each and everyone of these firms with its respective KTE measure. The variable X, then, is a random variable defined over real number between zero and one, corresponding to values taken by the index. The distribution of X is unknown, but it is assumed that it is symmetric around a location parameter U_A. Similarly, denote Y as a random variable over firms in group B and assume that it has a location parameter U_B.

Let the location parameter, U_A and U_B, be the mean of the random variables X and Y respectively. Each of these parameters could be interpreted as representing an average value of the technical efficiency measures of firms in each group. Specifically, U_A describe the average value of KTE measures of firms in group A, and like wise, U_B represents the average value in group B such that U_A and U_B are each bound between zero and one. A value of U_A (or U_B) close to one indicates that firms in group A (or group B) are highly efficient.

Therefore, the absolute difference between location parameters U_A and U_B, can be used to provide a measure of efficiency differential. The interpretation of this measure is straight forward. If the absolute value of $U_A - U_B$ approaches zero, firms in group A and B are equally efficient, that is either they are equally efficient or equally inefficient. On the other hand, if the absolute value of the difference approaches unity, either firms in group *A* are more efficient than firms in group B or vice versa.

In practice, often U_A and U_B are unobservable and thus have to be estimated from a samplė observations. Consider taking two independent random samples of size n in group *A* and size m in group B and denote $X_1, \ldots, X_n$ as a sample from group A and $Y_1, \ldots, Y_m$ as a sample from group B. Hence unbiased estimators of U_A and U_B are the respective sample means:

$$\overline{U}_A = \frac{\sum X_i}{n} \qquad \text{and} \qquad \overline{U}_B = \frac{\sum Y_i}{m}.$$

Unbiased estimates of $\overline{U}_A$ and $\overline{U}_B$ respectively are:

$$\overline{u}_A = \sum \tfrac{x_i}{n} \qquad \text{and} \qquad \overline{u}_B = \sum \tfrac{y_i}{m},$$

where x_i denote the observed values of random variable X_i, $i = 1, \ldots, n$ and y_i denote the observed values of random variable Y_i, $i = 1, \ldots, m$.

Further, it follows that an unbiased estimator for the difference of $(U_A - U_B)$ is $\overline{U}_D = \overline{U}_A - \overline{U}_B$. The unbiased estimates for $\overline{U}_D$ is $\overline{u}_D = \overline{u}_A - \overline{u}_B$. Neither distribution of X and Y nor of (X - Y) are assumed known. As such, a non-parametric test based on the Mann-Whitney U statistic is applied.

To apply the test, recall that $X_1, \ldots, X_n$ and $Y_1, \ldots, Y_m$ are samples from group A and B respectively. Sample observation $x_1, \ldots, x_n$ and $y_1, \ldots, y_m$ are the observed KTE measures for firms in the respective group relative to a common efficiency standard. Thus each of the observed values is comparable. In particular, if the two samples are combined, all sample observations can be ranked according to the observed technical efficiency measures. Subsequently, combining the two sample observations and ranking $x_1, \ldots, x_n$; $y_1, \ldots, y_m$ from the smallest to the largest and denoting this ordering by $Z_1, \ldots, Z_{n+m}$, then rank $(Z_i) = i$, where $i = 1, \ldots, n+m$.

In the case of tied observations, the mean of rank positions they would have occupied had there been no tie, is assigned to each of the observations.

Denote S as the sum of ranks assigned to sample observations from group A. When firms in group A are on the average less efficient than firms in group B, that is U_A is smaller than U_B, we would expect all observations from this group ($x_1, \ldots, x_n$) to rank $1, \ldots, n$ and hence $S = n(n+1)/2$. Thus the statistic $T = S - n(n+1)/2$ could be used as a test statistic. As T approaches zero, it signifies U_A is less than U_B and as T become large, it signifies U_A is greater than U_B. To determine the critical value of the test, for small n and m, one can use the table of quantile of the Mann-Whitney Test Statistic. When both n and m are large and $U_A = U_B$, the test statistic below approaches the standard normal distribution.

$$W = \frac{T - \frac{nm}{2}}{\sqrt{\frac{nm(n+m+1)}{12}}}.$$

In the above equation, $nm/2$ and $nm(n+m+1)/12$ are, respectively, the expected value and variance of the statistic T when $U_A = U_B$. Thus for large sample sizes, test on statistic W can be based on the standard normal distribution.[3]

TECHNICAL EFFICIENCY OF PEPPER INDUSTRY IN SARAWAK

THE DATA

A total of 330 cross-sectional random observations were obtained from Sarawak pepper cultivators. Of the total, 226 are bumiputera cultivators while the rest are observations from non-bumiputera cultivators. The distribution of samples according to state's districts are as indicated in Table 1. Further, since data on the soil conditions are not available, the samples are not differentiated according to soil types or topography.

