SUPPLY OF RICE AND DEMAND FOR FERTILIZER FOR RICE FARMING IN INDONESIA

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In 1985 Indonesia achieved self sufficiency in rice, this was a dramatic change from a major importing country in 1982 and became a potential for net exporter in 1985. However, this change has caused several effects on prices and the production structure of food commodities in Indonesia. Price of rice declined sharply in the main harvest seasons in February-April in 1985, where price of gabah (unmilled rice) was 20-40 percent below 1984 level.

The decline in the price of rice caused changes in the comparative advantage of other food crops namely Corn, Soybeans, Cane Sugar and vegetable crops. Policy issues related to this fact include support price for rice, input subsidy, marketing and supply management.

The effectiveness of the food policies depends on the level of resources and effort devoted to the implementation of the policies. Because resources are becoming more limited, it is extremely important to determine the level of resources require to sustain rice self sufficiency. The emphasis of this paper will be on demand for inputs and supply of outputs in rice farming using profit function analysis. Both farm level and agregate data were used in the analysis.

Profit Function Analysis

Analysis of the demand for inputs and supply of output using the production function approach has some limitations such as (1) it does not allow different firms to succeed at various level of profit maximization, (2) it does not allow that firms to face different sets of prices, and (3) it also does not allow different firms approach to produce at different levels of input-output combinations. The profit function approach overcomes there limitations.

Let the production function be defined as:

$$Q = F(X_1, X_2, \ldots X_m, Z_1, \ldots Z_n) \qquad (1)$$

and the variable cost equation as:

$$C = C(X_1, X_2, \ldots X_m, C_1, C_2, \ldots C_m) = \sum_{j=1}^{m} C_j X_j \qquad (2)$$

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The profit function can be formulated as :

$$P.F(X_1, X_2, X_3 \ldots\ldots X_m, Z_1, Z_2 \ldots\ldots Z_n) - \sum_{j=1}^{m} C_j X_j \qquad (3)$$

This is profit over variable cost or return to fixed factor inputs. Taking the derivative of equation (3) with respect to X_j, and the profit maximazing condition requires that :

$$\frac{d\,F(X, Z)}{d\,X_j} = C_j/P \qquad (4)$$

Let us define $\frac{C_j}{P} = h_j$ and $\frac{KU}{P} = K\,R$, therefore (5)

$$\frac{d\,F(X, Z)}{d\,X_j} = h_j$$

Where: X = Variable factor inputs

KU = Nominal profit

Z = Fixed factor inputs

KR = Normalized profit

P = Nominal price of output

C = Nominal price of input

h = Normalized price of input, input price deflated by unit output price.

Then equation (1) can be rewritten as :

$$K\,R = F(X, Z) - \sum_{j=1}^{m} h_j X_j \text{ for all i} \qquad (6)$$

From the profit maximizing condition in equation (5) we will be able to derive a demand function for factor inputs.

$$X_j = g(h, Z) \text{ for all j} \qquad (7)$$

By substituting equation (7) into equation (6) we get profit function tormulated as :

$$K\,R = F\left\{ g(h, Z) \right\} - \sum_{j=1}^{m} h_j\, g(h, Z). \qquad (8)$$

$$K\,R = G(h_1, h_2, \ldots\ldots h_m, Z_1, Z_2 \ldots\ldots Z_k)$$

$K\,R = G(H, Z)$. This is the general formulation of profit function. (9)

From equation (8)

$$\frac{KU}{P} = F\left\{g(h, Z)\right\} - \Sigma h_j\, g(h, Z)$$

$$KU = P F \left\{g(h, Z)\right\} - P\, \Sigma h_j\, g(h, Z) \tag{10}$$

With a Cobb-Douglas function, the profit function can be formulated as:

$$G(H, Z) = A \left[\prod_{j=1}^{m} h_j^{\beta_j}\right] \left[\prod_{k=1}^{n} Z_k^{\gamma_k}\right] \tag{11}$$

where: $\beta_j < 0$ for all $j = 1, 2, \ldots\ldots m$

$\gamma_k > 0$ for all k

h_j = normalized price of variable input

Z_k = quantity of fixed input

Taking natural logarithms of equation (11).

$$\ell n KR = \ell n A + \sum_{j=1}^{m} \beta_j\, \ell n h_j + \sum_{k=1}^{n} \gamma_k\, \ell n Z_k \tag{12}$$

where KR = Unit output price of profit or normalized profit.

