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AN EXAMINATION OF AGRICULTURTAL PRICE POLICY OPTIONS IN BANGLADESH:

OUTPUT PRICE VS. INPUT SUBSIDIES

by

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ABSTRACT

A normalized restricted profit function is used to estimate profit and factor demand functions from farm-level cross sectional data for the winter rice crop in Bangladesh. The results indicate that output price is a more important and less expensive policy tool than fertilizer and irrigation price to influence output supply and resources allocation.

An Examination of Agricultural Price Policy Options in Bangladesh; Output Price vs. Input Subsidies

Introduction

Policymakers in Bangladesh must substantially restructure current food policy to meet the challenge of the eighties. The challenge involves shifting the emphasis of current food policy from maintaining subsidized consumption levels to a policy providing greater incentive to agricultural production. This study addresses the policy problem to how to meet this challenge with respect to the winter rice crop.

Bangladesh's level of daily per capital cereal consumption of about 15.5 ounces is currently among the lowest in the world. To improve this low level of consumption even marginally in the 1980's will require either increasingly higher levels of cereal imports, currently about 1.6 million tons annually, or a substantial increase in domestic production.

A failure to improve current agricultural production growth rates, moreover, implies no opportunity to build up foodgrain stock levels to protect the nation against periodic droughts and floods which reduce production below trend. The challenge for Bangladesh is to exploit its potential to produce rice and wheat by implementing an agricultural policy providing greater incentives to rice and wheat producers.

Bangladesh's Agricultural Price Policy

The primary objectives of Bangladesh's food policy are (a) to increase foodgrain production and (b) to maintain adequate supplies of low cost foodgrains to consumers. 1/ The Government's foodgrain procurement program by providing output price incentives and input use subsidies to producers is intended to improve producer incentives. The most important input subsidies are those provided for fertilizer and irrigation. Table 1 shows the levels of Government expenditures on the procurement program and fertilizer input programs for 1973/74 to 1979/80.

Table 1--Estimated budget expenditures on foodstuff and fertilizer expenditures 1973/74-1979/80

Year	Procurement subsidy	fertilizer subsidy	Total subsidies	Subsidies as percent of Government expenditures
		Million dollars		
1973/74	63.8	2.0	65.8	23
1974/75	60.7	5.2	65.9	17
1975/76	66.6	11.8	78.4	18
1976/77	50.3	45.0	95.0	17
1977/78	70.2	77.5	147.7	21
1978/79	63.0	93.8	156.8	20
1979/80	87.4	69.0	156.4	20

Source: World Bank: Bangladesh Food Policy Issues. December 1979 and Monthly Statistical Bulletin of Bangladesh Selected Issues.

Bangladesh expended about $156 million on foodgrain procurement and fertilizer subsidies in 1979/80 as shown in table 1. These questions arise: Is this particular mix of expenditures the least

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1/ The ration distribution system in Bangladesh provides roughly 1.3 million tons annually of subsidized foodgrains to urban consumers. The extent to which imported foodstuffs distributed in a ration system may impact on producer prices has been well researched in India by Mann (1967) and Srivastava, Heady et.al. (1975).

cost way to increase rice and wheat production? What are the possible impications of changing the relationship between crop procurement prices and fertilizer input subsidies on resource allocation, producer incentives, and government expenditures?

This study uses quantity and price elasticities to evaluate the economic impact of various levels of procurement prices and input subsidies. The impact on producer incentives, resource allocations, and government expenditures of changing the procurement price and input subsidy relationships will be examined and quantified.

Economic Behavioral Assumptions and the Dual Approach

The analysis that follows is based on the duality that exists between production and the normalized restricted profit function, a result established by McFadden (1970) and Lau (1978). Duality implies that if producers maximize profits, then a profit function, such that well defined supply and demand functions amy be derived, con~~s~~tains sufficient information to describe the underlying technology completely. We do not need to specify a functional form for the production function and solve the profit ma~~n~~xi~~z~~mi~~n~~ization problem for the supply function and factor demand functions. We need only specify a functional form for the profit function.

