The only way to reduce the import of maize is by increasing domestic maize production, and it can be accomplished by expanding the maize production area or by intensifying the current maize production in the major maize producing regions. Since the former is much costly than the latter while the government budget for area expansion in the outer islands is also limited, one may conclude that intensifying the current maize production is more likely to be implemented. It is worthwhile to note that any attempt to expand the area of one food crop in irrigated field would reduce the areas of the other food crops. In other words, allowing the farmers to decide what they grow in irrigated land based on market mechanism would be a better policy than targeting the area of each food crop.

The government of Indonesia has no longer intervened either in the forms of tariff or non-tariff barriers for maize commodity at least in the last five years. In other words, maize commodity has being freely traded, but free trade may create many problems if the commodity has no competitive advantage. One of the factors affecting the competitive advantage of any commodity is the level of technical production efficiency. The higher the technical efficiency, the stronger would be the competitiveness of a commodity. Information on technical efficiency, therefore, is required for policy considerations.

Objectives

The objective of this study is to estimate the technical efficiency of maize production and to describe the distribution of farmers by the efficiency levels. Before discussing the objective, the paper presents the description of soybean farmers encompassing land holding, cropping patterns, input use, and costs and returns of maize production.

RESEARCH METHOD

Specification of the Model

Since there are so many factors affecting productivity, farmers do not know exactly the maximum production potential they might reach for each crop they grow. In practice, a farmer may estimate the production potential based on the best performance she/he has ever experienced or based on the best performance of other farmers. However, it does not necessarily mean that the farmer can always reach the potential because of the nature of agricultural production itself. In other words, the potential is not only dependent upon the physiological process of the crop but also on the genotype of the crop as the latter affects the vegetative and generative growth of the crop under study. The interaction of the genetic factors and biophysical environment in which the crop grows would ultimately influence the production.

As the interplay between external factors (uncontrollable by farmers) and internal factors (controllable, and hence it can be improved) affect farmers' performance, farmers are not always able to attain the highest efficiency. Climatic factors (such as temperature, moisture, precipitation, and wind) and soil condition are the examples of external factors, while related managerial factors (production technology and farmers' ability to accumulate economic information) are the examples of internal factors.

The level of output obtained from the harvest eventually reflects managerial competence of a farmer. If the achieved production level is relatively close to the achievable maximum potential, one may conclude that the farmer has managed the production at a high level of efficiency, and vice versa. In general, there are two types of production efficiency, i.e. technical and allocative efficiencies. The former relates to the ability of farmers to attain the maximum productivity given a bundle of inputs. The latter happens when, for a given input and output prices, a producer is able to equate marginal value product to marginal cost of a given input. Although economic efficiency includes both technical and allocative efficiencies, this paper focuses on technical efficiency only.

A method frequently used to estimate the level of technical efficiency, which was introduced initially by Aigner, Lovell dan Schmidt (1977) and Meeusen and van den Broek (1977) is the one that uses stochastic production frontier approach. In the subsequent years, Jondrow *et al* (1982), Waldman (1984), Schmidt (1986), Kumbhakar (1987), Battese and Coelli (1988, 1992, 1995), Bauer (1990), Greene (1993) and Garcia and Nelson (1993) carried out a wide range of review and development in this approach. The application of this approach in the last five years has been conducted, among others, by Wilson *et al* (1998) and Yao and Liu (1998). Similar approach has been carried out by Siregar (1987) and Erwidodo (1992[a] and 1992[b]) for the cases in Indonesia.

The general form of stochastic frontier production function as presented by Aigner et al (1977) can be rewritten as:

$$Q_i = Q(X_{ki}, \beta)e^{\epsilon_i} \qquad i = 1, \ldots, n \qquad k = 1, \ldots, K \qquad (1)$$

Q_i = Output produced by the i-th observation (farmer)

X_{ki} = Vector of inputs applied by the i-th observation.