Let equation (8) be rewritten as:

$$KR = F\, g(h, Z) - \Sigma h_j\, g(h, Z)$$

Then taking total derivative of this equation we get:

$$\frac{dKR}{dh_j} = \frac{dF}{dX_{ij}} \cdot \frac{dg(h, Z)}{dh_j} - g(h, Z) - h_j \frac{dg(h, Z)}{dh_j}$$

but $\frac{dF}{dX_{ij}} = h_j$ therefore

$$= h_j \frac{dg(h, Z)}{dh_j} - g(h, Z) - h_j \frac{dg(h, Z)}{dh_j}$$

$$= -g(h, Z)$$

$$g(h, Z) = -\frac{dKR}{dh_j} \text{ or} \tag{13}$$

$$X_j = -d\frac{G(H, Z)}{dh_j}$$

Demand for factor inputs is the negative derivation of the normalized restricted profit function with respect to input price. Let us define the profit function as:

$$G(H, Z) = F(g, Z) - \Sigma h_j g(h, Z),$$

then the supply function for output can be written as:

$$F\left\{ g(h, Z) \right\} = G(H, Z) - \Sigma h_j g(h, Z). \qquad (14)$$

This equation (14) is the supply function of output as a function of prices and fixed factor inputs. The above supply function can be formulated as equation (15).

$$F(H, Z) = G(H, Z) - \sum_{j=1}^{m} h_j \frac{d G(H, Z)}{d h_j} \qquad (15)$$

Equation (15) is the supply function for output as function of the normalized prices of factor inputs and fixed factor inputs. Therefore from the normalized profit function or unit output price (OUP) of profit function we will be able to derive demand functions for factor inputs and a supply function for output, respectively. This in known as the Shepherd-Uzawa - Mc Faden Lemma (Lau and Yotopoulus, 1971).

Let the profit function be defined as a Cobb-Douglas function as.

$$KU = A \left[\prod_{j=1}^{m} h_j^{\beta_j} \right] \left[\prod_{k=1}^{n} Z_k^{\gamma_k} \right]$$

Demand for factor inputs is as. $X_j = \dfrac{-d G(H, Z)}{d h_j}$

$$X_j = - \beta_j A (h_j^{\beta_{j-1}} \ldots..) (Z_k^{\gamma_k})$$

$$X_j = - \frac{\beta_j G(H, Z)}{h_j}$$

$$\frac{X_j h_j}{G(H, Z)} = - \beta_j \text{ since } G(H, Z) = KR \text{ or normalize profit then}$$

$$\beta_j = - \frac{X_j h_j}{KR}$$

where: β_j = profit elasticity of input factor j^{th}

$\dfrac{X_j h_j}{KR}$ = the share of input factor j.

Therefore criteria for testing allocative efficiency or profit maximization is profit elasticity with respect to the j^{th} input must be equal to factor share of the input.

The above criterion implies that if we have three factor inputs we should satisfy:

$$-\frac{X_1 h_1}{KR} = \beta_1 \quad (16)$$

$$-\frac{X_2 h_2}{KR} = \beta_2$$

$$-\frac{X_3 h_3}{KR} = \beta_3$$

Constant return to scale can be tested by

$$\sum_{k=1}^{n} \gamma k = 1 \quad (17)$$

or the Sum of elasticity of fixed factor input must be equal to unity.

Efficiency of technological change can be tested whether or not profit increases with the change of technology.

