BRAC University Journal, vol. IX, no. 1&2, 2012, pp. 5-13

THE STATE OF FOOD SECURITY IN BANGLADESH: AN ECONOMETRIC ANALYSIS

Yesmin Akhter[1]
Institute of Statistical Research and Training, (ISRT)
University of Dhaka
Dhaka-1000, Bangladesh
Email: yakhter@isrt.ac.bd

and

Pk. Md. Motiur Rahman
Institute of Statistical Research and Training (ISRT)
University of Dhaka
Dhaka-1000, Bangladesh

ABSTRACT

The main concern of this paper is to examine the food availability, self-sufficiency rate and food gap situation in Bangladesh. Attempt has been made to estimate food gaps between production and requirement for the last ten years. Future productions of rice and wheat have been forecasted by using appropriate econometric methods such as ARIMA and Holt's linear smoothing parameter approach. Forecasting of future food grain availability, food grain requirement and food gaps between production and requirement from 2007/08 to 2015/16 has been made. Finally some recommendations which would be helpful for improving the food security situation in Bangladesh have been suggested.

Key words: Food Security, Self-Sufficiency Rate, Food Gap, Forecasting of Food Production and Requirement.

I. INTRODUCTION

Food security of a country means the availability of sufficient stock of foods to meet the domestic demand until such time as stocks can be replenished from harvests or imports [Mahabub et al.2005]. The first responsibility of all states is to ensure an uninterrupted supply of food to all people at all times. The Government of Bangladesh is also committed at the 1996 World Food Summit to ensure food security to all people at all times and the Millennium Development Goal (2000) has set up its target at reducing the number of poor and undernourished people by half before the year 2015. According to Household Income and Expenditure Survey 2005, the average quantity of food intake was 947.8 grams per capita per day at the aggregate level. Bangladesh has continued to demonstrate a steady increase in food grains production since 1971 from independence. The production, particularly, rice has doubled in the last three decades due to use of Green Revolution Technology (high yielding varieties, fertilizer, irrigation and pesticides) [M.M. Rahman et al. (2005)]. The production of rice has increased from 11 million metric tons (Mt) in the 1970s to more than 27 million Mt in the recent years, though the yearly productions fluctuate by several hundred thousand to a million Mt. Despite an impressive increase in domestic food grain production, Bangladesh as a whole has a very low level of nutrition. Approximately 56 million of the 140 million people cannot afford an average daily intake of 2122 kilo calorie (an established food based poverty line) and 27 million people cannot afford even more than 1805 kilo calorie [BBS (1985/86)]. This means almost half of the country's population failed to fulfill their food requirements and suffer from undernourishment. The current food consumption scenario in Bangladesh has created a complex environment for national food security. The main obstacle to food security in

[1] For all correspondence

Bangladesh is the gradual increase in population and decrease in productive land. The rampant population growth resulted in an increasing pressure on available land. The net domestic production is not sufficient to meet the requirement of the increasing number of population in the country. Every year the food gap is, thus, met by import of food grain from other countries.

When addressing the above issues in respect of security there is only one data set that can be consulted is the availability of food. In Bangladesh context, domestic food production, public and private stocking and international trade determine food availability at the national level, while availability of food at the household level depends on the household's capability to produce or acquire food from the market and household level stockholding.

II. DATA AND METHODOLOGY

For the present study, the data were collected from different secondary sources among which the Bangladesh Bureau of Statistics (BBS) is important. The time series data, particularly, on food grain (rice and wheat) production for 1965-2007 were obtained from Statistical Year Book of different years published by the Bangladesh Bureau of Statistics (BBS).

In this paper the methodology first refers to use of ARIMA model as propounded by Box and Jenkins for forecasting of requirement and production of rice. The equation of ARIMA (p, d, q) model is as follows:

$$Y_t = c + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots\dots\dots + \phi_p Y_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \dots\dots\dots\dots - \theta_q e_{t-q} \quad (1)$$

Where,

AR: p is order of the autoregressive part,
I : d is degree of differencing involved,
MA: q is order of the moving average part,
c is constant term,
ϕ_i is ith autoregressive parameter,
θ_j is jth moving average parameter, and
e_t is the error term at time t.