β = Vector parameter coefficients

ϵ_i = Specific error term of the i-th observation

The other name for stochastic frontier model is composed error model since the error term consists of two elements:

$$\in_i = v_i - u_i \qquad i = 1, \ldots, n \qquad (2)$$

Component v_i is the random output variation due to external factors (such as climate) and it has symmetric and normal distribution ($v_i \sim N(0, \sigma_u^2)$); while u_i is the error term due to internal factors that can be controlled by farmers and it thus reflects farmers' managerial capability. This component is one-sided asymmetrically distributed ($u_i \geq 0$) and half normal distributed ($u_i \sim \left|N(0, \sigma_u^2\right|$). If the production process is perfectly efficient, the output level would coincide with maximum potential or $u_i = 0$. In contrast, if the output level is below the maximum potential, then $u_i > 0$. Aigner *et al* (1977), Jondrow et al (1982) and Greene (1993) define σ^2 and λ as:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \qquad (3)$$

$$\lambda = \frac{\sigma_u}{\sigma_v} \qquad (4)$$

Battese dan Corra (1977) define γ as total variation of actual output toward its frontier such that:

$$\gamma = \frac{\sigma_u^2}{\sigma^2} \qquad (5)$$

Consequently, $0 \leq \gamma \leq 1$ and one may obtain the estimated value of γ from σ^2 dan λ.

Jondrow *et al* (1982) also has proved that the individual technical efficiency can be measured from $\in_i$ in (1) and the expected value of u_i given $\in_i$ is:

$$E\left[u_i \middle| \in_i\right] = \frac{\sigma_u \sigma_v}{\sigma}\left[\frac{f(\in_i \lambda / \sigma)}{1 - F(\in_i \lambda / \sigma)} - \frac{\in_i \lambda}{\sigma}\right] \qquad i = 1, \ldots, n \qquad (6)$$

where f (.) and F (.) are, respectively, the normal standard density function and normal standard distribution function. One can measure the technical efficiency (TE_i) from:

$$TE_i = \exp(-E\left[u_i \middle| \in_i\right]) \qquad i = 1, \ldots, n \qquad (7)$$

2

such that $0 \leq TE_i \leq 1$. In order to obtain an unbiased estimation in this regard, Maximum Likelihood Method should be used (Greene, 1982).

For the purpose of this paper the model is specified as:

$$\ln y_i = \alpha_0 + \sum_{i}^{n} \beta_k \ln x_{ki} + \varphi D_i + \epsilon_i \quad k = 1, \ldots, 7 \qquad (8)$$

where $\epsilon_i = v_i - u_i$

y = production (in quintal)
x_1 = land size (in hectare)
x_2 = seed (in kg)
x_3 = N fertilizers (urea and or ZA in kg)
x_4 = P fertilizer (SP-36 in kg)
x_5 = K fertilizer (KCl in kg)
x_6 = Other fertilizers (Rp)
x_7 = Pesticides / herbicides (Rp)
x_8 = Pump irrigation (Rp)
x_9 = labor (in man-days)
D = seasonal dummy variable, taking the value of 0 (wet season) and 1 (dry season).

Maximum Likelihood (MLE) is applied to estimate the coefficients by using FRONTIER program (Version 4.1) prepared by Coelli (1996).

To further scrutinize how the technical efficiency (TE) distributes among the sample farmers, the distribution is examined by measuring the skewedness of the technical efficiency distribution.

Sampling Design and the Data

The scope of this study has initially been designed to cover the entire Brantas River Basin[3]. Three criteria that have been used in selecting the sample sites are: (a) relative area of paddy field (sawah) obtaining irrigation water from Brantas River, (b) variation in cropping patterns in paddy field, and (c) relative degree of irrigation water availability in paddy field. The smallest units of sample sites are tertiary blocks and the procedure for the sample site selection can be described as follows:

(1) Disaggregating the river basin into 3 sub-basins: upstream, middle-stream, and downstream regions.

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[3] The sampling design and data for this paper are drawn from the study of "Irrigation Investment, Fiscal Policy, and Water Resource Allocation in Indonesia and Vietnam", a collaborative study among IFPRI, ICASERD, KIMPRASWIL and JASA TIRTA.

