EFFECTS OF SOME SELECTED VARIABLES ON RICE-FARMERS TECHNICAL EFFICIENCY

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Abstrak

Analisa fungsi produksi frontier terhadap data yang diperoleh dari 63 petani padi di dua desa dataran rendah pantai utara Jawa Barat menunjukkan bahwa variasi efisiensi teknis produksi padi sangat besar. Dengan keterbatasan data yang tersedia, determinan efisiensinya juga ditelaah dalam tulisan ini. Curahan jam kerja di luar usahatani, baik di dalam maupun di luar sektor pertanian, serta umur petani ternyata tidak berpengaruh negatif terhadap efisiensi teknis sedangkan keikutsertaan petani dalam program intensifikasi berpengaruh sangat positif terhadap efisiensi itu. Determinan yang lain masih perlu diteliti lebih lanjut.

Abstract

The use of frontier production function towards data gathered from 63 rice farmers in two northern coastal plain villages of West Java indicates that technical efficiency indices vary considerably. Given the availability of data, factors explaining the variation are analyzed in this paper. Neither off-farm nor non-farm working hours negatively effects technical efficiency. Nor does the age of farmers. Farmers' participation in intensification program does influence technical efficiency but other determinants should properly be investigated further.

Background and Objectives

After Indonesia has successfully increased rice production and achieved self-sufficiency level in 1984, the emphasis of food production policy is placed on, at least, maintaining that level. After rice intensification program has been modified several times since 1969, a significant improvement has been implemented in northern coastal plain (pantura) of West Java since 1987. In this program, potash fertilizer and bio-stimulant were introduced for the first time in addition to the use of nitrogen and phosphorus fertilizers which have been widely applied by farmers before. The latest released rice varieties resistent to brown plant hoppers was promoted and the role of modified working groups of farmers was also emphasized.

The major goal of such a program modification was obviously to raise rice production through the increase in average yields per unit of land, while yield gap among rice farmers might have been overlooked so far. Given the existing technology and area devoted to rice production at a particular time, yield gap itself provides an opportunity to raise production when farmers' constraints bringing

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about the gap can be eliminated. Therefore, studies concerning relative technical efficiency and farmers' constraints in increasing rice production, which become the focuses of this paper, may be invaluable for policy consideration.

In order to investigate the gap, the concept of efficiency is brushed up in the second section of this paper followed consecutively by the presentation of the frontier production function notion, the estimation of the function itself, the computation of technical efficiency, and finally the relationship between selected variables and the technical efficiency indices. To do the analyses, data gathered from two coastal villages of Rural Dynamics Resurvey in wet season in 1983 were used (see some characteristics of the villages in Appendix Table 1).

Measuring Efficiency[1]

Overall economic efficiency, composed of technical efficiency and allocative efficiency, was first introduced by Farrell (1957). The basic ideas underlying his approach to efficiency measurement are illustrated in Figure 1. The efficient unit isoquant (EUI) represents a group of firm (I, J, Q, S, and K) using relatively least amount of input to produce one unit of output. The remaining firms (P and L) are therefore, deemed technically inefficient. Given relative input prices, the isocost line (AB) indicates the minimum cost of producing one unit of output and this suggests that overall economic efficiency be the highest at point S on EUI. He

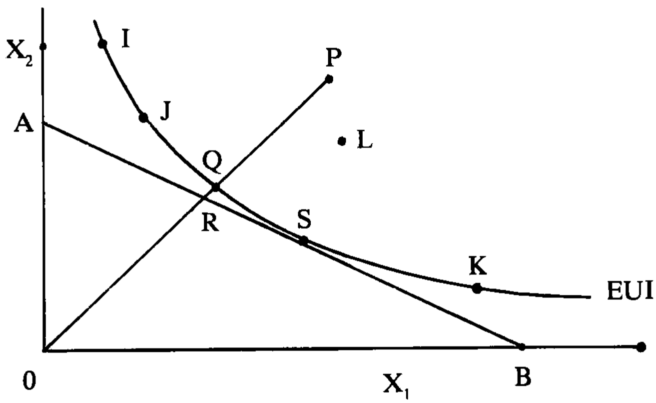

Figure 1. Farrell's measure of efficiency.