The economic behavioral assumptions used to derive input demand functions in this analysis are determined by the characteristics of Bangladeshi winter rice farmers. In Bangladesh at least three types of economic behavior can be postulated: (1) satisfaction of minimum family consumption requirements by subsistence farmers,

(2) maximization of production surplus over subsistence requirements--output maximization subject to a budget constraint--by farmers moving out of the subsistence category (see Ullah 1979), and (3) profit maximization by commercial farmers free of vary both inputs and output. This analysis assumes that producers of the winter rice crop can on average be characterized as short-run profit maximizers. A normalized restricted profit function consistent with this assumption is presented.

Sihdu and Baanante (1979, 1981) has used the profit function and its dual relationship to technology to assess output price and fertilizer price as policy instruments in India. In this paper the profit function model is used to assess price policy options on the winter rice crop in Bangladesh.

The Data and Model

In 1977/78 the United States Agency for International Development (USAID)/DACCA undertook a survey of the winter rice crop in Bangladesh. The data were tested to determine whether they were consistent with the existence of well-behaved convex profit function (Hanoch and Rothschild 1972). Price and quantity data were available for all observations except land--for which a value was inputed. The test consists of examining the data to determine if there exists any pair of observed outputs Q_1 and Q_2 such that $Q_1 < Q_2$ but $\Pi(Q_1) > \Pi(Q_2)$ 2/ thus violating the definition of the profit function.

2/ Variable profits for farmers producing observed outputs Q_1 and Q_2 are represented by $\Pi(Q_1)$ and $\Pi(Q_2)$, respectively.

Application of the test to the sample data identified eight percent of the observation that were inconsistent with the existence of a well-behaved profit function. Hence, the results dervied below must be interpreted with caution.

The restricted or variable profit function was developed by Samuelson (1953-54) and Gorman (1968). The normalized restricted profit function used in this analysis was developed by Lau (1978), and is defined by

$$G(W^*, U) = \max_{X} F(X,U) - W^*{}_X$$

where G is profit normalized by the output price, W* is a vector of input prices also normalized by the output price, X is a vector of variable inputs, and U is a vector of fixed inputs.

The normalized restricted profit function has the following properties: (1) nonincreasing in W*, (2) convex in W*, and (3) continuous in W*. The profit maximizing level of demand for the variable factors is derived by Hotelling's lemma as follows:

$\frac{\partial G}{\partial W^*} = -X^* (W^*_1, U)$ Hotelling's lemma can be proved by appealing to the envelope theorem (Silberberg 1978 and Takayama 1974).

Estimation of the Model

The analysis that follows is based on the duality that exists between production and the normalized restricted profit function, a result established by McFadden and Lau. Duality implies that if producers maximize profits, then a profit function, such that well defined supply and demand functions may be derived, contains sufficient information to completely describe the technology. We do not need to explicitly specify a functional form for the production function and solve the profit maximization problem for the supply function and factor demand functions. We need only specify a functional form for the profit function. The advantage of specifying the profit function is that the supply and factor demand functions are easily derived by Hotelling's lemma as the partial derivatives of the profit function with respect to output price and the prices of the factors of production, respectively. The parameters of the profit function and the factor demand functions may be estimated econometrically, providing indirect but complete estimation of the technology.

The purpose of this section is to extend the normalized restricted profit function and the corresponding system of derived demand to farm-level data for the winter rice crop in Bangladesh. The model will be used to generate estimates of the price elasticity of supply of rice and the price elasticity of demand for the variable inputs of fertilizer, labor, and irrigation. These are relevant policy variables since their prices can be influenced by the Government. Cross price elasticities across variable inputs, and supply and demand elasticities with respect to the fixed factors of land and capital will also be estimated. From these elasticities policy choices relating to the economic impact of changing the procurement price and the fertilizer input subsidy can be examined.