After primary guess of the order of the parameters p, d and q the tentative ARIMA model was identified. Before forecasting, stationarity of time series was also tested by Box and Pierce test (1970) and Ljung and Box test (1978). The test is based on the Box and Pierce Q statistic is

$$Q = n \sum_{k=1}^{h} r_k^2 \quad (2)$$

Where,

h is the maximum lag being considered
n is the number of observations in the data series,
and r_k is the autocorrelation at lag k.

And Ljung and Box Q^* statistic is

$$Q^* = n(n+1) \sum_{k=1}^{h} \frac{r_k^2}{n-k} \quad (3)$$

The selection of the best model is done by using the most common penalized Likelihood procedure as suggested by Akaike (1974) which is generally termed as Akaike's Information Criterion (AIC). The model is said to be best for which AIC is minimum and it is calculated by:

$$AIC = (-2 \log L + 2m) \quad (4)$$

Where,

L is the maximum likelihood function, and
m is the number of terms estimated in the model

The AIC can be found approximately by using the formula

$$\text{AIC} \approx n\,(I + \log(2\pi)) + n \log \sigma^2 + 2m \quad (5)$$

Where,

σ^2 is the residual variance and
n is the number of observations in the series.

For forecasting of wheat production and requirement, Holt's Linear Exponential Smoothing Method was used. This is done because wheat production is gradually declining in the recent years for which forecasted figure estimated by using ARIMA model gives constant value after certain period. The forecasted value for Holt's linear exponential smoothing is found using two smoothing parameters, α and β with values between 0 and 1 and by using three following equations:

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1}) \quad (6)$$

$$b_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1} \qquad (7)$$

$$F_{t+m} = L_t + b_t\, m \qquad (8)$$

Where,

L_t is the estimate of the level of the series at time t,

b_t is the estimate of the slope of the series at time t,

Y_t is the observation at time t,

α and β are constant between 0 and 1,

F_{t+m} is the forecasted value at period t + m, and

m is the number of periods ahead to be forecasted.

III. FOOD AVAILABILITY SITUATION IN BANGLADESH

One of the most important aspects of food security is to ensure adequate availability and stability in the supply of food to meet all people's need at prices commensurating with their income. Bangladesh obtains food grain (rice and wheat) through domestic production, imports and aids. The domestic production of rice has increased while wheat production is decreasing gradually (Table 1). But the domestic production plays an important role in food security given the country's low income and international prices of food grains. However, the net availability of food grain is estimated after adjusting of 11.58 percent [WFP (2005)] loss on seed, animal feed and wastage. The per capita availability/day of food grain based on the population of the corresponding year is also estimated and is shown in Table 1.

Table 1: Production and per capita availability of food grain, 1997/98 to 2006/2007.

Year	Gross Domestic Production (in thousand Mt)			Net Production (after 11.58% deduction for seed, animal feed and wastage)	Mid-year Population (in million)	Per Capita Availability (gm/day)
	Rice	Wheat	Total			
1997/98	18862	1803	20665	18272	125	447
1998/99	19905	1908	21813	19287	127	521
1999/00	23067	1840	24907	22022	129	514
2000/01	25085	1673	26759	23660	131	531
2001/02	24299	1606	25905	22905	133	507
2002/03	25188	1507	26694	24025	135	558
2003/04	26190	1253	27443	24265	138	546
2004/05	25157	976	26133	23107	140	532
2005/06	26530	735	27265	24108	142	527
2006/07	27318	737	28055	24806	143	533

Source: Statistical Pocket Book of Bangladesh (2007).

