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**REGIONAL VARIATION IN THE CONSUMPTION OF
FERTILIZER IN BANGLADESH**

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ABSTRACT

The present study aims at examining the regional variation in the consumption of fertilizer in Bangladesh. The objectives of the study were to estimate the growth rates of rice acreage, production and yield of rice, irrigated area and fertilizer by using the time series data for the period 1972-73 to 1990-91 among the different regions of Bangladesh. The exponential growth rates of rice acreage, production and yield of rice, irrigated area and fertilizer consumption were significant at one percent level but the growth rate of HYV area was significant in all the regions except in Khulna region. The stability test among the regions shows that the growth performance of fertilizer was better in Khulna and Rajshahi regions over the period.

I. INTRODUCTION

In Bangladesh, the scope of increasing food production through expansion of arable land is extremely limited, but there is a good potential for substantial increase in crop yields. The present level of paddy yield is about 2.61 tons per hectare which is one of the lowest in the world. But the yield rate for 1991 was 5.66 tons per hectare for China, 6.19 tons for Republic of Korea, 5.86 tons for Japan, 2.73 tons for Burma, 2.63 tons for India and 2.38 tons for Pakistan (FAO, 1993).

With the gradual closing of the land frontier, however, future increase in agricultural output has to depend on increasing use of fertilizer in order to improve the productivity of lands. Per hectare fertilizer consumption in Japan, Srilanka and India are 437 kgs, 72.2 kgs and 74.0 kgs respectively. But in Bangladesh, fertilizer consumption is 60 kgs per hectare which is one seventh of what is about used in Japan.

Although, in Bangladesh, it is difficult to have reliable farm level data to perform empirical research, some researchers undertook studies on this important issues relating to fertilizer use (IFDC, 1987; Khan, 1981; & Quasem, 1978). While there are a good number of studies on fertilizer use, very few have attempted to compare the growth

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performance of fertilizer use in different regions of Bangladesh. It is therefore, expected that the study will generate important information for use of the policy planners of Bangladesh. The specific objectives of the study are: (i) to estimate the growth rate of some selected factors including fertilizer consumption in different regions in rice production of Bangladesh and (ii) to determine the regional variations in the growth rates of fertilizer consumption of Bangladesh.

The paper has been organized in four sections. Following introduction, nature of data, data collection procedure and the model are discussed in section II. Analysis of the findings has been discussed in section III while conclusions and policy implications are drawn in the final section.

II. METHODOLOGY OF THE STUDY

Secondary data collected and published by the Government and various Semi-government agencies and research organizations have been used for this study. Time series information on area, yield and production of rice, HYV area, fertilizer use and irrigated area for the divisions and the nation as a whole were obtained from various publications of the Bangladesh Bureau of Statistics for the period 1972-73 to 1990-91. After collecting data necessary adjustments such as conversion from acres to hectares were made for analysing the same. The converted data were then summarised, tabulated and analysed in accordance with the aims and objectives of the study.

Analytical Techniques :

For computing the growth rates of fertilizer, rice, area and its production and yield, an exponential function of the following form was fitted to the data:

$$Y_i = ae^{bt_i}$$

$$\text{or } \ln Y_i = \ln a + b t_i$$

$$(i = 1, 2, 3, \dots, 19)$$

Where, \ln = Natural Logarithm and b is the growth rate. When b is multiplied by 100 it expresses percentage growth i.e., percent annual exponential growth rate.

The following model was applied to study the stability of growth rates of fertilizer between the period 1972-73 to 1979-80 and 1980-81 to 1990-91;

$$\log F_i = \log \beta_0 + \beta_1 T + \beta_2 D_1 + \beta_3 (D_1 T) + U_i$$

Where,

F = Per hectare use of fertilizer

T = Time trend

D = 1, for the period 1972-73 to 1979-80

= 0, other wise

β_0 = Intercept

β_1, β_2 and β_3 = Regression coefficients.