Such policy analyses are most valid when the functional form to be estimated involves the minimum number of restrictions. To avoid unduly restricting the functional form, the analysis uses the translog function rather than the Cobb-Douglas, CES or any other less flexible functional forms. 3/ The Cobb-Douglas profit function, for example, always generates parameter estimates of a production function exhibiting unitary elasticity of substitution--an unrealistic result. The translog function by contrast is less restrictive and provides a second order Taylor series approximation to an arbitrary twice differentiable restricted profit functionn which is nonincreasing, convex and continuous in W*. For this reason the translog function was used to approximate G(W*,U). A generalization of the normalized restricted translog profit function for a single output is given by Diewert.

$$
\begin{aligned}
(1)\quad \ln G = {} & \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln W^*_i + 1/2 \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} W^*_i W^*_j \\
& + \sum_{i=1}^{n} \sum_{k=1}^{v} \delta_{ik} \ln W^*_i \ln U_k \\
& + \sum_{k=1}^{v} \beta_k \ln U_k + 1/2 \sum_{k=1}^{v} \sum_{t=1}^{v} \phi_{kt} \ln U_k \ln U_t
\end{aligned}
$$

3/ Other functions capable of providing a second-order approximation to an arbitrary function include the generalized linear function (Diewert 1974) and the quadratic function. Each of these functional forms involves roughly the same number of parameters as the translog (Norman and Russell, 1976), hence, providing a choice of several flexible specifications.

where G is the restricted profit--total revenue less total costs of variable inputs--normalized by P, the price of output; W^*_i is the price of variable input X_i, normalized by P; U_k is the k^{th} fixed input; i,j=1,2,...n; k,t=1,2,...v; (ln is the natural logarithm); and α_o, α_i, γ_{ij}, δ_{ik}, β_k and ϕ_{kt} are the parameters.

Define the i^{th} variable input demand share by $S_i = \frac{W_i^* X_i}{G}$ and the output share by $S_y = \frac{Y}{G}$. Because the shares $\sum_{i=1}^{n} S_i + S_y = 1$ (by definition), the output share may be ignored and only the variable input demand equations and the translog variable proft function(1) need to be used to estimate the unknown parameters (Diewert). Applying Hotelling's Lemma--omitting the output share equation--to the translog normalized restricted profit function yields the following system of variable input demand functions.

$$(2) \quad S_i = -\frac{W_i^* X_i}{G} = \frac{\partial \ln G}{\partial \ln X_i} \quad \text{4/}$$

$$= \alpha_i + \sum_{j=1}^{u} \gamma_{ij} \ln W^*_j + \sum_{k=1}^{v} \delta_{ik} \ln U_k$$

4/ The derived demand functions are given by $X_i = -\frac{\partial G}{\partial W^*_i}$. Multiplying both sides of this expression by $-\frac{W^*_i}{G}$ gives $-\frac{W^*_i X_i}{G} = \frac{\partial \ln G}{\partial \ln W^*_1}$.

The normalized restricted profit function is well behaved if it has the properties as described previously ~~in Chapter V~~, namely; it is nonincreasing, convex, and continuous in W*; nondecreasing in U, and homogeneous of degree $\frac{-r}{1-r}$ in W*, where r is the degree of homogeneity of the production function. It follows that the derived supply function is upward sloping, the derived demand functions are downward sloping, and the cross price effects are symmetric (if G is also assumed to be twice continuously differentiable).

This analysis assumes that Bangladeshi producers of the winter rice crop are profit maximizers. Accordingly we must check empirically whether the restricted normalized profit function satisfies the properties relating to profit maximization. We may do this by testing whether signs of the supply and demand functions are positive and negative, respectively, and that the estimated principal minors of the Hessian are positive. If profit maximization holds it follows that the homogeneity and symmetry conditions hold. The symmetry conditions, $\gamma_{ij}=\gamma_{ji}$ must be imposed; implying that the derivative of ln G with respect to

$\ln W^*_i \ln W^*_j$ is identical to the derivative of ln G with respect to

$\ln w^*_j \ln w^*_i$.