Let profit function defines as:

$$\ell n KR = \ell n A + \sum_{j=1}^{m} \beta_j \ell n h_j + \sum_{k=1}^{n} \gamma_k \ell n Z_k + \alpha D \quad (18)$$

where D is dummy variable taking value of unity for 1983/1984 and value of zero for 1976/1977. The dummy variable D will capture the technological change.

Definition of variables in the model

Variable factors of production in the analysis include:

(a) labor measured in hours = X_L,
(b) nitrogen fertilizer measured in kg of Urea = X_{Fu},
(c) phosphate fertilizer measured in kg of TSP (triple super phosphate) = X_{FT},
(d) pesticides measured in normalized cost of pesticides = X_p,
(e) animal power measured in hours = X_A
(f) tractor power measured in hours = X_F
(g) size of rice land measured in ha = X_S
(h) normalized prices of inputs defined as P_J

Fixed factors include land, family labor and tenancy rate. For estimating the profit function we include land productivity and a dummy variable for year.

Rewriting profit function in Cobb-Douglas form. (19)

$$K(p, Z) = A\left[\prod_{j=1}^{m} p^{\beta_j} \prod_{k=1}^{n} Z^{\gamma_k}\right],$$

Taking the negative derivative of equation (19) with respect to p and take natural logarithms and rearrange the term we get.

$$\ell n X_L^D = \left\{ \ell n(-\beta_L) + \ell n A \right\} + (\beta_L - 1)\, \ell n p_L + \sum_{j=2}^{m} \beta_j\, \ell n p_j + \sum_{k=1}^{n} \gamma_k\, \ell n Z_k. \quad (20)$$

In terms of nominal prices the demand function can written as:

$$n X_L^D = \left\{ \ell n(-_L) + \ell n A \right\} + \sum_{j=1}^{m} \beta_j\, \ell n Pq + (\beta_L - 1)\, \ell n C_L$$

$$+ \sum_{j=2}^{m} \beta_j\, \ell n C_j + \sum_{k=1}^{n} \gamma_k\, \ell n Z_k + \alpha D$$

This is the demand for labor derived from the profit function, where X_L^D is demand for labor, P_L is normalized wage rate, P_j is normalized prices of other variable factor inputs and Z_k is fixed factor inputs, C_L is nominal wage rate and C_j is nominal price of other inputs and P_q is output (rice) price.

The supply of output is:

$$Q^s = G(P, Z) - \Sigma P_j\, d\frac{G(P, Z)}{d P_j} \quad (21)$$

$$\ell n Q = \left[\ell n(1 - \sum_{j=1}^{5} \beta_j) + \ell n A \right] - \sum_{j=1}^{5} \beta_j\, \ell n P_q$$

$$+ \sum_{j=1}^{5} \beta_j\, \ell n C_j + \sum_{k=1}^{3} \gamma_k\, \ell n Z_k + \sum_{j=1}^{2} \alpha_i D_i \quad (22)$$

Equation (21) is the output supply as function of prices and fixed factor inputs. Given predetermined prices of the output and variable factor inputs, there is a one-to-one correspondence between profit and costs of variable factors and between profit and the level of output supply, and quantity of variable inputs.

Many variables in equations (19) to (21) are jointly dependent. Application of ordinary least squares to each of the above equation will be inefficient because β_j s appear in both equation (19) and (20). A more efficient approach will be to estimate equations (19) and (21) jointly, by imposing conditions that β_j from both equation must be equal.

As mentioned earlier that d K R/d $p_j < 0$. If the response of profit with respect to the normalized price of an input is large, this means that the demand for the input is large or the input has important role in the production of output. The reverse is true wherever the elasticity of profit with respect to the normalized price of an input is small.

