Bangladesh J. Agric. Econs XXVII, 2 (2004) 25-44

DEMAND, SUPPLY ESTIMATION AND PROJECTION OF WHEAT SITUATION IN BANGLADESH

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ABSTRACT

This paper fills an information gap regarding factors affecting the supply and demand for wheat in Bangladesh. The short and long run supply elasticities were estimated using the Nerlovian Partial Adjustment model while demand elasticities were estimated by single equation model and different types of functions were fitted to study the income consumption relationship for wheat in Bangladesh. The gap between demand and supply has also been worked out. The demand for wheat will continue to increase rapidly but its demand in the urban areas will increase at a substantially higher rate. The study projected the future demand and supply of wheat up to 2012 A.D. The projections revealed that the country would face the shortage of wheat of about 2314 thousand tonnes during the period 2003 to 2012. So it was suggested that the need for mapping the demand and supply management strategy in the country be met by both the Ministry of Food and Agriculture as soon as possible to cope up the demand situation.

I. INTRODUCTION

Wheat has become an indispensable food item of the people of Bangladesh. The present consumption growth rate of wheat is about 3 per cent. With further urbanisation and industrialisation of the country, the consumption of wheat products obviously will increase further (Ahmed and Meisner 1996, p.179). Therefore, analysis of wheat demand and supply in Bangladesh is extremely important in the context of short and long term planning for economic growth. During the period of rice shortage, the landless, marginal and small farmers depend on wheat as their principal dietary source. As a matter of fact, the availability of local wheat at the time of cereal shortage saves millions of poor farmers from starvation in rural areas. For this reason, special efforts should be made to gear up production of cereal crops, particularly wheat in Bangladesh.

A study of projection of demand for and supply of wheat in a country like Bangladesh is of crucial importance, since it depicts the nature and the scale of problem that the country is likely to face in the years ahead; it leads to considerations of policies that may be needed to prevent the projected imbalances or difficulties from materializing; and it gives the basis for fixing such future targets as self-sufficiency in food. Per capita consumption of wheat has

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increased slowly during the past two decades although aggregate consumption during the same period increased by *3.25* per cent(Ahmed and Meiner *1996,p.179)*. In order to design optimal policy, a good understanding of aggregate demand and supply is required.

A comprehensive analysis of the demand for and supply of wheat does not appear to have been so far undertaken in Bangladesh. Therefore, it is needed to project the demand for wheat in sixth and seventh five-year plan period to see the demand and supply balance.

The paper has been organised in four sections. Methodology of the study is placed in section IL Results are presented and interpretations are given in sections III. Conclusions and policy implications have been made in the last section.

II. METHODOLOGY

Selection of the study area

Four districts of Bangladesh namely Rangpur, Dinajpur, Rajshahi and Pabna were selected for major wheat growing areas for this study. These four districts contributed more than *51* percent towards the country's wheat production (BBS, *1998* p.144). In respect of weather, the western part is more favorable for wheat cultivation. The physical, climatical and socio-economic conditions differ from region to region. Moreover, the magnitude of farmers' response to price varies with crop and for the same crop among different regions/ districts because of variations in resource endowments. So attempts were made to estimate the response of farmers to price and non-price variations of wheat supply in selected districts of Bangladesh. Therefore, it was decided to conduct a supply response analysis at the district level and the country as a whole.

Sources of Data

Data for the present study were collected from secondary sources. Secondary data were collected from various published sources such as Bangladesh Bureau of Statistics (BBS), Department of Agricultural Extension (DAE), Department of Agricultural Marketing (DAM) and other related agencies in Bangladesh.

Selection of Period of the Study

For the time series analysis the study covers the time period of *1982-83* to *1998-99*. This period indicates apparently the last two decades of the twentieth century covering period of intensified liberalized economy than any other time before. Therefore, time series data for the period *1982-83* to *1998-99* were employed for this study. In time series demand analysis the regression line was fitted for the country as a whole only because of non -availability of regional data. The Bangladesh Household Expenditure Survey (HES), *1995/96* provided detail information and quantities of various food items consumed by different income classes of both rural and urban people.

Selection of Price

In the present study harvest prices of wheat was taken for analysis. Harvest prices were farm gate prices of the farmers during harvest time which were taken into consideration for the reason that wholesale and retail prices would not reflect what the farmers actually received.

Selection of Competing Crops

The deflator price was taken as a proxy for the relative profitability for allocating land to the crop under study compared to the alternative use of land. As Boro rice is the main competing crop of wheat to arrive at real prices for wheat the price of Boro rice was used as the deflator.

Demand Estimation

Time series Analysis

For estimating **time series** analysis demand for wheat in Bangladesh, the regression equations were run by taking separately price and quantity as dependent variable.