The average net food grain availability is approximately 522 gram/person/day which is higher than the estimated requirement level of 491 gm/person/day. It can thus be inferred that food insecurity in Bangladesh is an outcome of inaccessibility to food rather than availability of it. In spite of having an average per capita availability of food grain of 522 gram/day at the national level, almost half of the total population are consuming less than 2122 kcal/person/day. It has been observed from India and other countries that even when the national level food security is achieved, households or individuals in the country can still go hungry because they do not have the sufficient income to access food.

A. Volume of food grain imports

The net production is not sufficient to meet the requirement of food grain by the increasing number of population. As a result, every year the food gap is met by import of good grain (Public import, private import, and import under food aid). For convenience, public import and food aid data were taken together for discussion as the volume is not large compared to domestic production and private imports. Import of food grains either by the private sector or by the public sector does not follow any pattern or trend (Table 2). It depends on the loss in production due to natural disasters (flood, cyclone, draught etc.). The total import (private and public), on average between 1994/95 to 2006/07 was 2.55 million tons per year (estimate based on Table 2), with substantial increase in imports in years following poor harvests due to flood and drought or other natural disasters. Table 2 shows that with gradual increase of private sector import, public sector import of food grains has decreased. Public sector import is expected to level off with further increase of private sector import which is more likely to happen in the future. The net total import of food grain is estimated after adjustment of 5 percent loss [WFR (2005)] in handling of imports of food grain. However, in the domain of import either by the Government or by the private sector, quality, price and timing of import are important parameters that need to be taken into account in ensuring food security.

No fixed trend is observed in public distribution and domestic procurement of food grains. In some years, both distribution and procurement of food grains increased and in other years, it decreased. This indicates that public distribution and domestic procurement of food grains are guided by the level of domestic production and availability in a given year. In Bangladesh severe floods happened in the year 1998 and 2004. In those years private imports as well as public distributions of food grains were respectively higher in order to keep the market price stable. Domestic procurement gradually increased during 1994/95 to 1999/00, with the highest volume of increase in 2000/01 and 2001/02; procurement then declined in the following years.

Table 2: Private import and public import of rice and wheat, public distribution and domestic procurement (1994-2007) (in thousand Mt)

Year	Private Imports	Public Imports+ Food Aid (Rice and Wheat)	Net imports after adjustment of 5% due to handling loss	Public Distribution	Domestic Procurement
1994/95	1014	1555	1573	1573	278
1995/96	850	1584	1794	1794	400
1996/97	237	730	1392	1392	615
1997/98	1135	798	1621	1621	617
1998/99	3480	2006	2134	2134	753
1999/00	1234	869	1901	1900	967
2000/01	1063	491	1774	1774	1088
2001/02	1289	509	1464	1463	1053
2002/03	2967	254	1435	1423	947
2003/04	2481	305	987	975	843
2004/05	2982	380	1367	1356	899
2005/06	2265	297	1245	1245	945
2006/07	2209	212	1480	1480	1140

Source: Statistical Pocket Book of Bangladesh (2007).

B. Estimate of food gaps and self-sufficiency rate

In order to calculate food gap we need to estimate food requirement for the whole population of the country. Food grain requirement of a country depends on the dietary pattern. For instance, the Bangladesh diet is mainly carbohydrate based and about 75 to 80% [BBS (1988)] of the total calorie intake comes from cereals. Cereals are the principal source of food calorie and protein supply of Bangladeshi diet which is seriously imbalanced diet with inadequate supply of protein and micronutrients. The food grain requirement is estimated by using FAO recommended daily

energy requirement of 2122 kcal/person/day. For Bangladesh with 80% of the daily energy intake coming from food grain and using a conversion factor 3.46 kcal/g. Thus the daily food grain requirement can be calculated as (0.80 × 2122 kcal)/ 3.46 = 491 gram/person/day The food requirement for the country as a whole may be calculated by the following formula:
Mid-year Population × 491 gm × 365 days