The data

In this analysis we used panel cross section and time series data from farm household in Java. The first data set was collected in 1977 for the wet season 1976/1977 and the second data set was collected in 1983 for the wet season 1982/1983. The same farm households were interviewed in the two data collection periods therefore we have what amount to panel data. There were 360 households located in major rice producing areas in Java. Interviewes were carried out by research assistants and they spent about one month and a half in the rural areas. In Table 1 changes in input-output data for rice between 1976-1983 are shown.

Empirical Results of the Profit Function Analysis

In Table 2 the estimated parameters of the profit function are presented. For Model C restrictions on profit maximization were imposed. In this model 61 percent of the variation in profit was explained by the variation of the independent variables included in the model. The elasticity of the profit with respect to all variable factor inputs was 0.51 where the elasticity wity respect to fixed factor inputs was unity, implying constant returns to scale. The profit has improved over time as depicted by a highly significant coefficient of the dummy for year.

The most important factor that influences profit is the cost of the labor input, more over as much as 65 percent of the total variable cost was for by the payment of the wage bill. Fertilizer accounted for 26.7 percent of the variable costs. This fact implied that rice farming is a most labor intensive agriculture. Marginal productivity of labor was 0.84 kgs of paddy which was less than unit cost of labor at 1.13 kgs of paddy. This suggest that to increase efficiency in rice farming the marginal product of labor should be increased through a reduction on the labor use.

Table 1. Changes in Inputs per Hectare of Rice Crop and Input - Output Prices in Java for Wet Seasons 1976/1977 and 1982/1983.

Items	Wet season 1976/1977	Wet season 1982/1983	% of changes from 1976/77 to 1982/83
Average size of cultivated land per farm (ha)	0.496	0.450	(- 7.5)
Yield (kgs paddy/ha)	2905	4202	44.6
Paddy price (Rp/kg)	64.0	121.0	89.1
Inputs:			
Fertilizer (kgs/ha)			
a. Urea	219.0	295.0	30.1
b. TSP	83.0	146.0	75.9
Labor (hrs/ha)			
Land preparation	488.7	541.5	10.8
Total preharvest	1049.7	1077.3	2.6
Total labor	1323.7	1409.3	6.5
Animal for land preparation	29.5	16.2	(-45.0)
Tractor	0.0	0.60	—
Real Input Prices (kgs of paddy)			
Fertilizer	1.12	0.72	(-35.8)
Wage for manual labor (kg/day)	0.98	1.13	15.3
Animal rental rate (kg/day)	12.8	17.6	37.5

In Table 3 slope coefficients of the Cobb-Douglas profit function using aggregate data for district level in Java 1980-1983 are presented. All the coefficients for the variable factor inputs in Table 3 are lower then the coefficients in Table 2. In Table 2 we used a panel of cross section and time series analysis where there error due to individual factor (λ i) was eliminated (see equations 22-24), where as in Table 3 the analysis was based on pooled time series and cross section aggregate data. However, the coefficients in those tables are probably consistent considering the type of data analyzed.

From these two tables it can be concluded that labor is still the major determinant of net return above variable costs to farm operators followed by fertilizer as the next most important determinant. In the short run farm income can be improved through reduction in the labor inputs, since fertilizer has already been

Table 2. Estimation of the Cobb-Douglas Profit Function Using Panel Data Wet Season 1976/1977 and 1982/1983 for Rice Farm in Java.

