SOCIOECONOMIC STUDY ON TECHNICAL EFFICIENCY OF FARM RICE PRODUCTION

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Abstract

Economic efficiency consists of two components : price or allocative efficiency and technical efficiency. The first concerns with the successfullness of the firms (farmers) as profit maximizers and the second deals with the maximum output out of a set of inputs that reflects the state of technical knowledge and capital possession. The study of technical efficiency on rice farming in Java is important due to the high level application of modern inputs of fertilizer and pesticide, that farming techniques may be related to technical efficiency and may increase production without much increase cost.

The estimated "average" production function of OLS regression from cross sectional data may have management bias. The yield criteria is used in this study as a proxy for the technical efficiency due to the most scarce resource of land input in study area. Some other methods used by other researchers are using managerial indexes of education, modernization, information etc., or using Linear-Programming Production Frontier.

The analytical results show that the technical efficiency was always related to output and coefficient of inputs, and that the small farmers were better farmers and better use of their abundant inputs of labour, pesticide, and fertilizer on scarce input of land. The use of tractor and draught animal were not clearly related to technical efficiency.

Ringkasan

Efisiensi ekonomi terdiri dari dua component : efisiensi harga atau efisiensi alokatif dan efisiensi teknis. Efisiensi harga berhubungan dengan keberhasilan pengusaha (petani) sebagai manusia ekonomi dalam mencapai keuntungan maximum. Hal ini berkaitan dengan unsur dinamis dari pengusaha dalam menyesuaikan dengan proses perubahan yang ada, sehingga sering efisiensi ini disebut sebagai efisiensi jangka pendek.

Efisiensi teknis mengukur berapa produksi yang dapat dicapai dari suatu himpunan input tertentu. Hal ini dapat juga menggambarkan keadaan pengetahuan teknis dan keadaan modal tetap yang dikuasai, dapat juga disebut efisiensi jangka panjang.

Fungsi produksi "rata-rata" yang diperkirakan (estimated) dari suatu regresi OLS **(ordinary least square)** dari data cross sectional mungkin mengandung **management bias** yang dikarenakan oleh adanya hubungan fungsional antara input dan output dengan kemampuan pengelolaan usahatani **(Farm management ability)**.

Criteria hasil per hektar digunakan dalam analisis ini sebagai pengukur efisiensi teknis berdasar bahwa tanah adalah sumberdaya terlangka di daerah penelitian (tanah sawah di Jawa) criteria ini hanya salah satu cara untuk dapat memasukkan faktor efisiensi teknis ini dalam analisis. Beberapa indek management telah digunakan juga oleh peneliti lain yang memasukkan faktor-faktor pendidikan, modernisasi, informasi dsb. (Shapiro & Muller 1977, Muller 1972, Hayami 1975, Massel 1977), cara lain adalah dengan menggunakan Frontier Produksi Linear Programming.

Hasil analisis menunjukkan bahwa faktor management atau efisiensi teknis ini selalu sangat erat berkaitan dengan produksi, sehingga terdapat perbedaan dalam efisiensi teknis di antara petani padi di daerah penelitian. Managemen bias atau elastisitas managemen dari koefisien input tanah selalu negatif yang berarti petani kecil adalah petani yang lebih baik dengan memanfaatkan tanah yang langka dengan jenis input yang relatif berlebihan seperti tenaga manusia, pupuk dan pestisida dalam jumlah yang lebih besar.

Dalam hal penggunaan traktor dan tenaga ternak, management bias ini tidak begitu jelas bahkan ada kecenderungan negatif. Hal ini mungkin karena kedua input ini lebih bersifat hemat tenaga.