The period of survey was between May and June 1990 and the data collected are highly aggregative in nature. In particular, for total average output (TO), white pepper output are converted to black by multiplying a conversion factor of 1.25.[4] The fields in each

TABLE 1. Distribution of sample

State Districts	Pepper Cultivators
Bahagian Kuching	41
Bahagian Semarahan	0
Bahagian Sri Aman	56
Bahagian Sarikei	160
Bahagian Sibu	49
Bahagian Bintulu	6
Bahagian Miri	18
Bahagian Limbang	0
Bahagian Kapit	0

Note: The districts of Semarahan, Limbang and Kapit do not have a significant number of pepper farms to warrant sampling.

observation include (1) the average value of fertilizer usage, denoted by VF, (2) the average value of insecticide usage, denoted by VI, (3) the total harvested acreage denoted by TA, (4) total labor usage, denoted by TL. For TA, the unit of measurement is in acre while TL is measured in man-years. Also, since pepper cultivation in Sarawak involve the usage of family labor, these family labor are converted to hired labor by multiplying with 0.5. In other words, two units of family labor is equivalent to one paid labor. Table 2 presents some descriptive statistics of the sampled farms.

METHOD OF ESTIMATION

For the purpose of establishing the technical efficiency standard, it is assumed that each farm has a deterministic frontier function in the following form:

$$y = f(x)e^{u} \qquad \text{with} \quad u \leq 0. \tag{1}$$

Stating equation (1) in Cobb-Douglas form. we have:

$$\ln y = \alpha + \sum \beta_i \ln x_i - u. \tag{2}$$

To estimate the frontier function. OLS is first applied to equation (2). Then, the intercept is shifted so that all residuals are either zero or negative. Statistically. such a shift will result in a best,

TABLE 2. Average output and input utilization

	Bumiputera	Non-bumiputera	Overall
Total Sample	226	104	330
Total Output ('000 kg)	173.46	178.64	352.10
	Total Input Utilization		
Fertilizer ($'000)	143.51	153.51	297.02
Insecticide ($'000)	25.79	37.08	63.59
Labor (man/year)	946.50	615.00	1,561.50
	Average Input utilization per kg of Output		
Fertilizer ($/kg)	0.83	0.86	0.84
Insecticide ($/kg)	0.15	0.21	0.18
Labor (man/year/kg)	0.0055	0.0034	0.0044
	Input Utilization per labor		
Fertilizer ($/man/year)	151.62	249.61	190.21
Insecticide ($/man/year)	27.24	61.46	40.72

linear and unbiased estimates for input coefficients and a biased but consistent estimate of the intercept term.

Subsequently, given the actual output and the same input ratio, Kopp's technical efficiency index is given by the ratio of optimal input usage and the actual input usage. That is, if x_j^* is the optimal usage of the jth input, then

$$\ln x_j^* = \frac{\ln y - \alpha - \sum \beta_i \ln \dfrac{x_i}{x_j}}{\sum \beta_i}.$$

THE ESTIMATED PRODUCTION FUNCTION

For the purpose of estimation, the Cobb-Douglas function for Sarawak's pepper cultivation industry is specified as follows:

$$\ln(TO) = \alpha + \beta_1 \ln(VF) + \beta_2 \ln(VI) + \beta_3 \ln(TL) + \beta_4 \ln(TA) + u.$$

When OLS was applied, estimates of the above equation resulted in the following average function (standard deviation in brackets):

$$\ln(\text{TO}) = \underset{}{1.951} + \underset{(0.056)}{0.598} \ln(\text{VF}) + \underset{(0.043)}{0.136} \ln(\text{VI})$$

$$+ \underset{(0.055)}{0.123} \ln(\text{TL}) + \underset{(0.035)}{0.115} \ln(\text{TA}),$$

with the largest positive residual being 1.524 and $\overline{R}^2 = 0.625$.

After adding the largest positive residual to the intercept, the resulting frontier function is:[5]

$$\ln(\text{TO}^*) = 3.475 + 0.598 \ln(\text{VF}) + 0.136 \ln(\text{VI})$$

$$+ 0.123 \ln(\text{TL}) + 0.115 \ln(\text{TA}),$$

where TO^* represent the maximum output that could be achieved using the actual amount of input. In Cobb-Douglas form, the frontier function is:

$$\text{TO}^* = 32.398\ \text{VF}^{0.598}\ \text{VI}^{0.136}\ \text{TL}^{0.123}\ \text{TA}^{0.115}$$