Variable	Parameter	Model		
		A	B	C
1. Intercept	β_0	-7.602	-6.047	-7.715
2. Manual labor	β_1	-0.1561	-0.0973	-0.3312
		(0.0737)[b)]	(0.0671)	(0.0292)[c)]
3. Animal labor	β_2	0.0192	0.0167	0.0210
		(0.0102)[a)]	(0.0092)[a)]	(0.0059)[c)]
4. Fertilizer	β_3	-1.4891	-1.4201	-0.1312
		(0.0981)[c)]	(0.0898)[c)]	(0.0081)[c)]
5. Pesticides	β_4	-0.0177	-0.0126	-0.0479
		(0.0094)[a)]	(0.0085)	(0.0079)[c)]
6. Land	γ_1	0.8536	0.8522	0.9062
		(0.0403)[c)]	(0.0366)[c)]	(0.0242)[c)]
7. Family labor	γ_2	0.1484	0.1236	0.0938
		(0.0376)[c)]	(0.0342)[c)]	(0.0292)[b)]
8. Land Productivity	α_1	1.6058	1.5191	1.8995
		(0.0919)[c)]	(0.0835)[c)]	(0.0681)[c)]
9. Dummy for Year	D_1	0.0317	0.0225	0.3575
		(0.0312)	(0.0301)	(0.0252)[c)]
10. Dummy for location	D_2	-0.0065	0.01566	-0.0993
		(0.0325)	(0.0296)	(0.0289)[c)]
	$\Sigma \beta_{j_2}$	—	—	0.5104
	R^2	0.896	0.701	0.610
	n	306	306	306

Note: a) Significant at 10% level.
b) Significant at 1% level.
c) Significant at 5% level.

heavily subsidized. In the long run farm income can be increased through technological changes and an increase in the size of cultivated land an each farm.

Slope coefficients of the production function can be derived from the profit function. In Table 4 we present the slope coefficients of the Cobb-Douglas production derived from the profit function analysis (indirect estimate). For comparison, directly estimated coefficients using panel data analysis are also presented. It can be concluded that both methods give similar and consistent estimates of the slope coefficients of the production function.

From Table 4 it can be noted that land is still the major determinant of rice output followed by labor inputs. The contribution of capital as a complement for increasing labor productivity was very small. Furtheremore the output elasticity with respect to fertilizer is only about 0.10. With the current level of fertilizer

Table 3. Slope Coefficients of the Cobb-Douglas Profit Function for Aggregate data at District level, data 1980-1983 from CBS for Rice farm in Java.

Variable	Parameter	Slope Coefficient
1. Intercept	β_0	9.544
2. Fertilizer Price	β_1	-0.064[c)] (0.00164)
3. Pesticides Price	β_2	-0.009[c)] (0.0004)
4. Animal labor rental rate	β_3	-0.0237[c)] (0.00164)
5. Manual labor wages	β_4	-0.269[c)] (0.0088)
6. Land	γ_1	1.041[c)] (0.0199)
	$\Sigma\beta_j$	-0.366
	R^2	0.725
	n	232

Table 4. Slope Coefficients of the Cobb-Douglas Production Function Using Panel Data Wet Season 1976/1977 and 1982/1983 for Rice farming in Java.

Variable	Parameter	Indirect Estimate	Direct Estimate
Intercept	β_0	5.234	5.556
Manual labor	β_1	0.2814	0.2510
Animal labor	β_2	0.0139	0.0235
Fertilizer	β_3	0.0869	0.1135
Pesticides	β_4	0.0319	0.0169
Land	β_5	0.6001	0.5515
	$\Sigma\beta_j$	1.014	0.956

application for rice at 203 kgs of plant nutrients or about 440 kgs of fertilizer in terms of urea and TSP (see Table 1) the marginal productivity of fertilizer was 2.1 kg of gabah per kg nutrient or 0.91 of gabah per kg of fertilizer. The price ratio of rice to fertilizer in terms of plant nutrient was 0.61 or 1.39 if fertilizer in term of urea or TSP. This indicates that the marginal productivity of fertilizer is still above marginal cost. However if the price of fertilizer is at border prices that was above 2 kgs of gabah per kg of urea, then the marginal productivity of fertilizer was below marginal cost of fertilizer at border price, therefore the level of fertilizer application was not efficient. The higher level of fertilizer application was due to artificially low price at farm level due to subsidy price of the inputs. Previous studies, for example Timmer and Falcon (1975) using cross - country data found out that the production elasticity of fertilizer range from 0.125 to 0.250 will give more satisfactory result. David (1975) stated that output elasticity of fertilizer ranged from 0.07 for the short run to 0.14 for long run using data on a cross section of countries.