(2) Selecting sample sites in each sub-basin.
(3) Selecting sample tertiary blocks in each sample site.

Two criteria, viz. the proportion of area among the three sub-basins and manageability of the study sites, have been used in determining 12 sample tertiary blocks. The distribution of the sample tertiary blocks by sub-basins is as follows:

(a) Upstream region: 3 samples of tertiary blocks.
(b) Middlestream region: 5 samples of tertiary blocks (2 in Mrican Kanan and 3 in Mrican Kiri).
(c) Downstream region: 4 samples of tertiary blocks.

A farm household as a sampling unit in the analysis is defined as a group of individuals having one expenditure management unit and cultivates at least a piece of land to earn income. The time reference is one year (Wet season, 1999/2000; dry season I and dry season II, 2000).

To obtain the sample farmers representing farmer population, a stratified random sampling has been used. The stratified random sampling is based on the three strata of cultivated land size (L) as follows.

(1) Strata 1 (small) $< \{Avg - \frac{1}{2}(StD)\}$

(2) Strata 2 (medium) $\{Avg - \frac{1}{2}(StD)\} \leq L \leq \{Avg + \frac{1}{2}(StD)\}$

(3) Strata 3 (large) $> \{Avg + \frac{1}{2}(StD)\}$

Notes: Avg=average; StD=standard deviation

As the number of samples in each tertiary block is 40 farm households, the total number of the samples is 480 farm households.

RESULTS OF THE STUDY

Land Holding and Cropping Patterns

Since maize in the study sites is grown on paddy field (*sawah*), the discussion on land holding and cropping patterns in this section relates to paddy-field-based farms. If land is simply classified into paddy field and non-paddy field, the average sizes of land ownership of farm households are 0.34 ha of paddy field and 0.09 ha of non-paddy field, totaling 0.43 ha. A general tendency shows that the farther one goes to the lower part of the river basin, the smaller is the land ownership. This tendency stems from the differences in agrarian population density in the region.

The major types of non-paddy field in the upstream of the basin are dry land for food (*tegalan*) and perennial crops (*kebun*), whereas the major type of non-paddy field in the middle and lower parts of the basin is home-yard. Since home-yard includes the area for the house, the area of home-yard for farming is small, that is less than 300 m^2. The major plants in home-yards are coconut, banana, *rambutan*, mango and so on, mostly for family consumption.

The proportion of farmers who do not have their own paddy field (their cultivated paddy fields are rented-in or sharecropped-in from other farmers) is around 23 %. More than half of farm households (53.5%) have their own paddy fields with an average size of 0.26 ha, while the average number of parcels for the size is 1.7 parcels. The percentage of farmers having their own paddy field in the range of 1–1.5 ha is only 4.2% with an average size of 1.2 ha, while the percentage of farmers having their own paddy fields more than 1.5 ha is only 1.5% with an average size of 2.5 ha (Table 1).

Tabel 1. Average size of paddy field (*sawah*) by the ownership categories, 1999/2000.

Size (L) of paddy field ownership (ha)	Number of Farmers n	%	Ownership Land parcel	Size (ha)
$L = 0$	111	23.13	0.0	0.000
$0 < L \leq 0.5$	257	53.54	1.7	0.255
$0.5 < L \leq 1.0$	85	17.71	3.5	0.647
$1.0 < L \leq 1.5$	20	4.17	4.4	1.213
$L > 1.5$	7	1.46	4.3	2.546
All	480	100.0	1.8	0.339

The ownership distribution of paddy field is somewhat skewed, with the Gini Index equals to 0.664. The lower half (50%) of farm households only have 12% of the total paddy field ownership. Inversely, the upper half of farm households has 88% of the total paddy field ownership. The highest 10% of farm households even have at least 37% of the total paddy fields in the study area.