ESTIMATES OF KOPP TECHNICAL EFFICIENCY INDEX

As indicated in the previous section, the Kopp technical efficiency index for each farm compares the level of input usage if the farm was on the frontier with the actual level of input usage. In other words, if TL^* is the optimal labor usage to produce the actual amount of output, then:

$$\ln(\text{TL}^*) = \frac{\ln(\text{TO}) - \alpha - \beta_1 \ln\left(\frac{\text{VF}}{\text{TL}}\right) - \beta_2 \ln\left(\frac{\text{VI}}{\text{TL}}\right) - \beta_4 \ln\left(\frac{\text{TA}}{\text{TL}}\right)}{(\beta_1 + \beta_2 + \beta_3 + \beta_4)},$$

where α being the corrected intercept. Thus, KTE $= \text{TL}^*/\text{TL}\ (\leq 1)$. Repeating the above calculation for each firm, the KTE indices for each farm were generated and ranked accordingly from the smallest to the largest. Table 3 depicts the summarized result.[6]

A closer examination of column (2) in the above table reveals some startling results; that is, 75.5 per cent of the observations (sampled farms) were less than 30 per cent efficient while 92.7 per cent of the sampled farms were not even 50 per cent efficient. Only 1.2 per cent of the sampled farms were more than 70 per cent efficient. Note that 1-KTE indicates the fraction of total cost a firm could have reduced if it eliminated the extra inputs associated with technical inefficiency. Hence, for the least efficient farm, its output level could have been achieved by an efficient producer with at least 98 per cent less of all inputs. Or more generally, 75 per cent of the sampled farms could have produced the same amount of output by using at least 70 per cent less of all inputs if they were to operate efficiently.

TABLE 3. KTE index

Index Classes (1)	Number of Observation (2)	Number of bumi farm (% in bracket)[b] (3)	Number of non-bumi farm (% in bracket)[c] (4)
0.01 - < 0.10[a]	32	22 (9.73)	10 (9.62)
0.10 - < 0.20	117	94 (41.59)	23 (22.12)
0.20 - < 0.30	97	64 (28.32)	33 (31.73)
0.30 - < 0.40	41	23 (10.18)	18 (17.31)
0.40 - < 0.50	20	11 (4.87)	9 (8.65)
0.50 - < 0.60	10	4 (1.77)	6 (5.77)
0.60 - < 0.70	9	4 (1.77)	5 (4.81)
0.70 - < 0.80	1	1 (0.44)	0 (0.00)
0.80 - < 0.90	2	2 (0.88)	0 (0.00)
0.90 - 1.00	1	1 (0.44)	0 (0.00)
Total	330	226	104

Note: [a] The least efficient firm had an index of 0.01679
[b] Percent out of 224
[c] Percent out of 106

For purposes of comparison, the KTE index was also calculated by holding land input fixed. The summarized results are presented in Table 4. Taking the least efficient farm as the reference farm, an efficient producer would use 99 per cent less of the other inputs in producing the same amount of output. Again, generally, 75 per cent of the sampled farms could have produced the actual output by using at least 74 per cent less of labor, insecticide and fertilizer inputs if they were efficient.

TABLE 4. KTE index with land fixed

Index Classes (1)	Number of Observation (2)	Number of bumi farm (% in bracket)[b] (3)	Number of non-bumi farm (% in bracket)[c] (4)
0.01 - < 0.10[a]	66	51 (22.57)	15 (14.42)
0.10 - < 0.20	129	97 (42.92)	32 (30.77)
0.20 - < 0.30	79	46 (20.35)	33 (31.73)
0.30 - < 0.40	22	11 (4.87)	11 (10.58)
0.40 - < 0.50	20	12 (5.31)	8 (7.69)
0.50 - < 0.60	5	3 (1.33)	2 (1.92)
0.60 - < 0.70	5	2 (0.88)	3 (2.88)
0.70 - < 0.80	1	1 (0.44)	0 (0.00)
0.80 - < 0.90	2	2 (0.88)	0 (0.00)
0.90 - 1.00	1	1 (0.44)	0 (0.00)
Total	330	224	106

Note: [a] The least efficient firm had an index of 0.010
[b] Percent out of 224
[c] Percent out of 106

ESTIMATES OF EFFICIENCY DIFFERENTIAL

Table 5 presents the mean KTE index for the bumiputera and non-bumiputera cultivators associated with Table 3. Statistical verification that the two means are not equal requires their difference to be significantly different from zero. The statistic W was calculated to be –3.02789, indicating that at $\alpha = 0.01$, hence the difference between the two means are significantly different from zero. Further, since the mean of bumiputera farms is smaller than the mean for the non-bumiputera farms, it can thus be concluded that bumiputera pepper cultivators in Sarawak are technically less efficient than the non-bumiputera counterpart.

