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PRICE RESPONSIVENESS OF FOODGRAIN SUPPLY IN BANGLADESH AND PROJECTIONS 2020

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FMRSP Working Paper No. 25

FMRSP **Bangladesh**
Food Management & Research Support Project
Ministry of Food, Government of the People's Republic of Bangladesh

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TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

Bangladesh has made substantial progress in rice production, more than doubling production since the mid-1970s. In recent years of normal rice harvests, supply from domestic production has essentially met domestic demand so that imports have been very small. Future supply-demand balances will be determined in part by the price-responsiveness of supply and demand, along with technical change, income growth and other factors. This paper provides estimates of the price-responsiveness of rice production (in particular, area planted to rice), and then simulates supply and demand balance for rice under alternative scenarios.

ECONOMETRIC ESTIMATES OF SUPPLY PARAMETERS

Rice supply projections are based on estimated coefficients from regressions on area and yield by rice crop (Aus, Aman and Boro). The area regression equations follow a basic Nerlovian model where area is expressed as a function of expected prices (proxied as lagged prices), lagged area and other factors. The yield regressions are simple estimates of logarithmic growth rates.

For the Aman regressions, the sample data is from 1972/73 to 1999/2000. The real rice price[1] at planting time (the average price from October-December of the previous year) is used as a proxy for the expected rice price (Table E1). Dummy variables for various years were added after examination of the outliers of plots of fitted versus historical values of the dependent variable (Aman area). The best fit was obtained with dummy variables with a value of one for 1975, 1976, 1987, 1988, 1989 and 1999.

The estimated short-run price elasticity with this model is 0.051, with a long-run elasticity of 0.067. Long-run elasticities computed from alternative regressions range from 0.041 to 0.110.

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[1] Real prices are calculated using the non-food CPI as a deflator.

Table E1 — Determinants of Area Planted to Foodgrains: Regression Results

Years Dependent Variable	1973-2000 Aus Area	1979-2000 Boro Area	1973-2000 Aman Area	1979-2000 Wheat Area
Constant	0.426	-0.410	-4.192	0.057
	(1.961)	(-1.123)	(-7.013)	(1.065)
Lagged Real Price	3.620	5.222	4.031	0.101
	(2.426)	(1.806)	(2.385)	(1.415)
Lagged Area	0.762	0.497	0.233	0.787
	(11.134)	(4.057)	(2.193)	(11.298)
Lagged Yield Rate		0.319		
		(3.379)		
Adj R^2	0.978	0.989	0.777	0.934
D-W	2.298	1.896	1.996	2.134
SR Elasticity	0.106	0.164	0.051	0.120
LR Elasticity	0.443	0.326	0.067	0.563

Note: t-statistics are shown in parentheses. Elasticities are computed at the arithmetic means values of the respective price and area variables.

The regression for Boro area includes lagged Boro yields as well as lagged area, planting time price (October-December of the same fiscal year as the Boro harvest), and dummy variables. The best regression includes a dummy variable with a value of 1 for 1988 and two other dummy variables equal to 1 for all years after 1988 and all years after 1998. These latter two dummy variables capture the large and apparently permanent increases in Boro area after the 1988 and 1998 floods. Using the full sample from 1972/73 to 1999/2000, the estimated short-run price elasticity with this model is 0.089 with a long-run elasticity of 0.168. Using only a 1978/79 to 1999/2000 sample, the short-run elasticity is 0.164, with a long-run elasticity of 0.326. In the projections, the parameters from this latter regression are used. A similar methodology was also used for Aus area, resulting in an estimated short-run elasticity of 0.106 and a long-run elasticity of 0.443.

For the yield regressions, a shorter sample from 1989/90 to 1999/2000 was used. Trend yield growth rates for Aman, Boro and Aus are 0.00073, 0.1935 and 0.0915, respectively (Appendix B). Since the coefficient for Aman was not significantly different from zero, however, a zero growth in Aman yields is assumed in the base projection.

SUPPLY PROJECTIONS

The parameters above were used to project annual rice production from 2001 through 2020 using alternative assumptions regarding real prices and yield growth (Table E2). In the base run, with no change in the real price of rice over time, total rice area increases by 11.0 percent, as the increase in Boro area more than offsets the decline in Aus and Aman area. Boro and Aus yields increase by 46.7 and 20.0 percent, respectively, over the twenty year period. As a result Boro production increases by 77.3 percent, Aman production is nearly constant, and Aus production falls by 14.6 percent. Total rice production in 2020 in the base run is 31.1 million MTs, 35.1 percent higher than in 2000.

If real rice prices gradually increase by 20 percent over the period, (assuming a constant growth rate of real rice prices), total production rises by 31.8 million MTs. A 20 percent decline in real rice prices results in production of 30.4 million MTs. Thus, with only area assumed to be responsive to price changes, total production varies by only 1.37 million MTs in these three scenarios. Increasing Aman yields by 1 percent per year along with a 20 percent increase in real rice prices over time raises 2020 production to 34.0 million MTs. Cutting Boro yield growth in half, together with a 20 percent reduction in real prices over time, lowers 2020 production to 25.6 million MTs.

SUPPLY AND DEMAND PROJECTIONS WITH ENDOGENOUS PRICES

Table E3 presents projections of supply and demand where prices are determined endogenously. Prices are generally set equal to the autarky market-clearing price where domestic supply (production less 10 percent for seed, feed and losses) equals domestic demand. However, in simulations where the autarky price exceeds the import parity price (or falls below the export parity price), the import (export) parity price is used to

Table E2 — Rice Area, Yield and Production Projections (Exogenous Price Model)

	Area (m. ha.)				Yield (MT/ha.)			Production (MT/ha.)			
	Aman	Aus	Boro	Total	Aman	Aus	Boro	Aman	Aus	Boro	Total
Year 2000 (Base)	5.71	1.37	3.65	10.73	1.81	1.26	3.01	10.30	1.73	11.00	23.03
Year 2020											
20% Increase Price	5.66	1.10	4.51	11.26	2.20	1.52	4.42	12.47	1.66	19.91	34.04
Higher Aman Yields	(-0.8%)	(-20.2%)	(23.4%)	(4.9%)	(22.0%)	(20.0%)	(46.7%)	(21.0%)	(-4.2%)	(81.0%)	(47.8%)
20% Increase Price	5.66	1.10	4.51	11.26	1.81	1.52	4.42	10.22	1.66	19.91	31.79
	(-0.8%)	(-20.2%)	(23.4%)	(4.9%)	(0.0%)	(20.0%)	(46.7%)	(-0.8%)	(-4.2%)	(81.0%)	(38.0%)
No Change in Price	5.61	0.98	4.41	11.00	1.81	1.52	4.42	10.13	1.48	19.50	31.11
	(-1.7%)	(-28.8%)	(20.8%)	(2.5%)	(0.0%)	(20.0%)	(46.7%)	(-1.7%)	(-14.6%)	(77.3%)	(35.1%)
20% Decrease Price	5.56	0.85	4.32	10.73	1.81	1.52	4.42	10.04	1.30	19.08	30.42
	(-2.5%)	(-37.7%)	(18.2%)	(0.0%)	(0.0%)	(20.0%)	(46.7%)	(-2.5%)	(-25.3%)	(73.5%)	(32.1%)
20% Decrease Price	5.56	0.85	3.89	10.31	1.81	1.52	3.65	10.04	1.30	14.21	25.55
1/2 Boro Yield Growth	(-2.5%)	(-37.7%	(6.6%)	(-3.9%)	(0.0%)	(20.0%)	(21.2%)	(-2.5%)	(-25.3%)	(29.2%)	(10.9%)

Notes: Higher Aman yields: 1.0 percent increase in yields per year.
Figures in Parentheses represent percentage changes over the base year (Year 2000) Figures.