The own price elasticity of input i can be derived by taking the derivative of X_i at profit maximization with respect to W^*_i (see Sidhu and Baanante 1981).

$$(3)\quad E_{ii} = \frac{\partial \ln X_i}{\partial \ln W^*_i} = \frac{\partial \ln G}{\partial \ln W^*_i} - 1 + \frac{\partial \ln}{\partial \ln W^*_i}\left(\frac{-\ln G}{\ln W^*_i}\right) = -S_i - 1 - \frac{\gamma_{ii}}{S_i}\ .$$ [5]

Similarly the cross-price elasticity of demand (E_{ij}) for input i with respect to the price of the j^th^ input can be derived from the demand equations as

$$(4)\quad E_{ij} = - S_j - \frac{\gamma_{ij}}{S_i}\ .$$

The elasticity of demand for input i (E_{ip}) with respect to output price, P, is derived from the demand equation as

$$(5)\quad E_{ip} = \sum_{i=1}^{n} S_i + 1 + \sum_{j=1}^{n} \frac{\gamma_{ij}}{S_i}\ .$$

The elasticity of demand (E_{ik}) for input i with respect to the k^{th} fixed factor υ_k is derived from the demand equations as

$$(6)\quad E_{ik} = \sum_{i=1}^{n} \delta_{ik} \ln W^*_i + \beta_k - \frac{\delta_{ik}}{S_i} + \sum_{k=1}^{V} \phi_{kt}\ .$$

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[5] The demand equation for the i^{th} variable input can be written as $X_i = \frac{G}{W_i}\left(-\frac{\partial \ln G}{\partial \ln W^*}\right)$. Hence $\ln X_i = \ln G - \ln W^* + \ln\left(\frac{-\partial \ln G}{\partial \ln W^*}\right)$. The elasticities of variable input demand with respect to own and cross-price, output price, and quantities of fixed factors at averages of S_i may then be derived as linear functions of parameter estimates (with known properties) of the normalized restricted profit function model.

The elasticity of supply (Q_{yi}) with respect to the i^{th} variable input is given by

$$(7) \quad Q_{yi} = \frac{\partial \ln Y}{\partial \ln w^*_i} = \frac{S_i - \sum_{j=1}^{n} \gamma_{ji}}{1 + \sum_{j=1}^{n} S_j} \; \underline{6/} \quad .$$

The own-price elasticity of supply (Q_{yp}) can be derived from the supply equation as

$$(8) \quad Q_{yp} = \sum_{i=1}^{n} S_i + \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij}}{1 + \sum_{j=1}^{n} S_j} \quad .$$

6/ The supply equation can be written as

$$Y = G - \sum_{i=1}^{n} W^*_i \frac{\partial G}{\partial W^*_i}$$

, or using the share equation formulation from footnote 2,

$$Y = G - \sum_{i=1}^{n} G \frac{\partial \ln G}{\partial \ln W^*_i} . \quad \text{Hence } \ln Y = \ln G + \ln \left(1 - \sum_{i=1}^{n} \frac{\partial \ln G}{\partial \ln W^*_i}\right).$$

The elasticities of supply with respect to output price, prices of variable inputs and quantities of fixed factors at averages of S_i may then be derived as linear functions of parameter estimates of the normalized restricted profit function model.

Finally, the elasticity of supply (Q_{yk}) with respect to the k^{th} fixed factor U_k is derived from the supply equation as

$$(9)\quad Q_{yk} = \sum_{i=1}^{n} \delta_{ik} \ln W_i^* + \sum_{k=1}^{v} \phi_{kt} + \beta_k - \frac{\sum_{i=1}^{n} \delta_{ij}}{\left(1 + \sum_{j=1}^{n} \delta_{ij}\right)}$$

If G(W*, U) is a well behaved 7/ normalized restricted profit function the signs of E_{ii} must be negative, and the signs of Q_{yp} and Q_{yk} must be positive. Further, if $E_{ij} < 0$, the inputs i and j are complements; if $E_{ij} = 0$, the inputs i and j are neutral; and if $E_{ij} > 0$, inputs i and j are substitutes.

7/ The term well-behaved is taken to mean that the profit function satisfies the conditions described in the previous section i.e., the normalized restricted profit function is non-increasing, convex, continuous, and homogeneous of degree $\frac{-r}{1-r}$ in W*.