Demand for Fertilizer

In the last fiveteen years demand for fertilizer has increased very rapidly at a rate of more than 16 percent a year, and fertilizers have been used for a wide range of crops and their use has spread all over the country. However a large percentage (72 percent) of the fertilizers were used for wet land rice, and 85 percent for all food crops in 1984.

In Table 5 we present slope coefficients of the demand function for fertilizer derived from the profit function analysis. The demand for fertilizer was elastic with respect to rice price and fertilizer price. This is consistent with other studies, for example Falcon (1985) mentioned that price elasticity (in terms of the ratio of rice to fertilizer prices) range from -0.6 to -1.0. David (1975) estimated the demand elasticities of fertilizer with respect to ratio of rice to fertilizer prices were -0.9 for long run and -0.3 to -0.6 for short run. The demand elasticity increased with technological changes and farmers becoming more commercially oriented.

Table 5. The Demand Elasticities for Factor Inputs in Rice Farming, With Respect to Price, Acreage, Size of Cultivated Land and Technology (Derived from Profit Function).

	Price of Rice	Price of Ferti-lizer	Price of Pesti-cides	Wages for Manual labor	Size of Culti-vated	Tech-nolo-gy
Java, Indonesia						
1. Farm level data[1] (1976-1983)	1.510	-1.131	-0.048	-0.331	0.906	1.995
2. Aggregate, data[2] (District level 1981 - 1983)	1.361	-1.103	-0.009	-0.265	1.051	—
Muda, Malaysia						
3. Farm level data[3]	1.417	-1.076	—	-0.253	—	—

Notes: 1) Panel time Series and Cross Section of Farm households 1976-1983 in Java.
2) Pooled time Series and Cross Section of district (Kabupaten) level data on Java 1981-1983.
3) Farm level data from Muda River Basin, 1972-1973. From Muchtar Tamin (1979) Micro economic analysis of Production Behaviour of Malaysia Farms: Lessons From Muda Food Res. Stud, Vol. XVII, No. 1. 1979.

Therefore the demand elasticity of 1.35 with respect to rice and the elasticity of -1.1 with respect to fertilizer price perhaps will give reasonable estimates for the long run. As can be seen from Table 1, the price ratio of rice to fertilizer in term urea or TSP has been increased from 0.91 in 1976 to 1.35 in 1983 or an increase of 48 percent (nearly 7 percent per annum).

The increase in fertilizer demand in the last 15 years has been a result of improving the ratio of rice to fertilizer price together with the introduction of technological changes and an increase in harvested areas. In the future the rate of increase in fertilizer demand will probably be slower. This is because there is a trend towards a decline in the price ratio as a result of decline in the price of rice and perhaps an increase in the price of fertilizer. In addition technological changes in rice are expected to be slower. The fertilizer demand for food crops other than rice will probably increase in the future with an improvement in technologic and an increase in area planted. However, the level of fertilizer used and the area planted with these crops were lower than for rice.

Supply of Rice output

Rice output has increased at a remarkable rate of 6.5 percent per annum in the last 15 years, while harvested area only increased at nearly one percent a year. Falcon (1985) noted that the trend of the trend of the increase in rice output is 2.5 percent a year due chiefly to improvement in irrigation facilities and improvement in farm management.

In Figure 1 were present trends in the price of rice from 1978-1985 at the farm level in West Java. Between 1978 to 1983 when Indonesia was a deficit country for rice, the price of rice at the farm level was above or very close to the floor price set by the government. After the surplus was reached in 1984 and 1985 the price at the farm level fell below the floor price. The nominal price of rice increase from Rp 83 per kg in January-February 1978 to Rp 165 in December 1985. The consumer price index increased by 209 during that period. Up to 1983 Indonesia was still a deficit country for rice and move to a potential net exporting country began during 1984/1985. The rate of growth[1] in the nominal price of rice was 11.8 percent a year from 1978 to 1983 and declined by 4.5 percent a year from 1983 to 1985. In real terms[2] the price of rice was nearly constant from 1978 to 1983, but it declined by 15 percent year since then.