In the case of wheat the factors that shift the demand curve can be divided into five categories, i) consumer income ii) the general price level iii) supplies and prices of competing products iv) population v) tastes and preferences. To measure the change in tastes and preferences over the years time variable can be used. But it was not some times possible to include time variable because of high correlation between time and price and time and income variables. The size of population is considered by expressing the variables in per capita term. Change in general price level was taken into account by deflating the price and income variable by consumer's price index. Logarithmic equation was fitted to estimate the demand for wheat. The single equation models are given below:

$$LnQ_t = b_o + b_1 Ln\, p_t + b_2\, Ln\, I_t + u_t \quad \text{and}$$

$$Lnp_t = b_o + b_1 LnQ_t + b_2\, Ln\, I_t + U_t$$

Where,

Q_t = Per capita net availability of wheat for consumption in t time
P_t = Retail price of wheat deflated by consumer's price index for time t
I_t = Per capita disposable income deflated by consumer's price index for time t
U_t = Residuals.
T = Time Trend

Cross Section Analysis

In cross section analysis, 1995-96 household expenditure survey data was used for estimating income elasticities of wheat in Bangladesh. The household was divided into 19 income classes in the survey data. Dependent variable can be considered the quantity consumed or the corresponding expenditure of the commodity. For perfectly homogeneous goods it is immaterial whether quantity or expenditure is used as the dependent variable

because price is invariant in this case. However, particularly for food items there are usually a number of qualities with obvious variation in price, and in such circumstances the use of quantity as the dependent variable may under- state the effects of income on consumption patterns (Currie, 1972 p.24). Therefore, expenditure on the commodity is taken as the dependent variable for this study.

Average per capita monthly expenditure on wheat as well as per capita monthly income for each income group was worked out and income elasticity for urban, rural as well as for the nation as a whole was worked out. The following types of functions were fitted to study the income consumption relationship for wheat in Bangladesh.

Type	**Function**	**Elasticity**
Linear	Y = a + bx +U	$b\frac{\overline{X}}{\overline{Y}}$
Logarithmic	LnY = a + bLnx +U	b
Semi-log	Y = a + bLnx +U	$\frac{b}{\overline{Y}}$
Inverse	Y = a + b/x +U	$\frac{-b}{\overline{X}\overline{Y}}$

Where,

Y = Average per capita monthly expenditure on wheat
X = Average per capita monthly income

In selecting elasticity, two things were considered, viz., i) high R^2 and ii) consistent to the real world situation.

The analysis was carried out with the Household Expenditure survey (HES) data of Bangladesh Bureau of Statistics (BBS, 1995-96). These were monthly data collected through a questionnaire survey from 5,760 households covering the whole country (16 households each from 360 primary sampling units, selected using the circular systematic sampling technique). The reference year of the data was 1995-96, which gave estimates of proportions of persons belonging to 19 classes of monthly per head income/expenditure. This implied that 19 observations were used to estimate the equation. Since data corresponding to an observation represented those of the average of households in each income group, they possessed the characteristics of group data. In view of the fact that the number of observations in the different income group were not the same. If the size of each group was not same, the error term (e) of the grouped function would show heteroscedasticity i.e. the variance of the error term was not constant. (Koutosoyiannis, 1977, p. 287). Thus, to test the heteroscedasticity, the Spearman rank correlation coefficient between error terms (e's) and the (x) values was calculated. A high rank correlation coefficient suggested the presence of heteroscedasticity.

Supply Response of Wheat: Econometric Estimates

Nerlovian Partial Adjustment Model

Nerlovian partial adjustment model was used for estimating supply response at district and national level in Bangladesh. The model implies that the changes in current area is in proportion to the difference between the long run equilibrium area and an actual area in the previous year. The double-log (natural) form of the Nerlovian[1] partial model was employed in view of its suitability to the data. Hence we get the following basic equation:

$$LnA_t^* = b_0 + b_1LnP_{t-1} + b_2LnEXYLD_t + b_3LnYR_t + b_4LnPR_t + u_t \quad \text{.....(i)}$$

$$LnA_t - LnA_{t-1} = \mu\,(LnA^*_t - LnA_{t-1}) \qquad 0 \le \mu \le 1 \quad \text{.....(ii)}$$

Where,

A_t^* = The planned or Long –run desired area at time t

LnP_{t-1} = Wheat/Boro harvest Price ratio lagged by a period. For same sowing seasons and more or less similar requirements for irrigation and other inputs, wheat can be considered as the most competitive crop for Boro rice.

$LnEXYLD_t$ = Expected yield in current production period based on moving average of preceding two years yield

$LnYR_t$ = Coefficient of variation of yields based on preceding two production periods[2]

$LnPR_t$ = Coefficient of variation of prices of the preceding two periods[2] (this is based on the price ratio).

$Ln\,A_{t-1}$ =Area variable for the lagged one period

μ = Coeffcinent of adjustment between the desired area and actually realised area

u_t =Error term

The equation (i) cannot be estimated because it includes an un-observable variable A_t^*. If (i) is substituted in (ii), an estimable equation emerges which is shown below.

$$LnA_t - LnA_{t-1} = \mu\{(b_0 + b_1LnP_{t-1} + b_2LnEXYLD_t + b_3LnYR_t + b_4LnPR_t + u_t) - LnA_{t-1}\}$$

$$LnA_t - LnA_{t-1} = \mu b_0 + \mu b_1LnP_{t-1} + \mu b_2LnEXYLD_t + \mu b_3LnYR_t + \mu b_4LnPR_t + \mu u_t - \mu LnA_{t-1}$$

$$\text{or } LnA_t = \mu b_0 + \mu b_1LnP_{t-1} + \mu b_2LnEXYLD_t + \mu b_3LnYR_t + \mu b_4LnPR_t + \mu u_t - \mu LnA_{t-1} + LnA_{t-1}$$

$$= \mu b_0 + \mu b_1LnP_{t-1} + \mu b_2LnEXYLD_t + \mu b_3LnYR_t + \mu b_4LnPR_t + \mu u_t + (1-\mu)LnA_{t-1}$$

$$= \mu b_0 + (1-\mu)LnA_{t-1} + \mu b_1LnP_{t-1} + \mu b_2LnEXYLD_t + \mu b_3LnYR_t + \mu b_4LnPR_t + \mu u_t \quad \text{.....(iii)}$$

Equation (iii) can be estimated by actual data available.

