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PRICE RESPONSIVENESS OF SUPPLY OF MAJOR CROPS IN BANGLADESH

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Section One
Introduction

1.1 Historical Evolution of Agricultural Pricing Policies

Agricultural price policy in Bangladesh has gone through a remarkable metamorphosis over the course of the last two decades. The progress in the adoption of the new technology in crop production can largely be attributed to a set of government policies introduced in the early 1960s. These include direct government involvement in the procurement and distribution of modern agricultural inputs at highly subsidized prices, support for agricultural research and extension, and public investment in irrigation. When chemical fertilizer was first introduced in Bangladesh in the late fifties, the policy consisted of two basic tenets: heavy subsidization with a view to promoting the use of this unfamiliar input, and complete public sector control over its procurement and distribution. This policy continued unabated until the mid-1970s. However, the policy of heavy subsidy on fertilizer has been reversed with a vengeance. As a result, successive reductions of subsidy have brought about manifold increase in the price of fertilizer over these two decades (Hossain 1987). Moreover, in consort with the predilections of the donor agencies the Bangladesh government introduced a new marketing system (NMS) in the 1977/78 whereby any person, group or organization is allowed to register as fertilizer dealer and to trade in fertilizer anywhere in the country. Accordingly, the Bangladesh Agricultural Development Corporation (BADC) closed its upazilla sales centres and consolidated its sales points at major

commercial centers, known as the primary distribution points (PDP). The government also adopted a policy of gradual elimination of subsidies on fertilizer. As a result of the policy the budgetary subsidy on fertilizer was virtually nothing from the second quinquennium of the 1980s. Moreover, the trade liberalizing regime (another prescription of the multilateral donor agencies) together with the subsidy-elimination policy resulted in somewhat negative effective rate of protection on fertilizer trading from the beginning of the 1990s (Rahman 1992).

Modern irrigation was introduced for the first time in Bangladesh in the early 1960s. At its inception, almost exclusive reliance was placed on the extraction of surface water. However, in the early 1970s use of BWDB gravity scheme and deep tube well (DTW) were popularized and the diffusion of Shallow tube well (STW) came into being in the early 1980s. As in the case of fertilizer, the use of irrigation water was also heavily subsidized in the early years of diffusion , but the policy has been shifted towards rapid reduction in subsidy in the late 1970s. Concurrent with the policy changes with regards to the reduction of subsidy, irrigation management has also gone through a gradual metamorphosis with the following steps: public ownership with bureaucratic management, public ownership with cooperative management, and private ownership with private management. Eventually the irrigation equipments, exclusively owned by the public sector so far, have been privatized since 1978/79. As a result of these policy regimes both the costs of irrigation and

the prices of irrigation equipments have risen markedly in 1980s compared to the 1970s (Osmani and Quasem 1990).

Recognizing that the policy changes would raise the cost of production to the farmers, the government also introduced a policy of price support for rice and wheat, and a rapid expansion in the supply of agricultural credit through financial institutions. However, it is estimated that only 15 to 20 percent of the farm households received agricultural loans and about one third of the loans were repaid in schedule.[1] Initially the main objective of the domestic foodgrain procurement system was to secure cereals to supplement external procurement to feed the public food distribution system aimed at providing subsidized food to urban consumers and low-income groups in rural areas. Since the mid-1970s the internal procurement system has been geared to supporting an incentive price for the farmers.

The response of agricultural production to relative prices is, thus, crucial to understanding the effects of price policies and policy reforms that influence agricultural prices on agricultural output. The policies outlined above have been employed either to spur agricultural production and efficiency or to achieve some social goal, or both. However, most occasions of their use have been without prior knowledge of the extent of their effect on output.

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1. For a review of agricultural credit policy see Government of Bangladesh and IDA, **Joint Review of Agricultural Credit in Bangladesh**, Dhaka 1983.

In the backdrop of the diverse agricultural pricing policies adopted in Bangladesh, we attempted to account for the differential effects of such policies by including within mathematical model the variables that are postulated to measure these effects, either directly or in proxy form. Although the present study tries, *ex post facto*, to gauge the roles played by such policies in increasing (or decreasing) agricultural production, it seems useful to undertake such an study like this, because the results of this study can be of benefit to policy makers in development-oriented bureaucracies in Bangladesh who previously have operated in the dark, acting on hunch or educated guess. Investigating the effects of trade liberalization resulting in "free trade" prices on supply of agricultural crops is also another major objective of this study.

The *raison-d'entre* of this study is, thus, an attempt to estimate supply response of major agricultural crops in Bangladesh. Over 30 crops covering 97% of the gross value of agricultural production are included in the analysis. Additionally, meaningful commodity groups such as foodgrains, rice, pulses, oilseeds, spices, and vegetables have also been investigated using alternative specifications.

1.2. Methodology

In view of widespread evidence of lagged price effects in the agricultural sector of developing economies, the theoretical framework used in this study postulates adaptive expectations (Nerlove 1958). Consider the following structural model[2]:

$$A^*_{it} = b_1+b_2 P^*_{it}+b_3 P^*_{jt}+b_4T_t+b_5 W_t+U_{it} \qquad \text{.....(2.1)}$$

$$P^*_{it} = P^*_{it-1}+\beta(P_{it-1}-P^*_{it-1}) \qquad \text{.....(2.2)}$$

$$A_{it} = A_{it-1}+\theta(A^*_{it}-A_{it-1}) \qquad \text{.....(2.3)}$$

where, A_i is the acreage of the crop, P_i is the harvest price of the crop, P_j is harvest price of the competing crop and T and W are indexes of technical change and weather, and t is a time subscript, and i and j are subscripts denoting commodities ($i \neq j$). The asterisk (*) denotes expectation formed at time t. And U_{it} is the random residual term satisfying the usual OLS assumptions i.e., constant variances and zero covariances.

The reduced form of the model above is easily obtained through substitutions,

$$A_{it} = b_1\beta\theta+b_2\beta\theta P_{it-1}+b_3\theta P^*_{jt}-b_3\theta(1-\beta)P^*_{jt-1}+b_4\theta T_t-b_4\theta(1-\beta)T_{t-1}$$

$$+b_5\theta W_t-b_4\theta(1-\beta)W_t+(1-\theta)A_{it-1})+\theta U_{it-1}-\theta(1-\beta)U_t \qquad \text{.....(2.4)}$$

2. For a more detailed treatment of agricultural supply response models and empirical results based on data for developing countries, see Askari & Cummings (1976).

Now if naive expectations are assumed, i.e., farmers take last year's price (P_{it-1}) as the expected price this year (P^*_{it}), i.e., $\beta=1$ then (2.4) simplifies to

$$A_{it} = b_1\theta+b_2\theta P_{it-1}+b_3\theta P^*_{jt}+b_4\theta T_t + b_5\theta W_t+(1-\theta)A_{it-1}+\theta U_{it} \qquad ...(2.5)$$

This is a traditional supply adjustment model. Lagged own price and dependent variables both appear as arguments in this model.

If full acreage adjustment, i.e., $\theta=1$ rather than naive expectations is assumed, (2.4) transforms to:

$$A_{it} = b_1\beta+b_2\beta P_{it-1}+b_3\beta P^*_{jt}-b_3(1-\beta)P_{jt-1}+b_4\beta T_t -b_4(1-\beta)T_{t-1}$$
$$+b_5W_t-b_5(1-\beta)W_t+(1-\beta)A_{it-1}+U_{it}+(1-\beta)U_{it-1} \qquad ..... (2.6)$$

i.e., it contains lagged values of all exogenous variables. If both restrictions $\beta=\theta=1$ are imposed, then (2.4) is further simplified to a simple Cobweb model:

$$A_{it} = b_1+b_2P_{it}+b_3P^*_{jt}+b_4T_t+b_5W_t+U_{it} \qquad .....(2.7)$$

Assuming naive expectations in formation of price of the competing crop, j, the unobservable variable P^*_{jt} is substituted by P_{jt-1} in (2.5)-(2.7). Equations (2.5) and (2.7), thus transformed, provide the two basic types of estimating equations used in this study. The small sample size did not permit estimation of (2.6). The price parameter obtained from (2.7) is a short-run one. However, (2.5) allows us to estimate of the long-run parameter as well. The estimated co-efficient of the lagged dependent variable allows computation

of θ, the price adjustment parameter, which when divided into the estimated co-efficient of the lagged price yields b_2, the long run price co-efficient.

1.3 Sources of Data

All econometric estimation in this study are based on annual time series data available mainly in secondary form in several publications of Bangladesh Bureau of Statistics (BBS). Despite the existence of a large hierarchy of infrastructure as well as the increasing sophistications and efficiency in collecting and processing agricultural statistics in Bangladesh we observe revised series of acreage and output data for minor cereals, pulses, and oilseeds from 1983-84 onwards virtually keeping all these series unrevised from 1971-72 to 1982-83. However, we assumed that the data series of these crops came from the same probability distribution despite these differences over the course of time. Accordingly, we revised the old BBS series multiplying each data point by the corresponding ratio of the arithmetic means of the revised series to that of the old ones. However, investigating the reliability of published data used here is not the purpose of this study. Rather, the approach taken here is to make the available data consistent in a theoretically meaningful way and see if the results thus obtained conform to *a priori* expectations. Rice was disaggregated into its three major types, i.e., Aus, Aman, and Boro. Total foodgrain supply function (Rice + Wheat + Barley + Maize) has also been estimated. Likewise pulses, oilseeds, spices, and vegetables have been disaggregated and supply response functions have been

estimated for these 'group' crops and for their major components (e.g., Pulses include Gram, Motor, Mung, Mashkalai, and Khesari; Oilseeds include Groundnut, Rape and Mustard, Til, and Linseed; Spices include Chilies, Onion, Garlic, Ginger, and Turmeric; Vegetables include Brinjal, Arum, Pumpkin, Cauliflower, Cabbage, Tomato, Radish, and Beans).