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Introduction

Theoretically economics provides us with a theory of efficient resource use based on the concept of production function. A production function is an input-output relationship, both continuous or discontinuous, but usually refers to more continuous relationship. Economists have been concerned with the nature of production function. Although the production function is a physical phenomenon, or a technical consideration, its specificnature has many economic implication. There are four kinds of production function models that are widely used in economic analysis (Yotopoulos & Nugent 1976) : Cobb-Douglas, constant elasticity of substitution (CES), input-output (Leontief), and linear programming production function. The Cobb-Douglas production function is more widely used in economic literature with its properties of homogenous function that enable one to measure the return to scale and to interpret the elasticity coefficient easily (Henderson & Quant 1971). Although it has several restrictive assumptions (such as constant elasticity of production, unitary elasticity of input substitution etc.), its simple functional form is computationally economical and yield statistically significant estimates of coefficients without imposing excessive demand on data accuracy (Yotopoulos & Nugent 1976). Its estimation provides important information that is generally consistant with economic theory and seems realistic, such as declining marginal productivity as the level of input increase, the inverse relationship between marginal rate of technical substitution and factor proportion.

Suppose farmers are economically rationale, their actual yields may be at the optimum level with respect to many constraints faces by farmers such as limited resources, technology and knowledge (Schlutz 1964). The problem appears when some governments and planners wonder why farmers had much lower yields than the potential yield obtained in experiment station (Barker 1979, Herdt & Wickham 1978). But most of the potential yields in experiment stations were the maximum yields in favorable conditions. Gomes et al (1979) stated that the yield gap between the actual farm yield and the experiment station yield was considered consist of two distinct parts : the difference between experiment station yield and potential farm yield, and the difference between potential farm yield and actual farm yield. The first is mainly because of environmental differences that the technology in farm condition does not give the yield as high as in experiment station or migth be the technology is not transferable. The second is because farmers use input or cultural practices that result in lower yield than those possible on their farms. It concerns the biological and socioeconomic constraints.

Barker (1979) said that the gap can be partitioned into three segments : (1) the segment due to the profit seeking behavior reflect the difference between maximum yield and maximum profit, (2) *price* or *allocative inefficiency* is the failure to maximize profit, and (3) technical *inefficiency* is the failure to produce on most efficient production function. The problem is that it is difficult to separate technical inefficiency to the allocative one and the technical inefficiency might be influenced by factors (both physical and social) beyond the control of the farmers.

The term of technical and price efficiencies are not new. Marschak & Andrews in 1944 (Nerlove 1965) emphasized the differences in managerial ability associated each

firm and splitted it into technical efficiency and economic efficiency. And Farrel in 1957 attempted to measure these efficiencies (Nerlove 1965).

Marschak & Andrews constructed from the Cobb-Douglas production function

$$X_{Of} - {}_1X_{1f} - {}_2X_{2f} = A + u_{Of}$$

Where X_{of}, X_{1f}, and X_{2f} represent the logarithms of output and two kinds of inputs of cross sectional firm, respectively, the residuals u_{Of} reflects, for each firm, its deviation from the average production function. U_{Of} represents the differences in technical efficiencies; i.e. managerial factor as relates to the achievement of maximum output with a given inputs, or a given output with a minimum inputs. But u_{Of} will also reflects the differing qualities of factors available to individual firms, the differences by the process of aggregation and by omited factors. Marschak & Andrews also interpreted the residuals of the other derivatives of profit maximization equation as due to differences in firms' abilities to maximize profit, which they called a firms' economic efficiencies.