Source: Authors' calculations.

recalculate supply, demand and imports (exports). The import parity price is calculated as the average 1995/96 to 1999/2000 import parity price of rice from India, expressed in dollars ($293/MT) multiplied by the 2000/2001 exchange rate of Tk 54/$, or 15.8 Tk/kg). An export parity price of $240/MT (12.3 Tk/kg) is used, slightly above the average export parity price of $229/MT (11.7 Tk/kg) from 1995/96 to 1999/2000, and 10 percent higher than the actual price in 1999/2000. (This export parity price implies that if marketing channels had been established, the Bangladesh private sector could have profitably exported rice to India, or competed with Indian exports to third-country markets in 1999/2000.)

In the base run, demand is modeled using an income elasticity of demand of zero, an own-price elasticity of demand of – 0.4 and population growth of 2 percent per year. Under these assumptions, real prices rise by 19.6 percent by 2020 as domestic demand increases faster than supply. Assuming per capita income growth of 5 percent per year and an income elasticity of demand of 0.2, domestic demand grows even faster. Prices rise to import parity by 2013 (an increase of 35 percent in real terms) and by 2020, imports reach 1.52 million MTs per year, equal to 5.0 percent of total consumption of 32.5 million MTs. Similarly, with base run demand parameters, but with slower growth in Boro yields, prices rise to import parity by 2011, and by 2020 imports reach 2.67 million MTs per year.

If Aman yields are assumed to increase by 1 percent per year, then in the absence of exports, real prices are almost constant over the 20 year period, rising by only 4.9 percent by 2020. If export parity holds as a price floor, however, then exports reach 720 thousand MTs per year in 2020, equal to 2.4 percent of net production.

Table E3 — Rice Supply and Demand Projections with Endogenous Prices

	Production (mMT)				2020	2020
	Aman	Aus	Boro	Total	Price (Index)	Trade[a] (mMT)
2000 (base)	10.30	1.73	11.00	23.03	0.050	0.00
Base Simulation 2020	10.22	1.70	19.95	31.86	0.060	0.00
	(-0.8%)	(-2.1%)	(81.3%)	(38.3%)	(19.6%)	(0.0%)
Increased Aman Yields	12.39	1.55	19.63	33.58	0.052	0.00
	(20.3%)	(-10.3%)	(78.5%)	(45.8%)	(4.9%)	(0.0%)
Increased Aman Yields with Rice Exports	12.42	1.60	19.73	33.74	0.055	0.72
	(20.6%)	(-7.9%)	(79.4%)	(46.5%)	(10.0%)	(2.4%)
High Rice Demand	10.30	1.87	20.30	32.47	0.068	-1.52
	(0.0%)	(8.0%)	(84.6%)	(41.0%)	(35.0%)	(-5.0%)
Slow Boro Yield Growth	10.30	1.88	15.22	27.39	0.068	-2.669
	(0.0%)	(8.2%)	(38.4%)	(18.9%)	(35.0%)	(-9.8%)

Notes: % Change from 2000 Base Simulation Shown in Parentheses
[a] Share of imports or exports in net production is shown instead of the percentage change.
Base run: per capita income growth 3%; population growth 2%; income elasticity 0.0; Price elasticity of demand -0.4.
Increased Aman yields: 1 percent increase in average yields per year.
High rice demand: per capita income growth 5%; income elasticity 0.2

Source: Authors' calculations.

1. INTRODUCTION

Bangladesh has made substantial progress in rice production, more than doubling production since the mid-1970s. In recent years of normal rice harvests, supply from domestic production has essentially met domestic demand so that imports have been very small. Future supply-demand balances will be determined in part by the price responsiveness of supply and demand, along with technical change, income growth and other factors. This paper provides estimates of the price-responsiveness of rice production (in particular area planted to rice), and then simulates supply and demand balance for rice under alternative scenarios.

The projection of demand-supply balance of foodgrains, especially rice which constitutes about 90 percent of total foodgrain production, is of crucial importance given the predominantly agrarian nature of the Bangladesh economy. This has a close bearing upon the rate and structure of economic growth, the rate of inflation, poverty and malnutrition, the overall trade balance, foreign exchange reserves and the fiscal position of the government. Foodgrains are the main consumption item, accounting for 35% of total consumption expenditure and more than 80% of total calorie intake. It is thus clear that the shape of development in the medium to long term is most likely to be influenced in a significant way by the dynamics of foodgrain demand-supply balance in the economy. This paper has thus carried out supply and demand projections of rice under alternative scenarios, especially under both exogenous and endogenously determined prices.

2. LITERATURE REVIEW

Numerous previous econometric studies have estimated rice supply or area elasticities in Bangladesh (or East Pakistan), using alternative methodologies and sample periods[2]. Hossain (1964) used a simple linear model to estimate price responsiveness of rice area in the sample period of 1949-1963. They estimated that short-run elasticity was quite high (0.76), though the explanatory power of the regression was low (Table 2.1). Cummings (1974) used a Price Expectations Model and estimated the supply responsiveness of rice area for almost the same period (1949-1968). His fit was better than that of Hossain (1964), though the coefficient of the price variable was less significant and there was hardly any difference between the long run and short run elasticity estimates. Ahmed (1977) also used a price expectation model to measure the responsiveness of the rice area as a whole. The sample size was smaller (1960-77). As a result, regression equation had poor statistical fit and low elasticities (SR elasticity was 0.21 and LR Elasticity was 0.33). None of these studies reported the use of dummy variables or inclusion of external factors such as technical change and weather in the estimation of supply responsiveness. Furthermore, most of these studies considered prices received by the farmers to be the annual average retail or wholesale prices, which might be questioned on the ground of seasonality in the case of rice and other agricultural prices.

Rahman (1986) used a Nerlovian Framework in the analysis of supply responsiveness. His study was an elaborate one. He disaggregated rice into different varieties and used separate regressions to estimate the supply responsiveness of individual crop variety. His also estimated the supply responsiveness of wheat. But the study had a major drawback; it used a very small sample (1973-82). Still, most of the regression fits

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[2] The econometric estimates of previous studies on supply elasticities in Bangldesh are presented in Annex-A

were good. Furthermore, the SR and LR elasticities revealed mixed results. This study included yield rate as a proxy for technical change and incorporated dummy variables to explain the impact of weather on supply responsiveness. Instead of using the conventional retail or wholesale prices, Rahman (1986) used deflated harvest prices, the deflators being the wholesale price index.

Of the recent studies, Alam (1992) applied improved methods (instrumental variable, non-linear least squares and MLE) in estimating the acreage response functions of rice, jute and wheat. The specifications included rainfall in the sowing/transplanting season on the assumption that rainfall follows a gamma distribution. However, weather-drop relations in Bangladesh are so complex that one indicator, such as rainfall, may not be adequate (Ahmed 1977). His study also included pulses and sugarcane. Rahaman and Yunus (1993) updated the earlier work done by Rahman (1986). They used different deflators and ignored the yield rate as a possible regressor. Their regression fit was better than the earlier one. They also corrected errors of measurement in the case of wheat acreage and price data, which improved the fit of wheat regression. Yunus (1993) updated the previous work done by Rahman and Yunus (1993) and Rahman (1986), increasing the crop coverage to include pulses. His sample size was larger compared to the earlier ones (1973-89). He also used yield rate as one of the regressors but left out dummy variables. Nonetheless, his regressions produced very good fits and the estimated SR and LR elasticities were in the expected range, except for wheat elasticities, which were very high. Furthermore, he also calculated the yield elasticity of respective crops. Finally, Shahabuddin and Zohir (1995) used the Macguirk and Mundlak (1991) model of dynamic productions system to estimate the supply elasticities. Their SR elasticities were consistent with the results of earlier studies.

