DEMAND FOR FERTILIZER IN BANGLADESH - A NOTE

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ABSTRACT

The present study attempts to estimate the regional variations in the demand for fertilizer in Bangladesh. The objectives of the study is to quantify the impact of prices of fertilizer and irrigation on fertilizer consumption in different regions in the country using time series data by the static and dynamic models. The price coefficients of the regions Dhaka, Chittagong, Rajshahi, Khulna and all Bangladesh were highly significant ($p<0.01$). The coefficients of irrigated area in Dhaka, Chittagong, Rajshahi, Khulna and Bangladesh as a whole were also significant ($p<0.01$). The regional fertilizer demand elasticities were found significant ($P < 0.05$). The long term price elasticities of fertilizer consumption in Dhaka, Khulna and Bangladesh were elastic but those of Chittagong and Rajshahi were inelastic.

I. INTRODUCTION

Bangladesh is mainly an agricultural country. But it is one the most densely populated country of the world with a population about 112 million people and an annual growth rate of 2.17 percent (BPS, 1991). Agriculture is the main source of gross domestic product (G. D. P.) and it contributes over 33 percent to the G. D. P. and provides employment to abotut 66 percent of its labour force of 45.22 million in 1995 (BES, 1996). Because of this predominance of agricultural sector in the economy of Bangladesh, economic development of the country is largely dependent upon agricultural development. About 83 percent of the cropped area in Bangladesh is occupied by rice and wheat, yet the country has to meet nearly one-tenth of its consumption of cereals through imports. In 1994, paddy yield in Bangladesh is about 1.8 tonnes per hectare which is one of the lowest in the world paddy production. For China it is 5.9 tonnes, 6.1 tonnes for Republic of Korea, 6.8 tonnes for Japan, 2.9 tonnes for Burma, 2.82 tonnes for India and 2.5 tonnes for Pakistan (FAO, 1994). But according to BBS (1994) per hectare paddy yield in Bangladesh is 1.8 tonnes. This rate is not homogeneous in different regions of the country. It is about 1.79 tonnes in Chittagong, 1.4 tonnes in Dhaka, 2.0 tonnes in Rajshahi and 1.62 tonnes in Khulna. Agricultural output can be increased through the expansion of cultivable area or through improving the productivity of arable land (Subramaniyan & Nirmala, 1991). But with the gradual closing of the arable land, future increase in agricultural output has to depend on increased use of fertilizer and other modern inputs. In Bangladesh fertilizer was introduced at the farm level in the middle of the 20th

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century. At that time it was mostly limited to the tea gardens and governmental experiment farms until the early sixties. The total consumption was 2000 tonnes in 1952-53 which was increased to 11,000 tonnes in 1959-60. It was a little over one kg per hectare (Hossain, 1985). But the trend of fertilizer use gradually increased which has direct impact on the yield of agricultural commodities.Considering the importance of fertilizer, researchers of Bangladesh had undertaken some studies regarding fertilizer use.

But the studies relating to fertilizer demand in different regions (Dhaka, Chittagong, Rajshahi and Khulna) of Bangladesh hardly exist. Hence this study makes an attempt in that direction. The objectives of the study is to understand the factors affecting fertilizer demand with the help of static and dynamic models. The analysis based on time series data from 1972-73 to 1992-93 on yield of rice, price of rice, price of fertilizer and irrigated area at the regional level and all Bangladesh; published by Bangladesh Bureau of Statistics (BBS). The paper has been organized as follows: after introduction, Section II discusses the analytical technique of the study. In Section III, results of static and dynamic models are presented. The last section provides the conclusion.

II. ANALYTICAL TECHNIQUE

The following static and dynamic models were applied separetely to time series data (1972-73 to 1992-93) for each of the four regions and aggregate of Bangladesh.

Static Model :

The model derived by Subramaniyan and Nirmala (1991) was used to estimate the demand for fertilizer both at national and regional level. Including all the variables in the model several unsuccessful attempts were made, but neither percent of area planted to high yielding varieties, land intensity and weather condition (rainfall), nor the trend variable improved the results in Barmon's (1995) research work and hence were omitted in the model for simplicity. Then the static model became

$$\text{Log (F/hac)} = B_0 + B_1 \log (P/Pa) + B_2 \log IRR + U_i \tag{1}$$

where

F/ha	=	consumption of fertilizer in kg/ha.
P/Pa	=	fertilizer to rice price ratio.
IRR	=	percent of area irrigated.
U_i	=	random disturbance term.