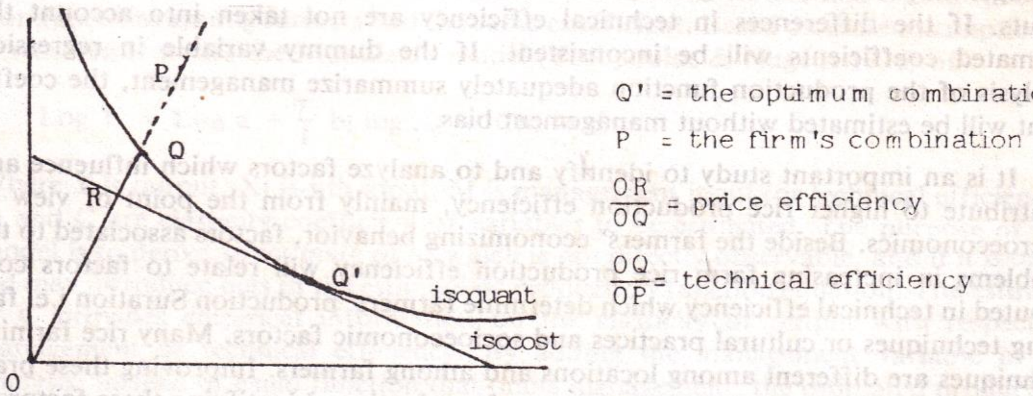

Figure 1. Farrel Model of Price and Technical Efficiency

Farrel model, in fig. 1 (Nerlove 1965), related the technical afficiency ($\frac{OQ}{OP}$) to improper choice of production function and price efficiency ($\frac{OR}{OQ}$) reflected to the proper (or improper) choice of input combination.

Nerlove (1965) summarized that the differences among firms consist of (1) price efficiency, (2) technical efficiency, and (3) the environment. The price efficiency is the ability to maximize short run profit, given a particular production function and in a given environment. The technical efficiency is the production function itself which sum marize the state of technical knowledge and the possesion of fixed input. He called the technical efficiency as long-run efficiency. The difference in efficiencies may be associated with a variety of factors such as managerial input or quality, price

availability, capital rationing and the like. It relates to dynamic elements in producer behavior. These take the form of the delayed adjusment to changed conditions. In part it is because of cost of making change, the lag behavior, and uncertainty.

Yotopoulos & Nugent (1976) noted that efficiency refers to the achievement of maximum output from a given set of resources, and there are two kinds of efficiencies : price and technical efficiency. Price efficiency is related to the managerial decision making about allocation of the variable factors of production, factors that are within the control of the firm. Technical efficiency is related to the fixed resources of the firm, at least in the short run, it is exogenous and a given part of the environment. When price efficiency and technical efficiency are accuring jointly, they are sufficient condition on for economic efficiency.

Massel (1967) said that management can relate to technical efficiency or it can relate to allocative efficiency. Althought there is likely to be a high correlation between technical and allocative efficiency, the two need not always be found together. If both output and input are functionally related to a farm's management ability, the estimated productionfunction coefficients may have management bias. Better manager may tend to use larger input and to obtain a large output from a given set of inputs. If the differences in technical efficiency are not taken into account the estimated coefficients will be inconsistent. If the dummy variable in regression analysis of the production function adequately summarize management, the coefficient will be estimated without management bias.

It is an important study to identify and to analyze factors which influence and contribute to higher rice production efficiency, mainly from the point of view of microeconomics. Beside the farmers' economizing behavior, factors associated to the problems in increasing farm rice production efficiency will relate to factors contributed in technical efficiency which determine farmers' production Suration i.e. farming techniques or cultural practices and socioeconomic factors. Many rice farming techniques are different among locations and among farmers. Improving these practices ussually does not increase much cost of production. Identifying these factors is much usefull in area that has already obtained high yield and applied high level of input. The study of technical efficiency is an important aspect of the study of development, because it quantifies the productive contribution of factors that are not easily amenable to measurement.

2. Analytical Method

Cobb-Douglas types of production function were employed in regression analysis,

$$Y = A \prod_{i=1}^{m} X_i^{B_i} + \varepsilon \quad \text{or} \quad \text{Log } Y = a + \sum_{i=1}^{n} B_i \text{ Log } X_i + \varepsilon$$

Where Y is the farm rice production, and Xi (i = 1, 2, ..., m) are inputs of land Urea, TSP, Labor, animal work, tractor use and pesticide.