Table 2.1 — Summary of Elasticity Estimates: Previous Studies

Source	Period Coverage	Dependent Variable	SR Elasticity	LR Elasticity
Hussain (1964)	1949-1963	Rice Area	0.76	
Cummings (1974)	1949-1968	Rice Area	0.13	0.19
Ahmed (1977)	1960-1977	Rice Area	0.21	0.33
Rahman (1986)	1973-82			
		Total Aus Area	0.11	
		Total Aus Output	0.11	
		Total Aus Area	0.08	0.09
		Total Output	0.08	0.07
		Total Aus Output	0.19	
		Local Aus Area	0.08	0.8
		Local Aus Output	0.01	0.27
		HYV Aus Area	0.12	0.5
		HYV Aus Output	0.12	0.34
		Total Aman Area	0.13	0.28
		Total Aman Output	0.13	0.14
		Local Tranplanted Aman Area	0.11	0.41
		Local Tranplanted Aman Output	0.46	1.34
		Broadcast Aman Area	2.22	0.3
		Total Boro Output	0.072	
		Local Boro Output	0.84	
		HYV Boro Area	0.88	
		HYV Boro Output	0.7	
		Wheat Area	0.1	0.51
		Wheat Output	0.12	0.46
Alam (1992)	1971-87			
		All Aus Area		0.32
		Local Aus Area		0.56
		HYV Aus Area		4.56
		All Boro Area		0.22
		All Boro Area		0.22
		Local Boro Area		0.45
		HYV Boro Area		0.24
		Wheat Area		1.28
		All Aman Area		0.32
		Broadcast Aman Area		0.38
		Transplanted Aman Area		0.22
		HYV Aman Area		0.25

Table 2.1 — Summary of Elasticity Estimates: Previous Studies (Continued)

Source	Period Coverage	Dependent Variable	SR Elasticity	LR Elasticity
Rahman and Yunus (1993)	1972-83			
		Aus Area		
		Aman Area		
		Boro Area		
		Wheat Area		
Yunus (1993)	1973-89			
		Foodgrain Area	0.05	0.14
		Rice Area	0.06	0.06
		Aus Area	0.02	0.14
		Aman Area	0.36	0.55
		Boro Area	0.5	2.86
		Wheat Area	0.61	5.24
		Maize Area	0.09	1.58
		Lentil Area	0.07	1.09
Shahabuddin and Zohir (1995)	1984-91			
		Rice Area	0.062	
		Wheat Area	0.147	

3. METHODOLOGY

The main purpose of this study is to estimate the response of planned production to various explanatory variables. Since time series data of planned output is not available, some proxy has been utilized. Due to various environment and climate factors, actual output cannot be used as the particular proxy variable.[3] This and other external factors, which are beyond the control of the farmers, have led many researchers to approximate planned output not by actual output, but by actual area (Behrman 1968). Actual acreage of the crop concerned is therefore the dependent variable in the present study.

The previous empirical studies suggest that there are lagged price effects in the agricultural sector of the developing countries, particularly in Bangladesh. Therefore, most of the previous works on supply and demand projections of the agricultural crop have used the Nerlovian Framework (Nerlove 1958), which incorporates Adaptive Expectations behavior in the case of agricultural sectors. The structural equations of this model are as follows:

$$\mathbf{A^*_{it} = b_1 + b_2 P^*_{it} + b_3 P^*_{jt} + b_4 T_t + b_5 W_t + U_{it}} \quad \text{------------}(1.1)$$
$$\mathbf{P^*_{it} = P^*_{it-1} + \beta (P_{it-1} - P^*_{it-1})} \quad \text{------------}(1.2)$$
$$\mathbf{A_{it} = A_{it-1} + \theta(A^*_{it} - A_{it-1})} \quad \text{------------}(1.3)$$

where Ai is the acreage of the crop, Pi is the harvest price of the crop, Pj is the harvest price of the competing crop and T and W are indexes of technical change and weather, t is a time subscript, and i and j are subscripts denoting commodities ($i \neq j$). The asterisk (*) denotes expectation formed at time t. Finally, U it is the random residual term satisfying the OLS assumptions i.e. constant variance and zero covariance. After converting these equations into reduced form equations and assuming naïve expectations (in which case

[3] The issue of proper proxy for the dependant variable is explained in Rahman and Yunus (1993).

the farmers take last year's price as the expected price this year, thereby making $\beta = 1$) and full acreage adjustment (in which case $\theta=1$) from the farmers' point of view, we derive the traditional supply adjustment model or the simplified cobweb model, which is as follows[4],

$$A_{it} = b_1 + b_2 P_{it-1} + b_3 A_{it-1} + b_4 T_t + b_5 W_t + U_{it} \text{ ------------------------------- (1.4)}$$

Again, in view of the various unexplained fluctuations in the response and the regular occurrence of various natural disasters, it would be logical and necessary to use a number of dummy variables. As a result, the actual model used for estimation is:

$$A_{it} = b_1 + b_2 P_{it-1} + b_3 A_{it-1} + b_4 T_t + b_5 W_t + D_1 + D_2 + U_{it} \text{ ----------------- (1.5)}$$

where, D_1 and D_2 indicate dummy variables. Equation 1.5 can be used to estimate both short run and long run price elasticities. The estimated coefficient of the lagged dependent variable allows computation of θ, the price adjustment parameter, which can be used along with the estimated coefficient of the lagged price, yields b_2, to complete the long run price elasticities.

SOURCES OF DATA

All econometric estimation in this study is based on annual time series data available mostly from the publications of the Bangladesh Bureau of Statistics (BBS). However, some of the latest figures on production and acreage are collected from the Department of Agricultural Marketing (DAM), Ministry of Agriculture. We collected the relevant data on Aus, Aman and Boro rice separately and ran separate regressions for each of these varieties to examine individual variety responses. Furthermore, we

[4] For a more detailed explanation of the Nerlovian Framework and other agricultural supply response models based on data of thedeveloping countries, please see Rahman and Yunus (1993) and Askari and Cummings (1976).

collected data on wheat crop and ran similar regressions. The time series covered the period from 1972/73 to 1999/2000. However, due to a lack of consistency in available data, regressions for Boro and Wheat covered the time series of 1979-2000.

A large time series for the study could have been generated if the sample size were increased by including data for the pre-Bangladesh period. But it may not be meaningful to pool together pre-independence and post-independence data because of technological innovations and structural changes that occurred in the agricultural sector between these two periods. Price response estimates based on the data since 1972-73 have, therefore, been considered relevant for drawing implications for current agricultural policies and proposed diversification policies in the future.

In line with the post Nerlovian developments, we assume that the relevant crop price received by the farmers is the harvest price of the respective crop. But the choice of price deflators posed serious problems. In the absence of any agricultural input index and the presence of highly competing crops, the rice price was deflated using the Non-Food Consumer Price Index (Non-Food CPI) with the base 1985-86=100. But in the case of wheat, there exists a strong competition between wheat and Boro rice production for land. So the wheat price was deflated by the Boro price for the same period.