The following analysis of covariance model has been applied to test the stability of growth rates among different regions of Bangladesh for the entire reference periods, viz. 1972-73 to 1990-91 and two sub periods 1972-73 to 1979-80 and 1980-81 to 1990-91:

$$\text{Log } F = \text{Log } \beta_0 + \beta_1 T + \beta_2 D_1 + \beta_3 D_2 + \beta_4 D_3 + \beta_5 (D_1 T) + \beta_6 (D_2 T) + \beta_7 (D_3 T) + U_i$$

Where, F = per hectare use of fertilizer

D_1 = 1, for Dhaka region
= 0, other wise

D_2 = 1, for Chittagong region
= 0, other wise

D_3 = 1, for Rajshahi region
= 0, other wise

β_0 = Intercept

$\beta_1, \beta_2, \beta_3, \dots, \beta_7$ = Regression coefficients.

Khulna division has been considered as a base regional dummy.

In studying the stability of growth rates, the entire period of 1972-73 to 1990-91 (19 years) was divided into two sub-period. The first sub-period covers 8 years from 1972-73 to 1979-80 while the second one from 1980-81 to 1990-91.

III. RESULTS AND DISCUSSION

Table 1 shows the growth rates of rice acreage, production, yield, HYVs area, irrigated area and fertilizer use in Bangladesh for the period 1972-73 to 1990-91. It appears from the table that significant rice production occurred during the period 1972-73 to 1990-91. Over the period the production grew at a rate of 2.64 per cent. The yield on the contrary, grew at the rate of 2.24 percent. The growth rate of both production and yield are significant at one percent level. The improvement in the rice production occurred mainly due to the adoption of HYV technology. The growth rates of HYV area (7.02 percent), irrigated area (4.97 percent) and fertilizer consumption (9.90 percent) are all significant at one percent level of significance. It appears from the table that during the period the growth rate of rice production in Rajshahi (3.11 percent) and Khulna (2.93 percent) exceeded the national growth rate (2.64 percent). The growth rate of production was the lowest in Chittagong (2.01 percent). At the regional level also significant increase in rice production occurred mainly due to the use of HYV technology. It is interesting to note that over the period (1972-73 to 1990-91) the growth rate of fertilizer use in Rajshahi region (12.80%) and in Khulna region (12.13%) were higher in Dhaka (8.70%) and Chittagong (5.50%) regions. From the results presented in Table 1 it can be concluded that at the regional level the total performance of rice production was better in Rajshahi region while it was the lowest in Chittagong region although the growth rate

Table 1. Exponential Growth Rate of Rice Acreage, Production and Yield of Rice, HYV Area, Fertilizer Consumption and Irrigated Area from 1972-73 to 1990-91 by Regions

Variables	Dhaka	Chittagong	Rajshahi	Khulna	Bangladesh
Rice Acreage	0.22*** (0.0021)	0.50*** (0.0051)	0.23*** (0.0015)	0.85*** (0.0015)	0.40*** (0.00087)
Production	2.12*** (0.0021)	2.01** (0.0031)	3.11*** (0.0032)	2.93*** (0.0026)	2.64*** (0.0022)
Yield	1.80*** (0.0020)	1.51*** (0.0023)	2.89*** (0.0032)	2.08*** (0.0023)	2.24*** (0.0022)
HYV Area	6.90*** (0.0055)	4.60** (0.0051)	10.32*** (0.0094)	-1.21 (0.0697)	7.02*** (0.0047)
Fertilizer Consumption	8.70*** (0.0088)	5.50*** (0.0061)	12.80*** (0.0070)	12.13*** (0.0081)	9.90*** (0.0059)
Irrigated Area	5.07*** (0.0046)	12.30*** (0.0035)	8.57*** (0.0048)	7.27*** (0.0065)	4.97*** (0.0029)

Notes: Figures in parentheses indicate standard error.

*, ** and *** indicate 10, 5 and 1 percent level of significance respectively.

of irrigated area in Chittagong was the highest (12.30 percent) during the period 1972-73 to 1990-91.

Table 2 shows the growth rates of rice acreage, production, yield, HYV area, fertilizer use and irrigated area for the first sub period 1972-73 to 1979-80. It appears from the table that the growth rate of rice production for the sub period was 2.73 percent and that of yield was 2.30 percent. Both the coefficients are significant at one percent level of significance. The increase in rice production and yield rate were mainly due to the extensive use of fertilizer and expansion of HYV area. The growth rates of fertilizer use and that of HYV area were 13.94 percent and 3.44 percent, respectively. The increased rice production during the first sub period 1972-73 to 1979-80 in Rajshahi and Khulna regions occurred mainly due to the extensive use of fertilizer and the expansion of irrigated area as could be judged from their growth rates. In Dhaka and Chittagong regions the increased production were mainly due to the extensive use of fertilizer. Over this period the growth rate of fertilizer use was the highest in Rajshahi region (19.75%) and it was the lowest in Chittagong region (10.27%).