Dynamic Model :

In this study the model used consists of two parts: a long-run dynamic function and an adjustment equation. The functional form chosen for the estimation of demand function is an equation linear in the logarithms of fertilizer to rice price ratio. The adjustment equation

assumes that the farmer moves in the direction of eliminating disequilibrium of fertilizer consumption but does not necessarily eliminate it at once. Operationally, the change in fertilizer use is a function of the difference between "desired" and actual use. In particular, the percentage change in actual consumption is a power function of the percentage difference between "desired" and actual consumptions. The dynamic function and adjustment equation when taken together lead to the estimation of demand function in which the logarithm of the actual fertilizer use is a linear function of the logarithm of fertilizer to rice price ratio and the logarithm of the lagged fertilizer use. This type of equation provides estimates of both short and long-run price elasticities and also to estimate the "adjustment coefficient" (Griliches 1959). This model utilizes some of the dynamic elements in fertilizer demand better than simple static models which have frequently failed to perceive clearly significant price impact on demand. Parikh (1965) observed insignificant effect of price on demand of nitrogenous fertilizers. According to Timber (1974) dynamic adjustment model is much superior to the static model. Let capital letters denote logarithms of the relevant variables. Then the dynamic function is

$$F_t^* \quad = \quad a_0 + a_1 P_{ft} + U_t \tag{2}$$

where

F_t^* = desired fertilizer consumption in long-run equilibrium,

P_{ft} = fertilizer to rice price ratio at time t,

U_t = a random disturbance term.

As the actual fertilizer use does not adjust immediately to the desired use but only through proportional changes the following adjustment equation is quite correctly useful to establish a demand function. The adjustment equation:

$$F_t - F_{t-1} = c \, (F_t^* - F_{t-1}) \tag{3}$$

where

F_t = actual   fertilizer consumption in time t, and

c = adjustment coefficient $(0 < C < 1)$

F_{t-1} = actual fertilizer consumption during the last season.

Substituting equation (2) directly into equation (3) yields equation (4), the demand function (reduced form equation)

$$F_t = a_0 + a_1 c \, P_{ft} + (1\text{-}c) \, F_{t-1} + cU_t \tag{4}$$

The two equations (1) and (4) were estimated using the Ordinary Least Square (OLS) method.

III. ANALYSIS OF THE RESULTS

Results of the static Model for the period 1972-73 to 1992-93.

Table I shows that the price coefficient at the national level comes out to be −0.6976 which was highly significant $(p < 0.01)$. The price coefficient of Dhaka, Chittagong, Rajshahi

and Khulna regions were -0.7417, -0.1179, -0.6727 and -0.5949 respectively. All of the values were highly significant ($p < 0.01$) except the price coefficient of Dhaka region ($P < 0.05$). The coefficients of relative prices indicated that when relative price of fertilizer (real price of fertilizer) increases by 10 percent fertilizer use decreases by 7.42, 1.18, 6.73, 5.95 and 6.98 percent in successive regions (as stated in Table-I) and the all Bangladesh respectively. Irrigated area (in percent) had a positive relationship with the fertilizer demand. It indicates that a 10 percent increase in irrigated area leads to 11.17, 8.37, 10.97, 7.91 and 10.33 percent increase in fertilizer use among the regions of Dhaka, Chittagong, Rajshahi, Khulna and the aggregate Bangladesh respectively. The R^2 values for the regions were very encouraging and indicated that the explanatory variables in the model have accounted for over 78 percent of the variation in fertilizer use.

Results of Dynamic Model:

The long run price elasticity of demand may be obtained by dividing the coefficient of real price in (3) by one minus the coefficient of lagged quantity (Nerlove,1958). For the period 1972-73 to 1992-93, the short run price elasticities for fertilizer demand were -0.435, - 0.0602, -0.0108, -0.2545 and -0.3737 (Table II); the adjusted coefficients were 0.2514, 0.1168, 0.0469, 0.2078 and 0.2476 ; and the long run elasticities for fertilizer demand were - 1.7319, - 0.5154, -0.2303, -1.2247 and -1.509 (Table-III) respectively for the regions Dhaka, Chittagong, Rajshahi, Khulna and Bangladesh as a whole. In case of Dhaka, Khulna and Bangladesh fertilizer demand were price elastic and that of Chittagong and Rajshahi were inelastic. In the short run, fertilizer demand decreases by 4.35, 0.60, 0.11, 2.54, and 3.74 percent and in the long run, these were 17.32, 5.15, 2.30, 12,25 and 15.09 percent in response to a 10 percent increase in its real price for the regions Dhaka, Chittagong, Rajshahi, Khulna and over all Bangladesh. R^2 values for all regions and Bangladesh were significant ($P<0.01$).