1) This section is heavily drawn from Russell and Young (1983) and Ranaweera and Hafi (1985), and so are the related references.

proposed that overall economic efficiency of firm P be measured as OR/OP = OQ/OP × OR/OQ consisting of technical efficiency (OQ/OP) and allocative efficiency (OR/OQ). In other words, technical inefficiency arises when more than the least bundle of factors are used to produced one unit of output and allocative inefficiency arises when the proportion of factors does not lead to profit maximization.

Besides the concept of relative technical efficiency based on input use among firms to produce standardized (unit) output, Farrell (1957) also proposed relative efficiency based on outputs produced by firms when input levels are standardized. Fare and Lovell (1978) pointed out that both input-base and output-base measurements are equivalent only in the case of homogenous technology with constant return to scale.

The concept of efficiency, however, has been questioned as a guide of policy formulation since its assumptions of perfect competition is not appropriate to the real world performance (see Kirzner, 1979 and Pasour, 1981). Nonetheless, such a problem seems highly related to allocative efficiency concept rather than to technical efficiency notion though they are mutually interrelated as the components of economic efficiency. In this paper, therefore, technical efficiency is deemed to retain validity in exploring farmers' performance as compared with the best practice.

The second area of controversy is concerned with our ability to measure inputs. Inaccurate measurements of land and labor due to ignoring quality differences, problems of measuring capital inputs and our inability to measure management expertise are examples of this phenomenon (see Russel and Young, 1983). Such problems do exist in the use of production function framework in this paper and not to mention the problems in the inclusion of variables which are very much constrained by the lack of management-related variables.

Production Function Framework

Shapiro and Muller (1977) argued that once we include all variables in estimating production function, interfarm variability in productivity, except the differences due to random elements, will disappear. Hence, we have to identify all kinds of variables including socio-economic and institutional ones that should be taken into account if the model is to be specified as exactly as possible. Johnson (1964), however, argued that factors causing productivity differences under socio-economic and institutional factors should not be treated as factors of production, because attempts to do so will deminish the effectiveness of technical production relationship itself and reduce our ability to understand managerial performance and human agent improvement (see also Ranaweera and Hafi, 1985).

By definition, as noted by Forsund *et al.* (1980), production function holds the relationship that describes the greatest possible output for a given combination of inputs (see among others Ferguson, 1966). Therefore, there would seem to be a concensus in the recent literature on production estimation that it is a production frontier rather than an average function which corresponds to the theoretical notion of production function. The frontier production function adopted here takes the following general Cobb-Douglas form:

$$\ln Yi = a + b \sum_{j=1}^{j=k} \ln Xji + ui, \qquad u <= 0 \tag{1}$$

The random disturbances (ui) are assumed to be independently and identically distributed (Judge *et al.*, 1980). As done by Russell and Young (1982), corrected ordinary least square (COLS) is also chosen as the most convenient means of estimating equation (1). Having applied OLS to equation (1), the intercept estimate is then corrected by shifting the production function until no residual is positive and one of them is zero.

A data set derived from 63 rice farmers in two northern coastal villages of West Java, i.e. the samples of Rural Dynamics Resurvey in wet season in 1982/83, is used to estimate equation (1)[2]. In this connection, rice production produced in farm i (Yi) is considered to be determined by rice area in hectare (X1i), pre-harvest labor in hours (X2i) and the total amount (nitrogen and phosphorus) fertilizers in kilograms (X3i). The result of the estimation of the frontier production function is

$$\ln Y^* = \underset{(17,32)}{7,6179} + \underset{(10,31)}{0,7251^{***}}\, X1 + \underset{(1,72)}{0,0154^{*}}\, X2 + \underset{(3,29)}{0,2131^{***}}\, X3 \tag{2}$$

$\sum_{j=1}^{j=3} b_j = 0.9536$; Adj.R.square = 0.84

No. of observations = 63

*** = highly significant (at 99 percent).

* = significant at 90 percent.

t-ratios are in parentheses.