The growth rates of rice acreage, production and yield, HYV area, fertilizer use and irrigated area were also estimated for second sub period 1980-81 to 1990-91 and it is shown in the Table 3. It appears from the table that the increased rice production during this period both at national and regional levels was mainly due to the adoption of HYV technology. This is evident from the various growth rates coefficients and their significance levels (Table 3). During this period also the total performance in case of rice production was better in Rajshahi and Khulna regions as compared to Dhaka and Chittagong regions. During this period the growth rate of fertilizer use in Khulna region remained stable (14 percent) as compared to the period 1972-73 to 1979-80. During this sub period the growth rate of fertilizer use sharply decreased as compared to the period 1972-73 to 1979-80.

Table 2. Exponential Growth Rate of Rice Acreage, Production and Yield of Rice, HYV Area, Fertilizer Consumption and Irrigated Area from 1972-73 to 1979-80 by Regions

Variables	Dhaka	Chittagong	Rajshahi	Khulna	Bangladesh
Rice Acreage	-0.43 (0.0062)	0.31 (0.0098)	1.13** (0.0044)	0.71* (0.0032)	0.43 (0.0033)
Production	1.94* (0.0092)	2.20 (0.0161)	2.68** (0.0085)	3.79*** (0.0094)	2.73*** (0.0098)
Yield	2.27** (0.0091)	1.89 (0.0126)	1.55* (0.0074)	3.07*** (0.0074)	2.30*** (0.0077)
HYV Area	3.18* (0.0148)	3.67 (0.0256)	1.98 (0.0451)	-4.91 (0.0302)	3.44** (0.0211)
Fertilizer Consumption	13.42*** (0.0382)	10.27*** (0.0267)	19.75*** (0.0217)	14.72*** (0.0354)	13.94*** (0.0295)
Irrigated Area	0.75 (0.0408)	1.69 (0.0154)	2.97 (0.0094)	8.68*** (0.0217)	2.81 (0.0109)

Notes : Figures in parentheses indicate standard error.

*, ** and *** indicate 10, 5 and 1 percent level of significance respectively.

Table 4 and 5 show the per hectare fertilizer consumption and percentage of HYV's rice area to total rice both at regional level as well as for Bangladesh. The table reveals that per hectare fertilizer consumption in Bangladesh were 32.40 kgs, 68.44 kgs and 159.43 kgs during the years 1972-73, 1980-81, 1990-91, respectively. In Bangladesh per

Table 3 Exponential Growth Rate of Rice Acreage, Production and Yield of Rice, HYV Area, Fertilizer Consumption and Irrigated Area from 1980-81 to 1990-91 by Regions

Variables	Dhaka	Chittagong	Rajshahi	Khulna	Bangladesh
Rice Acreage	-0.97*** (0.0032)	0.075 (0.0021)	-0.26 (0.0032)	1.34*** (0.0032)	-0.086 (0.0021)
Production	1.65*** (0.0045)	1.58*** (0.0049)	3.28*** (0.0089)	4.01*** (0.0049)	3.00*** (0.0050)
Yield	2.61*** (0.0031)	1.50*** (0.0036)	3.55*** (0.0085)	2.67*** (0.0052)	3.08*** (0.0047)
HYV Area	6.39*** (0.0129)	6.22*** (0.0070)	10.33*** (0.0039)	7.26*** (0.0125)	7.41*** (0.0064)
Fertilizer Consumption	5.21*** (0.0120)	4.73*** (0.0087)	9.75*** (0.0072)	14.31*** (0.0148)	9.35*** (0.0069)
Irrigated Area	6.84*** (0.0085)	1.30 (0.0076)	10.77*** (0.0037)	6.94*** (0.0169)	6.21*** (0.0036)

Notes: Figures in parentheses indicate standard error.

*, ** and *** indicate 10, 5 and 1 percent level of significance respectively.