The estimating equations for the normalized restricted profit function follow from equations (1) and (2) as

$$
\begin{aligned}
(10)\quad \ln G = {} & \alpha_o + \alpha_F \ln W^*_F + \alpha_L \ln W^*_L + \alpha_I \ln W^*_I \\
& + 1/2\, \gamma_{FF} \ln W^*_F \ln W^*_F + 1/2\, \gamma_{LL} W^*_L \ln W^*_L + 1/2\, \gamma_{II} W^*_I \ln W^*_I \\
& + \gamma_{FL} \ln W^*_F \ln W^*_L + \gamma_{FI} \ln W^*_F \ln W^*_I + \gamma_{LI} \ln W^*_L \ln W^*_I \\
& + \delta_{FT} \ln W^*_F \ln T + \delta_{FK} \ln W^*_F \ln K \\
& + \delta_{LT} \ln W^*_L \ln T + \delta_{LK} \ln W^*_L \ln K \\
& + \delta_{IT} \ln W^*_I \ln T + \delta_{IK} \ln W^*_I \ln K \\
& + \beta_T \ln T + \beta_K \ln K \\
& + 1/2\, \phi_{TT} \ln T \ln T + 1/2\, \phi_{KK} \ln K \ln K \\
& + \phi_{TK} \ln T \ln K + E_1
\end{aligned}
$$

$$
\begin{aligned}
(11)\quad \frac{-W^*_F X_F}{G} = {} & \alpha_F + \gamma_{FF} \ln W^*_F + \gamma_{FL} \ln W^*_L \\
& + \gamma_{FI} \ln W^*_I + \delta_{FT} \ln W^*_F \ln T + \delta_{FK} \ln W^*_K \ln K + e_2
\end{aligned}
$$

$$
\begin{aligned}
(12)\quad \frac{-W_L X_L}{G} = {} & \alpha_L + \gamma_{LL} \ln W^*_L + \gamma_{LF} \ln W^*_F \\
& + \gamma_{LI} \ln W^*_I + \delta_{LT} \ln W^*_L \ln T + \delta_{LK} \ln W^*_L \ln K + e_3
\end{aligned}
$$

(13) $$\frac{-W^*_I X_I}{G} = \alpha_I + \gamma_{II}\ln W^*_I + \gamma_{IF}\ln W^*_F$$

$$+ \gamma_{IL}\ln W^*_L + \delta_{IT}\ln W^*_I \ln T + \delta_{IK}\ln W^*_I \ln K + e_4,$$

where G is the restricted profit from rice production per farm: total revenue less total costs of chemical fertilizer, labor, and irrigation normalized by the price of rice; W^*_F is the money price of fertilizer nutrients per seer 8/ normalized by the price of rice; W^*_L is the wage rate in takas per man day normalized by the price of rice; W^*_L is the price of irrigation per acre normalized by the price of rice; T is the land input measured as acres of winter rice grown per farm; K is the capital input measured as the cost of capital inputs, including the cost of animal power, seed, pesticides, organic fertilizer and credit; F is the fertilizer input per farm measured as seers of plant nutrients of N, P_2O_5, and K_2O; L is man days of hired and family labor used; I is irrigation use measured as the number of acre-irrigations ; and e_i, i=1,2,3,4, are the error terms for equations (10), (11), (12), and (13). The parameters $\alpha_o, \alpha, \delta, \beta$ and ϕ are to be estimated and the subscripts F, L, and I stand for the variable inputs for chemical fertilizer, labor, and irrigation, respectively.

The analysis assumes that disturbances are contemporaneously related. That is, the covariances of the errors of any two of the equations of the model for the same farm may not be zero. Hence,

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8/ 1 seer = 2.05 pounds.

ordinary least squares (OLS) will yield consistent, but not necessarily efficient results when applied to equations (10), (11), (12), and (13). Moreover OLS will not provide parameter contraints necessary to obtain symmetry. To achieve efficient as well as consistent estimates of the parameters of the model, the Full Information Maximum Likelihood (FIML) method was used (see Theil 1971).