For all the crops, there were large changes in output and acreage in several years due largely to external factors such as the flooding in 1987, 1988, and 1998 and famine during 1974-75. This necessitated the use of dummy variables in all the supply response functions. The inclusion of Dummy Variables facilitated proper identification of supply response functions and estimation of statistically significant parameters. Still, as the results would point out, there were some errors in measurement in the case of wheat data. Several other studies [5] have attempted to correct the weakness in the data set by applying

[5] Other studies have attempted to adjust the data for 1971-72 to 1982-84 series from old BBS series according to the new one from 1984. The census data were usedfor this purpose. For a more detailed explanation, see Rahman and Yunus (1993), and Yunus (1993).

adjustment parameters. This, however, was not done in the present study. We have attempted to estimate the supply response on the basis of available data and the weak results have indicated the presence of unexplainable factors indicating the need to undertake further research in this area.

Again, in the absence of a suitable proxy variable for weather, it was assumed that the statistical significance of the dummy variables (which were set according to major environmental disasters) would indicate the importance of weather in estimating the supply responses of individual agricultural crop. The issue of technical change however, is far more important to be neglected, particularly in the case of Boro rice, for which yield rate is used as a proxy variable for the technical change.

Finally, in order to derive statistically significant results, alternative regressions were run with and without dummy variables, for both the Nerlovian and simple cobweb models and with different price variables. In the present report, only the best estimates are presented.

4. ECONOMETRIC RESULTS

The results of the empirical exercise are presented in Table 4.1. They are briefly discussed below.

AUS RICE

For Aus rice, both the lagged price and area coefficients are statistically significant at a 1% level of significance except for regression 1(c) where the price coefficient is significant at the 5% level of significance. The DW value in all cases indicates the absence of auto-correlation. The explanatory power, as indicated by the magnitude of the both R^2 and adjusted R^2, is very high, around 98% in all regressions. Yield rate as an explanatory variable failed to show any significant and meaningful influence. The sign of this variable was negative. Actual data reveals that the yield rates stagnated within the range of 0.90-1.2 mt/ hectares. But the actual area for total Aus rice is declining. Thus the yield rate for Aus rice failed to capture any technological change. So, none of the final regression results contain this proxy variable. The dummy variables used in the regressions were statistically significant, indicating the importance of weather factors (such as floods in 1998 and 1988, as incorporated by dummy variables DD89 and DD99) in the supply response of the Aus Crop.

For price elasticity, we have two types of results. One result (Regression 1-a) shows low short term elasticity (0.129) and a very high long run elasticity (2.363) which is consistent with Rahman and Yunus (1993). But the last two regressions (Regression 1-b and 1-c) give low SR elasticity and moderately high LR elasticity, which are consistent with Rahman (1986) and Yunus (1993). It may be recalled that the cultivation of Aus is constrained by the amount of rainfall. So, it is highly unlikely that the price fluctuation would have a significant impact on the area allocation decision of Aus rice (Yunus 1993).

Table 4.1 — Determinants of Crop Area: Regression Results

	1(a)	1(b)	1(c)	2(a)	2(b)	2(c)	2(d)
Years	**1973-2000**	**1973-2000**	**1973-2000**	**1973-2000**	**1973-2000**	**1979-2000**	**1979-2000**
Dependent Variable	**Aus Area**	**Aus Area**	**Aus Area**	**Boro Area**	**Boro Area**	**Boro Area**	**Boro Area**
Constant	-0.24	0.53	0.43	0.09	-0.29	0.01	-0.41
	(-2.29)	(2.32)	(1.97)	(0.35)	(-1.18)	(0.02)	(-1.12)
Lag Price	4.46	3.90	3.62	3.56	2.43	5.45	5.22
	(2.53)	(2.63)	(2.43)	(1.90)	(1.52)	(1.47)	(1.81)
Lag Area	0.95	0.72	0.762	0.72	0.47	0.7	0.50
	(19.08)	(9.71)	(11.13)	(6.03)	(3.75)	(5.1)	(4.10)
D88				0.40	0.39	0.37	0.36
				(2.89)	(3.38)	(3.10)	(3.93)
DD89		-0.33	-0.30	0.52	0.67	0.54	0.68
		(-3.61)	(-3.37)	(3.34)	(4.89)	(3.84)	(5.81)
DD99		-0.12		0.47	0.50	0.49	0.50
		(-1.31)		(3.78)	(4.82)	(3.91)	(5.17)
Lag Yield Rate					0.36		0.32
					(3.22)		(3.38)
R2	0.971	0.982	0.981	0.982	0.988	0.986	0.992
Adj R2	0.969	0.979	0.978	0.977	0.984	0.981	0.989
D-W	1.60	2.36	2.30	1.92	1.94	1.57	1.90
No of Observation	27	27	27	27	27	22	22
Mean Area	2.515	2.503	2.503	1.965	1.965	2.170	2.170
Mean Price	0.073	0.073	0.073	0.072	0.072	0.068	0.068
SR Elasticity	0.129	0.114	0.106	0.130	0.089	0.171	0.164
LR Elasticity	2.363	0.407	0.443	0.463	0.168	0.567	0.326

Notes: * t-statistics are shown in parentheses. Elasticities are computed at the arithmetic mean values of the respective price and area variables.

** Di is defined as follows: Di =1 if year = i
Di = 0 if otherwise

*** DDi is defined as follows: DDi =1 if year > = i
DDi = 0 if otherwise

Table 4.1 — Determinants of Crop Area: Regression Results (Continued)

	3(a)	3(b)	3(c)	4(a)	4(b)	4(c)	4(d)
Years	**1973-2000**	**1973-2000**	**1973-2000**	**1973-2000**	**1983-2000**	**1983-2000**	**1979-2000**
Dependent Variable	**Aman Area**	**Aman Area**	**Aman Area**	**Wheat Area**	**Wheat Area**	**Wheat Area**	**Wheat Area**
Constant	-3.57	-4.20	3.53	-0.02	0.10	0.10	0.60
	(-3.43)	(-7.01)	(-4.30)	(-0.36)	(1.70)	(1.60)	(1.07)
Lag Price	5.57	4.03	6.35	0.07	0.08	0.08	0.10
	(2.11)	(2.39)	(2.47)	(1.07)	(1.19)	(1.36)	(1.42)
Lag Area	0.32	0.23	0.27	0.88	0.75	0.75	0.79
	(1.75)	(2.19)	(2.09)	(14.47)	(8.22)	(8.27)	(11.30)
D7576	-0.35						
	(-1.80)						
D878889	-0.28						
	(-2.18)						
D75		-0.40	-0.40				
		(-3.41)	(-3.28)				
D76		-0.26	-0.35				
		(-1.53)	(-1.78)				
D80					0.13		
					(3.55)		
D81					0.14		
					(3.94)		
D85					0.14	0.13	0.14
					(4.16)	(4.34)	(4.50)
D86					-0.13	-0.12	-0.12
					(-3.80)	(-4.06)	(-4.03
D87		0.17	0.14				
		(1.41)	(1.21)				
D88		-0.33	-0.36				
		(-2.80)	(-2.96)				
D89		-0.70	-0.71				
		(-6.04)	(-5.94)				
D92					-0.027		
					(-0.92)		
D96					0.07	0.07	
					(2.21)	(2.32)	