Price Elasticity

The coefficient of price in the area response equation represents the short- run price elasticity. The long- run price elasticity may be obtained by the following formula.

$$E^{P}_{(L)} = E^{Pnt}_{(S)} / \mu$$

Where,

$E^{P}_{(L)}$ = Long run price elasticity

$E^{P}_{(S)}$ = short run price elasticity

μ = Area adjustment coefficient =1- coefficient of lagged dependent variable

Thus, one of the advantages of using Nerlovian dynamic supply response model is the estimation of short- run and long-run elasticities of changes in prices.

Projection of Demand

A demand projection is generally based upon a set of assumption regarding the factors that influence the demand .The quantification of all factors influencing demand is a complex and difficult task. Therefore, the important factors like growth in population, growth in per capita income and income elasticity of demand were taken into account in estimating future demand for wheat in Bangladesh for the period sixth and seventh five year plan.

Base Period Demand

The availability approach was adopted to estimate the base period demand under this approach, the net availability for consumption during a particular year was calculated by the following formula:

$$TC = \{TP - (W + TS) + IW\}$$

Where,

TC = Total net availability for consumption

TP = Total production

W = Wastage which is assumed 0.51%of total production (BBS, 2000 p.451)

TS = Total seed requirement which is calculated by assuming 2.50 per cent (BBS, 2000 p.451)

IW= Imported Wheat

Per capita net availability for consumption is obtained by dividing total availability by the population in a particular year.

The next problem is to choose the base year. A cursory look at the relevant data suggests that we should take the average of three years from 1996-97 to 1998-1999 and centered at 1998-1999.

Factors Affecting Future Demand

The identification of factors that may have influenced the demand and the choice of assumption about their future behaviour are the second consideration in a projection. Such factors are:

Rate of population Growth

Of all the factors affecting the demand for food, the rate of population growth is probably the most important one. The rate is determined by birth rate, the death rate and the net migration rate. The population for different year calculated by BBS on the assumption that the population will grow at a continuously diminishing rate was used for this study. The total population is calculated using the data of Bangladesh Bureau of Statistics by giving weight 1.0, 0.8 and 0.5 to adult male, adult female and children respectively. Projected value is calculated using the following semi-logarithmic equation.

$$LnY_i = a + bt \quad \text{.....(i)}$$

Where,

LnY_i = Dependent variable (population in the natural logarithmic value

b = Annual rate of change in the logarithmic of Y

t = Number of years from the base year of the series

Rate of Income Growth

This is another important factor comparatively more difficult to estimate. Per capita growth of real income was calculated by fitting exponential function ($Y_t = ae^{bt}$) to the per capita disposable income (at constant price) data during the period of 1989-1999.

Income Elasticity of Demand

The parameter essential for projection was estimated by using 1995-96 household expenditure survey data, where income elasticity was calculated from the best fitted equation.

Formula for Projection

For projecting per capita demand the following model used:

$$Q_1 = Q_o\left(1 + \frac{1_1 - 1_o}{1_o}\right)^b$$

were

Q_1=Per capita quantity demanded in the projected

Q_0= Per capita quantity consumed in the base year

I_1_Per capita income in the projected year

I_0= Per capita income in the base year

b= Income elasticity of demand

Total demand was obtained by multiplying the per capita by the projection in a particular year (Sabur,1983 p.33).

Projection of Supply

In the case of wheat supply is composed of domestic production, as there is foreign trade. Consequently, attempt was made to project the domestic production and import.In fact,the projection of agricultural production is a much more complex job than of demand. Future production depends upon those factors, which are to a large extent uncertain and uncontrollable. Weather and natural calamities are some of the examples. Both trend method and supply function approach was used in this study[3].

Trend Method

Of all mechanisms, one can employ for projection, trend method is probably the easiest but at the same time a most dangerous method, particularly for the long run. Because of a wide variability of domestic production, it is necessary to give some careful thought to the time period to be considered. In this study the trend value of wheat production was estimated by fitting exponential function using wheat production data for the period from 1982-83-1999.

Supply function Approach

Under this approach, the area response function was fitted with the possible independent variables influencing the decision of growers in allocating their land under wheat. The fitted equation showed that the lagged price, lagged area, yield and price risk and expected yield under wheat are the important variable in allocating land under wheat . The trend value of wheat price was obtained by fitting simple linear function using wheat price for the period from 1982 to 1999.The future area under wheat in different year was then calculated from the best-fitted area response function. Future yield was estimated by fitting exponential function using yield data for the period from 1982-83. Finally, the estimated production was obtained by multiplying the estimated area and yield for a particular year.