The system of profit and share equations given in equations (10), (11), (12), and (13) was estimated using 100 cross section observations on the 1978 winter rice crop.

The model was estimated with symmetry and parametric constraints generating profit, supply and input demand equations. 9/ These functions were checked to determine whether they were consistent with a well-behaved normalized restricted profit function. Recall from the last section that if a normalized restricted profit function is nonincreasing and convex in W_i^*, then the supply function is positive, the demand functions are downward sloping, and cross-price effects between variable inputs are symmetric. Nonincreasing in W_i^* is checked by determining if the fitted values of the input share ratios, S_i, are negative. Convexity is checked by determining whether the estimated principal minors of the Hessian are positive (Lau). The estimated supply function is checked to see whether it is positive.

9/ Lau (1973) shows for the Cobb-Douglas profit function that imposing equality between the parameters of the profit and demand functions is a sufficient condition to obtain a profit function. Hence, the homogeneity and symmetry conditions must follow. Note that joint estimation also improves the efficiency of the parameter estimates. It can be shown that constrained parameter estimation of the translog profit function is a sufficient condition to obtain a legitmate profit

The estimated values of the expenditures rations of -.110, for fertilizer -.657 for labor and -.121 for irrigation are non-increasing in W^*_i. The supply function is positive with a value of 29.786. The estimated values of the principal monirs and eigenvalues at the means of the data indicate that the convexity condition is satisfied. Hence, the estimated normalized restricted profit function is well-behaved and gives unique estimates of the supply and demand functions.

One statistical test using the likelihood ration was carried out to test for the Cobb-Doublas (CD) hypothesis.

For the "CD" test, the likeihood ratio test is the ratio of the maximum of the likeihood function under the null hypothesis of the Cobb Douglas profit function to the maximum of the likeihood ratio under the alternative hypothese of the translog profit function. The calculated χ^2 equals 99.912 which is higher than the critical values at the 1 and 5 percent levels of significance. The null hypothesis is rejected, and the translog profit function formulation appears to be more suitable than the Cobb-Douglas for the data and model being analyzed (Table 1).

Table 1--Chi-square statistic for CD hypothesis test

Item	χ^2 value	Critical χ^2 values		
		Degree of freedom	5 percent level of significance	1 percent level of significance
Cobb-Douglas formulation	99.912	14	23.685	29.141

Table 2 presents the parameter estimates of the translog and Cobb Douglas profit functions and input demand functions. The elasticity relationships derived in equations (3) through (9) are shown in Table 3. These elasticity estimates can now be used to assess the impact on producer incentives, resource allocation, and government expenditures resulting from a policy changing the output price and input price relationships.

All own price effects in Table 3 are reasonable and in accord with the usual hypotheses on sign and seem to be of reasonable magnitude. That is, rice supply is quite inelastic and is positively related to increases in the price of rice and exogenous increases in land quantity and the input of capital--primarily bullock power. The supply elasticity is within the range of elasticities reported by the World Bank (1979). Also, rice supply is negatively related to increases in the price of variable inputs of chemical fertilizer, labor and irrigation.

Labor, fertilizer, and irrigation have negative own price elasticities of demand, as predicted by economic theory. The absolute value of the elasticities for fertilizer and irrigation are greater than one, indicating an elastic response of fertilizer and irrigation use to the price of fertilizer and irrigation, respectively. By contrast, the labor elasticity indicates an inelastic response of labor use to the wage rate.

Cross elasticities of demand are positive for substitutes and negative for complements. Substitutability appears to exist between the labor-fertilizer and labor-irrigation pair. But only the substitutability of labor and fertilizer is significant and is likely due to the short-run nature of the data set. Note that as expected complementarity appears to exist between fertilizer and irrigation.