	3(a)	3(b)	3(c)	4(a)	4(b)	4(c)	4(d)
Years	**1973-2000**	**1973-2000**	**1973-2000**	**1973-2000**	**1983-2000**	**1983-2000**	**1979-2000**
Dependent Variable	**Aman Area**	**Aman Area**	**Aman Area**	**Wheat Area**	**Wheat Area**	**Wheat Area**	**Wheat Area**
D98					0.11	0.12	0.11
					(3.73)	(3.84)	(3.10
D99		-0.61	-0.60		0.14	0.14	0.13
		(-5.15)	(-5.09)		(3.86)	(4.00)	(3.42)
D00			0.05	-0.14			
			(0.39)	(-3.43)			
DD78				0.04			
				(1.44)			
DD98				0.11			
				(3.84)			
Lag Yield Rate			0.21				
			(1.23)				
R2	0.354	0.846	0.861	0.984	0.963	0.959	0.959
Adj R2	0.237	0.777	0.774	0.975	0.9301	0.931	0.934
D-W	2.264	1.996	2.049	2.303	2.354	2.585	2.134
No of Observation	27	27	27	26	18	18	22
Mean Area	5.750	5.750	5.750	0.523	0.644	0.713	0.610
Mean Price	0.073	0.073	0.073	0.713	0.747	0.7465	0.725
SR Elasticity	0.071	0.051	0.081	0.095	0.086	0.088	0.120
LR Elasticity	0.104	0.067	0.110	0.766	0.350	0.350	0.563

Note: t-statistics are shown in parentheses. Elasticities are computed at the arithmetic mean values of the respective price and area variables.

If we accept this hypothesis, then Regressions 1(b) and 1(c) give consistent results. Again, this phenomenon can be explained in two alternative ways. First, since Aus production comes into serious competition with HYV Boro and wheat, own price fluctuation had very little impact on Aus acreage. But the lagged area response is dominant (as indicated by a high coefficient of lagged area in all the regression results), thereby increasing the LR supply elasticity. Again, the discrepancy between the results can be easily identified when we see that the first regression did not include any dummy variable while the last two did. This indicates that weather factors play a major role in the determination of Aus rice acreage.

BORO RICE

Boro rice is the most dynamic element of Bangladesh's rice production. So, the estimated results are interesting and debatable. To begin with, we used two different samples, as explained earlier. The price coefficients were the biggest of all the rice regressions and statistically very significant. All the coefficients were significant at a 1% level of significance. The R^2 and the adjusted R^2 were very high. The DW statistics also indicated the absence of any auto-correlation. The dummy variables were highly significant, indicating a strong influence of weather in the determination of Boro acreage. But the most important feature of Boro regression was that the yield rate was very significant. In Bangladesh, technical changes (HYV-seed, fertilizer and irrigation) have taken place mostly in the case of Boro cultivation (Rahman 1986). Since the mid-1980's there has been tremendous growth in the Boro area and the output growth has followed. The adoption of new technology has boosted this growth. Again, natural calamities such as the flood have favored Boro cultivation. For example, in 1998, the flood ended during

November and the farmers, without any alternative, shifted to Boro-HYV[6]. This is evident in the actual data for 1988 and 1998. This explains the high significance of the flood dummy (D88, DD89 and DD99) variables.

Some interesting features can be noted when the SR and LR elasticities are analyzed. The SR elasticity is high for all the Boro regressions compared to all other rice regressions, in the range of 0.15. The LR elasticity appears to be quite high. Four explanations can be given. First, the price for rice was relatively high after the floods, thus providing incentives to the farmers to grow rice. Secondly, Boro is the third (dry season) crop. Unlike Aus and Aman, farmers depend much less on Boro for subsistence and hence, are likely to be far more price responsive in making production decisions (Rahman 1986). Thirdly, since there has been a continuous substitution of Aus production by Boro HYV, the lagged area response is very high, thereby making the LR elasticity higher. Fourthly, since Boro is labor intensive, the low wage rate during the period might also contribute to the high SR responsiveness (Yunus 1993).

AMAN RICE

For Aman, both the lagged price and the area were statistically significant at 5% and 10% levels of significance respectively. The price coefficient was considerably high, in one case higher than Boro rice. Without dummy variables the regression results were not very good. Consequently, we had to use a number of dummy variables. All the dummy variables were statistically significant. Surprisingly, the yield rate turned out to be statistically quite significant in the case of Aman (Regression 4 c). This directly contrasted with previous studies (Rahman 1986). Official data (BBS) indicate that there has been a transition from local Aman to HYV Aman since the beginning of the 1980's.

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[6] The seasonal pattern of flooding in Bangladesh has been that it occurs during AugusDecember. In most cases, all the rice production during this time islost. The Boro season begins in January. So, farmers, in order to cover their losses, have tended to increase their Boro cultivation. This occurred both in the case of the 1988 and 1998 floods. We had this experience when we undertook a survey to colbt data on the coping strategies of the people during the (immediate) aftermath of the flood of 1998. For a more elaborate analysis of those survey findings, please see Ninno, Dorosh, Smith and Roy (2001).

In recent years, HVV Aman constitutes almost 70% of total Aman production. Although official data are not available, it can be assumed that the technical dissemination in the form of chemical fertilizers and HYV seeds has already occurred in case of Aman.

While estimating the SR and LR elasticities, it was seen that they were the lowest for Aman. Both SR and LR elasticities were very low indicating the poor price and acreage response. One possible explanation of this behavior may be due to the escalation of wage rates during the transplanting and harvesting seasons (Yunus 1993).

WHEAT

As we have mentioned in our analytical framework (Chapter 3), there were some measurement-errors in wheat data. This is evident in the estimated regression results. In order to avoid measurement errors, we used three different samples, 1973-2000, 1979-2000 and 1983-2000. The price variable was insignificant in every regression at a 10% level of significance. This is in contrast with previous studies (Rahman 1986, Rahman and Yunus 1993 and Yunus 1993). The lagged acreage variable and other variables were significant at a 1 % level of significance.

However, when we look at the SR and LR elasticities, we see that the SR elasticity is quite low, in the region of 0.1 while the LR elasticity is quite high in all cases, in the region of 0.4-0.5. This implies a perplexing situation. It is usually maintained that scarcity of rice forces a sharp break in traditional food habits of low-income consumers, in particular. This group, as a result, has increased the consumption of wheat as a substitute for rice (Rahman and Yunus 1993). This is evident in the rapid increase in the production of wheat since the beginning of the 1980's. But that would imply high price responsiveness. The evidence presented in our study indicates that low-income people do not change their consumption pattern very rapidly. Again the price of wheat, although increasing, is still far below the average rice price (1331 taka per quintal for Boro HYV and 881 for wheat taka per quintal in February 2001). So, it is more profitable to produce rice, particularly HYV varieties of Boro, which competes with wheat. As a result, they are not very sensitive to wheat price. But on a longer time horizon, the substitution is evident from the high lagged area response.

SUMMARY OF REGRESSION RESULTS

The summary of selected regression results is presented in Table 4.2.

In the case of Aus rice, there appears to be no significant technological influence on the Aus area. The negative yield coefficient seems to capture the effect. Weather plays an important role in supply determination, as indicated by the significance of the flood dummy variables. The SR supply elasticity is low which suggests that acreage allocation decisions depend more on other factors (such as the rainfall) than the price. The LR supply elasticity is quite high indicating the existence of strong lagged response in the acreage decision.