Certainly it would add to the strength of the econometric results of this study if the sample size would be increased by including data for the pre-Bangladesh period. But it is hardly meaningful to pool together pre-independence and post-independence time-series data. Further, only price response estimates based on the data since 1971 are relevant for drawing implications for a current agricultural policies in general and proposed future diversification policies in particular.

Following this introduction Section two discusses the analytical framework. Section three presents the econometric estimates of supply response functions of individual as well as 'group' commodities. Finally, Section four provides summary and conclusions.

Section Two
Analytical Framework

2.1 The Issue of Dependent Variable: Output vs. Acreage

The main interest of this study is the response of total planned production, as opposed to marketable surplus, to various explanatory variables. Because time series estimates of planned output are not available, some proxy must be utilized. One possible proxy would be the actual output. Realized agricultural output, however, often differs considerably from planned output because of important environmental and climatic factors which remain virtually beyond farmers' control. The frequent widespread discrepancies between ex-ante and ex-post agricultural production have led to approximate planned output not by actual output, but by actual area (Behrman, 1968). The area actually planted in a particular crop is, to a greater extent than output, under farmers' control, and, thus presumably a much better index of planned production. Let bar (-) over a variable denote the ex-ante value of that variable, then the above analysis suggests that $A \approx \bar{A}$. Equation (3.1) then gives the relationship between the elasticities of $\bar{Q}$, A, and $\bar{Y}$ with respect to P as:

$$\epsilon_{\bar{Q}P} = \epsilon_{AP} + \epsilon_{\bar{Y}P}. \qquad \text{.....(3.1)}$$

The smaller is the absolute value of $\epsilon_{\bar{Y}P}$, *ceteris paribus*, the better will ϵ_{AP} approximate $\epsilon_{\bar{Q}P}$. As will be found later on this is true in most of the crops under consideration. Actual acreage of the crop concerned is, therefore, the dependent variable in the present study.

2.2 The Issue of Price Variables and Deflators

There are some problems involved when a model of this kind is used for annual crops. Confronting the researcher immediately is the question as to what price variable should be used in the model. In line with the post Nerlovian developments in this field we presumed that the price of the crop received by farmers is the harvest price of the respective crop. No price index for agricultural inputs is available and hence could not be used. The problem of price deflator is a serious one in these types of exercises. A general harvest price index was computed and used to deflate the prices of almost 95 per cent of the crops under consideration. In the absence of a highly competing crop this price index is postulated to be a proxy for the 'best' alternative use of land. Since Aus rice competes with jute, estimates of the supply function were also made with the Aus price deflated by the jute price. Similarly the wheat price was also deflated by the Boro price for the same reason. When supply response for 'group' crops (e.g., foodgrain, rice, pulses, etc.) were estimated the price variable was obtained as a weighted (output values) average of prices of the underlying crops in the group. A Non-Food Agricultural Output Price Index (NF) was computed and used to deflate the 'price' of foodgrain in estimating foodgrain supply response functions. Again a Non-Rice Agricultural Output Price Index (NR) was computed and used to deflate the price of rice in estimating rice supply response functions. For the Rabi crops (winter crops) we computed a Rabi Crop Agricultural Price Index (RPI) and used to deflate the Rabi crops. Supply response functions gave poor results when it was used as a deflator for each individual Rabi crop price.

However, this might be attributed to the small coverage of crops in computing the index. All of the indices computed by us were Laspeyres' price indices each with base 1985-86 = 100.

2.3 The Issue of Technical Change and Weather

Insurmountable difficulties were faced in procuring time series data on technical change. Irrigation and fertilizer use are the most appropriate variables reflecting technical progress in agriculture. But, time series data on irrigation are not available by individual crops. The same is also true for crop specific fertilizer use. However agricultural technical progress is reflected in yields and hence, yield data being easily available, have been used as a proxy for technical change.

The problem of procuring a suitable variable to capture the effect of weather continues to pose serious difficulty for the applied researches in Bangladesh. Temperature, rainfall, and humidity at different periods of the crop cycle influence the volume of the output. These detailed weather information data are not available. Data are available only for rainfall. Unfortunately, even the annual average rainfall data could not be used as a proxy for weather effects since the series prior to 1977 and post-1977 are not comparable. The Meteorological Department has altered the method of calculations since 1977.

2.4 The Appropriate Method of Estimation

The most appropriate estimating technique for (2.5) above is the Maximum Likelihood Method (MLE) due to the presence of lagged dependent variable as one of the regressors. However, MLE and all other simultaneous equations estimating techniques (2SLS, 3SLS etc.) yield unbiased, efficient, and consistent estimates <u>if and only if</u> the sample size is large. Very little is known about the small sample properties of simultaneous equations estimators including MLE (Nagar 1960). Even Model (2.7) above can be appropriately estimated using simultaneous equations techniques, though, there is no simultaneity between dependent variable and the price and weather variables both of which are truly exogenous. To avoid a possible simultaneity between the technical change variable and yield, lagged yield instead of current one has been used as a proxy for the former. The presence of cross price effects (competing crops) also points to the appropriateness of using simultaneous equation techniques. But, the small sample size does not allow meaningful use of simultaneous equations techniques to estimate the parameters of (2.5) or (2.7) as stated above.

The simplest and most widely used econometric estimation technique viz. Ordinary Least Squares (OLS) has made extensive applied economic research possible by allowing a powerful computational algorithm to estimate parameters based on small samples. It has been demonstrated theoretically that OLS yields the best estimate in case of small samples (Mariano 1978). Accordingly, OLS has been applied in this study to estimate all parameters.

Since, the sample is quite small it is of course appropriate to view the results of this study with some caution. However, if the magnitudes of elasticities appear to be reasonable for a country like Bangladesh and the results appeal to economic theory and intuition then they may be utilized with a reasonable degree of confidence.

For almost all crops, there were sharp changes in output and acreage in certain years which regressors (price and yield) were unable to capture. This necessitated the use of dummy variables in most of the supply response function estimations. These variables have allowed proper identification of the supply response functions in most cases and allow the estimated real parameters to be statistically significant at higher level of confidence in some cases. Presentation of the results of all econometric estimates conducted within the scope of the study is both unnecessary and burdensome. Estimates of acreage response with several alternative prices (deflated), with and without yield and dummy variables for both simple Cobweb and Nerlovian supply were obtained. Only the best estimates for each crop are presented and discussed in the study. It should be mentioned in order to avoid the possible source of confusion that both the price and the yield elasticities are computed at the arithmetic mean values of the respective variables.

Section Three

Econometric Results

In this section we will first analyze the econometric estimates of supply response functions for individual crops along with the respective price and yield elasticities. Policy implications for the results obtained will also be discussed within the same premises. After that we will deal with the 'group' commodities as well as the aggregate output following the same procedures.

3.1 Index of Symbols Used in the Study

AA	=	Aus Acreage	PA	=	Price of Aus
AMA	=	Aman Acreage	PAM	=	Price of Aman
BOA	=	Boro Acreage	PBO	=	Price of Boro
WA	=	Wheat Acreage	PW	=	Price of Wheat
BRA	=	Barley Acreage	PBR	=	Price of Barley
MZA	=	Maize Acreage	PMZ	=	Price of Maize
MA	=	Masur Acreage	PM	=	Price of Maize
MTA	=	Motor Acreage	PMT	=	Price of Motor
MKA	=	Mashkalai Acreage	PMK	=	Price of Mashkalai
KSA	=	Khesari Acreage	PKS	=	Price of Kheshari
TLA	=	Til Acreage	PTL	=	Price of Til
RMA	=	Rape and Mustard Acreage	PRM	=	Price of Rape and Mustard
LNA	=	Linseed Acreage	PLN	=	Price of Linseed
CLA	=	Chilies Acreage	PCL	=	Price of Chilies
ONA	=	Onion Acreage	PON	=	Price of Onion
GLA	=	Garlic Acreage	PGL	=	Price of Garlic
TMA	=	Turmeric Acreage	PTM	=	Price of Turmeric
GNA	=	Ginger Acreage	PGN	=	Price of Ginger
BJA	=	Brinjal Acreage	PBJ	=	Price of Brinjal
ARA	=	Arum Acreage	PAR	=	Price of Arum
CFA	=	Cauliflower Acreage	PCF	=	Price of Cauliflower
CBA	=	Cabbage Acreage	PCB	=	Price of Cabbage
TMTA	=	Tomato Acreage	PTMT	=	Price of Tomato
RDA	=	Radish Acreage	PRD	=	Price of Radish
BNA	=	Beans Acreage	PBN	=	Price of Beans