Cropping pattern is a reflection of choices made by farmers about what, how much, and when to produce. The data on cropping pattern are collected not only from the sample tertiary blocks but also from all land parcels cultivated by the sample farmers. It should be noted that a farmer might apply more than one cropping pattern, particularly if the farmer has more than one land parcel. Consequently, the cropping patterns in the study sites considerably vary from one site to another. In 1999/2000 there are 84 cropping patterns covering 22 crops planted. The dominant ten cropping patterns are presented in Table 2.

Table 2. Dominant Cropping Patterns in Paddy Fields, Brantas River Basin, 1999/2000.

Cropping patterns	Parcels		Area	
	Number	%	(Ha)	%
Rice-rice-soybean	203	19.9	43.6	19.8
Rice- rice- fallow	212	20.8	37.0	16.9
Rice- rice- maize	125	12.2	28.1	12.8
Rice-maize-maize	43	4.2	13.2	6.0
Rice-rice-mungbean	76	7.4	12.4	5.6
Rice-tobacco	54	5.3	10.2	4.6
Rice-rice-rice.	44	4.3	9.3	4.2
Rice-'bengkoang'-maize	30	2.9	6.7	3.1
Sugar cane	8	0.8	6.4	2.9
Rice-rice-squase (blewah)	13	1.3	5.4	2.5
Others (74 types)	213	20.8	47.3	21.5
Total	1021	100.0	219.6	100.0

The largest cropping pattern is paddy-paddy-soybean, meaning that the farmers grow paddy in both wet season and dry season-I, and soybean in dry season-II. The proportion of this cropping pattern in terms of both land parcel number and area is 20 %. In terms of area, the second dominant cropping pattern is paddy-paddy-fallow (17 %), while the third is paddy-paddy-maize (13 %). The area of paddy-paddy-paddy is 4 %, whereas sugarcane is only 3 %. Sugarcane is usually planted in relatively larger land parcels than the average cultivated land size. As shown in Table 2, the proportion of parcel in the case of sugarcane is much less than the proportion of area. The farmers' decision about the sequence of commodities by seasons is not only determined by water availability but also by other factors such as input availability, labor availability, and certainly farmers' expectation of income.

Aside from paddy, the most popular crops grown in paddy fields are secondary food crops. Based on the area devoted to the crops, the sequence of the crops from the largest to the smallest is maize, soybean, mungbean, and groundnut. The most popular types of horticulture are red pepper, tomato, shallot, and watermelon.

Input Use, Costs and Returns in Soybean Production

Agricultural technology implies not only the amount of inputs used but also the quality and even the way to apply the inputs in agricultural production. The analysis of this study, however, focuses only on the quantity of inputs such as seeds, fertilizers, labors, and water that farmers apply. It seems that the amounts of inputs used in both dry season-I and in dry season-II are almost the same (Table 3). The productivity of maize in 1999/2000 is around 5.6 tons (dried grain) per ha, ranging from 3.8 to 7.2 tons per ha. Since the availability of water in the dry season-I is better than that of in the dry-season-II, the maize yield in the dry season-II is somewhat lower than that of in dry season-I.

The level of farm income is dependent upon the types of input used, the quantity and quality of each input, the prices of input and output, and the productivity of each crop. In Brantas River Basin, farmers can easily find material inputs at kiosks or nearest market. When the government provided farm credit (KUT), many farmers obtained material inputs through the credit. Since 1999, the credit has been so difficult to get that almost all farmers have to buy farm inputs in cash. Some farmers have the opportunity to borrow the inputs from input traders or to borrow money from affluent farmers to buy the inputs. '*Ijon*' system, in which moneylender buys standing crops, is not recorded during the data collection.

The prices of food crops during the field survey (1999/2000) were almost similar to that in the previous year. In other words, there is no significant change in the prices of food crop, including the price of maize. The price of paddy was even lower than the floor price (see Sumaryanto et al., 2002). On the other side, the prices of material inputs, as usual, have never gone down.

Table 3. Productivity and the Use of Material Inputs and Labors in Maize Production, Brantas River Basin, 2000.