In identifying whether there are differences in technical efficiencies or management among rice farmers, it needs to quantify the technical efficiency or the management component. It requires the combination of two sets of observations on farm or two groups of farmers. Some researchers grouped the sample farmers according to tenurial status (Fujimoto 1983), farm size (Tamin 1978, rice varieties (Sutawan 1977), and ''good'' and ''poor'' farmers (Swanson 1956, p. 137). It seemed that the grouping depended upon the purposes of the analysis. The last grouping that was according to the ''good'' and ''poor'' farmers meant to study the effect of management by including a management index in production function.

Based on the condition that land was the most limited resources in the study area of lowland rice farming in Java, that small farmers might maximize return per unit of land, the yield per hectare might be one of the best criteria to indicate the technical efficiency. Therefore the sample farmers were devided into two groups, the better farmers and the ordinary farmers by using the rice yield (rice production per hectare) criteria which assumed that the higher yield was the better farmer and that the production functions among farmers had the same coefficient. Based on these assumptions it is reasonable to use the Mundlak's model (Yotopoulos & Nugent 1976) of

$$\text{Log } Y = \text{Log } a + \sum_{i} b_i \log X_i + CM + \varepsilon$$

Where Y is output. X_i is-i-th input, M is management input (or technical efficiency), b_i and C are elasticity coefficient of variables to be estimated. The purpose of this model is to derive an estimate of M which is not directly observable, and if *it is omit* ted may introduce bias in the estimate of production function equation. The estimate of C provides empirical information on the elasticity of output with respect to management or technical efficiency. By adding the management variable in the analysis, instead of usual function that omits management, the estimated production coefficients are free of the specification bias. The management input (CM) can be used for further analysis as dependent variable for studies that explore the factors determining the quality of management. The problem with the dependent variable of C M here is that the management (M) is dummy, so the use of logit model needs group data that the probability of choice can be measured. In a accordance to Marshak & Andrews (Nerlove 1965) that the residual of the regression of the C D production function represent the differences in technical efficiencies among farms, it is better to use C M + ε as dependent variable that represents technical efficiency, although the physical environmental variation is included in it, but at least the input effect has been separated.

To examine how management is related to the other inputs of production, it can be done by comparing the b_i coefficient with the coefficient of a function estimated in the usual manner by omitting management as

$$\text{Log } Y = \text{Log } A + \sum_{i} B_i \log X_i + \varepsilon$$

The management bias is $E(B_i - b_i) = Cd_i$ that can be decomposed in two part : d_i = the coefficient of the regression of the management variable on other input variables, $M = d_o + \sum_i^T d_i X_i$, and C = the coefficient of omitted management. The estimates of di can be obtained by : $d_i = \frac{E(B_i - b_i)}{C.}$ or regressing M on other input variables.

Let the production estimated by input without management bias is $\hat{Y}$, the logarithm of this production estimates is

$$\text{Log } \hat{Y} = a^* + \sum_i^T b_i \log X_i$$

$$CM + \mathcal{E} = \log Y - \log \hat{Y} = \log \frac{Y}{\hat{Y}} = \log E$$

$$E = \frac{Y}{\hat{Y}}$$

E is the antilogarithm of $CM + \mathcal{E}$, which is in the form of ratio of the actual and input-estimated production, with the advantage that E is free from unit of measurement that makes more convenience to be used across location and time with any variation of measurement units.

3. The Technical Efficiency Elasticity of Output and Management Bias

In case of Rancaudik 1982 - 83 wet season the average yield was 5570 kg of rice per hectare and the standard deviation was 1496 kg/ha. From the 64 sample farmers there were 26 below the average yield and other 38 were above the average yield. It is presented in table 1 the results of the regression analysis of four model by adding and omitting the technical efficiency dummy and pesticide input. Land, Urea and the dummy came out consistently significant with the Urea had lower level of significance on the regression with the dummy included. In this regression model pesticide input was tried to be omitted, because it was not only that pesticide coefficient was not significantly different from zero, but also it is difficult to relate the pesticide application to production, because farmers might not apply any or applied very little if there was no sign of pests attack. And the pesticide-omitted function came out with better result such as higher F-value (140.8 compare to 97.61), positive sign of labor coefficient (although not significant), and about the same value of coefficient of determination (R^2 = 0.924).