PTA =	Potato Acreage	PPT =	Price of Potato
SPA =	Sweet Potato Acreage	PSP =	Price of Sweet Potato
JUA =	Jute Acreage	PJU =	Price of Jute
SNA =	Sunhemp Acreage	PSN =	Price of Sunhemp
CTA =	Cotton Acreage	PCT =	Price of Cotton
SGA =	Sugarcane Acreage	PSG =	Price of Sugarcane
TBA =	Tobacco Acreage	PTB =	Price of Tobacco
MLNA =	Melon Acreage	PMLN=	Price of Melon
FA =	Foodgrain Acreage	PF =	Price of Foodgrain
FQ =	Foodgrain Output		
RA =	Rice Acreage	PR =	Price of Rice
RQ =	Rice Output		
PUQ =	Pulses Output	PPU =	Price of Pulses
OA =	Oilseeds Acreage		
OQ =	Oilseeds Output	PO =	Price of Oilseeds
SA =	Spices Acreage		
SQ =	Spices Output	PS =	Price of Spices
VA =	Vegetables Acreage	PV =	Price of Vegetables
VQ =	Vegetable Output	YSP =	Yield of Sweet Potato
TOTQ =	Aggregate Output	TT =	Domestic terms of trade between agriculture and industry
YMT =	Yield of Motor	YCT =	Yield of Cotton
YMK =	Yield of Mashkalai	YR =	Yield of Rice
YTM =	Yield of Turmeric	YF =	Yield of Foodgrain
YBT =	Yield of Brinjal	YPU =	Yield of Pulses
YCB =	Yield of Cabbage	YS =	Yield of Spices
YRD =	Yield of Radish		

HPI = Harvest Price Index of Agricultural Crops (Base=1985-86=100)
NR = Non-Rice Agricultural Price Index (Base =1985-86 = 100)
NF = Non-Foodgrain Agricultural Price Index (Base = 1985-86 = 100)
D_i = Dichotomous (0,1) dummy variables

R^2 = Coefficient of Determination
DW = Durbin - Watson Statistics
t = Time Subscripts

3.2 Cereals

3.2.1 Aus Rice:

Since lagged dependent variable appears in case of Aus acreage response function, it implies partial adjustment to relative price level changes within the year or, the Nerlovian expectations. In the estimated response function Aus price is deflated by the jute price. The estimated response function includes dummy variables to control for outliers and thereby, provides the best approximation for the Aus supply response function. The estimated lagged acreage and price coefficients in this model are statistically different from zero at 1 % and 5% error probability levels respectively. Moreover, the explanatory power as indicated by the magnitude of R^2, is very high. While the short-run price elasticity estimate given by this model is 0.02 the long-run-price elasticity is higher at 1.4. All price and yield elasticity estimates in this study are computed at the arithmetic means of real price (deflated) and acreage. These price elasticity estimates are shown in Table-8 for individual crops and the yield elasticities are shown in Table-11.

3.2.2 Aman Rice:

In estimating acreage response function for Aman rice, yield was never statistically significant as an explanatory variable. As the statistical fit of the response function was unsatisfactory without dummy variables, so dummy variables are used to capture the synergy effect of the excluded explanatory

variables. Since the lagged dependent variable is statistically significant at 5% error probability level we estimated both short run and long run price elasticities. While the short run price elasticity is small at 0.36, the long-run price elasticity in much higher at 0.55. The magnitudes of elasticity estimate indicate that a 10 percent increase in the real price will lead to an increase in the acreage of Aman approximately by 3.6 percent and 5.5 percent in the short-run and long-run respectively. There is, thus, some scope for output pricing policy to boost production of this vital crop.

3.2.3 Boro Rice

In Boro rice there was evidence of lagged supply adjustment. Thus long-run price effects could be obtained along with the short-run one. Short-run and long-run price elasticities estimated from the Nerlovian model shown in Table-8, which are 0.50 and 2.86 respectively. These are much higher compared to those obtained for Aus and Aman rice respectively. These elasticity estimates might be considered high even for a developing country like Bangladesh. But there appears to be good reason for this. Boro is the third major (winter season) crop grown in Bangladesh. Unlike Aus and Aman, farmers depend much less on Boro for subsistence and hence, are likely to be far more price conscious in making supply decisions. All estimated parameters of acreage response function are statistically significant at 5% error probability level or better and the explanatory power of the model is very high.

Table-1

Econometric Estimates of Supply Response Functions for Cereals

---

Aus. $AA_t = 7221400.04 + 0.89\ AA_{t-1} + 159389.70\ (\frac{PA}{PJU})_{t-1} + 500081.92\ D_1 - 425446.19\ D_2$ $R^2 = 0.85$ (3.1)
(0.70) (6.65) (2.10) (2.95) (-2.96 DW = 1.731

Aman. $AMA_t = 14567478.00 + 0.35\ AMA_{t-1} + 106142.44\ (\frac{PAM}{HPI})_{t-1} + 808684.86\ D_1 - 992916.69\ D_2$ $R^2 = 0.97$ (3.2)
(5.24) (2.34) (2.18) (2.14) (-3.20) DW = 2.177

Boro. $BOA_t = -2648936.10 + 0.83\ BOA_{t-1} + 39203.22\ (\frac{PBO}{HPI})_{t-1} + 763620.84\ D_1 - 759096.31\ D_2$ $R^2 = 0.97$ (3.3)
(-2.94) (4.91) (2.42) (4.81) (-4.55) DW = 2.50

Wheat. $WA_t = 820644.17 + 0.88\ WA_{t-1} + 625345.20\ (\frac{PW}{PBO})_{t-1} + 191622.26\ D_1 - 294467.71\ D_2$ $R^2 = 0.98$ (3.4)
(3.50) (21.80) (3.09) (3.11) (-4.00) DW = 2.211

Barley. $BRA_t = -19033.85 + 0.93\ BRA_{t-1} + 475.58\ (\frac{PBR}{HPI})_{t-1} - 18295.19\ D_1$ $R^2 = 0.97$ (3.5)
(-2.56) (28.89) (2.34) (-3.39) DW = 1.886

Maize. $MZA_t = -1148.53 + 0.94\ MZA_{t-1} + 28.23\ (\frac{PMZ}{HPI})_{t-1} + 2145.44\ D_1 - 1740.12\ D_2$ $R^2 = 0.99$ (3.6)
(-2.37) (34.73) (2.62) (3.99) (-4.73) DW = 2.132

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

In Bangladesh, the greatest technical change i.e., Seed-fertilizer and irrigation technology (SFT) has taken place in Boro cultivation. The crop also offers the most scope for price policies to raise rice production compared to Aus and Aman. It seems, therefore, that policy makers need not view price policy and technical changes in agriculture as mutually exclusive instruments for boosting output. Because hybrid seeds (especially in the Boro season) need a lot of water, fertilizer, and pesticides; if one of these is missing (due to rising inputs costs etc.) yield drops sharply. These may indeed be complementary for sustained technical change. Technical change over a period *per se* is likely to pave the way for greater market orientation of farmers, as productivity increase raises marketable surplus.

3.2.4 Wheat

Despite the comparative advantage in switching over to Boro cultivation, wheat production in Bangladesh has increased dramatically. It is extremely difficult to separate the influence of various factors causing such a sharp upward trend. While the influence of some factors are continuous (such as SFT) that of others are sporadic (such as Government's Agriculture Rehabilitation Program launched after the devastating flood of July-August-September 1987 and use of extensive cultivation method for this crop — Bandarban has been encompassed under wheat cultivation from 1987 onwards). Notwithstanding the above facts, irrigation has been the main determinant of this dramatic increase. Parameter estimates of acreage response function are statistically significant

at 1% error probability level. While the short-run price elasticity estimate is small at 0.61, the long-run price elasticity estimate is much higher at 5.24. Scarcity of rice has forced a sharp break with traditional food habits of low-income consumers in particular. This group has increased the consumption of wheat as a substitute for rice remarkably. It can be presumed that the pressure of foodgrain demand will keep wheat prices buoyant and contribute to further increase in wheat production.

3.2.5 Barley

Barley production in Bangladesh has decreased gradually over the whole period under consideration. This decline may be attributed to the gradual increase in area under irrigation and lack of interest shown by farmers in growing the crop in some regions of the country. With yield almost constant the decline in production is, thus, due to the decrease in the cultivated area of the crop. Parameter estimates of the response function are statistically significant at 5% error probability level. While the short-run price elasticity is at 0.19, the long-run elasticity is high at 2.79. The high magnitude of the long-run price elasticity indicates the substantial scope for output pricing policy in boosting the production of the crop. However, the estimated long-run price elasticity is over estimated as the magnitude indicates. So the elasticity results should be taken with some degree of caution.

3.2.6 Maize

The price and lagged acreage variables alone, explain 99% of the variation in Maize acreage. Though the price coefficient is statistically significant at 5% error probability, the coefficient of the lagged acreage is statistically significant even at 1% error probability level. The estimated short-run price elasticity is low at 0.09 and the estimated long-run price elasticity is high at 1.58. The estimated long-run price elasticity is over estimated as the magnitude indicates. This could not be so high because profitability is a secondary consideration in Maize growing in Bangladesh.

3.3 Pulses:

3.3.1 Masur (Lentil)

The lagged acreage response function provided meaningful results. When yield variable is included it is found that the variable is significantly negatively related. Because data in this period show yield to be declining; this is reflected in the yield variable. This is contrary to expectation. There is no strong reason for yield to be declining over time, except for lack of support provided by the public policy makers. Hence, it is more appropriate to use model (3.7) as an approximation of Masur supply response function. However, unlike the results of a comprehensive study in the past (Rahman 1986), the present estimate of price parameter is highly statistically significant at 5% error probability level thereby, enabling us to compute the short-run and long-run price elasticities. While the estimated short run price elasticity is small at 0.07, the estimated long-run price elasticity is higher at 1.09. Because of the presence of negative auto-correlation the sample variances, in principle, are supposed to be over estimated. We corrected for this auto-correlation problem assuming the nature of auto-correlation as first order auto-regressive scheme (AR(1)). The estimate of rho (P) is -0.48 and is significant at 10% error probability level.