III. RESULTS AND DISCUSSION

Demand Estimation

Time Series Analysis

The analysis carried on for the period from 1982/83 to 1998/99. Consumer's price index was taken as a deflator. In this study, to arrive at a real pr capita picture, disposable income at current price and retail price of wheat were deflated by the consumer's price index. The availability of wheat for consumption in a particular year was worked out by deducting seed and wastage from the total production. The results of the analysis are shown bellow:

Demand Equation :

$$LnQp=0.280-0.156LnP+0.768^{S}\ Lnl$$
$$(0.226) \qquad (2.162)$$
$$R^2=0.26$$

Price Equation:

$$LnP=-5.277-0.0248Qp+0.152Lnl$$
$$(0.226) \qquad (0.954)$$
$$R^2=0.07$$

Where,

Q_P= Per capita availability of wheat for consumption

P= Retail price of wheat deflated by consumer's price index

1= Per capita disposable income deflated by consumer's index

The demand equation yielded expected result showing negative price and positive income affecting the demand for wheat in Bangladesh. The income coefficient had come out to be significant but the same was not true for price coefficient. between price and income was 0.562. The price coefficient was not significant due to high correlation between price coefficient and income in this model. Due to the existence of multicollinirity estimate, the t – ratio of price coefficient was very low. The price elasticity was worked out to be –0.156 for wheat in Bangladesh. The income elasticity was estimated to be 0.768 which implies that if the income changes by one percent, wheat The lower price elasticity than the income elasticity is reasonable under homogeneity condition. will be changed by 0.768 per cent in the same direction. When price was taken as dependent variable, both quantity and income coefficient had turned out with desired sign. The R^2 value decreased considerably in case of price equation. The price flexibility was estimated –0.0250 indicating that if supply of wheat is increased by one per cent the price will decrease by 0..25 per cent and vice versa.

Cross Sectional Analysis

The fits of the functions were primarily by (a) t-ratios,(b) adjusted coefficients of determination (R^2). Since the functional forms were different, R^2 and t-ratios alone could not ideally be used as criteria of good fits. A compromise was adopted. From the estimated functions in which all parameters were statistically significant, those functions were selected

which showed a minimum value of SEE and as high a value of R^2 as possible (Rahman.1980 p18-19).

The analysis was carried out with the Household Expenditure Survey (HES) data of Bangladesh Bureau of Statistics (BBS,1995-96).These were monthly data collected through a questionnaire survey from 5,760 households covering the whole country (16 households each from 360 primary sampling units, selected using the circular systematic sampling technique). The reference years of the data were 1995-96, which gave estimates of proportions of persons belonging to 9 classes of monthly per head income/expenditure. This implied that 19 observations were used to estimate the equation.

In cross section analysis, value (expenditure) elasticities of wheat were calculated by fitting different types of function. The income elasticities as obtained from different types of equations are depicted in Table1 . At the national level, the income (expenditure) elasticity ranged from 0.34 for inverse function to 0.63 for linear function. The elasticity in case of urban area ranged from 0.65 to 0.87 while for rural area the elasticity ranged from 0.02 to 0.12. In all the cases the elasticity was the highest for linear function followed by, semi log, logarithmic and inverse function. Although the R^2 value for linear was highest but the elasticity obtained from inverse function was more consistent to the real world situation because wheat was not considered as a luxury commodity in Bangladesh. In a cross section study (Samad *et al.* 1993 p.101) income elasticity of wheat in rural and urban areas was estimated at –0.18 and 0.18. In this study, the income elasticities as obtained from inverse function were 0.34, 0.65 and 0.02 for national, urban and rural areas respectively.

Table 1. Income Elasticity of Demand for Wheat in Bangladesh in 1995-96.

	Type of Equation	Coefficients	R^2	Elasticity	Rank Correlation Coefficients
National	Linear	$Y=4.596 + 0.0156^{HS} X$ (4.432)	0.536	0.637	0.21
	Logarithmic	$Y= -0.383 + 0.462^{C} LnX$ (3.171)	0.372	0.46	0.07
	Semi log	$Y =-27.749 + 6.487^{C} LnX$ (3.396)	0.404	0.537	0.20
	Inverse	$Y=16.847 - 2063.140^{HS} 1/X$ (2.752)	0.308	0.346	0.09
Urban	Linear	$Y=1.847 + 0.0222^{HS} X$ (6.634)	0.722	0.870	-
	Logarithmic	$Y= -2.426 + 0.801^{HS} LnX$ (5.053)	0.600	0.800	-
	Semi log	$Y=-59.453\ 11.786^{HS} LnX$ (5.222)	0.616	0.809	-
	Inverse	$Y=25.387–5418.00^{HS} 1/X$ (4.138)	0.502	0.651	-

Table 1. Contd.

Rural	Linear	Y=9.099 + 0.00280X (0.583)	0.020	0.121	-
	Logarithmic	Y=2.128 + 0.0296LnX (0.144)	0.001	0.029	-
	Semilog	Y=5.683 + 0.770LnX (0.374)	0.008	0.074	-
	Inverse	Y=10.683 –135.0521/X (0.163)	0.002	0.029	-

Y= Average per capita monthly expenditure on wheat
X= Average per capita monthly income
hs, s and c indicates highly significant, significant and critically significant at 1%, 5% and 10% level respectively.