In case of Boro, which is one of the most dynamic of all crops, high responsiveness to price, weather and technological change variables are revealed. Regression results show that sufficient technological influence on the acreage decision in the case of Boro is present. Again lagged area response appears to be very significant in the case of Boro. Finally, both the SR and LR elasticities appear to be high for Boro.

In the case of Aman, both technology and weather, along with price, appear to have significant roles in supply decisions. But both the LR and SR elasticities are low.

In the case of wheat, technological influence appears to be insignificant. But the apparently surprising result is the insignificance of the price variable, which is in sharp contrast with all the previous studies. This indicates some measurement errors in the data related to wheat. Again, the SR elasticity was low while the LR elasticity is very high, which calls for adequate explanations of the supply responsiveness in the case of wheat.

In general, the regression results on various crops indicate the importance of weather as an external factor in acreage decisions. Price responsiveness of most of the crops appears to be significant. Technological change does not appear to be very significant in supply decisions of farmers in Bangladesh's crop sector, with the possible exception of Boro rice.

Table 4.2 — Summary of the Selected Regression Results

	1	2	3	4
Years	**1973-2000**	**1979-2000**	**1973-2000**	**1979-2000**
Dependent Variable	**Aus Area**	**Boro Area**	**Aman Area**	**Wheat Area**
Constant	0.426	-0.410	-4.192	0.057
	(1.961)	(-1.123)	(-7.013)	(1.065)
Lagged Real Price	3.620	5.222	4.031	0.101
	(2.426)	(1.806)	(2.385)	(1.415)
Lagged Area	0.762	0.497	0.233	0.787
	(11.134)	(4.057)	(2.193)	(11.298)
Lagged Yield Rate		0.319		
		(3.379)		
Adj R^2	0.978	0.989	0.777	0.934
D-W	2.298	1.896	1.996	2.134
SR Elasticity	0.106	0.164	0.051	0.120
LR Elasticity	0.443	0.326	0.067	0.563

Note: t-statistics are shown in parentheses. Elasticities are computed at the arithmetic means values of the respective price and area variables.

5. SUPPLY AND DEMAND PROJECTIONS

Table 5.1 presents projections of total rice production in 2020 under alternative assumptions regarding real prices and yield growth[7]. In the base run, with no change in the real price of rice over time, total rice area increases by 11.0 percent, as the increase in Boro area more than offsets the declines in Aus and Aman area. Boro and Aus yields increase by 46.7 and 20.0 percent, respectively, over the twenty-year period. As a result Boro production increases by 77.3 percent, Aman production is nearly constant, and Aus production falls by 14.6 percent. Total rice production in 2020 in the base run is 31.1 million MTs, 35.1 percent higher than in 2000.

If real rice prices gradually increase by 20 percent over the period, (assuming a constant growth rate of real rice prices), total production rises to 31.8 million MTs. A 20 percent decline in real rice prices results in production of 30.4 million MTs. Thus, with only area assumed to be responsive to price changes, total production varies by only 1.37 million MTs in these three scenarios. Increasing Aman yields by 1 percent per year along with a 20 percent increase in real rice prices over time raises 2020 production to 34.0 million MTs. Cutting Boro yield growth in half, together with a 20 percent reduction in real prices over time, lowers 2020 production to only 25.6 million MTs.

[7] The projections are calibrated to match historical data for 1999-2000. For the Aman area projections, the average area of 1997/98 and 1999/2000 is used as lagged area in 1999/2000, instead of the 1998/99 area.

Table 5.1 — Rice Area, Yield and Production Projections (Exogenous Price Model)

	Area (m.ha.)				Yield (MT/ha.)			Production (mMT)			
	Aman	**Aus**	**Boro**	**Total**	**Aman**	**Aus**	**Boro**	**Aman**	**Aus**	**Boro**	**Total**
Year 2000 (Base)	5.71	1.37	3.65	10.73	1.81	1.26	3.01	10.30	1.73	11.00	23.03
Year 2020											
20% Increase Price	5.66	1.10	4.51	11.26	2.20	1.52	4.42	12.47	1.66	19.91	34.04
Higher Aman Yields	(-0.8%)	(-20.2%)	(23.4%)	(4.9%)	(22.0%)	(20.0%)	(46.7%)	(21.0%)	(-4.2%)	(81.0%)	(47.8%)
20% Increase Price	5.66	1.10	4.51	11.26	1.81	1.52	4.42	10.22	1.66	19.91	31.79
	(-0.8%)	(-20.2%)	(23.4%)	(4.9%)	(0.0%)	(20.0%)	(46.7%)	(-0.8%)	(-4.2%)	(81.0%)	(38.0%)
No Change in Price	5.61	0.98	4.41	11.00	1.81	1.52	4.42	10.13	1.48	19.50	31.11
	(-1.7%)	(-28.8%)	(20.8%)	(2.5%)	(0.0%)	(20.0%)	(46.7%)	(-1.7%)	(-14.6%)	(77.3%)	(35.1%)
20% Decrease Price	5.56	0.85	4.32	10.73	1.81	1.52	4.42	10.04	1.30	19.08	30.42
	(-2.5%)	(-37.7%)	(18.2%)	(0.0%)	(0.0%)	(20.0%)	(46.7%)	(-2.5%)	(-25.3%)	(73.5%)	(32.1%)
20% Decrease Price	5.56	0.85	3.89	10.31	1.81	1.52	3.65	10.04	1.30	14.21	25.55
1/2 Boro Yield Growth	(-2.5%)	(-37.7%	(6.6%)	(-3.9%)	(0.0%)	(20.0%)	(21.2%)	(-2.5%)	(-25.3%)	(29.2%)	(10.9%)

Notes: Higher Aman yields: 1.0 percent increase in yields per year.
Figures in Parentheses represent percentage changes over the base year (Year 2000) Figures.

Source: Authors' calculations.

SUPPLY AND DEMAND PROJECTIONS WITH ENDOGENOUS PRICES

Table 5.2 presents projections of supply and demand where prices are determined endogenously. Prices are generally set equal to the autarky market-clearing price where domestic supply (production less 10 percent for seed, feed and losses) equals domestic demand. However, in simulations where the autarky price exceeds the import parity price (or falls below the export parity price), the import (export) parity price is used to recalculate supply, demand and imports (exports). The import parity price is calculated as the average 1995/96 to 1999/2000 import parity price of rice from India, expressed in dollars ($293/MT) multiplied by the 2000/2001 exchange rate of Tk 54/$ (or 15.8 Tk/kg). An export parity price of $240/MT (12.3 Tk/kg) is used, slightly above the average export parity price of $229/MT (11.7 Tk/kg) from 1995/96 to 1999/2000, and 10 percent higher than the actual price in 1999/2000. (This export parity price implies that if marketing channels had been established, the Bangladesh private sector could have profitably exported rice to India, or competed with Indian exports to third-country markets in 1999/2000.)

In the base run, demand is modeled using an income elasticity of demand of zero, an own-price elasticity of demand of –0.4 and a population growth of 2 percent per year. Under these assumptions, real prices rise by 19.6 percent by 2020 as domestic demand increases faster than supply. Assuming per capita income growth of 5 percent per year and an income elasticity of demand of 0.2, domestic demand grows even faster. Prices rise to import parity by 2013 (an increase of 35 percent in real terms) and by 2020, imports reach 1.52 million MTs per year, equal to 4.6 percent of total consumption of 32.5 million MTs. Similarly, with base run demand parameters, but with slower growth in Boro yields, prices rise to import parity by 2011, and by 2020 imports reach 2.67 million MTs per year.