3.3.2 Motor (Pea)

The coefficient of lagged dependent variable is significantly different from zero implying partial adjustment to relative price level changes within the year or Nerlovian expectations. Although the statistical fit of the response is excellent, the estimated parameters of price and yield are significant only at 10% error probability level. While the short-run and long-run price elasticities estimated at the mean level of the variables are 0.05, 1.20 respectively, the same for yield elasticities are 0.21 and 4.86 respectively. However, these elasticity estimates should be viewed with caution keeping in mind the poor significance level of the coefficient estimate.

3.3.3 Mashkalai (Black gram)

Although the estimated price parameter is significant at 10% error probability level the estimated coefficients of lagged acreage and yield are significant at 1% error probability level. When dummy variables were used to control for outliers the significance of individual coefficient estimates as well as the overall significance improved markedly. The short-run and long-run price elasticities computed at the mean values of the respective variables are 0.11 and 0.91 respectively. The corresponding figures for the yield variable are 0.85 and 7.27 respectively.

Table-2

Econometric Estimates of Supply Response Functions for Individual Pulses

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Masur. $MA_t = 65748.05 + 0.93\ MA_{t-1} + 551.39\ (\frac{PM}{HPI})_{t-1} + 58102.77\ D_1$ $R^2 = 0.91$ (3.7)
(1.38) (13.96) (2.14) (5.14) DW = 2.031

Motor. $MTA_t = -19301.91 + 0.96\ MTA_{t-1} + 60.22\ (\frac{PMT}{HPI})_{t-1} + 55585.76\ YMT_{t-1} - 10450.75\ D_1 + 8073.39\ D_2$ $R^2 = 0.99$ (3.8)
(-2.35) (26.31) (1.81) (1.87) (-7.30) (7.27) DW = 1.943

Mashkalai. $MKA_t = -203863.99 + 0.88\ MKA_{t-1} + 359.95\ (\frac{PMK}{HPI})_{t-1} + 677715.59\ YMK_{t-1} + 19609.27 D_1 - 12602.77\ D_2$ $R^2 = 0.99$ (3.9)
(-3.93) (22.00) (1.95) (4.67) (5.78) (-3.29) DW = 2.218

Khesari. $KSA_t = 84892.81 + 0.84\ KSA_{t-1} + 566.36\ (\frac{PKS}{HPI})_{t-1} + 136468.77\ D_1 - 85103.79\ D_2$ $R^2 = 0.94$ (3.10)
(1.26) (10.25) (2.97) (5.37) (-5.50) DW = 2.538

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

3.3.4 Khesari (Chickling vetch)

Unlike the results of a previous study (op.cit. Rahman 1986) we arrived at fairly reasonable estimate of acreage response function for Khesari. As with the earlier case for Motor, the dummy variables used to control for outliers improved both the significance of individual coefficients and the overall significance. The coefficients of lagged dependent variable and price variable are significant at 1% and 5% error probability levels respectively. Accordingly, we have both short-run and long-run price elasticities. While the

short-run price elasticity is small at 0.04, the long-run price elasticity is higher at 0.25. Acreage response functions were also estimated for Gram and Mung (other two major varieties of pulses), but no meaningful estimates could be obtained.

3.4 Oilseeds

3.4.1 Til (Sesame seed)

It was not possible to capture the effect of technical change as reflected in yield in case of Til. The results of econometric estimation in case of Til were in general satisfactory. The lagged acreage and price variables are statistically significant at 1% and 5% error probability levels respectively and the explanatory power is also high. The short-run price elasticity in the model shown in (3.11) is relatively high at 0.13, while the long-run price elasticity is even higher at 0.27.

3.4.2 Rape and Mustard

The same observation with respect to yield holds in case of rape and mustard as in case of Til above. The estimated acreage response function given by model (3.12), provides parameters that are statistically significant at the 1% error probability level and the explanatory power is also reasonably high. The short-run and long-run price elasticities are high at 0.13 and 0.27 respectively, thus revealing scope for using price policies to increase production significantly. This is an important finding since, edible oils are among one of the major import items in Bangladesh. Domestic production of edible oil can be increased significantly through higher relative prices of rape and mustard thereby reducing the budgetary burden of imports.

Table-3

Econometric Estimates of Supply Response Functions for Individual Oilseeds

Til. $TLA_t = -1181.49 + 0.75\ TLA_{t-1} + 726.93 \left(\frac{PTL}{HPI}\right)_{t-1} - 66666.35\ D_1 + 35779.68\ D_2$ $\quad R^2 = 0.96$ $\quad$ (3.11)

(-0.94) (11.24) (2.47) (-5.13) (3.46) $\quad DW = 2.406$

Rape & Mustard. $RMA_t = 316462.94 + 0.52\ RMA_{t-1} + 1072.67 \left(\frac{PRM}{HPI}\right)_{t-1} - 71717.68\ D_1 + 46212.74\ D_2$ $\quad R^2 = 0.93$ $\quad$ (3.12)

(4.18) (6.39) (3.40) (-5.70) (4.07) $\quad DW = 2.045$

Linseed. $LNA_t = 46061.30 + 0.66\ LNA_{t-1} + 241.28 \left(\frac{PLN}{HPI}\right)_{t-1} - 26601.82\ D_1$ $\quad R^2 = 0.88$ $\quad$ (3.13)

(2.63) (8.47) (2.11 (-6.27) $\quad DW = 2.727$

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

3.4.3 Linseed

The results of estimating acreage response function of linseed have been satisfactory though, it was not possible to capture the effect of yield. While the price variable is significant at the 5% error probability level, the parameter of the lagged acreage is significant even at 1% error probability level. When dummy variable is included the explanatory power increases markedly. However, inclusion of dichotomous dummy variables also ensues positive serial correlation, which if corrected, does dissipate much of the price effect of the estimated response function. Thus the short-run and long-run

price elasticities are 0.11 and 0.32 respectively. However, these would be viewed with some caution because of this positive serial correlation. Acreage response function was also estimated for Groundnut (another major variety of oilseeds), but no meaningful results could be obtained.

3.5 Spices

3.5.1 Chilies

Results of estimation are fairly good for chilies. The Nerlovian acreage response function with the own price deflated by Harvest Price Index (HPI) gave better results. The price and lagged acreage coefficients are statistically significant at the 1% error probability level, and the explanatory power is also satisfactory in model (3.13). While the short-run price elasticity is low at 0.05, the long-run elasticity is high at 0.17. It may be noted that chilies are consumed as a complement to rice in Bangladesh and hence a part of the subsistence diet. A low price response is, therefore, expected to be in the case of chilies.

3.5.2 Onion

A Nerlovian model of acreage response function provided the best approximation of onion supply response in Bangladesh. All estimated parameters are statistically significant at the 5% error probability level. The explanatory power is,however, not very high. The short-run and long-run price elasticities are estimated as 0.05 and 0.09 respectively, which are very low. Thus the scope for output price policies to boost production is rather limited.

3.5.3 Garlic

The results of estimation are fairly good for garlic. The Nerlovian model provided the best approximation of garlic supply response function in Bangladesh. The acreage response function given by model (3.15) provides parameters that are statistically significant at the 1% and 10% error probability levels respectively. While the short-run price elasticity is at 0.001, the long-run price elasticity is at 0.01. These elasticity estimates are however very low thereby indicating little scope for output pricing policies to boost production of the crop.

3.5.4 Turmeric

A Nerlovian model for acreage response function provided the best approximation to acreage supply response function of turmeric in Bangladesh. All estimated parameters in model (3.16) are statistically significant at 1% and 10% error probability levels respectively. When dummy variables were used the significance of individual coefficient estimates as well as the overall significance improved markedly. While the short-run price elasticity is low at 0.03, the long-run price elasticity is also low at 0.05 thereby indicating little scope for output pricing policies to boost production in the long-run.

Table-4

Econometric Estimates of Supply Response Functions for Individual Spices

Chilies.	$CLA_t = 49190.69 + 0.68\ CLA_{t-1} + 43.20\ (\frac{PCL}{HPI})_{t-1} + 19029.40\ D_1 - 13805.24\ D_2$ (2.57) (6.56) (2.86) (4.35) (-3.82)	$R^2 = 0.88$ DW = 2.190	(3.13)
Onion.	$ONA_t = 40665.68 + 0.45\ ONA_{t-1} + 93.46\ (\frac{PON}{HPI})_{t-1} - 5978.56\ D_1 + 3430.93\ D_2$ (2.93) (2.59) (2.23) (-2.68) (2.45)	$R^2 = 0.70$ DW = 1.690	(3.14)
Garlic.	$GLA_t = 19075.32 + 0.38\ GLA_{t-1} + 1.48\ (\frac{PGL}{HPI})_{t-1} + 1046.40\ D_1 - 1655.61\ D_2$ (4.54) (2.83) (2.05) (4.57) (-4.43)	$R^2 = 0.82$ DW = 2.726	(3.15)
Turmeric.	$TMA_t = 7876.31 + 0.42\ TMA_{t-1} + 5.50\ (\frac{PTM}{HPI})_{t-1} + 15972.65\ YTM_{t-1} - 1599.33\ D_1 + 1517.40\ D_2$ (3.52) (2.82) (3.30) (3.15) (-3.47) (3.45)	$R^2 = 0.97$ DW = 2.356	(3.16)
Ginger.	$GNA_t = 762.44 + 0.90\ GNA_{t-1} + 6.52\ (\frac{PGN}{HPI})_{t-1} + 1413.09\ D_1$ (0.90) (13.98) (2.61) (5.87)	$R^2 = 0.94$ DW = 1.957	(3.17)

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

3.5.5 Ginger

The price and lagged acreage variables alone, explain 93% of the total variation in ginger acreage. However, statistically significant coefficient estimates and hence price effect could be obtained only when dummy variables are used to control for outliers. The short-run and long-run price elasticities are computed as 0.04 and 0.45 respectively. The high long-run price elasticity indicates substantial scope for output pricing policies to boost production of ginger in Bangladesh.