It is seen from Table1 that the elasticities for urban areas are higher than those for the rural areas. This is reasonable under real world situation, particularly for low-income countries. Urban people are relatively more educated and their level of education and exposure to information generally increase with increasing income. The national information media gives some publicity to the importance of wheat in the diet both on economic and nutritional grounds. Thus urban dwellers are better equipped to understand the lower unit cost of calories and protein from wheat. Also urban people make diversified use of wheat and wheat flour in their dietary patterns and such diversification increases with rising income and level of education. (Talukdar, 1990 p.144)

In order to test the heterosecdasticity in error term, the Spearman rank correlation coefficient was estimated for all the equations at national level. The result presented in Table 1 shows that in all the cases the rank correlation coefficient was very low ranging from 0.07 for logarithmic function to 0.21 to linear function. This low value of correlation coefficient indicates that the error terms are not heterosecdasticity and thereby prediction based on the income elasticity obtained from these functions would not be inefficient.

Supply Response Results

The lagged area and price variables were found to be significant in Bangladesh supply response model while the risk factor was insignificant. The coefficient of lagged area was found significant at 5 per cent level whereas lagged price of wheat was significant at 10 per cent level. It implies that allocation of area in wheat in the preceding year had significant influence on current period's allocation. The price elasticity of wheat was 0.57 (Table 3), which is inelastic. This means that for every one per cent increase in wheat price, wheat area at the aggregate or national level could increase only 0.57 per cent. From the result, it could be inferred that in Bangladesh wheat supply was positively influenced by market signals (price) and hence, small incremental changes in wheat prices had significant impact on the national wheat supply level. Yield risk was found with negative sign but not significant. It indicated that yield risk might not be considered as a problem. Price risk variable came out with positive sign but insignificant. Price fluctuation of a subsistent crop might induce farmers for more area allocation to that crop to reduce market buying as much as possible.

However, the parameter was not significant. Expected yield trend of wheat had no significant influence on current year's area allocation.

The elasticity estimates of lagged area were found to be positive and significant at 1 per cent level in Dinajpur and Pabna. The magnitude of coefficient was close to 1, indicating that the farmers had considerably high adjustment response. On the other hand, lagged area was found non-significant in Rajshahi and Rangpur. Thus other factors such as techno-institutional and subjective factors may influence the farmers' decision making regarding wheat in these districts.

Table 2. Estimated Parameters of Nerlovian Partial Adjustment Models of Wheat in Selected Areas of Bangladesh for the Period from 1982/83 to 1998/99.

Area	Constant	Lagged Area	Lagged Price	Yield Risk	Price Risk	Expected Yield	R^2	Estimator	Auto Regressive Process
Bangladesh	3.202	0.751 (3.368)^{hs}	0.571 (2.796)^{s}	-0.0152 (-1.257)	0.02032 (1.655)	0.1022 (0.722)	0.93	MLE	1st order
Dinajpur	0.278	0.984 (5.054)^{hs}	0.172 (0.552)	0.02973 (0.619)	-0.0348 (-.469)	-0.0359 (-0.043)	0.80	OLS	No autocorelation
Pabna	1.231	0.8825 (5.604)^{hs}	0.1566 (0.432)	0.00269 (0.086)	0.0371 (0.761)	0.09216 (0.384)	0.85	MLE	1st order
Rajshahi	7.97	0.2276 (0.995)	0.0624 (0.226)	-0.0725 (-4.352)^{hs}	-0.0572 (-1.369)	1.084 (2.577)^{s}	0.97	MLE	2nd order
Rangpur	6.834	0.332 (1.641)	0.669 (4.006)^{hs}	0.0525 (2.557)^{s}	0.0759 (2.202)^{s}	0.560 (2.602)^{s}	0.92	MLE	2nd order

Figure in parenthesis shows t- statistic, hs, s and c indicates highly significant, significant and critically significant at 1%,5% and10% error level respectively

Variable prefixing 'Ln' are in natural logarithms

OLS = Ordinary Least squres.Used when there is no auto-corelation

ML = Maximum Likelihood

Lagged price variable was found to be positive in Rangpur, Pabna, Dinajpur and Rajshahi but only significant in Rangpur at 5 per cent level. It implied that the farmers of Rangpur considered relative price (Boro) in making a decision about land allocation to this crop. Output prices deflated by major input cost (labour, irrigation and fertilizer costs) could have corrected the variable to represent profitability in the equation. But due to non- availability of time –series data for these inputs individually any index for deflation could not be formed. So, the non- significant results of price variable for wheat was obtained in most of the selected districts. Wheat is a staple crop and assures food security of the households for which farmers would be willing to continue producing wheat even for not showing immediate price responsiveness.

Yield risk variable was found to have a negative sign in Rajshahi. The farmers of Rajshahi exhibited yield risk averse attitude as the yield risk variable came out with negative sign. Yield risk was found to have positive sign in Dinajpur and Pabna areas but not significant. It indicates that yield risk was not a problem in this area. On the other hand, yield risk was found significant at 5 per cent level with positive sign in Rangpur. Only the farmers of Rangpur appeared to be yield risk lover and would allocate more area to wheat, which reinforces the assumption of farmers attaining target income.