From model II and IV (table 1) it is found that the elasticity of output with respect to management or technical efficiency was 0.1821 and very highly significant. It means that there were great differences in technical efficiencies among farmers, and that the better farmers had better production function and use more inputs to obtain higher outputs. The coefficients of the regression equation which omits the management dummy certainly have bias. The magnitutes of these bias or the management elasticities of coefficients on production is presented in tabel 2.

Table 1. Estimates of Cobb-Douglas Production Functions of Rancaudik 1982-1983 Wet Season

		I	II	III	IV
Land	(X1)	.7433**	.8530**	.7250**	.8679**
		(6.967)	(11.148)	(7.354)	(12.051)
Urea	(X2)	.2503**	.1219*	.2605**	.1154*
		(2.741)	(1.831)	(2.958)	(1.777)
TSP	(X3)	.0906	.0504	.0839	.0559
		(1.107)	(.868)	(1.048)	(.987)
Labor	(X4)	.0418	-.0047	.0319	.0037
		(.488)	(-.077)	(.387)	(.059)
Tractor	(X5)	-.0921*	-.0530	-.0931*	-.0532
		(-1.948)	(-1.571)	(-1.985)	(-.570)
Pesticide	(X6)	-.0383	.3020	-	-
		(-.467)	(.516)		
Dummy (Techn.Eff)	(X7)		.1840**		.1821**
			(7.647)		(7.708)
Constant		2.2024	2.3951	2.2035	2.3923
	F	51.85**	97.61**	63.02**	115.32**
	R^2	.845	.924	.845	.924
Degree of freedom		57	56	58	57

Note : t-value in parentheses
* Significant at 10% level
** Significant at 1% level.

The management bias have different sign. The management elasticity of land coefficient has negative sign, that means better farmers used less land or smaller farmers had better production function. It also happened on tractor input but since the tractor coefficient was negative it means that the negative effect of tractor input on production was smaller for better farmers. The other elasticities are positive, it means that better farmers used more fertilizers and labor to obtain higher production.

The geometric mean of Urea application was 125.6 kg for 0.586 hectare, that meant 214.4 kg/ha. The response on additional Urea application still significantly increased production. But whether it would still profitable to increase the Urea use it can be analyzed further. However, with the average of 141.2 kg/ha of TSP application the response was not significant any more, that means this amount had been too large for rice farming in Rancaudik this time. The average of total labor use was 529.7 man hours per hectare. It shows the labor intensive character of rice farming in Subang, and it is consistent with the prior studies in Subang but in different village (Pusakaratu and Karanganyar Village) in 1976 - 77 wet season with 121.[1] man days of average (Nataatmadja *et al.* 1979). The cost of pest control was high enough, 8.5 thousand rupiahs per hectare, but the analytical result was difficult to interpret, because it depends upon the accurance of the pest attack.

The other result of this kind of analysis of Rancaudik 1982 dry season and Rancaekek 1982 - 83 wet season are presented from table 3 through 6. These results show that land input and the dummy of technical efficiency always consistently and very highly significantly affect production. The other inputs seemed varied among locations and seasons, and most of the coefficients were not significantly different from zero, although all the regression analysis came out with good results with high coefficients of determinations and high F-values.

Table 2. Production Function Elasticities Without and With Management in Rancaudik 1982-83 Wet Season

	Elasticity with Management excluded	Elasticity with Management included	Management Elasticity
X1 (land)	.7250	.8679	-.1429
X2 (Urea)	.2605	.1154	.1451
X3 (TSP)	.0839	.0559	.0280
X4 (labor)	.0319	.0037	.0282
X5 (tractor)	-.0931	-.0532	-.0399
Sum of Elasticities	1.0082	.9897	
Output Elasticity			.1921

Table 3. Estimate of Cobb-Douglas Production Function of Rancaudik 1982 Dry Season