3.6 Vegetables

3.6.1 Brinjal

The estimates of brinjal acreage response function is one of the 'best' acreage response function estimated in the present study. The Nerlovian model of acreage response provided the best approximation of brinjal acreage response function in Bangladesh. When dummy variables are used to control for outliers we get the best approximation of acreage response function of brinjal. All the estimated parameters are significant at 5% error probability level, and the explanatory power is also very high. While short-run price is low at 0.03, the long-run price elasticity is marginally higher at 0.08, thereby indicating little scope for output pricing policies to boost production of brinjal.

3.6.2 Arum

A simple Cobweb model of acreage response provided the best approximation of arum response function in Bangladesh. All estimated parameters are significant at 10% or more and the explanatory power is fairly high. The short-run price elasticity is computed at 0.3, which is pretty high. The main lacuna of this result, however, is that serial correlation remained even after correction had been made using Cochrane-Orcutt iterative procedure. Hence the result of price elasticity should be viewed with some caution.

3.6.3 Cauliflower

A Nerlovian model of acreage response function provided the best approximation of acreage response function of cauliflower in Bangladesh shown in (3.20). All estimated parameters of the supply response function are statistically significant at 5% error probability level. However, there remained the problem of auto-correlation even after correction using Cochrane-Orcutt iterative procedure had been made. Moreover, the estimate of rho (P) is not also

significant thus opening up the possibility of some other types of auto-correlation or the problem of model specification. The estimated short-run and long-run price elasticities are 0.07 and 0.51 respectively. However, these elasticity estimates should be taken with caution since the coefficients are fairly over estimated owing to the presence of positive auto-correlation.

3.6.4 Cabbage

The price, lagged acreage, and yield variables alone explain 99% of the total variation in cabbage acreage. Cabbage supply response estimates are among the best for the commodities considered in this study. Since both the price and yield parameters are significant in model (3.21), it has been possible to estimate both short-run and long-run price and yield effects. The short-run and long-run price elasticities are at 0.08 and 0.28 respectively. Thus the long-run price elasticity is significantly higher than the short-run price elasticity. The same argument also holds for short-run and long-run yield elasticities. These are 0.48 and 1.83 respectively. The high magnitude of long-run price elasticity might have made room for using output pricing policy in boosting production of the crop in face of growing demand for the crop from the Middle East and the European Countries.

3.6.5 Tomato

A Nerlovian model provided the best approximation of acreage response function of tomato in Bangladesh. All estimated parameters are significant at 5% error probability level and the explanatory power is also very high. While the short-run price elasticity is low at 0.08, the long-run price elasticity is much higher at 0.29 thereby indicating the possibility of output pricing policies to boost tomato production in Bangladesh. Hence, the cultivation of the crop is and will likely be profitable in the eve of growing demand both in home and abroad especially in European Communities and the Middle East countries.

Table-5

Econometric Estimates of Supply Response Functions for Individual Vegetables

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Brinjal. $BJA_t = \underset{(6.48)}{44960.07} + \underset{(7.84)}{0.69}\ BJA_{t-1} + \underset{(2.67)}{65.46}\ (\frac{PBJ}{HPI})_{t-1} + \underset{(6.47)}{8253.60}\ YBJ_{t-1} - \underset{(3.67)}{1480.85}\ D_1 - \underset{(-5.60)}{2243.52} D_2$ $R^2 = 0.95$ DW = 1.722 (3.18)

Arum. $ARA_t = \underset{(0.40)}{39060.85} + \underset{(2.13)}{199.91}\ (\frac{PAR}{HPI})_{t-1} + \underset{(1.98)}{2581.90}\ D_1 - \underset{(-2.07)}{2901.54}\ D_2$ $R^2 = 0.90$ DW = 1.486 (3.19)

Cauliflower. $CFA_t = \underset{(2.01)}{1686.64} + \underset{(15.43)}{0.86}\ CFA_{t-1} + \underset{(4.22)}{34.97}\ (\frac{PCF}{HPI})_{t-1} + \underset{(2.50)}{674.70}\ D_1 - \underset{(-4.10)}{728.35}\ D_2$ $R^2 = 0.99$ DW = 1.691 (3.20)

Cabbage. $CBA_t = \underset{(-2.28)}{-4548.60} + \underset{(11.20)}{0.74}\ CBA_{t-1} + \underset{(5.32)}{66.38}\ (\frac{PCB}{HPI})_{t-1} + \underset{(2.94)}{2495.50}\ YCB_{t-1} + \underset{(4.60)}{838.84}\ D_1 - \underset{(-4.52)}{940.27}\ D_2$ $R^2 = 0.99$ DW = 1.949 (3.21)

Tomato. $TMTA_t = \underset{(2.33)}{4668.95} + \underset{(5.93)}{0.72}\ TMTA_{t-1} + \underset{(2.62)}{77.39}\ (\frac{PTMT}{HPI})_{t-1} + \underset{(2.67)}{1689.58}\ D_1$ $R^2 = 0.96$ DW = 2.399 (3.22)

Radish. $RDA_t = \underset{(-3.56)}{-57618.82} + \underset{(2.64)}{309.04}\ (\frac{PRD}{HPI})_{t-1} + \underset{(6.46)}{31427.80}\ YRD_{t-1} - \underset{(-3.51)}{6862.12}\ D_1$ $R^2 = 0.85$ DW = 2.197 (3.23)

Beans. $BNA_t = \underset{(2.77)}{1875.69} + \underset{(9.55)}{0.79}\ BNA_{t-1} + \underset{(2.29)}{58.90}\ (\frac{PBN}{HPI})_{t-1}$ $R^2 = 0.95$ DW = 1.817 (3.24)

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

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3.6.6 Radish

A simple Cobweb model provided the best approximation of acreage response function of radish in Bangladesh. All the estimated parameters are significant at the 5% error probability level, and the explanatory power is also fairly high at 85%. Since no lagged dependent variable appears in the model we have only short-run price and yield elasticities. These are computed as 0.16 and 2.83 respectively. The high magnitude of short-run price elasticity indicates substantial scope for output pricing policies to influence production of the crop in Bangladesh.

3.6.7 Beans

A Nerlovian model provided the best approximation of acreage response function of beans in Bangladesh. Lagged acreage and price variables alone, explain the 95% of the total variation in beans acreage. After having been corrected the problem of autocorrelation using the Cochrane - Orcutt iterative procedure we arrived at fairly good estimates of lagged acreage and price parameters. While the short-run price elasticity shown in model (3.24) is low at 0.1, the long-run price elasticity is much higher at 0.51 revealing the scope for output pricing policies to influence production of the crop.

3.7 Tuber Roots

3.7.1 Potato

A Nerlovian model of acreage response gave the best approximation of potato supply response function in Bangladesh. All estimated parameters are statistically significant at the 5% error probability level and the explanatory power is very high. While the short run price elasticity is low at 0.01 the long run price elasticity is higher at 0.21 indicating some scope for using output pricing policy to influence the production of the crop.

Table-6

Econometric Estimates of Supply Response Function for Tuber Roots

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$$\text{Potato. } PTA_t = \underset{(1.42)}{15223.80} + \underset{(22.25)}{0.94}\, PTA_{t-1} + \underset{(2.41)}{120.95} \left(\frac{PPT}{HPI}\right)_{t-1} + \underset{(9.29)}{18191.65}\, D_1 + \underset{(6.18)}{10271.49}\, D_2 \qquad R^2 = 0.99,\ DW = 1.663 \qquad (3.25)$$

$$\text{Sweet Potato. } SPA_t = \underset{(-2.12)}{-204907.83} + \underset{(2.05)}{858.06} \left(\frac{PSP}{HPI}\right)_{t-1} + \underset{(3.67)}{81202.35}\, YSP_{t-1} + \underset{(3.07)}{31946.66}\, D_1 - \underset{(-3.75)}{24064.60}\, D_2 \qquad R^2 = 0.82,\ DW = 1.937 \qquad (3.26)$$

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

3.7.2 Sweet Potato

A Nerlovian model provided the best approximation of sweet potato acreage response function in Bangladesh. Although the parameters of both price and yield are statistically significant at the 5% error probability level or more, the explanatory power is not so high. The short-run price and yield elasticities are 0.08 and 2.27 respectively. The magnitude of short-run price elasticity indicates that there is little scope for output pricing policies to boost the production of the crop in Bangladesh.

3.8 Cash and Other Crops

3.8.1 Jute

Jute cultivation is a completely commercial activity in agricultural sector of Bangladesh given the world market demand conditions. Even today, over of 29% total foreign exchange earnings originate from jute. Jute competes directly with Aus for land. Jute prices are, therefore, deflated by Aus prices in acreage response model estimation. The inclusion of dummy variables in model (3.27) enhanced the explanatory power substantially and the high significance of parameter estimates remains unchanged. Inclusion of lagged acreage variable and assuming Nerlovian expectations provide parameter estimates which are all statistically significant at the 1% error probability level. The

short-run and long-run price elasticities of jute are high at 0.49 and 0.68 respectively, which would be expected in case of a cash crop.However,there is little significant difference between the short run and the long run price elasticities.

3.8.2 Sunhemp

Sunhemp is a fiber like jute and is used to furnish broadly the same purposes as jute does. Hence, its cultivation is also a completely commercial activity in the agricultural sector of Bangladesh. A simple Cobweb model for acreage response provided the best approximation of sunhemp supply response function in Bangladesh. The estimated price parameter is statistically significant at the 1% error probability level and the explanatory power is also very high. The short-run price elasticity is high at 0.71, which one would expect for a cash crop like it in Bangladesh.