Table 4. Per Hectare Use of Fertilizer (Kgs) by Regions

Period	Dhaka	Chittagong	Rajshahi	Khulna	Bangladesh
1972-73	33.98	52.10	20.37	22.63	32.40
1974-75	20.39	39.48	19.52	14.73	23.26
1979-80	68.39	84.10	66.09	50.77	68.01
1980-81	67.92	78.12	75.58	48.71	68.44
1984-85	103.26	100.79	109.19	73.89	97.77
1989-90	105.56	113.02	182.66	153.88	155.91
1990-91	110.64	119.59	209.67	163.76	159.43

Source : BBS, 1974, 1980, 1985, 1990, 1992.

hectare use of fertilizer increased by about 5 times in the year 1990-91 than 1972-73. At regional level per hectare use of fertilizer was the highest in Chittagong (52 kgs) and it was the lowest in Rajshahi (20.37 kgs). By the year 1990-91 per hectare use of fertilizer

in Chittagong region increased by about 2 times whereas it increased by about 10 times in Rajshahi region. The reason for this sharp increase in fertilizer consumption might be due to the highest increase in HYV rice area in Rajshahi region in the year 1990-91 (Table 5). Hence it can be concluded that there is a strong regional variation in the consumption of fertilizer in Bangladesh.

Table 5. Percentage Area of HYV of Total Rice Acreage by Regions

Period	Dhaka	Chittagong	Rajshahi	Khulna	Bangladesh
1972-73	12.23	15.81	10.49	10.58	12.19
1974-75	14.57	24.51	13.66	11.15	15.89
1979-80	17.97	25.58	18.35	15.87	19.19
1980-81	18.29	27.37	21.84	17.35	21.27
1984-85	29.08	31.54	30.41	20.94	28.42
1989-90	43.10	42.76	53.64	30.30	43.14
1990-91	43.33	47.89	57.23	34.49	46.94

Source : BBS, 1974, 1980, 1985, 1990, 1992.

Table 6 shows the results of stability test of growth rates between the sub periods 1972-73 to 1979-80 and 1980-81 to 1990-91. It appears from the table that at the national level both the differential intercept and slope coefficients are insignificant. This indicates that there does not lie any significant difference between the growth rate of fertilizer consumption in the two sub-periods. At the regional level the same conclusion could be drawn in case of Khulna region. But in cases of Rajshahi and Dhaka region both the differential intercept and slope coefficients are statistically significant at one percent level of significance. Thus one may accept the hypothesis that there was definitely a shift in the level of growth rates of fertilizer consumption and since the slope dummies are negative the growth performance was better in seventies than in the eighties. In case of Chittagong region although the differential intercept is insignificant but the slope coefficients are significant at 5 percent level of significance. It may therefore, be concluded that there lies a significant difference in the growth performance of fertilizer consumption in two sub periods. Growth performance was better in the seventies than in eighties.

In order to find out whether the structural break in the level of growth rate of fertilizer use at the regional level for the whole period 1972-73 to 1990-91 is caused by better shift

Table 6. Testing the Stability of the Growth Rates Between the Period 1972-73 to 1979-80 and 1980-81 to 1990-91 among the Regions of Bangladesh

Regions	Constant	T	D	DT	R2	F-Value
Dhaka	4.11	0.13*** (0.0285)	0.74*** (0.2910)	-0.082** (0.0247)	0.88	44.520
Chittagong	4.50	0.102*** (0.0201)	0.296 (0.2054)	-0.055** (0.0237)	0.85	35.79
Rajshahi	3.69	0.197*** (0.0165)	0.762*** (0.1679)	-0.100*** (0.0193)	0.98	286.94
Khulan	3.39	0.147*** (0.0291)	-0.268 (0.2969)	-0.0041 (0.0342)	0.93	79.62
Bangladesh	5.41	0.134*** (0.0169)	0.128 (0.0233)	-0.346 (0.0222)	0.95	111.47

Notes : Figures in parentheses indicate standard error.