If Aman yields are assumed to increase by 1 percent per year, then in the absence of exports, real prices are almost constant over the 20 year period, rising by only 4.9

percent by 2020. If export parity holds as a price floor, however, then exports reach 720 thousand MTs per year in 2020, equal to 2.4 percent of net production.

Table 5.2 — Rice Supply and Demand Projections with Endogenous Prices

	Production (mMT)				2020	2020
	Aman	Aus	Boro	Total	Price (Index)	Trade[a] (mMT)
2000 (base)	10.30	1.73	11.00	23.03	0.050	0.00
Base Simulation 2020	10.22	1.70	19.95	31.86	0.060	0.00
	(-0.8%)	(-2.1%)	(81.3%)	(38.3%)	(19.6%)	(0.0%)
Increased Aman Yields	12.39	1.55	19.63	33.58	0.052	0.00
	(20.3%)	(-10.3%)	(78.5%)	(45.8%)	(4.9%)	(0.0%)
Increased Aman Yields with Rice Exports	12.42	1.60	19.73	33.74	0.055	0.72
	(20.6%)	(-7.9%)	(79.4%)	(46.5%)	(10.0%)	(2.4%)
High Rice Demand	10.30	1.87	20.30	32.47	0.068	-1.52
	(0.0%)	(8.0%)	(84.6%)	(41.0%)	(35.0%)	(-5.0%)
Slow Boro Yield Growth	10.30	1.88	15.22	27.39	0.068	-2.669
	(0.0%)	(8.2%)	(38.4%)	(18.9%)	(35.0%)	(-9.8%)

Notes: [a] Share of imports or exports in net production is shown instead of the percentage change.
% Change from 2000 Base Year Simulation Shown in Parentheses
Base run: per capita income growth 3%; population growth 2%; income elasticity 0.0; Price elasticity of demand -0.4.
Increased Aman yields: 1 percent increase in average yields per year.
High rice demand: per capita income growth 5%; income elasticity 0.2

Source: Authors' calculations.

6. CONCLUSIONS

This report has provided a medium term outlook of the rice sector involving supply and demand projections of rice under alternative scenarios, especially under both exogenous and endogenously determined prices. The following conclusions emerge from the empirical exercise carried out in the report.

(a) Without an increase in Aman rice productivity or an acceleration of technological progress in Boro rice production, Bangladesh may be a net importer of 1.5 to 2.7 million metric tons by 2020.

(b) With moderate productivity increases, however, Bangladesh could be a net rice exporter of about 720 thousand metric tons by 2020, if trading links are established and world prices remain at their average levels of the late 1990s.

(c) Thus, technological progress in rice production remains the key determinant of whether Bangladesh is surplus or deficit in demand-supply balance of rice in the next two decades.

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Annex A — Previous Econometric Estimates of Previous Studies on Supply Elasticities in Bangladesh

Source	Period Coverage	Dependent Variable	Constant	Lagged Dependent Variable	Lagged Price Variable	Alternative Price Variable	Yield Variable	Lagged Yield Variable	Weather Variable	Alternative Weather Variable	Dummy Variable 1	Dummy Variable 2	R^2	Adjusted R^2	D-W Stat
Hussain (1964)	1949-1963	Rice Area											0.31		
Cummings (1974)	1949-1968	Rice Area											0.65		
Ahmed (1977)	1960-1977	Rice Area											0.3		
Rahman (1986)	1973-82														
		Total Aus Area	6851483		180803.1			256843.8					0.69		1.94
					(3.7)			(0.09)							
		Total Aus Output	-353742		69175.95			7875703					0.92		1.94
					(3.69)			(22.26)							
		Total Aus Area	5721471	0.1178128		765450.9		1614674					0.58		1.87
				(0.5)		(2.47)		(0.44)							
		Total Output	-422292	0.00340808		285062.4		8333511					0.98		1.63
				(0.03)		(2.38)		(5.34)							
		Total Aus Output	5253.43		116641.3			6485713					0.98		1.63
					(7.11)			(9.25)							
		Local Aus Area	4944329	0.9032825		704284.1		15721680					0.64		1.63
				(1.83)		(1.56)		(1.33)							
		Local Aus Output	-3427062	0.5524104.0		34657.7		13055700					0.56		1.06
				(0.81)		(1.62)		(1.63)							
		HYV Aus Area	202307.9	0.7653278		134446.1							0.88		
				(6.04)		(0.89)									
		HYV Aus Output	264623.2	0.643652		126786.9							0.77		
				(4.11)		(0.79)									

Note: t-statistics are shown in parentheses

Annex A — Previous Econometric Estimates of Previous Studies on Supply Elasticities in Bangladesh (cont. 2)

Source	Period Coverage	Dependent Variable	Constant	Lagged Dependent Variable	Lagged Price Variable	Alternative Price Variable	Yield Variable	Lagged Yield Variable	Weather Variable	Alternative Weather Variable	Dummy Variable 1	Dummy Variable 2	R^2	Adjusted R^2	D-W Stat
Rahman (1986)	1973-82	Total Aman Area	5052477	0.5398863.0 (2.66)	305468.5 (4.89)						-972456 (-4.65)		0.91		1.98
		Total Aman Output	-492342	0.1005401 (1.62)	147945.8 (2.62)		12453100				-602972 (5.06)		0.98		1.7
		Local Tranplanted Aman Area	759658.2	0.7323448 (4.56)	73803.5 (1.16)								0.811		2.01
		Local Tranplanted Aman Output	-241142	0.657412 (3.91)	311259.4 (1.48)						-1.31985 (-1.16)		0.86		1.37
		Broad Cast Aman Area	2616125												
		Total Boro Output	-1089605		270188.8 (9.71)			232718 (6.23)			-4.97195 (-9.23)		0.98		1.82
		Local Boro Output	-720156		80355.14 (4.68)			1403581 (6.91)			170494.2 (5.12)		0.95		1.4
		HYV Boro Area	-974909		1371444 (3.97)			1437613 (2.22)			-773359 (-4.67)		0.9		2.35
		HYV Boro Output	-377555		196353.3 (2.65)			983939.6 (1.08)			-336891 (-2.36)		0.77		0.062
		Wheat Area	-127071	0.7939169.0 (12.82)		72881.3 (0.64)		315189.8 (1.91)			41373.1 (6.52)		0.99		2.5
		Wheat Output	-151227	0.7390768 (14.99)		57566.32 (0.82)		356225.4 (3.3)			302095.4 (7.66)		0.99		2.51

Note: t-statistics are shown in parentheses

Annex A — Previous Econometric Estimates of Previous Studies on Supply Elasticities in Bangladesh (cont. 3)