3.8.3 Cotton

Cotton has experienced a rapid increase supported by government initiatives since 1976/77. In this situation it is rather difficult to capture the effect of relative price changes on cotton supply analysis. However, a simple Cobweb model provided the reasonable approximation of cotton supply response function in Bangladesh. Although the yield coefficient is significant at the 5% error probability level, the price coefficient is significant only at the

10% error probability level. The explanatory power is also not satisfactory. The short-run price and yield elasticities are 0.16 and 0.34 respectively thereby indicating some scope for using output pricing policy.

3.8.4 Sugarcane

A lagged acreage response function for sugarcane provided meaningful results. The lagged adjustment parameter computed from the coefficient of the lagged acreage variable shows that about 21% of the adjustment of acreage in response to a real price changes in the previous year takes place within the following year (decision period). Sugarcane yield did not offer any significant explanation for the variation in acreage from year to year. Both the price and lagged acreage parameters are statistically significant at the 1% error probability and the explanatory power is also very high. The short-run price elasticity of sugarcane is 0.15, implying that a 10%, increase in real price will raise sugarcane acreage only by 1.5%. The long-run price elasticity is, however, almost 55% higher at 0.73. This magnitude of high long-run price elasticity indicates that there is substantial scope for output pricing policy in boosting the production of the crop. This is an important finding since sugar is a major import item of the country. And hence, increased domestic production of sugar would reduce the budgetary burden of import of the government.

Table-7

Econometric Estimates of Supply Response Functions for Cash and Other Crops

Jute.	$JUA_t = 330597.86 + 0.28\ JUA_{t-1} + 582245.16\ (\frac{PJU}{PA})_{t-1} + 328121.67\ D_1 - 166408.77\ D_2$ (3.12) (5.37) (2.30) (6.41) (-2.78)	$R^2 = 0.97$ DW = 2.117	(3.27)
Sunhemp.	$SNA_t = 275.39 + 72.64\ (\frac{PSN}{HPI})_{t-1} + 7001.57\ D_1$ (0.16) (3.04) (5.04)	$R^2 = 0.95$ DW = 2.170	(3.28)
Cotton.	$CTA_t = 11906.96 + 81.74\ (\frac{PCT}{HPI})_{t-1} + 80959.54\ YCT_{t-1} + 11639.97\ D_1$ (2.89) (1.87) (2.40) (2.01)	$R^2 = 0.69$ DW = 1.607	(3.29)
Sugarcane.	$SGA_t = 29798.55 + 0.79\ SGA_{t-1} + 10224.47\ (\frac{PSG}{HPI})_{t-1} + 43450.29\ D_1 - 45443.61\ D_2$ (0.98) (13.32) (3.96) (5.16) (-7.05)	$R^2 = 0.96$ DW = 1.893	(3.30)
Tobacco.	$TBA_t = -137052.46 + 191.76\ (\frac{PTB}{HPI})_{t-1} + 640581.87\ YTB_{t-1} - 13488.89\ D_1 + 11304.76\ D_2$ (-4.72) (7.24) (8.13) (-2.93) (3.17)	$R^2 = 0.93$ DW = 2.024	(3.31)
Melon.	$MLNA_t = 6387.13 + 0.49\ MLNA_{t-1} + 124.30\ (\frac{PMLN}{HPI})_{t-1} + 2812.03\ D_1 - 2731.47\ D_2$ (1.97) (2.48) (3.07) (2.56) (-2.43)	$R^2 = 0.85$ DW = 2.233	(3.32)

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

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3.8.5 Tobacco

A simple Cobweb model provided the best approximation of acreage response function for tobacco in Bangladesh. As observed in model (3.31) price and yield variables alone, explain 93% of the total variation in tobacco acreage. Moreover, these two variables are statistically significant at 1% error probability level. Tobacco is a cash crop and hence, price response is expected to be high. The short-run price and yield elasticities are 0.23 and 1.87 respectively. The magnitude of short-run price elasticity implies that a 10% increase in relative price of tobacco would increase acreage by approximately 2.3% in the short-run.

3.8.6 Melon

A lagged acreage response function provided the best approximation of melon supply response function in Bangladesh. All estimated parameters are statistically significant at the 5% error probability level and the explanatory power is also fairly high. The short-run and the long-run price elasticities are 0.23 and 0.45 respectively indicating some scope for output pricing policies to influence the production of this seasonal fruit in Bangladesh.

Table-8

Price Elasticities of Supply for Individual Agricultural Commodities

	Price Deflator	Price Elasticity (Short-run)	Price Elasticity (Long-run)
1 Aus	PJU	0.02**	0.14
2 Aman	HPI	0.36**	0.55
3 Boro	HPI	0.50**	2.86
4 Wheat	PBO	0.61*	5.24
5 Barley	HPI	0.19**	2.79
6 Maize	HPI	0.09**	1.58
7 Masur	HPI	0.07***	1.09
8 Motor	HPI	0.05***	1.20
9 Mashkalai	HPI	0.11***	0.91
10 Khesari	HPI	0.04**	0.25
11 Til	HPI	0.25**	0.98
12 Rape & Mustard	HPI	0.13*	0.27
13 Linseed	HPI	0.11**	0.32
14 Chilies	HPI	0.05*	0.17
15 Onion	HPI	0.05**	0.09
16 Garlic	HPI	0.001***	0.01
17 Turmeric	HPI	0.03*	0.05
18 Ginger	HPI	0.04**	0.45
19 Brinjal	HPI	0.03**	0.08
20 Arum	HPI	0.30***	0.30
21 Cauliflower	HPI	0.07*	0.51
22 Cabbage	HPI	0.08*	0.28
23 Tomato	HPI	0.08**	0.29
24 Radish	HPI	0.16**	0.16
25 Beans	HPI	0.10**	0.51
26 Sugarcane	HPI	0.15*	0.73
27 Jute	PA	0.49*	0.68
28 Cotton	HPI	0.16***	0.16
29 Sunhemp	HPI	0.71*	0.71
30 Tobacco	HPI	0.23*	0.23
31 Melon	HPI	0.23*	0.45
32 Potato	HPI	0.01**	0.21
33 S.Potato	HPI	0.08***	0.08

Notes:

i. *denotes significance at the 1% error probability level.

ii. **denotes significance at the 5% error probability level.

iii. ***denotes significance at the 10% error probability level.

iv. Significance test for long-run elasticities are not necessary since these were indirectly estimated.

3.9 Group Commodities

It is highly useful for policy analyses to group the individual commodities considered in this study into broader groups and investigate their output supply structures. Thus, the commodities have been aggregated into six groups, viz., foodgrain, rice, pulses, oilseeds, spices, and vegetables. Supply response functions have been estimated for each of these commodity groups using alternative specifications. Moreover, contrary to our initial setting we also estimated the output supply response function along with the acreage supply response function for each of the 'group' crops except for pulses for reasons discussed later on. In these estimations, the price variable for each group is the (output) weighted average of all individual crop prices. The same holds for the respective yield variables. Again only the best results of econometric estimations are presented. All price and yield elasticity estimates obtained from the econometric results are shown in Table-10 and Table-11 respectively.

3.9.1 Rice

The rice price variable is the weighted average of harvest prices of Aus, Aman and Boro. Output weights have been used. Deflation of rice price by the Harvest Price Index did not yield satisfactory results in most of the estimations. The best results were obtained when the Non-Rice Agricultural Price Index (NR) was used as the deflator. NR excludes rice and is indeed the

more appropriate deflator. The yield variable is also a weighted average of all individual rice yields with the weights being the output shares of the three rice crops.

The econometric results for rice supply functions are very good as may be observed from equations (3.33) and (3.34). The explanatory power of all estimated models are excellent. In the acreage response function both the price and yield parameters are statistically significant at the 5% and 1% error probability levels respectively. Since the lagged acreage variable was never statistically significant in estimation of acreage supply response, it was not possible to estimate the long-run acreage response for rice. Thus, there is no difference between the short-run and long-run elasticities. Furthermore, the magnitude price elasticity is very low at 0.06, reflecting the fact that rice is a subsistence crop as distinct from a commercial crop meant to be exchanged in the market.

The lagged output variable was never statistically significant in estimations of output supply response. Thus, it was not possible to estimate a long-run output supply response for rice as was the case in the acreage response function. Thus, model of output response is of the Cobweb-type. And hence, the short-run price elasticity of output supply which is 0.24 is not different from the long-run output supply elasticity.