Table 2--Restricted parameter estimates of the translog and Cobb-Douglas profit function

Parameter	Translog	Cobb-Douglas
α_0	-1.063 (0.738)	1.608 (5.893)
α_F	-0.379 (2.129)	-0.101 (6.042)
α_L	-2.698 (5.898)	-0.616 (11.202)
α_I	-0.341 (2.898)	-0.114 (6.884)
γ_{FF}	0.063 (1.547)	
γ_{LL}	-0.915 (5.362)	
γ_{II}	-0.026 (0.758)	
γ_{FL}	-0.189 (3.138)	
γ_{FI}	-0.001 (0.053)	
γ_{LI}	-0.086 (1.819)	
δ_{FT}	0.011 (1.628)	
δ_{FK}	-0.007 (2.124)	
δ_{LT}	0.012 (0.320)	
δ_{LK}	0.016 (1.132)	
δ_{IT}	-0.052 (4.112)	

Continued--

Table 2--Restricted parameter estimates of the translog and Cobb-Douglas profit function

Parameter	Translog	Cobb-Douglas
δ_{IK}	0.003 (0.612)	0.919 (19.033)
β_{T}	0.240 (0.439)	0.312 (0.703)
β_{K}	0.129 (0.260)	
ϕ_{IT}	-0.436 (2.267)	
ϕ_{KK}	(0.007) 0.121	
ϕ_{TK}	0.121 (1.214)	

Table 3--Elasticity estimates for rice supply and demand for variable inputs of rice production

Item	Price of rice	Price of labor	Price of fertilizer	Price of irrigation	Land	Capital
<u>Translog profit function</u>						
Rice supply	0.279 (1.428)	-0.030 (0.304)	-0.045 (1.511)	-0.063 (1.958)	0.960 (30.969)	0.044 (3.927)
Labor	1.084 (3.133)	-0.264 (1.015)	0.170 (1.932)	0.010 (0.141)	0.927 (4.063)	0.282 (1.883)
Fertilizer	1.779 (2.5117)	1.016 (1.928)	-1.683 (4.512)	-0.112 (0.683)	0.843 (3.678)	0.216 (1.431)
Irrigation	1.954 (3.770)	0.054 (0.139)	0.102 (0.685)	-1.336 (4.771)	1.373 (5.639)	0.258 (.612)

Source: T-statistics computed from asymptotic standard errors are in parentheses. (See Kendall and Stuart 1958).

A policy analysis comparing the relative effects on producer incentives, resource allocation and governemnt expeditures of increasing output price-procurement price--compared to decreasing the price of fertilizer can now be made. First, table 3 shows that changing output price is a more powerful policy tool in improving producer incentives and influencing resource allocation than changing the price of fertilizer. The importance of rice price in influencing producer incentives and returns to fixed resources is indicated by the relatively large size of the own-price elasticity of supply to fertilizer price--as well as other inputs.

The analysis suggests that the effect of relatively modest increases in procurement price for winter rice could offset substantial decreases in the current fertilizer subsidy. Reductions in the fertilizer subsidy are desirable because they improve resource allocation by forcing rice producers to more nearly equate VMP to the real cost of fertilizer. Such reductions on fertilizer subsidies also reduce government expenditures. The same argument holds true in the case of irrigation subsidies as shown in Table 3.

More importantly, raising procurement prices provides the Bangladeshi government with the most direct route to raising production and achieving food self sufficiency. The analysis shows that a 1 percent increase in output price will generate a .28 percent increase in output. By contrast a 1 percent reduction in the price of fertilizer would generate only a .05 percent increase in output.

What would be the impact of raising the procurement price or increasing the fertilizer subsidy on government expenditures? Let's take 1981 as the base year for raising the procurement price for the winter rice crop. In that year 2.6 million tons of milled rice was produced, of which approximately 300,000 tons or 11.5 percent was procured by the Government at 130 taka/maund. 10/ Total cost of procurement to the Government was, therefore, 1,061 billion taka or \$68.5 million. Winter rice crop production consumed somewhat less than one-fourth of total 1981 fertilizer consumption of 415,000 tons, including 46,000 tons of N, 35,000 tons of P_2O_5, and 15,000 tons of K, assuming 1978 consumption rates (USAID). The price to farmers per ton of fertilizer was 7,810 taka (\$520) for N, 6,805 (\$453) for P_2O_5, and 4,083 (\$272) for K. Thus, total farm expenditures on fertilizer amounted to 658.68 million taka or \$43.91 million or (\$457.42 per ton). The Government reported providing subsidies (4,015 (\$236) for N, 7,954 (\$467) for P_2O_5, and 4,115 (\$265) for K. Total fertilizer subsidies paid for all crop production in 1980/81 amounted to 1,100 billion taka or \$62.75 million. Assuming that fertilizer subsidies for winter rice production corresponded to the proportion of winter rice fertilizer consumption, total fertilizer subsidies for this crop amounted to about \$15 million in 1981 (an average of \$156 per ton).