The total requirement of food grains in 2006/07 is estimated to be 25.63 million Mt, based on 491 gm/capita/day consumption for a population size of a 143 million. Against this, production of food grain (cleaned rice and wheat) in 2006/07 is estimated at 24.81 million Mt. The average food gap for Bangladesh from 1997/98 to 2006/07 stands out to be nearly 1.6 million Mt. Table 3 shows that in almost all years there is a food gap and now a day it is a big challenge for food security in Bangladesh. The self-sufficiency ratio (SSR) expresses magnitudes of production in relation to domestic utilization. It is another way of expressing the food deficiency in the country. SSR is defined as SSR = Production/ (Production + Imports) * 100

Based on the official and private food grain production and import figures the food grain SSR for Bangladesh is gradually declining. The lowest self-sufficiency rate is found in 1998/99 (78%) and 2004/05 (87%), which could be attributed to the crop damage during the severe flood in 1998 and 2004. Considering the estimates on self-sufficiency ratio it can be deduced that Bangladesh has an average SSR of about 89 percent.

Table 3: Food grain requirement, gaps and self-sufficiency rate (1997-2007)

Year	Net Production (after11.58% deduction for Seed, animal & wastage)	Mid-year Population (in million)	Food grain Requirement (in thousand Mt)	Food Gap *(-) / Surplus(+) (in thousand Mt)	Self-Sufficiency Rate (%)
1997/98	18272	125	22402	-4130	90
1998/99	19287	127	22760	-3473	78
1999/00	22022	129	23119	-1097	91
2000/01	23660	131	23477	+183	94
2001/02	22905	133	23836	-931	93
2002/03	23602	135	24194	-592	88
2003/04	24265	138	24732	-467	90
2004/05	23107	140	25090	-1983	87
2005/06	24108	142	25449	-1341	90
2006/07	24806	143	25628	-822	91

** Food gap is calculated as: Requirement- Domestic production*

IV. FORECASTING OF RICE AND WHEAT PRODUCTION AND REQUIREMENT

There are several approaches of economic forecasting based on time series data among which Holt's Linear Exponential Smoothing Method, Single-Equation Regression models, Autoregressive Integrated Moving Average (ARIMA) models, and Vector Autoregressive (VAR) models may be mentioned as popular approaches. For any forecasting based on time series data it is essential to assume that the time series are stationary which means that mean and variance are constant and its covariance is time-invariant. Therefore, stationary criterion is important for efficient forecasting. However, in order to test the stationarity of the time series, we plot the data, on 'Rice Production' against the time period. The time sequence plot is presented in Figure1. From the time sequence plot we observe that over the period 1965-66 to 2006-07, production of rice has been showing an upward trend.

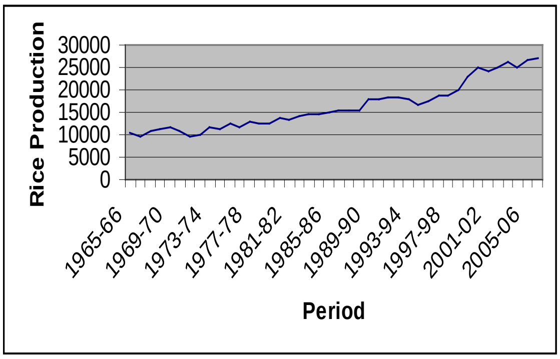

Figure 1: The Time Sequence Plot of Rice Production

For testing the stationarity empirically we obtain ACF (Autocorrelation Function) or PACF (Partial Autocorrelation Function) of rice production and the correlograms (or ACF/ PACF plots) and observe that the autocorrelations decline very slowly and most of the spikes fall out sides the 2-standard error limits which indicate that the data set is non-stationary. The estimated value of the Box-Pierce Q statistic is 152.04 at h=16 d.f. which is found to be significant. Also the Ljung-Box test gives the value 175.809 with 16 d.f. which is also found to be significant. These findings indicate that the data set does not follow a white noise series, which means that the data set does not have zero mean, constant variance and is not serially uncorrelated.