Technical Efficiency Analysis

Based on equation (2), Timmer and Kopp technical efficiency indices are computed for each farm (see Timmer, 1971 and Kopp, 1981). Timmer technical efficiency (Timmer TEi) is defined as the ratio of actual output (Y) to the best practice of potential output (Y*). Let ei = ln Yi - ln Yi*, then:

2) In each sample village of the Rural Dynamics Study, a block census of about 200-250 households was carried out in 1975. From this census, 60 sample households (including landless) were proportionally chosen on the basis of household distribution by cultivated land area classes.

$$\text{Timmer TEi} = \exp(ei) = \ln Yi/\ln Yi^* <= 1 \quad (3)$$

Kopp technical efficiency (Kopp TEi) compares the actual level on input use to the level which could be used if a farm was located on frontier given the actual output of the farm and the same ratios of input usage. Such a measure assumes that all inputs can be adjusted proportionally towards the efficiency standard. Let X1i*, X2i* and X3i be the optimum use of inputs on farm i for output level Yi, and let R1i = X1i/X3i and R2i = X2I/X3i, then

$$\ln X3i^* = (\ln Yi - 7.6179 - 0.7252 \ln R1i - 0.0154 \ln R2i)/0.9536 \quad (4)$$

In a similar manner, ln X1* and ln X2* can be calculated and we may then compute Kopp TEi as

$$\text{Kopp TEi} = X3i^*/X3i = X2i^*/X2i = X1i^*/X1i \quad (5)$$

Both Timmer and Kopp technical efficiency indices are presented in Table 1. As examined by Fare and Lovell (1978), had the production function exhibited constant return to scale, both the Timmer and Kopp measures would have been identical. Since mild decreasing returns to scale is found in equation (2), the Kopp measures are slightily smaller than those of Timmer (see Table 1). It is obvious, however, that the ranking of efficiency level is similar in both cases. The complete result of the computation shows that technical efficiency indices among the sample farms are vary considerably, i.e. only 15 percents of the observations are at least 75 percent efficient, 61 percents of the farms are at least 50 percent efficient and the entire sample is at least 26 percent efficient. This implies that, given the existing technology, there will be a great opportunity to increase rice production up to the best-practice level without changing the amount of inputs used if factors constraining rice farmers can be minimized as much as possible. Given the availability of data, the next section of this paper is dedicated to seek such factors.

Table 1. Relative technical efficiency and input use in a sample of 63 rice farms in West Java, wet season, 1982.

Items	Farmers' ranking by relative technical efficiency				
	1	2	3..........61	62	63
1. Timmer technical efficiency	1.00	0.89	0.89 ...... 0.30	0.28	0.27
2. Kopp technical efficiency with:					
a. no input-fixity	1.00	0.89	0.89 ...... 0.28	0.26	0.25
b. land fixity	1.00	0.61	0.60 ...... 0.21	0.18	0.13
3. Input use:					
a. land area (ha)	0.50	1.38	0.18 ...... 1.43	0.21	0.36
b. labor (hours/ha)	1049	993	1303 980	1200	1374
c. fertilizer (kgs/ha)	400	295	447 210	234	462

The ability of farmers to achieve a desired allocation of resources is not only determined by management-related factors but it is also often impaired by the fixity of some conventional factors of production in the short run. In conjunction with the latter, land-input fixity is a particular example. In most cases, production elasticity of land, as indicated by equation (2), is extremely high but farmers can not easily change the stock of land in the short run.

Taking the stock of land in each farm as fixed and assuming the level of output and the ratio of the other factors to remain unchanged, we may recompute the Kopp technical efficiency indices (Table 1). Thus, for example, the actual level of output of the least efficient farm would be achieved by an efficient producers with 75 percents less of all inputs but if the land stock is fixed, the other input could be reduced by 87 percents. In other words, had all farms operated at best practice level, total production in the study area would have been substantially increased. Note that, as depicted by Table 1, an increase in input use does not necessarily imply an increase in technical efficiency.