		I	II	III	IV
Land	(X1)	.7534***	.5637***	.7517***	.5565***
		(7.626)	(4.095)	(7.649)	(4.044)
Urea	(X2)	.0919	.1138	.0878	.1243
		(1.216)	(1.046)	(1.171)	(1.145)
TSP	(X3)	-.0058	.0054	-.0024	-.0016
		(-.080)	(.051)	(-.033)	(-.015)
Labor	(X4)	.1186	.0478	.1134	.0553
		(1.616)	(.455)	(1.560)	(.527)
Tractor	(X5)	.0716*	.0620	.0695*	.0661
		(1.919)	(1.155)	(1.878)	(1.233)
Pesticide	(X6)	.0913	.1202	.0935	.1169
		(1.590)	(1.456)	(1.639)	(1.417)
Animal	(X7)	-.2343*	-.4713**	-.2446*	-.4623**
		(-1.763)	(-2.532)	(-1.860)	(-2.485)
Variety	(X8)	.0301	-.0616		
		(.700)	(-1.037)		
Dummy (Techn.Eff.)	(X9)	.2332***		.2270***	
		(7.548)		(7.701)	
Constant		2.1302	2.4977	2.1527	2.4690
	F	47.52***	22.32***	53.93***	25.31***
	R^2	.893	.880	.892	.770
Degree of freedom		51	52	52	53

Note : t-value in paretheses **. significant at 5% level
* significant at 10% level *** significant at 1% level

Table 4. Production Function Elasticites Without And With Management in Rancaudik 1982 Dry Season

	Elasticity With Management	Elasticity With Management	Management Elasticity
X1 (land)	.5565	.7517	.1952
X2 (Urea)	.1243	.0878	.0365
X3 (TSP)	-.0016	-.0024	.0008
X4 (labor)	.0553	.1134	-.0581
X5 (tractor)	.0661	.0695	-.0034
X6 (pesticide)	.1169	.0935	.0234
X7 (animal)	-.4623	-.2446	-.2177
Sum of Elasticity	.4552	.8689	
Output Elasticity			.2270

Most of the R^2 were more than 90% and the F-value ranged from 53.93 at Rancaudik 1982 dry season to 115.35 at Rancaudik 1982 - 83 wet season. The coefficients of land input were always very high in all locations and season, those were close to unity although most of them were still significantly different from unity except for Rancaekek 1982-83 wet season. This might be one thing that made most the other input coefficients were not significantly different from zero.

The coefficients of the dummy variable ranged from 0.1874 Rancaekek 1982-83 wet season to 0.227 at Rancaudik 1982 dry season, with the t-values from, 5.947 at Rancaekek 1982-83 wet season to 7.708 at Rancaudik 1982 - 83 wet season. It means that the dummy was always very highly significant that the level of significance was always less than 0.1% level at all locations and seasons. It can be concluded that the first hypotheses is successfully tested by using the yield criteria, that there were differences in technical efficiencies among rice farmers in the lowland area of Rancaudik and Rancaekek of West Java. Based on the consistent result of the high significancy, it can be expected that this method in the most lowland area of Indonesia will give similar phenomena that there will be differences among rice farmers in Java especially or it may be in other areas too.

From the analytical result or the Rancaudik 1982-1983 wet season, it has been discussed that there was unconsistency and nonsignificancy of the pesticide input coefficient on production. This phenomena can also be found in the analytical results of Rancaekek 1982-1983 wet season, but at Rancaudik 1982 dry season the pesticide effect was consistently positive although it was not significant.

In Rancaudik 1982 dry season variety was tried to be included as dummy where Cisadane variety is one and otherwise is zero, but since the other varieties were all modern varieties, it came out with not significantly influenced the production function. There were some traditional varieties to be used in Rancaekek, but there were only on parts of the plots that the input and output data were not separatable.