Table-9

Econometric Estimates of Supply Response Functions for 'Group' Commodities

Rice.	$RA_t = \underset{(15.89)}{20230527.00} + \underset{(2.07)}{29811.68} \left(\frac{PR}{NR}\right)_{t-1} + \underset{(5.25)}{6681335.40}\, YR_{t-1} - \underset{(-3.99)}{674129.06}\, D_1 + \underset{(4.56)}{768800.09}\, D_2$	$R^2 = 0.88$, DW = 1.716	(3.33)
	$RQ_t = \underset{(-2.09)}{-5945839.10} + \underset{(1.90)}{67988.74} \left(\frac{PR}{NR}\right)_{t-1} + \underset{(10.14)}{31265215.00}\, YR_{t-1} - \underset{(-2.06)}{1313485.80}\, D_1$	$R^2 = 0.38$, DW = 2.656	(3.34)
Foodgrain.	$FA_t = \underset{(3.08)}{7143451.90} + \underset{(6.31)}{0.62}\, FA_{t-1} - \underset{(2.43)}{28434.81} \left(\frac{PF}{NF}\right)_{t-1} + \underset{(2.33)}{2646415.30}\, YF_{t-1} + \underset{(2.84)}{651962.20}\, D_1 - \underset{(-5.13)}{1000860.90}\, D_2$	$R^2 = 0.94$, DW = 2.452	(3.35)
	$FQ_t = \underset{(-0.81)}{-942173.90} + \underset{(27.72)}{0.98}\, FQ_{t-1} + \underset{(2.43)}{37226.68} \left(\frac{PF}{NF}\right)_{t-1} + \underset{(7.66)}{2664133.60}\, D_1 - \underset{(-4.25)}{1517732.70}\, D_2$	$R^2 = 0.99$, DW = 2.355	(3.36)
Pulses.	$PUQ_t = \underset{(-0.22)}{-20011.26} + \underset{(7.63)}{0.92}\, PUQ_{t-1} + \underset{(1.84)}{786.80} \left(\frac{PPU}{HPI}\right)_{t-1} + \underset{(5.45)}{51105.47}\, D_1 - \underset{(-4.26)}{51806.98}\, D_2$	$R^2 = 0.94$, DW = 1.894	(3.37)
Oilseeds.	$OA_t = \underset{(-1.00)}{129720.23} + \underset{(9.96)}{0.93}\, OA_{t-1} + \underset{(2.34)}{1926.95} \left(\frac{PO}{HPI}\right)_{t-1} + \underset{(4.35)}{107982.10}\, D_1$	$R^2 = 0.92$, DW = 2.411	(3.38)
	$OQ_t = \underset{(1.54)}{71564.92} + \underset{(4.92)}{0.51}\, OQ_{t-1} + \underset{(5.39)}{1101.47} \left(\frac{PO}{HPI}\right)_{t-1} + \underset{(3.71)}{27250.16}\, D_1 - \underset{(-3.92)}{28804.04}\, D_2$	$R^2 = 0.88$, DW = 2.205	(3.39)
Spices.	$SA_t = \underset{(2.40)}{129920.32} + \underset{(4.07)}{0.61}\, SA_{t-1} + \underset{(1.84)}{77.82} \left(\frac{PS}{HPI}\right)_{t-1} + \underset{(3.34)}{19096.99}\, D_1 - \underset{(-4.93)}{21016.86}\, D_2$	$R^2 = 0.83$, DW = 1.507	(3.40)
	$SQ_t = \underset{(9.64)}{221837.26} + \underset{(3.73)}{134.08} \left(\frac{PS}{HPI}\right)_{t-1} + \underset{(2.44)}{67777.00}\, YS_{t-1} - \underset{(-7.74)}{54290.05}\, D_1$	$R^2 = 0.91$, DW = 1.932	(3.41)
Vegetables.	$VA_t = \underset{(0.86)}{4707.03} + \underset{(29.34)}{0.97}\, VA_{t-1} + \underset{(1.96)}{270.96} \left(\frac{PV}{HPI}\right)_{t-1} - \underset{(-3.26)}{6134.40}\, D_1 + \underset{(4.81)}{7844.93}\, D_2$	$R^2 = 0.99$, DW = 2.412	(3.42)
	$VQ_t = \underset{(9.17)}{361725.08} + \underset{(6.16)}{10158.16} \left(\frac{PV}{HPI}\right)_{t-1} + \underset{(3.82)}{104494.29}\, D_1 - \underset{(-2.49)}{97503.08}\, D_2$	$R^2 = 0.78$, DW = 2.417	(3.43)
Aggregate Output	$TOTQ_T = \underset{(-0.35)}{-603712.57} + \underset{(17.55)}{0.98}\, TOTQ_{t-1} + \underset{(7.70)}{153617.20}\, TT_{t-1} + \underset{(2.12)}{1538950.50}\, D_1$	$R^2 = 0.93$, DW = 2.235	(3.44)

Note: Figures in the parentheses are 't' statistics of the estimated parameters.

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It is evident that in the short-run output price policies offer very little scope for increasing supply. The results show quite clearly that yield is an important factor in explaining the variation in rice supply (both in output or acreage). An interesting notion is given by the yield elasticity of output. It shows the percentage change in output attributable to a 1% change in yield. Model (3.34) shows the short-run yield elasticity to be 1.22 which is several times higher than the price elasticity. While a 10% increase in real rice price would increase output by about three percent, the same increase in yield level would increase output by more than twelve percent in the short-run.

The large magnitude of the yield elasticity variable suggests that the short-run optimal policy for raising production would be to raise yields rather than output price (via price supports, for example). These econometric results confirm the notion that the scope of output price policies is limited and that technical change must provide the vehicle for boosting agricultural production in Bangladesh at least in the foreseeable future. Thus, investment in yield augmenting agricultural technology holds the key to raising production. However, output price policy and technology policy should not be viewed as being conflicting. Focussing on technical change in the short-run, is likely to allow a large surplus over subsistence to be realized in the long-run and hence, will probably increase the price sensitivity of rice production.

Table-10

Price Elasticities of Supply for 'Group' Agricultural Commodities

Commodities	Model	Price Deflator	Price Elasticity (Short-run)	Price Elasticity (Long-run)
Rice	Acreage	NR	0.06***	0.06
	Output	NR	0.24***	0.24
Foodgrain	Acreage	NF	0.05**	0.14
	Output	NF	0.10**	6.40
Pulses	Output	HPI	0.09***	1.20
Oilseeds	Acreage	HPI	0.14**	2.07
	Output	HPI	0.30*	0.61
Spices	Acreage	HPI	0.02***	0.06
	Output	HPI	0.05*	0.05
Vegetables	Acreage	HPI	0.03***	0.92
	Output	HPI	0.39*	0.39
Aggregate Supply	Output		0.05*	2.67

Notes:

i. *denotes significance at the 1% error probability level.

ii. **denotes significance at the 5% error probability level.

iii. ***denotes significance at the 10% error probability level.

iv. Significance test for long-run elasticities are not necessary since these were indirectly estimated.

3.9.2 Foodgrains

Foodgrains include rice, wheat, barley and maize in this study. The price variable is a (output) weighted average of the three rice crops, wheat, barley, and maize. Likewise the yield variable is also a weighted average of rice, wheat, barley, and maize yields. In the case of acreage supply response the Nerlovian model provided the best results. The most appropriate deflator

for price in case of foodgrain is the Non-Foodgrain Price Index (NF). In fact, all the coefficients were statistically significant at an acceptable level only when NF was used as the deflator. Both price and yield coefficients are significant at acceptable levels and the model explains 94% of the variation in foodgrain acreage. Again, in accordance with expectation a very small price elasticity magnitude is obtained. By comparison the yield elasticity is relatively larger. While the short run and the long-run price elasticities are 0.05 and 0.14 respectively, the same for yield are 0.07 and 0.18 respectively. Thus, the same policy implications about focussing on technical change in the short-run to boost production holds in case of foodgrain also.

In case of output supply response the Nerlovian model provided the best results. As in the case of acreage the most appropriate deflator for price is the NF. The lagged output and the price variables are significant at 1%, and 5% error probability levels respectively. The difference between the short-run and the long-run price elasticities, which are 0.10 and 6.40 respectively, reflects the divergence of the adjustment parameter from unity. Moreover, unlike in the acreage response function, the yield variable is not statistically significant in the output supply response function, thereby indicating the fact that the policy implications should be drawn on the basis of output pricing policy only.

Lastly, it should be noted that dichotomous dummy variables are used both in the acreage and the output supply response function to control for

outliers. And, this helped improve the significance of individual co-efficient estimates as well as the over-all significance.

3.9.3 Pulses

The six major pulse varieties grown in Bangladesh, i.e., Gram, Masur, Motor, Mung, Mashkalai, and Khesari have been aggregated under the head 'pulses'. Model (3.37) is the only reasonable econometric result that could be obtained. The yield data for all individual pulses except Motor and Mashkalai show a tendency to decline in the period under consideration. However, there is no plausible reason for yields of any Rabi crop to decline over time. Yield, has therefore not been used as a proxy for technical progress in alternative estimating equations. Deflation of price with the RPI did not yield meaningful results, nor were experiments with pulse acreage functions successful since the estimation of acreage response function came out with non-sense results. All parameters of model (3.37) are statistically significant at the 10% level or more and the explanatory power of the model is satisfactory. Co-efficient of the lagged dependent variable shows that only 8% of the adjustment of pulse output to a change in real price takes place within the year. The short-run and the long-run price elasticities are 0.09 and 1.20 respectively. Thus, the long-run price elasticity is much higher than the short-run price elasticity.

3.9.4 Oilseeds

Rape and mustard, till, linseed, and groundnut have been aggregated to give oilseeds output/acreage in this study. Similar problems of yield data were evident in case of oilseeds. Yield was not statistically significant in explaining supply behavior either in the acreage response or in the output response models in the several experiments carried out. The lagged acreage adjustment model without yield variable gave the best results. All coefficients were statistically significant at the 5% level or more when the HPI was used as the deflator. Thus, model (3.38) may be taken as the 'best' approximation of the actual oilseeds acreage response function. As in the case of pulses, the co-efficient of the lagged acreage variable shows that only 7% of the adjustment of acreage to real price change takes place within the year (short-run) and hence there is great divergence between the short-run and long-run price elasticities. The short-run and the long-run price elasticities are 0.14 and 2.07 respectively. Hence, there is scope for using price policies to raise production particularly in the long-run.