Several Socio-Economic and Institutional Factors Explaining Technical Efficiency Variation

A linear regression model has been employed to estimate the relationship between farm specific technical efficiency and variables under socio-economic and institutional setting. Given the availability of data, Timmer technical efficiency (TE) is specified as a function of age in years (AG), intensification program participation dummy (PR, taking the value of unity if the farmer participated the program, zero for otherwise), household off-farm agricultural working hours (AE), and household off-farm non-agricultural working hours (NA). The result of estimation is

$$TE = \underset{(.03)}{.0045} - \underset{(-.45)}{.0015\,AG} + \underset{(3.81)}{.3074\,PR^{***}} + \underset{(1.94)}{.0002AE^{*}} + \underset{(.55)}{.0001\,NA} \quad (6)$$

Adj.R. Square = 0.71; no of observations = 63

*** = highly significant (at 99 percent).

* = significant at 90 percent.

t-ratios are in parentheses.

It is not surprising, of course, that the participation of farmers in Bimas Intensification Program (PR) is a highly significant determinant of technical efficiency since the program provides more intensive extension services and better access to credit facilities and material inputs. Nevertheless, one may argue that such significant effect of intensification program might be resulted, to a great extent, from the better quality of land included in the program rather than from those services given by the program. For the sake of the analysis, however, the major reason for selecting only two villages in a relatively similar environment is to minimize this problem so that land quality differences may be considered as random (see also Timmer, 1970).

Farmers' age appears to be insignificant as a determinant of technical efficiency though they are tend to be negatively related.

It is interesting to note from the result of regression estimation that neither off-farm nor non-agricultural working hours of households negatively affect technical efficiency. This implies that non rice-farm works in this major rice producing area have so far been adjusted to the rice cropping schedule.

Conclusions

Since the range of interfarm technical efficiency indices are quite large, there will be a great opportunity to raise technical efficiency given the existing technology. This indicates that rice production can be increased substantially if factors preventing farmers from performing best practice can be diminished to a certain extent. Although the inclusion of such factors in the model is constrained by the data availability, the regression analysis in this paper at least highlights the significance of farmers' participation in Intensification Program to technical efficiency issue. Attempts dedicated to the improvement of the program, therefore, are undoubtedly relevant but it seems always imperative that farmers' constraints to increase production be entirely understood. For instance, it is essential that we be aware of returns to farmers' resources when they are participating the modified rice intensification program such as Opsus Jalur Pantura in the Northern Coastal Plain of West Java and not to mention the importance of our knowledge about their individual and collective access to the new farm credit system and to extension services. It is also depicted in the regression analysis that off-farm and non-farm agricultural working hours do not impair technical efficiency. In other words, there is also an opportunity in increasing such kinds of employment to a certain extent without decreasing technical efficiency of rice production.

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Appendix Table 1. Some characteristics of the sample villages, input use, and off-farm working hours.

Items	Warga-binangun	Lanjan
Distance to:		
a. Sub-district town (km)	4	7
b. District town (km)	35	17
Elevation (mt)	8	17
Distribution of census households by area of cultivated sawah (%):		
Landless	54.5	23.3
< 0.25 ha	19.4	15.2
0.25-0.49 ha	14.5	18.6
0.50-0.99 ha	4.8	18.1
>= 1.00 ha	6.7	24.8
Input use:		
a. cultivated rice area (ha)	0,90	1.04
b. pre-harvest labor (hours/ha)	1274	1321
c. fertilizer (urea and TSP/ha)	367	335
Distribution of census households sources of income:		
a. farmer	6.5	11.6
b. farmer - farm laborer	21.6	21.9
c. farmer - farm laborer - non agriculture	13.4	31.7
d. farmer - non agriculture	16.4	12.1
e. farm laborer	16.3	6.0
f. farmer laborer - non agriculture	14.4	12.1
g. non agriculture	11.4	4.7
Off-farm household working hours per year:		
a. In agriculture	308	1054
b. Non agriculture	304	531