Input and Output	Unit	Quantity		Value (Rp000/ha)	
		DS-1	DS-II	DS-1	DS-II
Seed	Kg/ha	59	61	145	146
Fertilizers:					
Tablet Urea	Kg/ha	48	38	53	43
Granular Urea	Kg/ha	309	330	331	355
ZA	Kg/ha	114	112	108	107
TSP	Kg/ha	59	56	102	96
SP-36	Kg/ha	39	41	62	66
KCL	Kg/ha	37	39	71	75
Others	Rp000/ha	17	11	17	10
Insecticides/Herbicides	Rp000/ha	123	130	123	130
Tractor					
Hired	Rp000/ha	247	241	246	241
Family	Rp000/ha	44	41	44	41
Draft animal					
Hired	Hours/ha	3	3	15	20
Family	Hours/ha	1	1	6	4
Hired irrigation pump	Rp000/ha	3	12	3	12
Irrigation fees:					
Irrigation Fees (IPAIR)	Rp000/ha	12	13	12	13
HIPPA	Rp000/ha	22	24	22	24
Others	Rp000/ha	1	1	1	1
Labors:					
Male labor					
Hired	Hours/ha	418	451	613	669
Family	Hours/ha	514	502	754	745
Female labor					
Hired	Hours/ha	359	352	383	373
Family	Hours/ha	142	139	152	148
Yield	Kg/ha	5653	4832	5415	4652

The major cost components in maize production, as shown in Table 4, are the costs of material inputs and hired labors. The shares of the two cost components in the total revenue are 24-26% and 16% respectively. Since the share of total cash costs in the total revenue is about 46-49%, then the proportion of net returns to maize farmers as landowner-operators is about 51% which is much higher than that in the case of soybean both in relative and in absolute terms (see Siregar and Sumaryanto, 2003). Although the proportion of net returns is relatively high, it is still small in absolute terms, which is around Rp2.4 millions per hectare for about three months of one maize production cycle or about Rp800 thousands per hectare per month. The net returns would even be much smaller for an average cultivated land size of 0.4 Ha, which is around Rp320 thousand per farm household per month.

Table 4: Costs and Returns in Maize Production, Brantas River Basin, 2000.

Costs and Returns	Dry Season - I		Dry Season – II	
	Value (Rp/ha)	Factor shares (%)	Value (Rp/ha)	Factor shares (%)
Material inputs	1271	26	1110	24
Hired labors	768	16	760	16
Hired hand tractors	263	5	240	5
Hired draft animal	24	1	11	0
Irrigation Fees	21	0	21	0
Other Equipment	4	0	23	0
Land Tax	38	1	38	1
Total cash Costs	2389	49	2203	46
Total Returns	4832	100	4652	96
R/C	2.02	n.a	2.11	n.a
Land rent	572	12	572	12
Interest Rates	199	4	184	4
Returns to:				
Land owner's family-resources	2443	51	2449	51
Tenant's family-resources	1871	39	1877	39
Management	1672	35	1694	35

Note: 0=less than one; n.a.=not applicable.

If a farmer is a tenant, he or she has to pay the land rent. In this case, the net returns for the tenant would be Rp1.8 million per hectare or about 39% of the total revenue. When imputed family labor costs and interest rate are taken into account, the returns to a farmer, as the manager of soybean production, would be Rp1.6-1.7 million per hectare or about 35% of the total revenue. This information help explain that, given the present state of technology, maize production would be feasible for a large company to carry out since the value of R/C is about 2.0. In relation to free trade regime, the domestic resource cost (DRC) of maize production in Brantas River Basin is 0.52, meaning that domestic production of maize has a good comparative advantage (see Siregar and Sumaryanto, 2003).