*, ** and *** indicate 10, 5 and 1 percent level of significance respectively.

in constant term alone, shifts in slope coefficient alone or shift in both, a dummy variable technique has also been applied and the results are presented in the Table 7. It appears from the table that in case of Chittagong region both the intercept dummy and slope dummy are significant at 5 percent level of significance. Thus one may accept the hypothesis that there was definitely a structural break over the whole period. Further, the slope dummy coefficient is negative in case of Chittagong region. So it can be concluded that the growth performance of fertilizer use was significantly better in Khulna than that of the Chittagong region.

It also appears from Table 7 that the differential slope coefficients of Rajshahi (3.08) is significant at 5 percent level of significance. That indicates the growth performance of fertilizer consumption in Rajshahi was significantly different from Khulna region over the period. The growth performance of fertilizer consumption in Dhaka region was similar to that of Khulna region as could be judged from the insignificant differential slope coefficient in this case. When comparisons are made on the basis of sub period it appears that growth performance of fertilizer consumption in Rajshahi region was significantly different from the base region (Khulna) over the period 1972-73 to 1979-80. The growth performance of fertilizer consumption in Chittagong and Dhaka regions was similar to Khulna region over the period 1972-73 to 1979-80. During the period 1980-81 to 1990-91

the growth rate of fertilizer consumption in Rajshahi region was not significantly different than that of Khulna region. But in cases of Dhaka and Chittagong regions the differential slope coefficients were negative (-7.15 and -0.30 respectively) and significant at 5 percent level of significance which indicates that the growth performance of fertilizer consumption in Khulna region was better than that of Dhaka and Chittagong region during the period.

Table 7 Estimates of Growth Equations for Fertilizer Consumption in Different Regions of Bangladesh for the Period 1972-73 to 1990-91 and Sub period 1972-73 to 1979-80 and 1980-81 to 1990-91

Coefficients	1972-73 to 1990-91	1972-73 to 1979-80	1980-81 to 1990-91
Constant	-6.0533	10.5861	16.0380
T (time)	6.7430*** (0.6047)	4.2870*** (0.9646)	13.0471*** (1.4632)
D ₁	25.0218* (9.7511)	7.7578 (7.6766)	52.4913*** (12.8394)
D ₂	49.0263*** (9.7511)	26.1931*** (7.6766)	53.3587*** (12.8394)
D ₃	-4.6468 (9.7511)	-5.4203 (7.6766)	32.0647* (12.8394)
D ₁ xT	-1.0683 (0.8552)	1.5820 (1.3642)	-7.1542*** (2.0693)
D ₂ xT	-2.9912*** (0.8552)	1.1278 (1.3642)	-8.3068*** (2.0693)
D ₃ xT	3.1877*** (0.8552)	3.0872** (1.3642)	1.9379 (2.0693)
R ₂	0.89	0.89	0.89

Notes : Figures in parentheses indicate standard error.

*, ** and *** indicate 10, 5 and 1 percent level of significance respectively.

IV. CONCLUSION AND POLICY IMPLICATIONS

Production and yield of rice grew significantly in Bangladesh over the period 1972-73 to 1990-91. The growth rate of rice production was 2.64 percent and that of the yield was 2.24 percent. At the regional level also rice production increased significantly. This

significant increase in rice production was mainly due to the extensive use of chemical fertilizer and the expansion of HYV area. During the first sub-period 1972-73 to 1979-80, the growth rate of fertilizer was the highest in Rajshahi region and it was the lowest in Chittagong region. In Bangladesh per hectare use of fertilizer increased by about 5 times in the year 1990-91 than 1972-73. Among the regions fertilizer use increased by about 2 times in Chittagong region whereas it increased by about 10 times in Rajshahi region. It indicates that there exists a strong regional variation in the consumption of chemical fertilizer in Bangladesh. The regional comparison shows that growth performance of fertilizer consumption in Rajshahi and Khulna region was better as compared to other two regions. Further, it reveals that due to better performance of fertilizer consumption the growth rate of yield of rice were also higher in these two regions. As for sub period, growth performance of fertilizer consumption of Dhaka and Chittagong regions were similar to Khulna region over the first sub-period 1972-73 to 1979-80. During the second sub-period, 1980-81 to 1990-91, the growth performance of fertilizer consumption was significantly better in Khulna region than Dhaka and Chittagong regions. Therefore the policy maker should take viable policies so that farmer of all the regions can use chemical fertilizer at the optimum level to get maximum production.

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