Source	Period Coverage	Dependent Variable	Constant	Lagged Dependent Variable	Lagged Price Variable	Alternative Price Variable	Yield Variable	Lagged Yield Variable	Weather Variable	Alternative Weather Variable	Dummy Variable 1	Dummy Variable 2	R^2	Adjusted R^2	D-W Stat
Alam	1971-87	All Aus	3.31	0.5564	0.1422	-0.0002	0.0038			0.0383			0.59		
(1992)		Area	(1.45)	(2.4)	(2.33)	(-0.02)	(0.02)			(1.9)					
		Local Aus	11.17	0.7823	0.12222	-0.0248	-1.3792			-0.0322			0.83		
		Area	(2.69)	(3.66)	(2.41)	(-1.92)	(-2.85)			(-0.98)					
		HYV Aus	-2.9	0.8458	0.6835	-0.0403	0.1012		-0.0041	0.7559			0.94		
		Area	(-0.65)	(5.05)	(2.21)	(-1.52)	(0.21)		(-2.77)	(2.49)					
		All Boro	0.24		0.4109	-0.0139	0.9098						0.29		
		Area	(0.03)		(2.38)	(-0.54)	(0.93)								
		All Boro	-4.51		0.2996		1.338						0.32		
		Area	(-0.77)		(2.23)		(1.77)								
		Local Boro	5.54		0.4484	-0.0212	0.6273						0.44		
		Area	(1.32)		(2.72)	(-1.9)	(0.11)								
		HYV Boro	-15.57		0.3416	0.011	2.81						0.52		
		Area	(-1.9)		(3.14)	(0.7)	(2.72)								
		Wheat Area	0.173	0.6418	0.4612	-0.0331	0.6466						0.99		
			(0.595)	(8.97)	(2.3)	(2.42)	(5.68)								
		All Aman	5.91	0.5107	0.5066	-0.0749	-0.5645		-0.0172	0.5582			0.96		
		Area	(4.82)	(5.24)	(6.83)	(3.33)	(-2.91)		(-3.74)	(3.73)					
		Broadcast	9.73	4141	0.2255	-0.026	-0.8621		-0.0066	0.2141			0.97		
		Aman Area	(5.12)	(3.68)	(4.32)	(-3.43)	(-5.02)		(-7.06)	(6.64)					
		Transplanted	2.49	0.276	0.217	0.0193	0.3841			0.1016			0.76		
		Aman Area	(1.31)	(1.1)	(2.55)	(1.65)	(2.11)			(1.5)					
		HYV Aman	1.24	0.8804	0.2473	-0.0202	0.409			0.1213			0.76		
		Area	(0.44)	(1.11)	(3.21)	(-1.79)	(2.51)			(1.71)					

Note: t-statistics are shown in parentheses

Annex A — Previous Econometric Estimates of Previous Studies on Supply Elasticities in Bangladesh (cont. 4)

Source	Period Coverage	Dependent Variable	Constant	Lagged Dependent Variable	Lagged Price Variable	Alternative Price Variable	Yield Variable	Lagged Yield Variable	Weather Variable	Alternative Weather Variable	Dummy Variable 1	Dummy Variable 2	R^2	Adjusted R^2	D-W Stat
Rahman and Yunus (1993)	1972-83														
		Aus Area	7221400	0.89	159389.7						500081.9	-42446.2	0.55		1.731
			(0.7)	(6.65)	(2.1)						(2.95)	(-2.96)			
		Aman	14567478	0.35	106142.4						808684.9	-992917	0.97		2.177
		Area	(5.24)	(2.34)	(2.18)						(2.14)	(-3.2)			
		Boro Area	-2648936	0.83	39203.22						763620.8	-759096	0.97		2.5
			(-2.94)	(4.91)	(2.42)						(4.81)	(-4.55)			
		Wheat	820644.2	0.88	625345.2						191622.3	-294468	0.98		2.211
		Area	(3.5)	(21.8)	(3.09)						(3.11)	(-4)			
Yunus (1993)	1973-89														
		Food grain	7143452	0.62	28434.81			264615.3						0.94	2.452
		Area	(3.08)	(6.31)	(2.43)			(2.33)							
		Rice Area	20230527		29811.68			6681335						0.88	1.716
			(15.89)		(2.07)			(5.25)							
		Aus Area	7221400	0.89	159389.7									0.85	1.731
			(0.7)	(6.65)	(2.1)										
		Aman	1456748	0.35	106142.4									0.97	2.177
		Area	(5.24)	(2.34)	(2.18)										
		Boro Area	-2648936	0.83	39203.22									0.97	2.5
			(-2.94)	(4.91)	(2.42)										
		Wheat	820644.2	0.88	625345.2									0.98	2.2111
		Area	(3.5)	(21.8)	(3.09)										
		Maize	-1148.53	0.94	28.23									0.99	2.132
		Area	(-2.37)	(34.73)	(2.62)										
		Lentil Area	66748.05	0.93	551.39									0.91	2.031
			(1.38)	(13.96)	(2.14)										

Note: t-statistics are shown in parentheses

Annex A — Previous Econometric Estimates Previous Studies of on Supply Elasticities in Bangladesh (cont. 5)

Source	Period Coverage	Dependent Variable	Constant	Lagged Dependent Variable	Lagged Price Variable	Alternative Price Variable	Yield Variable	Lagged Yield Variable	Weather Variable	Alternative Weather Variable	Dummy Variable 1	Dummy Variable 2	R^2	Adjusted R^2	D-W Stat
Hussain (1964)	1949-1963	Rice Area											0.31		
Cummings (1974)	1949-1968	Rice Area											0.65		
Ahmed (1977)	1960-1977	Rice Area											0.3		
Rahman (1986)	1973-82														
		Total Aus Area	6851483		180803.1			256843.8					0.69		1.94
					(3.7)			(0.09)							
		Total Aus Output	-353742		69175.95			7875703					0.92		1.94
					(3.69)			(22.26)							
		Total Aus Area	5721471	0.1178128		765450.9		1614674					0.58		1.87
				(0.5)		(2.47)		(0.44)							
		Total Output	-422292	0.00340808		285062.4		8333511					0.98		1.63
				(0.03)		(2.38)		(5.34)							
		Total Aus Output	5253.43		116641.3			6485713					0.98		1.63
					(7.11)			(9.25)							
		Local Aus Area	4944329	0.9032825		704284.1		15721680					0.64		1.63
				(1.83)		(1.56)		(1.33)							
		Local Aus Output	-3427062	0.5524104.0		34657.7		13055700					0.56		1.06
				(0.81)		(1.62)		(1.63)							
		HYV Aus Area	202307.9	0.7653278		134446.1							0.88		
				(6.04)		(0.89)									
		HYV Aus Output	264623.2	0.643652		126786.9							0.77		
				(4.11)		(0.79)									

Note: t-statistics are shown in parentheses

Annex B — Summary of Yield Regressions

Years	**1999-2000**	**1999-2000**	**1999-2000**
Dependable Variable	**Log Aman Yield Rate**	**Log Boro Yield Rate**	**Log Yield Rate Aus**
Constant	0.456	0.5313	-0.0793
	(3.69)	(6.45)	(-0.816)
Time Trend	0.0007	0.01935	0.009
	(0.14)	(5.45)	(2.183)
R2	0.0021	0.0021	0.346
Adjusted R2	0.1088	-0.1088	0.27

Note: Figures in Parentheses show the value of t-statistics

- 31 -

FMRSP Bangladesh

Food Management & Research Support Project
Ministry of Food, Government of the People's Republic of Bangladesh

International Food Policy Research Institute
IFPRI

The FMRSP is a 3.5 year Project of the Ministry of Food, Government of the People's Republic of Bangladesh, providing advisory services, training and research, related to food policy. The FMRSP is funded by the USAID and is being implemented by the International Food Policy Research Institute (IFPRI) in collaboration with the Food Planning and Monitoring Unit (FPMU) of the Ministry of Food, the Bangladesh Institute of Development Studies (BIDS), the University of Minnesota and International Science & Technology Institute (ISTI).

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