TABLE 5. Result of KTE index

	Mean KTE	Std. Dev.
Bumiputera	0.23516	0.14948
Non-bumiputera	0.27279	0.14295
Difference	0.03763	

SOURCES OF EFFICIENCY DIFFERENTIAL

The differences in technical efficiency for bumiputera and non-bumiputera owned farms can be attributed to the differences in technical knowledge and social-economic background of the two groups of farmers. These differences eventually caused differences in farm output for the two groups of farmers.

In the case for Sarawak pepper producers, four factors are identified to be the possible factors that may have contributed to the efficiency differential. They are (1) harvesting practice, (2) capital intensity, (3) crop diversity and (4) education and experience.

Harvesting practice For the two groups of farmers, it was noted that there were distinct differences in harvesting period; that is, for at least 80 per cent of the bumiputera farmers, harvesting was started between the months January and June and ended between April and August. In the case of non-bumiputera farmers, the same percentage of farmers started harvesting between March and May and finished between May and July. While there are many possible reasons for bumiputera farmers preference for such a harvesting practice, the effect of such non-synchronized and "off-season" harvesting can be detrimental to the output.

Capital intensity Since pepper is planted on the hill slopes, the fertilizer applied is subjected to surface run-off. Therefore, sufficient application of fertilizer is important to induce greater output. As indicated in Table 2, bumiputera farmers, on the average, use less fertilizer and insecticide than their non-bumiputera counterparts. Therefore their output is lower.[6]

Crop diversity For bumiputera and non-bumiputera farmers, it was noted also that the former group of farmers tend to have greater diversity in farming activities. Indirectly, such a practice leads to a smaller plot of land being allotted to each crop and thus economies of scale cannot be exploited. This practice is also worsened by farmers diverting fertilizer and insecticide intended for peppers to other crop. Hence the pepper output is affected.

Education and experience Relative to the non-bumiputera counterparts, bumiputera farmers are generally less educated and tended to have less experience in pepper production. It is believed that this factor, in general, constrained the adoption of the correct pepper farming practice. However, it should be noted that while overall efficiency of the bumiputera cultivator is lower than that of non-bumiputera, 1.2 per cent of bumiputera cultivators actually out-performed other cultivators by achieving KTE index of at least 0.70. These farms, in our opinion, can serve as model farms for others to emulate.

CONCLUSION

From the observed samples, this paper reveals that the pepper cultivators of Sarawak are as a whole not technically efficient. At the same time, the results also indicate that bumiputera cultivators are generally technically less efficient than the non-bumiputera cultivators.

In general, technical inefficiency occurs because a producer has failed to use the correct amount of input to produce a given amount of output. While there are many factors that can contribute to this failure, the general consensus for the poor technical efficiency is producer mismanagement of farms. In the case of Sarawak's pepper cultivators, evidence of farming mismanagement are indicated by the incorrect harvesting practice, inappropriate capital intensity and crop diversity.

Based on these conclusions, there are two important policy implications. For the long run, since a higher level of education is associated with greater ability to adopt correct farming techniques, greater efforts need to be directed towards the provision of education and training, especially for bumiputera cultivators. In the short run, to discourage the continuation of inappropriate farming practices such as harvesting practices and application of inputs, the local agricultural agency in congruent with their extension services, must come up with an input subsidy scheme that require the adoption of proper and recommended pepper farming practices as a prerequisite.

NOTES

[1]This interpretation is possible only when the measure is made along the input proportion ray and thus independent of input prices (Kopp,

1981). As such, any reduction in cost associated with the firm moving from point R to point B will be a result of input reduction due to increased technical efficiency.

[2]That is, the function satisfies Kopp's compatibility requirements. They are: (i) the function is strictly monotonic, continuous and quasi-concave, (ii) the function must be a boundary function so that all sample observations (or the firms) must not lie above the frontier and (iii) the frontier model assumes all variation in output to be the result of technical inefficiency alone.

[3]For detailed exposition of the methodology, see Mansor Jusoh and Hamid Jaafar (1989).

[4]The conversion factor from white to black pepper is 1.25 because 45 kg of pepper berries can produce 15 kg of black pepper or 12 kg of white pepper.

[5]It should be noted that the approach utilized here limits the frontier to be that of the best practice technology within the sample. However, the use of a representative sample implies that it can also be used as an estimated frontier for the whole farm population.

[6]It was estimated that the output per tree for bumiputera and non-bumiputera farms are 1.48 kg and 2.58 kg respectively. For more details, see Hamid Jaafar and Mansor Jusoh (1993).

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Department of Agricultural Economics and Resource
Faculty of Economics
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor D.E.

Department of Statistical Economics
Faculty of Economics
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor D.E.