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[1] The rate of growth was computed using growth formula:
$P_t = P_0.e^{rt}$, where P is the price, t is time and r is rate of growth.

[2] Real term means nominal price of rice deflated by consumer price index at the farm level.

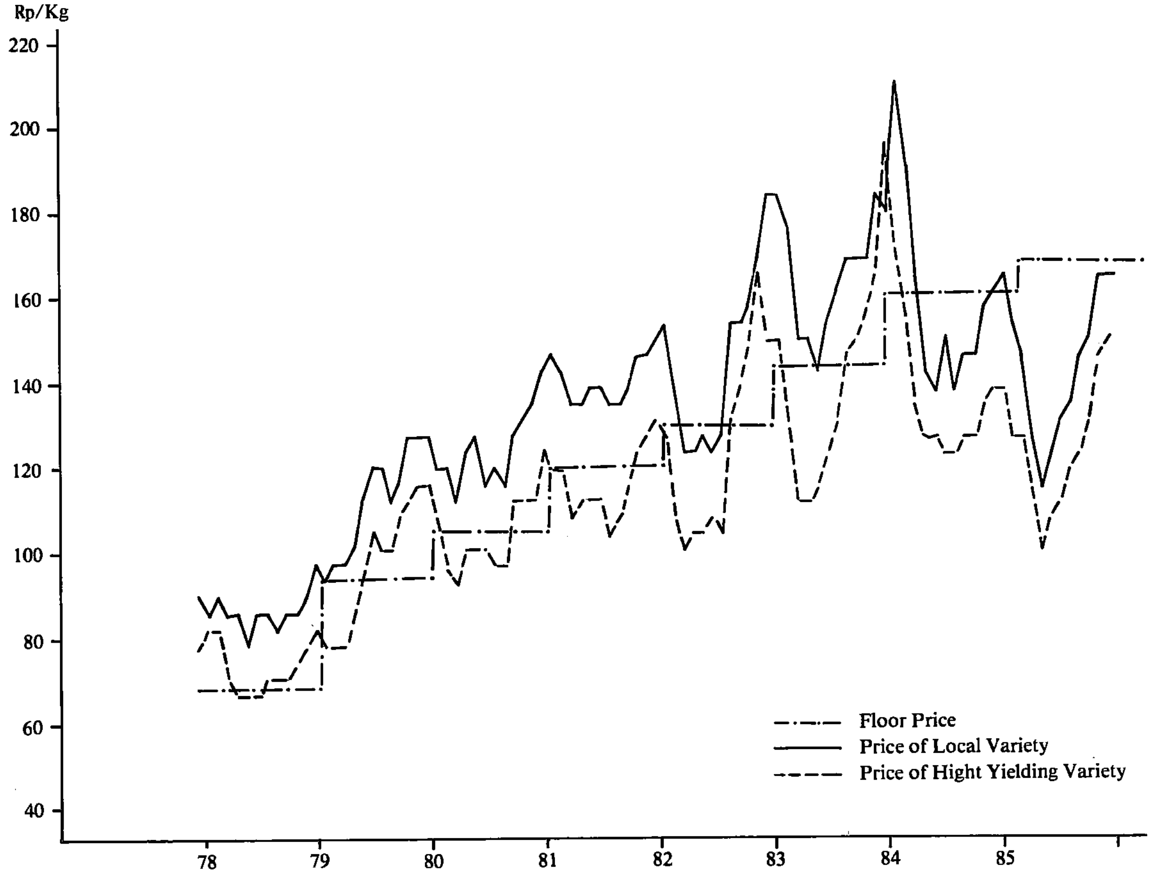

Figure 1. Trend in the Price of Rice at the farm level in West Java 1978-1985.