Like the acreage response function a Nerlovian model without the yield variable provided the best approximation of output supply response function for oilseeds. All the estimated coefficients are significant at 1% error probability level. The lagged output and the price variable alone account for 88% of the total variation in the oilseeds output. Because of the significance of lagged output coefficient we have both short-run and long-run price

elasticities. These are 0.30 and 0.62 respectively. It should be noted that the magnitudes of these elasticities are relatively low. However, these low magnitudes can be accepted on the ground that like pulses etc. edible oils (obtained from oilseeds) also are consumed as complement to rice in Bangladesh. Further, the magnitudes indicates that there is some scope for output pricing policy to influence the production of the crops in the long-run.

3.9.5 Spices

Spices include chilies, onion, garlic, turmeric, and ginger in this study. The price and yield variables are the weighted average of component prices where the weights being the output shares of comprising crops. Acreage response function did not yield reasonable estimate when RPI was used as a deflator. Instead HPI gave better estimate of the acreage response function. While the lagged acreage variable is significant at 1% error probability level, the price variable is significant only at 10% error probability level. The estimated coefficient of lagged acreage shows that 39% of the adjustment takes place within a year. The short-run and the long-run price elasticities are 0.02 and 0.06 respectively. There is, thus, little scope for output pricing policy in boosting the production of the crops.

In case of output supply response function the Cobweb-type model gave the better estimate. Both the price and yield variables are significant at 1% and 5% error probability levels respectively. When the dummy variable was used

the individual coefficient significance as well overall significance improved markedly. The price and yield variables can explain 91% of the total output variation. The short-run price and yield elasticities are 0.05 and 0.20 respectively. Thus yield augmenting policy as opposed to output pricing policy can help increase in production in the long-run.

3.6 Vegetables

The production/acreage of seven major vegetables, viz., brinjal, arum, cauliflower, cabbage, tomato, radish, and beans have been added to give the vegetables group in this study. The lagged supply adjustment model with acreage as the dependent variable gives the best results. Therefore, both short-run and long-run elasticities could be computed. All estimated parameters are statistically significant at the 5% level or more and the explanatory power is highly satisfactory. Co-efficient of the lagged dependent variable shows that only 3% of the adjustment of acreage to lagged real price change takes place within the current year. The short-run and the long-run price elasticities are 0.03 and 0.92, respectively. Thus, there is some scope for influencing production favorably through price policies in the long-run.

Table-11

Yield Elasticities of Supply for 'Group' and Individual Agricultural Commodities

Commodities	Model	Price Deflator	Yield Elasticity (Short-run)	Yield Elasticity (Long-run)
Rice	Acreage	NR	0.15*	0.15
	Output	NR	1.22*	1.22
Foodgrain	Acreage	NF	0.07**	0.18
Spices	Output	HPI	0.20**	0.20
Motor	Acreage	HPI	0.21***	4.86
Mashkalai	Acreage	HPI	0.85*	7.27
Turmeric	Acreage	HPI	0.34*	0.59
Brinjal	Acreage	HPI	0.32*	1.04
Cabbage	Acreage	HPI	0.48*	1.83
Radish	Acreage	HPI	2.83*	2.83
Cotton	Acreage	HPI	0.34**	0.34
Tobacco	Acreage	HPI	1.87*	1.87
Sweet Potato	Acreage	HPI	2.27*	2.27

Notes:

i. *denotes significance at the 1% error probability level.

ii. **denotes significance at the 5% error probability level.

iii. ***denotes significance at the 10% error probability level.

iv. Significance test for long-run elasticities are not necessary since these were indirectly estimated.

Again, the fit of the estimated output response function was poor. Meaningful econometric results can be obtained only when a Cobweb-type model is used to estimate the output supply response function of vegetables. All estimated coefficients are statistically significant at 1% error probability level or more. Moreover, when dichotomous dummy variables are used to control for outliers the individual coefficient significance as well as the overall significance improve markedly. The short-run price elasticity is 0.39. This is a quite fascinating magnitude of short-run vegetables supply elasticity indicating that there is some scope for pricing policy to boost production of vegetable in the face of growing demand from home and abroad.

3.9.7 Aggregate Supply

In addition to the 'group' supply response functions we have estimated an aggregate supply response function by regressing the aggregate output on the lagged aggregate output and the domestic terms of trade defined as the ratio of the agricultural harvest price index to the industrial price index. This Nerlovian function provided satisfactory estimates in that the individual coefficients are significant at 1% error probability level. Further, the overall fit is also satisfactory in that the coefficient of determination, R^2, is 93%. The short-run and the long-run price elasticities are 0.05 and 2.67 respectively. There is, thus, scope for output pricing policy to boost output in the long-run. This is important since the country can achieve self-reliance in agricultural output by carefully manipulating the agricultural pricing policies.

Section Four

Summary and Conclusions

This study has investigated the supply response of 32 individual agricultural commodities, 6 'group' commodities, and aggregate output. The study began with an overview of the evolution of agricultural pricing policies in Bangladesh since 1971. The most recent "normal" year after the emergence of Bangladesh in 1971 (viz. 1985/86) was chosen as the base year in the calculation of various indices.

Some significant changes have taken place in the structure of agricultural production in Bangladesh since 1971. First, among the rice crops the significant growth in Boro production is continuing. Most of the expansion of rice output is, however, due to increased acreage. However, irrigation has mainly been responsible for the rapid increase in Boro production. Most of the Boro crop uses the seed - fertilizer - irrigation technology and has played a crucial role in keeping the food deficit within limits.

Second, there has been an equally impressive growth in wheat production. However, unlike Boro most of the growth in wheat output is attributable to increases in yield. The sharp increase in wheat production and the rapid acceptance of wheat by the lower income groups as a substitute for rice in consumption has been surprising. From an insignificant agricultural commodity

in 1972/73, it now ranks second after the rice crops. (Aman, Aus and Boro in terms of output value).

The importance of jute in Bangladesh agriculture has declined. Depressed world market conditions have caused jute acreage and output to fall. The output of other crops including cash crops have stagnated despite potential for expansion. The pressure of foodgrain production appears to have restrained farmers from allocating more land to other crops. The non-food Rabi crops do not seem to have received adequate public policy support and hence their full potential is far from being realized. Production of these crops may be increased substantially by exploiting the world market. However, there may be large price increase of some of these crops if they are exported. Policy makers would have to reckon with this possibility since the overwhelming proportion of farmers are net consumers of these commodities.

This study provides the most detailed analysis of supply price response of agricultural commodities available for Bangladesh. In spite of problems relating to the quality of available data the econometric results obtained for almost all crops are very good. The range of elasticities obtained are not contrary to expectation and are also comparable to estimates available for similar developing countries. The price elasticities of cash crops, e.g., jute, tobacco, cotton, and sugarcane are relatively higher as one would expect. The price elasticity of Boro rice which is not produced mainly for subsistence, is also high. Theoretically plausible results could be obtained

for jute only when Aus price was used as the price deflator; for wheat only when Boro price was used as the price deflator; for foodgrains only when the non-foodgrain agricultural price index was used as the price deflator. The signs of price and yield parameters consistently conformed to *a priori* expectations and the explanatory power of estimated equations are satisfactory in general. The results are intuitively appealing. Thus, it may be inferred that the quality of annual time series data as transformed and used here is in general good.

It is evident from the price elasticity estimates that Aman and Aus rice cannot be influenced significantly by output price policies. However, the Boro rice crop can be substantially influenced by a price support policy. The rapid expansion in production of wheat took place in response to the demand for foodgrain and under substantial government support. The influence of relative price on wheat supply was therefore, not statistically significant. The full potential for wheat production in Bangladesh may actually have been relaxed and further expansion at least at this rate should not be expected.

Cotton production in Bangladesh dropped sharply in 1971, during the War of Independence. It was followed by further declines until 1975/6. Production had not reached its 1971 level even in 1989/90. Substantial amount of cotton are produced under government support, and so, a statistically significant price elasticity could not be obtained.

The supply price elasticity was statistically significant for all cash crops except cotton. The magnitude of the short-run price elasticity of Aman, Boro, Wheat, Til, Arum, Jute, Sunhemp, Tobacco, and Melon were 0.36, 0.50, 0.61, 0.25, 0.30, 0.49, 0.71, 0.23 and 0.23 respectively. These magnitudes suggest that there is some scope, albeit restricted, for price policies to raise production of cash crops.

Price elasticity estimates for most of the 'group' commodities also suggest a rather limited scope for price policy to raise production of food-grain, pulses, and species respectively. By contrast, price elasticities estimated for rice, oilseeds, and vegetables were much higher. Moreover, the yield elasticity of rice is also much higher. Increasing yield, i.e., effecting technical change in agriculture is the "best" option to ensure rapid growth of production. However, increasing yield and output price support policies need not be viewed as conflicting objectives of public policy makers. At this stage of its development it appears that technical change (initiated and heavily supported by government) should be emphasized as an instrument for raising production. Once a threshold level of productivity resulting from technical change has been attained, the price sensitivity of agricultural output would increase. The relative importance of output price policies is likely to increase beyond that stage.

Input price subsidies have been rapidly withdrawn in Bangladesh and at present there is virtually no input subsidies in Bangladesh. If input price

subsidies had strained the public exchequer, it is likely that output price supports would strain the exchequer much more. Doubling the rice/foodgrain price for example, increases rice/foodgrain supply by merely 5-6%. Supporting foodgrain prices to provide incentives for farmers to raise foodgrain supply would certainly prove socially costly. Extension of credit facilities to farmers and its regulation in order to allow them to adjust their decisions in line with market signals, while focussing on continuous yield improvements appears to be the most appropriate policy to boost agricultural production.

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