Price risk variable was found with negative sign in Dinajpur but not statistically significant. Price risk variable with negative sign implying farmers' risk averse response to price fluctuation. While in other districts the coefficient was positive but statistically non-significant except for Rangpur .In Rangpur Price risk came out significant with positive sign and farmers this case appeared risk lover in case of price variation of wheat.

The impact of technological changes was reflected through increase in yield of the crop. The analysis revealed that expected yield showed significant influence on crop area in Rajshahi and Rangpur areas. However, the farmers preferred this crop for having more technological advantages than other crops. Wheat would attract use of more land as the trend yield variable came out significant and positive in Rajshahi and Rangpur.

Short and Long-Run Elasticity and Coefficient of Adjustment

The estimated short-run and long–run elasticities for wheat with respect to lagged wheat price are presented in Table 3. Price elasticity of area response for Dinajpur, Pabna and Rajshahi districts could not be found significant and as a result, price elasticity of supply (both short- run and long-run) could not be derived for these districts. The short- run and long run price elasticities of wheat was 0.57 and 2.29 respectively for the country as a whole. The short- run elasticity was 0.67 in Rangpur. Price variable had turned out significant for Rangpur district and the elasticity magnitude was 0.67. That is, a hundred per cent increase in real price of wheat would increase wheat area 0.67 per cent in the following year.

Table 3. Estimated Price Elasticities of Areas Response Functions.

	Short-Run	Long-Run	Coefficient of Adjustment
Bangladesh	0.57	2.29	0.24
Rangpur	0.66	1.00	0.66

Source: Derived from the Table2; *Only significant price co-efficient found from Nerlovian partial adjustment model.

Note: A long-run elasticity is computed by dividing the respective short-run elasticity by the coefficient of adjustment for the partial adjustment model.

The adjustment coefficient turned out to be less than one, which signifies the prevalence of area adjustment problems. As the area adjustment coefficients reflect, there are adjustment problems in attaining the desired level of area to be covered under this district. The area adjustment problem are acute for the country as a whole which are highly dependent on

modern factors, inputs and natural hazards like temperature rise in grain formation and rain during harvesting time. The short- run and long run price elasticities of wheat was 0.61 and 5.24 respectively for the country as whole (Yunus 1993, p103) for the period from 1972/73 t01988/89.

The Test of Multicollinearty Among the Explanatory Variables

There is no correlation between explanatory variables of the regression analysis for the selected areas of Bangladesh and Bangladesh as a whole. Partial R^z for each explanatory variables were found less than total R^Z for the selected areas of Bangladesh and Bangladesh as a whole, that is all the variables in the equations were free from inter correlation.(Appendix Table 1)

Demand-Supply Projection

Base Period Demand

In this study the year 1998-99 was taken as base period and base period demand was calculated by taking average demand of three years from 1996-97 to 1998-99. The demand for wheat in the base year, calculated by availability approach, is depicted in Table 5. The per capita demand for wheat in the base year (1998-99) was estimated to be 20.86 kg.

Table 4. Estimation of Base Year Demand (Base Year 1999-2000).

Year	Total Production ('000' Tonne)	Wastage and Seed from Domestic Production ('000' Tonne)	Domestic Availability fog Consumption ('000' Tonne)	Import ('000' Tonne)	Total Availability for Consumption ('000' Tonne)	Populatior (Million)	Per capita Net Availability for Consumption (kg)
1996-97	1454	44	1410	643	2053	124.3	16.52
1997-98	1803	54	1749	596	2345	126.5	18.54
1998-99	1988	60	1928	1603	3531	128.2	27.54
Average							20.86 kg

Projection of Demand

For projecting demand for wheat, value (expenditure) elasticity instead of quantity (income) elasticity was used. Particularly in the low-income countries the value elasticity may be a reasonably good approximation. First, in low income country the extra value of expenditure on food will tend to be largely for farm produced items. Second, in low income country, not only the increased expenditure largely reflects improvement in quantity of food, but to at least some extent, the increased expenditure reflects quality. For this also additional resources are used in the production of the higher quality goods. For this reason value (expenditure) elasticity may give more accurate results in projecting demand for product of resources than quantity elasticity (Mellor, 1969 p.61).

Table 5. Projected Demand for Wheat During Sixth and Seventh Five Year Plan Period of Bangladesh.

Year	Projected per Capita Disposable Income at 1995-96 price ((Tk.)	Projected per Capita Demand (kg)	Projected Population ('000')	Total Projected Demand (Tonne)
2002-03	17470.40	21.99	141.54	3113033.11
2003-04	17978.08	22.29	144.24	3214680.05
2004-05	18500.52	22.58	146.99	3319612.57
2005-06	19038.14	22.88	149.80	3428143.34
2006-07	19591.38	23.19	152.65	3539904.00
2007-08	20160.70	23.50	155.56	3655444.19
2008-09	20746.56	23.81	158.53	3774862.95
2009-10	21349.45	24.13	161.56	3898262.94
2010-11	21969.86	24.45	164.64	4025503.40
2011-12	22608.30	24.78	167.78	4156928.90

The projected demand for wheat during sixth and seventh five-year plan period is summarised in Table 6. Per capita demand for wheat is expected to rise from 21.99 kg in 2002-03 to 23.19 kg and 24.78 kg by the end of sixth (2006-07) and seventh (2011-12) five year plan period respectively; while total demand for wheat is expected to increase from 3113 thousand tonnes to 3540 and 4157 thousand tonnes respectively during the same period. The result shows that the population effect is more important than income effect.