Table 5. Estimates of Cobb-Douglas Production Function of Rancaekek 1982-83 wet season

		I	II	III	IV
Land	(X1)	.7799***	.9579***	.7848***	.9393***
		(5.821)	(9.667)	(7.057)	(11.368)
Urea	(X2)	-.0247	-.0469	-.0225	-.0549
		(-.891)	(-.687)	(-.251)	(-.865)
TSP	(x3)	.0665	.0556	.0663	.0562
		(.891)	(1.059)	(.903)	(1.084)
Labor	(X4)	.1034	.0000	.1007	.0102
		(.743)	(.000)	(.766)	(.109)
Tractor	(X5)	.0786*	.0198	.0771*	.0252
		(1.717)	(.586)	(1.926)	(.853)
Pesticide	(X6)	.0104	-.0377		
		(.068)	(-.352)		
Animal	(X7)	.0515	.0009	.0509	.0029
		(1.408)	(.035)	(1.443)	(.111)
Dummy (TEF)	(X8)		.1883***		.1874***
			(5.877)		(5.946)
	F	36.40***	68.54***	43.75***	80.45***
	R^2	.885	.945	.885	.945
Degree of freedom		33	32	34	33

Note : t-value in parentheses
* Significant at 10% level
** Significant at 5% level
*** Significant at 1% level

Table 6. Production Function Elasticities Without And With Management in Rancaekek 1982-83 Wet Season

	Elasticity with Management excluded	Elasticity with Management included	Management Elasticity
X1 (land)	.7848	.9393	-.1545
X2 (Urea)	-.0225	-.0549	.0324
X3 (TSP)	.0663	.0562	.0101
X4 (Labor)	.1007	.0102	.0905
X5 (Tractor)	.0771	.0252	.0519
X6 (Animal)	.0509	.0029	.0480
Sum of Elasticity	1.0573	.9789	
Output Elasticity			.1874

Most of the input coefficients were not significantly different from zero except the land input, and even some of them had negative sign although most of them were not significant. It might be due to the multicollinearity because all input might vary proportionally to the land input. But the correlation matrix show that the multicollinearity were not quite serious. The other reason might be that the fertilizers and labor had been applied at high level and the use of draught animal and tractor were in transition that the effects seemed not consistent. There were only at Rancaudik 1982 dry season for the tractor use that increased rice production significantly at 10% level.

The managerial bias or the management elasticities of the input coefficients were always negative for the land input. It means that the better farmers with better technical efficiency were smaller farmers. It is not surprising and it is consistent with most the other researches (Berry & Cline 1979) that the small farm made better use of its available land that did the large farm through applying higher level of more abundant inputs per unit of land. It was true for the positive sign of the managerial bias that the better farmers used more labor, fertilizers and pesticides. Tractor use and animal work with the nonconsistent of the sign of the managerial bias were uncertainly related to the technical efficiency. Or it might be able to be concluded that they tended to be negative due to the more labor saving character of these inputs.

4. Remarks

The estimated ''average'' production function of OLS (ordinary least square) regression from cross sectional data may have management bias because both input and output are functionally related to a farm management ability. The yield criteria is used in this analysis as a proxy of the technical efficiency or management factor due to the most scarce resource of land input in the study area (lowland rice of Java). Yield criteria is only one method in trying to include the technical efficiency factor in the analysis. Some managerial indexes that include education, modernization, information etc. have been used by other researchers (Shapiro & Muller 1977, Muller 1972, Hayami 1975, Massel 1967). Another method is using the Linear-Programming Production-Frontier (Timmer 1971).

The analytical results show that the technical efficiency or management factor was always very highly significantly related to output, that there were differences in technical efficiency among rice farmers in the study area. The management bias or the management elasticity of input coefficient were always negative for land, that the better farmers were the small farmers, who had made better use of its available land through applying higher level abundant input per unit of land of labour, fertilizer and pesticide. Tractor and draught animal use with nonconsistency of the sign of the management bias were uncertainly related to the technical efficiency and tended to be negative due to the more labour-saving character of these inputs.

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