Farm Technical Efficiency Level

From now on, the problems facing food-crop farmers would be more complicated since the problems always relates to two things. First, the impacts of international free trade on food crops in general and maize in particular would be significant. Its impact would be the increasing pressure of competitors from abroad: (a) in agricultural output markets, prices would be pressed down because farmers in some exporting countries may sell their commodities at lower prices; and (b) in agricultural input markets, the real prices tend to go up since all input subsidies would be lessened or even eliminated. Second, the implication of scarcity and degradation of resources, particularly land and water. The population growth and economic development would increase the demand for land and water. On the other hand, if the use of resources (based on sustainability principles) does not directly result in an adequate short run profitability to farmers, then the rate of resource degradation cannot be reduced. Ultimately, the real problem would be the increasing competition in the use of declining-quality resources.

The extent to which farmers may respond to the challenges is dependent upon their capability to increase farm efficiency. In other words, the challenge the farmers are facing is to produce more output given their resources, or to produce the same level of output by using less quantity of inputs. In practice, attempt to increase farm efficiency is not simple since it depends on their managerial capability and the dynamics of the environment. Managerial capability itself is not only determined by economic variables, but also by social dimensions.

To evaluate the managerial capability of maize farmers, it is necessary that the parameters of stochastic frontier production function in equation (8) be evaluated. The results indicate that the factors positively and significantly affect soybean production are land size and labors. An increase in land size by 10%, for instance, would increase maize production by 8.1%, whereas an increase in the use of labor by 10% would increase maize production by 1,2% only (Table 5). Since, for the farmers in general, land is more limited a production factor than labors, expanding cultivated land size is of course much costly than adding labor use.

The only factor negatively and significantly affect maize production is the use of pump irrigation, meaning that the farmers might not properly irrigate their maize crop using pump irrigation. The farmers usually hire pump irrigation for particular hours without considering the optimal amount of water required by the crop. In relation to he use of fertilizers, it is worthwhile to note that although the signs of coefficients of all kinds of fertilizers are positive but the effects of the fertilizers on maize production are not significant. This implies the farmers need to be informed about a balanced application of fertilizers resulting from local verification trials that urgently need to be carried out right away in the maize producing areas.

Table 5. Parameter estimates of maize stochastic frontier production function.

Coefficients	Variables	Coefficients
Beta 0	Constant	2.9640 (0.3438)
Beta 1	Land size	**0.8133** (0.0554)
Beta 2	Seed	0.0805 (0.0514)
Beta 3	N-fertilizer	0.0068 (0.0049)
Beta 4	P-fertilizer	0.0043 (0.0026)
Beta 5	K-fertilizer	0.0027 (0.0038)
Beta 6	Other-fertilizers	-0.0010 (0.0027)
Beta 7	Pesticides / herbicides	0.0024 (0.0026)
Beta 8	Pump irrigation	**-0.0133** (0.0050)
Beta 9	Labors	**0.1183** (0.0520)
Sigma-squared	n.a	0.1740 (0.0219)
Gamma	n.a.	0.9764 (0.0190)

*) Figures in parentheses are the standard errors; n.a.=not applicable;

Bold letters: significantly different from zero at $\alpha = 0.01$;

Since all input and output variables are in log forms, each coefficient directly refers to elasticity.

The level of technical efficiency that can be attained in soybean production in the study sites is relatively high, that is around 0.74, (Table 6). Although the range in efficiency levels among farmers is large, the range is still in the range of technical efficiency of paddy production (see Sumaryanto, 2001). The large range of technical efficiency indicates that there remains an opportunity for improving the efficiency. Considering the insignificance of coefficients of fertilizers, one may conclude that it is urgent to improve the combination of fertilizer use based on local verification trials.

As stated by Aigner et al. (1977), the error component of stochastic frontier production function is $\epsilon_i = v_i - u_i$ where u_i is a component that can be controlled or internalized by farmers. This implies that if production process were perfectly efficient, the output would coincide with maximum potential of output. In other words, the estimation of potential maximum output can be obtained from the estimation of stochastic frontier production function. In line with the concept, the estimation of maximum potential of maize production in Brantas River Basin can be described as in Figure 1.