We present supply elasticities of rice with respect to prices, hectarage and technology in Table 6. The supply elasticity of rice with respect to own price was inelastic, that is 0.36 to 0.51. The elasticity of 0.40 is considered reasonable for the long run. Falcon (1985) estimated the own price elasticity of rice supply 0.3 for long run and 0.15 for short run. Cross price elasticity of rice supply was -0.10 for fertilizer price and -0.26 for wage rate.

Table 6. The Supply Elasticities of Rice Output With Respect to Price, Acreage and Technology (Demand from Profit Function).

	Price of Rice	Price of Ferti-lizer land	Price of Pesti-cides	Wages for Manual labor	Size of Culti-vated	Tech-nolo-gy
Java, Indonesia						
1. Farm level data[1] (1976-1983)	0.510	-0.131	-0.048	-0.331	0.906	1.995
2. Aggregate, data[2] (District level) 1981-1983	0.361	-0.103	-0.009	-0.265	1.051	—
Muda, Malaysia						
3. Farm level data[3]	0.417	-0.076	—	-0.253	—	0.927

Notes: 1) Panel time Series and Cross Section of Farm households 1976-1983 in Java.

2) Pooled time Series and Cross Section of district (Kabupaten) level data on Java 1981-1983.

3) Farm level data from Muda River Basin, 1972-1973. From Muchtar Tamin (1979) Micro economic analysis of Production Behavior of Malaysia Farms: Lessons From Muda Food Res. Stud, Vol. XVII, No. 1. 1979.

The increase in rice output in the last 15 years was due to: (a) favorable prices of rice and fertilizer at the farm level up to 1983; (b) technological change, especially with the adoption of rice varieties resistant to brown plan hoppers; (c) improvement in irrigation management; (d) institutional innovation such as the group approach for intensification (INSUS or Special Intensification Program); and other factors such as weather and pest damage.

In real terms there exists a declining trend in rice price and an increasing trend in the price of fertilizer, therefore in the future sources of growth for rice output will be technological changes and expansion of area especially irrigated area off Java. In Java it is projected that at most technological changes will be just enough to compensate for a decline in area planted with rice.

Concluding Remarks

Nominal price of rice has increased at a rate of 11.80 percent a year from 1978 to 1983 and declined at a rate of 4.5 percent a year since then. However in real terms (price of rice deflated by consumer price index at the farm level) the price of rice declined or at the most remained constant, but the declined at a rate of 15.0 percent a year from 1983 to 1985. Rice output increased at a rate of nearly 6.5 percent a year from 1968 - 1984, and increased less than one percent in 1985. Harvested area only increased at almost one percent during that period.

Demand for fertilizer has also increased very rapidly at about 16 percent from 1968 - 1983. Fertilizer price at nominal level increased by 3.5 percent a year in the last ten years, and in real terms it declined by nearly 6.0 percent a year. This is a result of fertilizer subsidies.

A profit function was analyzed using panel cross - section and time series data of farm households. In addition aggregate data at district (Kabupaten) level from the BPS was also analyzed. The demand parameters for fertilizer inputs and supply parameters for rice output were derived from the profit function analysis.

The own price elasticity of rice output was 0.40 for the long run and estimated at 0.20 for short run effects. The cross price elasticities of the rice output were -0.10 with respect to for fertilizer and -0.26 for labor. The own price elasticity of demand for fertilizer was -1.10 the long run and estimated at -0.50 for the short run. The cross price elasticity of demand for fertilizer was elastic with respect to rice price, that was 1.50 for the long run effect.

The increase in rice production in the last 15 years has been a result of favorable prices at the farm level, technological changes and improvement in irrigation facilities and management. The rapid increase in fertilizer demand was due to declining in its real price, technological and institutional changes, improvement in irrigation and a stable real price of rice. In the future the real price of rice may tend to decline and fertilizer price may increase, therefore the sources of growth in the rice output will rest heavily on technological and institutional changes and expansion of the irrigated area outside Java.

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