It appears from Table-I that in static model, the price elasticities of Dhaka, Chittagong, Rajshahi, Khulna and of Bangladesh were -0.74, -0.12, -0.67, -0.59 and -0.70 respectively. But in dynamic model (Table-II), these were -0.44, -0.06, -0.01, -0.25 and -0.37 respectively, In these values only -0.0602 was highly significant ($P < 0.01$). All the price coefficients have the right sign and all of them were larger than their standard errors except the region of Rajshahi. The estimates presented in Table-II indicate regional differences in price elasticities because a covariance analysis rejected the hypothesis that there is no difference among the regional price coefficients.

Durbin-Watson ratio statistics were computed and the hypothesis of no autocorrelation against positive autocorrelation is tested. Results of static model remain inconclusive at 5% probability level. But in case of dynamic model D-W values varied from 1.69 to 2.15, i.e., there was no autocorrelation.

Table I. The Results of the Static Model.

Region	Coefficient of		Intercept	R^2	F-Value	D-W Statistic
	Relative price (p/pa)	Irrigated Area (A)				
Dhaka	−0.7417*	1.1169**	1.6520	0.83	473.59	1.38
	(2.5532)	(4.5551)				
Chittagong	−0.1179**	0.8368***	1.7597	0.81	987.26	1.42
	(4.0938)	(21.238)				
Rajshahi	−0.6727**	1.0967**	1.9826	0.86	890.98	1.25
	(5.7057)	(11.630)				
Khulna	−0.5949**	0.7907**	2.5928	0.78	463.13	1.15
	(4.2615)	(9.2049)				
Aggregate Bangladesh	−0.6976**	1.0325**	1.0764	0.88	406.96	1.37
	(3.9704)	(5.9034)				

The figures in parenthesis indicate the t-values.

** and * indicate 1 and 5 percent level of significance respectively.

Table II. The Results of the Dynamic Model.

Region	Coefficient of		Intercept	R^2	F-Value	D-W Statistic
	Relative price (p/pa)	(F_{t-1})				
Dhaka	-0.4354	0.7486**	1.8258	0.88	682.18	1.69
	(1.7939)	(6.4313)				
Chittagong	-.0602**	0.8832**	0.6506	0.92	1129.62	1.87
	(4.3623)	(45.762)				
Rajshahi	-0.0108	0.9531**	0.3452	0.90	886.41	2.15
	(0.0969)	(17.111)				
Khuna	-0.2545	0.7922**	1.3394	0.82	429.26	1.94
	(1.3984)	(7.9939)				
Aggregate Bangladesh	-0.3737	0.7524**	1.7680	0.86	527.37	2.08
	(1.8638)	(7.4055)				

The figures in parenthesis indicate the t-values.

** indicate 1 percent level of significance.

IV. CONCLUSIONS

The presence of higher values of long-run elasticities in the dynamic model implies that in the long-run the farmers will be more sensitive to use fertilizer when the price of fertilizer increase. The demand for fertilizer is more price elastic, in the long run, in the region with

Table III. **Fertilizer Demand Elasticities, Adjustment Coefficients and Average per hectare Fertilizer Consumption of Different Regions.**

Regions	Elasticities of Demand		Adjustment coefficients	Average per hectare (Kg) fertilizer consumption
	Short run	Long run		
Dhaka	−0.4354	−1.7319	0.2514	73.15
Chittagong	−0.0602	−0.5154	0.1168	82.71
Rajshahi	−0.0108	−0.2303	0.0469	100.30
Khulna	−0.2545	−1.2247	0.2078	58.47
Bangladesh	−0.3737	−1.5093	0.2476	78.66

low level of fertilizer use. The long run demand elasticities in Dhaka and Khulna regions were −1.7319 and −1.2247 correspond to average fertilizer use 73.15 and 58.47 kg per hectare respectively while in Rajshahi it is −0.2303 corresponds to 100.30 kg per hectare fertilizer use. The low values of the adjustment coefficients of the regions Dhaka, Chittagong, Rajshahi, Khulna and aggregate Bangladesh were 0.25, 0.12, 0.05, 0.21 and 0.25 respectively (Table-III) indicate that the actual fertilizer consumption is not moving towards the desired level of fertilizer use. It is worth to use the results of dynamic model than that of static model. The significant regional fertilizer demand elasticities indicate that different regions especially Rajshahi is the most affected region. In order to maximize the production of agricultural commodities and to minimize the regional variation in fertilizer use, there is a great scope of fertilizer use provided price of fertilizer is kept minimum or reasonable to the farmers.

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