Projection of Supply

Supply, composed of domestic production, depends upon number of factors ranging from those factors which are to a large extent uncertain and uncontrollable viz., weather, natural calamities etc., to the factors such as relative price of the product, price of inputs, general economic condition etc. The supply of wheat, in this study, was predicted on the basis of historical growth of production figure and on the basis of area response function. The future supply of wheat, calculated by two different methods, are presented in Tables 7 and 8. If past growth rate in production will continue in the future, the future production is expected to increase to 1825 and 2060 thousand tonnes, respectively by the end of the sixth and seventh five year plan period. Whereas, total net availability for consumption is likely to increase to 1770 and 1999 thousand tonnes respectively during the same period of time.

Table 6. Projected Demand, Supply and Resultant Deficit of Wheat During Sixth and Seventh Five Year Plan Period of Bangladesh (When Production is Projected on the Basis of Past Growth Rate).

Year	Total production (Tonne)	Wastage and Seed from Domestic Production (Tonne)	Total Net Availability for Consumption (Tonne)	Total Demand (Tonne)	Total Deficit (Tonne)	Deficit as a Percentage of Total Production
2002-03	1656832.67	49871	1606962	3113033.11	1506071.10	90.90
2003-04	1697505.81	51095	1646411	3214680.05	1568269.16	92.39
2004-05	1739177.42	52349	1686828	3319612.57	1632784.39	93.88
2005-06	1781872.01	53634	1728238	3428143.34	1699905.68	95.40
2006-07	1825614.71	54951	1770664	3539904.00	1769240.29	96.91
2007-08	1870431.23	56300	1814131	3655444.19	1841312.94	98.44
2008-09	1916347.93	57682	1858666	3774862.95	1916197.09	99.99
2009-10	1963391.84	59098	1904294	3898262.94	1993969.19	101.56
2010-11	2011590.61	60549	1951042	4025503.40	2074461.67	103.13
2011-12	2060972.60	62035	1998937	4156928.90	2157992.16	104.71

Table 7. Projected Demand, Supply and Resultant Deficit of Wheat During Sixth and Seventh Five Year Plan Period of Bangladesh(when Production is Calculated on the Basis of Area Response Function).

Year	Total Area	Yield (Tonne/ ha)	Total Production (Tonne)	Wastage and Seed from Domestic Production (Tonne)	Total Net Availability for Consumption (Tonne)	Total Demand (Tonne)	Total Deficit (Tonne)	Deficit as a Percentage of Total Production
2002-03	799026.98	1.954	1561298.72	46995.09	1514303.63	3113033.11	1598729.48	102.40
2003-04	815837.12	1.956	1595777.40	48032.90	1547744.50	3214680.05	1666935.55	104.46
2004-05	832975.91	1.958	1630966.83	49092.10	1581874.73	3319612.57	1737737.84	106.55
2005-06	850347.19	1.961	1667530.83	50192.68	1617338.16	3428143.34	1810805.18	108.59
2006-07	868002.61	1.963	1703889.12	51287.06	1652602.06	3539904.00	1887301.94	110.76
2007-08	886352.50	1.965	1741682.65	52424.65	1689258.00	3655444.19	1966186.19	112.89
2008-09	904954.55	1.967	1780045.60	53579.37	1726466.23	3774862.95	2048396.73	115.08
2009-10	923873.10	1.969	1819106.13	54755.09	1764351.03	3898262.94	2133911.91	117.31
2010-11	943111.70	1.971	1858873.15	55952.08	1802921.07	4025503.40	2222582.33	119.57
2011-12	962645.02	1.973	1899298.62	57168.89	1842129.73	4156928.90	2314799.17	121.88

Future production of wheat, calculated on the area response function (Table 8), is predicted to 1704 and 1999 thousand tonnes by 2006/07 (sixth plan period) and 2011/12 (Seventh plan period) respectively. The production of wheat will increase due to increase in both area and productivity (Yield). The respective levels of supply by the end of sixth and seventh five-year plan period for wheat are expected to stand at about 1652 and 1842 thousand tonnes. Based on the findings reported in the text and the past performance, the projection obtained through area response functions seems to be better.

Demand-Supply Balance

On the basis of calculation of supply by two different methods, the demand - supply balance are exhibited in Table 6 and Table 7.Table 7 shows that the deficit goes on increasing

both in absolute and in percentage terms when supply was projected on the basis of past growth rate. The projection suggested that by the end of the sixth and seventh five plan period, the country would have respective deficits of *1769* and *2157* thousand tonnes of wheat in absolute terms and *96.91* and *104.71* per cent of production in percentage term.

In contrast, Table *7* exhibits that the deficit goes an increasing both in absolute and in percentage term when supply was projected on the basis of area response function. By the end of the sixth and seventh five-year plan the country is expected to have a deficit of about *1887* and *2314* thousand tonnes on *110.76* and *121.88* per cent of production of wheat respectively. This implies that the country will face the problem of deficit production of wheat in future unless steps are taken to increase the supply for wheat in domestic resources. To solve the situation and to check the drain out of a lot of foreign currency for importing a huge quantity of wheat grain, more attention should be given in the extensive and intensive cultivation of wheat in the country.