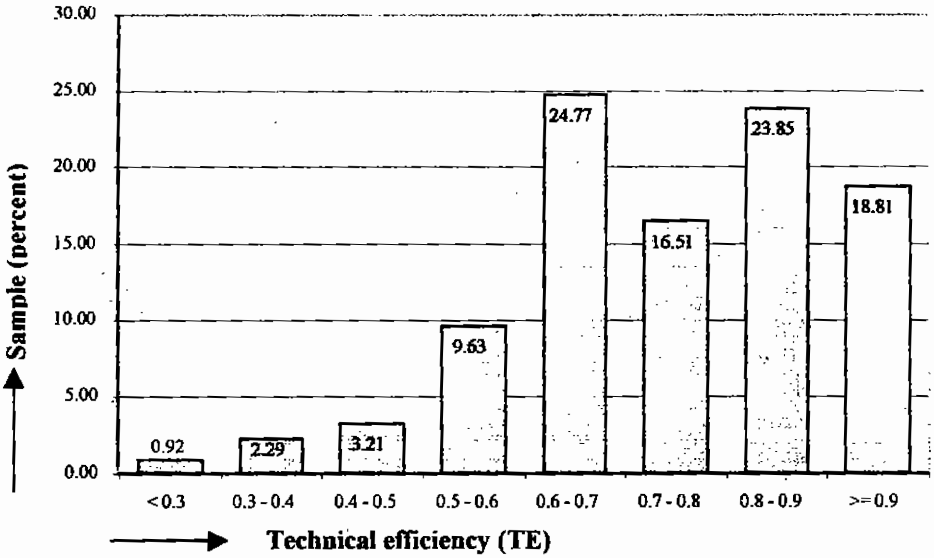
Table 6. Descriptive statistics of technical efficiency levels of maize production in irrigated area of Brantas River Basin, 1999/2000.

Statistics	Magnitude
Mean	0.744
Standard Deviation	0.158
Kurtosis	0.067
Skewness	-0.670
Minimum	0.213
Maximum	0.978
Confidence Level (95.0%)	0.021

Agricultural production is inherently the result of interaction process between genetic factors and manipulation of the environmental factors via agronomic engineering. In practice, genetic factors are translated into crop varieties. The most important environmental factors are climate (moisture, temperature, precipitation, sunlight, etc.) and soil fertility (physical and chemical). The environment certainly varies across time and location. The most important implication of this concept is that the nature of maximum production potential is location specific. This implies that the estimation results of production potential should be translated as maximum average.

The proportion of farmers having technical efficiency less than 0.7 in maize production is about 41% (Figure 1). This implies that more than a half of farmers in Brantas River Basin have a sufficiently high managerial capability in the production of maize. On the other hand, since the farmers have used considerably high managerial capability to achieve the recent productivity levels, it also implies that attempt to increase production via the improvement of farm managerial capability becomes more difficult without significant technological improvement. As shown by the estimation results of the stochastic frontier production function (Table 5), an immediate technological improvement that should be carried out is in the use of balanced fertilizers.

Figure 1. Distribution of farmers by technical efficiency rating in Maize production in irrigated area of Brantas River Basin, 1999/2000.



CONCLUSION AND RECOMMEDATION

1. The estimation results of maize stochastic frontier production function indicate that the factors positively and significantly affect soybean production are land size and labors. In relation to he use of fertilizers, although the signs of coefficients of all kinds of fertilizers are positive, the effects of the fertilizers on maize production are not significant. This implies that the use of fertilizers needs to be improved by applying a balanced amount of fertilizers.

2. More than half of the farmers in Brantas River Basin have a sufficiently high managerial capability in the production of maize. On the other hand, since the farmers have used considerably high managerial capability to achieve the recent productivity levels, it also implies that attempt to increase production via the improvement of farm managerial capability becomes more difficult without significant technological improvement. As stated in (1), an immediate technological improvement that may be carried out is in the use of balanced fertilizers. This implies the farmers need to be informed about a balanced application of fertilizers resulting from local verification trials that urgently need to be carried out right away in the maize producing areas.

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