The impact on Government expenditures of a policy which raises procurement prices roughly sufficient to raise production by 1 percent can be calculated as follows. Trend analysis incorporating technology advances indicates that winter rice production would reach 2.72

10/ One taka = \$.06.

million tons in 1982. To raise output another 1 percent to 2.75 million tons would require, based on our analysis, at least a 3.57 percent increase in procurement prices. 11/ If the percent of the winter rice crop procured in 1982 remained at 1981 levels of 11.5 percent, total procurement would amount to 316,000 tons. Total procurement would increase by 16,000 tons over 1981 levels and 3,000 tons over trendline procurement.

Procurement costs would amount to 1.16 billion taka ($77.24 million) compared to a no change trendline procurement cost of 1.11 billion taka ($73.87 million). Hence, procurement cost would increase by 50 million taka ($3.37 million).

Further a 3.57 percent increase in the procurement price would increase fertilizer demand by 6.42 percent. Fertilizer consumption would rise to 104,000 tons compared to 100,500 tons for trendline rice production. Increased fertilizer consumption of roughly 3,500 tons would raise subsidies by about $550,000 compared to a no change trendline analysis. Similarly labor demand would increase by 3.87 percent and irrigation demand by 6.98 percent. Labor costs to farmers, of course, are not subsidized by the Government, nor are operating costs for irrigation. But capital costs for irrigation are subsidized.

11/ An increase in procurement price of one percent is assumed to effectively raise output price by one percent. To what degree this is not the case is beyond the scope of this study. Clearly, a subsistance farmer has no supply function. But our sample results indicate that on average, Bangladeshi winter rice farmers do have a supply function derived from a well-bahaved profit function.

If we assume that the one percent increase in output occurs on newly irrigated land, capital expenditures for new irrigatrion pumps would be required by the Government. At average yields of 2.0 MT/HA, a 1 percent increase in output (30,000 tons) would required additional irrigation of 15,000 HA. Such additional irrigation would require, at 20 HA/PUMP, roughly 750 new irrigation pumps. At $1,250 per pump the additional cost to the government would amount to $940,000. Additional cost due to storage, handling and waste would likely amount to almost $30/Ton (World Bank, March 1979) for $900,000. Thus total cost to the Government of increasing the procurement price would amount to the sum of additional procurement, fertilizer, irrigation and incidental costs of $5.21 million.

By contrast, to raise output only an additional 1 percent by lowering fertilizer prices would require a 20 percent decrease in the price of fertilizer to $366. A 20 percent reduction in fertilizer prices faced by farmers translates into a 33.6 percent increase in fertilizer demand to 128,000 tons. Subsidies per ton must be increased from $156 per ton to $247 (the difference between the old farm price of $457 and the new price of $366). 12/

The new subsidy level would amount to $31.62 million compared to $15.99 million for a no change trendline consumption level or an increase of $15.63 million.

12/ The impact on irrigation use of a 20 percent reduction in fertilizer price is ignored because the cross-price elasticity between fertilizer and irrigation is statistically insignificant, problematic in sign, and small in obsolute value. One would, a piori, expect the two inputs to be complements so that a decrease in fertilizer price would increase irrigation use.

Additional procurement costs at the old procurement price level would amount to \$710,000. As in the case of the procurement price increase, storage and other costs would increase by \$900,000. Hence, total costs of the fertilizer price reduction program would amount to \$17.24 million, more than three times more than a policy raising the the procurement price.

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