IV. CONCLUSIONS AND RECOMMENDATIONS

On the basis of the findings of this study the following recommendations may be put forward for formulation of policy with a view to improving the existing situation.

i) The demand for wheat will continue to increase rapidly but its demand in the urban areas will increase at a substantially higher rate. The study projected the future demand and supply of wheat up to *2012* . The projections revealed that the country would face the shortage of wheat of about *2314* thousand tonnes during the period *2003* to *2012*. So it was suggested that the need for mapping the demand and supply management strategy in the country be met by both the Ministry of Food and Agriculture as soon as possible to cope up the demand situation.

ii) During the last *28* years, increases in wheat production (supply) in Bangladesh were basically, attributed to the expansion in wheat area. However, the productivity (yield) level of wheat was very low ranging from *0.76* to *2.30* tonne/ha. This indicates an urgency for the concerned government agencies to review their past programs and policies in the wheat sector. More especially, it can be suggested that concerned government agencies/ research institutes should adopt alternate policies, which could increase not only the wheat area but also its productivity levels.

iii) Price and yield risk aversion can be averted by the timely spread of information on prices and weather. Information provisions to farmers can take the following forms: strengthening extension work, visit programmes and farmer training, development of market facilities, more radio- television talks and holding freqent exhibitions in rural areas.

iv) The study indicated a positive response of land resource allocation to prices. This means that the farmers can find it possible to make adjustments on the area allocation under wheat cultivation through manipulation of relative prices of wheat and substitute crops. In order to bring about an effective adjustment in area allocation, the support prices for various

crops must be announced well before the sowing season and thus announced, should carry a long - run guarantee. This policy will not only enable the farmers to plan their production programs better but will also help to correct the inter- commodity imbalance to some extent.

v) Agricultural research efforts should be made towards varietal improvement in wheat for increasing their yield. Greater emphasis should, therefore, be given for evolving drought, heat tolerant and disease resistant high yielding varieties of wheat. New thrust on research must be in the direction of evolving high-yield-cum-high-stability varieties suitable for rainfed as well as irrigated area; and also greater emphasis should therefore, be given for evolving short duration and heat tolerant high-yielding varieties of wheat.

vi) Temperature fluctuation might be the reason for fluctuating the yield of wheat as wheat is a photosensitive crop and there by yields depends on temperature. Rain during harvesting period, temperature increase at the time of grain formation and appropriate timing for sowing are some of the reasons for fluctuating yield of wheat. Ahmed (1996, p.99) mentioned that wheat yield, in general, was reduced due to late seeding. When wheat is planted beyond December 15, the low temperature helps vegetative growth but the reproductive phase is affected by the rising temperature from mid – February. The experimental results showed that loss is about 1.3 % or 44/kg/ha/day of delay in seeding after November 30. The yield loss resulted from reduced grain weight, by about 20-47% (30-45 mg / grain) in comparison to optimum planting (53-55 mg / grain) . Therefore, heat tolerant high– yielding varieties should be developed by the researchers.

viii) In order to check the diversion of land and other resources from wheat towards competing crops, (like Boro, potato and lentil) the comparative advantages need to be increased by improving the yields and prices of wheat. Development of yield increasing technologies only can reduce cost of production per unit area and will enable the farmers to stay in the competitive market in the liberalised economy. More budgetary allocation should be made available for varietal improvement and production management researches. This is empirically proven that farmers were more responsive to yield increasing technologies than to price variable when both the variables turned out to be significant in the selected district.

Footnotes:

1.Estimation of dynamic models (Nerlovian type) allow measuring short -run and long-run elasticities. Though short-run elasticities are more relevant for policy analysis and forecasting purposes (and in the long run many things may change). For details about the Nerlovian Models for estimating crop supply responses. see Nerlove. 1958.

2.This sounds reasonable on the grounds that farmers, in general seldom keep any systematic records of yields, costs and returns on a yearly basis. Therefore, the output particularly yield for any crop for three years or more appears to be a long period to remember for farmers with multi-product farm enterprises. In this study, three years variation of yields and prices of the preceding years was also tried but did not yield satisfactory results.

3.$LnA_t = \mu b_0 + (1-\mu)LnA_{t-1} + \mu b_1 LnP_{t-1} + \mu b_2 LnEXYLD_t + \mu b_3 LnYR_t + \mu b_4 LnPR_t + \mu u$

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APPENDIX

Table 1. Test of Multicolinearty of the Explanatory Variables (By Klein's Rule) Used in the Regression Analysis

Regression Equation	Partial R^2 (Each explanatory variable as a dependent variable to others)						
	Total R^2	Lagged Area	Lagged Price	Expected yield	Yield Risk	Price Risk	Comment on the Status of Colinearity
Bangladesh	0.93	>0.66	>0.63	>0.17	>0.44	>0.29	No severe correlation
Dinajpur	0.80	>0.30	>0.35	>0.34	>0.29	>0.58	No severe correlation
Pabna	0.85	>0.32	>0.26	>0.19	>0.32	>0.18	No severe correlation
Rajshahi	0.97	>0.68	>0.52	>0.16	>0.64	>0.73	No severe correlation
Rangpur	0.92	>0.30	>0.71	>0.44	>0.52	>0.65	No severe correlation