The ACF and PACF are also calculated up to 16 lags to examine the seasonality. But since there is no significant spike at seasonal lags we can conclude that there is no seasonality in the data set. As there is no seasonality we simply take the first difference to make it stationary. The time plot of the fist difference series shows that the values are scattered around a constant mean. Now the series looks like a “white noise series”, with almost no autocorrelation or partial autocorrelations outside the 95% confidence limits. Moreover, the Box-Pierce Q statistic takes the value 6.72 and the Ljung Box statistics takes the value 9.987 for the first difference data series when the maximum lag being considered, h=16 compared to the tabulated chi-square value 26.30 with 16 degrees of freedom, but neither of the estimated values are found to be significant. Since, we take only one difference to make the original data series, the value of the parameter d in the model ARIMA (p, d, q) will be 1.

A. Selection of econometric model for forecasting

As mentioned earlier, the plot of ACF and PACF can give a primary guess about the order of the parameters, p and q for ARIMA model. But we can not guess about the order of the parameters, p and q for the model.

So we can use the Akaike Information Criterion (AIC) to choose the best model among the plausible class of models and the model which has the minimum AIC value is our model of interest. For different values of p and q we find the AIC value with the help of maximum likelihood estimation method. The AIC values for different p and q values for (p,1,q) are given in Table 4.

Table 4: The AIC values for ARIMA (*p,1,q*) model

	q=0	q=1	q=2	q=3	q=4
p=0		691.82	693.62	694.20	696.08
p=1	691.81	693.36	691.49	696.13	696.99
p=2	693.49	**691.57**	693.21	696.00	694.93
p=3	694.05	693.37	695.33	695.44	695.8

It is revealed from Table 4 that the model (2,1,1) gives the minimum AIC. This model includes two AR (Autoregressive) coefficients and one MA (Moving average) coefficient and takes the form:

$$Y_t = Y_{t-1} + c + \phi_1(Y_{t-1} - Y_{t-2}) + \phi_2(Y_{t-2} - Y_{t-3}) - \theta_1(Y_{t-1} - Y_{t-2}) + e_t \quad (9)$$

Where,

ϕ_1 is the first AR coefficient,

ϕ_2 is the second AR coefficient,

θ_1 is the first MA coefficient,

e_t is the error term, and

c is the constant.

Now we have to test the significance of the parameter. The coefficient with their estimated value and corresponding standard error and the t-statistic values are given in Table 5.

Table 5: The significance test of the parameters of ARIMA (*2,1,1*)

Coeffi-cients	Para-meters	Standard error	t-value	Decision
θ_1	0.9544	0.1048	5.06	Significant
ϕ_1	0.8748	0.1728	0.72	Significant
ϕ_2	0.1244	0.1731	9.10	Significant

From the above Table 5 we see that the coefficients are significant. For the ARIMA (2,1,1) model the value of the constant is found to be 415.56 which is not significant. So, the revised model becomes,

$$Y_t = Y_{t-1} + \phi_1(Y_{t-1} - Y_{t-2}) + \phi_2(Y_{t-2} - Y_{t-3}) - \theta_1(Y_{t-1} - Y_{t-2}) + e_t \quad (10)$$

In order to examine the suitability of the models we have forecasted the production of rice by using ARIMA (2,1,1) model and Holt's liner methods. The mean error, mean absolute error, mean square error, mean percentage error, and mean absolute percentage error have been calculated for both ARIMA (2,1,1) and Holt's liner method. But ARIMA (2,1,1) model gives the minimum error than the Holt's linear methods. Because of this reason ARIMA (2,1,1) has been used to forecast our rice production.

Forecasted value of rice production from the year 2007 to 2016 using ARIMA (*2, 1, 1*) model is given in Table 6.

Table 6: Rice production, 2007-2016

Year	**Forecast value (in thousand Mt)**
2007-2008	27732.2
2008-2009	28241.4
2009-2010	28746.4
2010-2011	29251.6
2011-2012	29756.3
2012-2013	30260.7
2013-2014	30764.7
2014-2015	31268.3
2015-2016	31771.6

B. Forecasting of wheat production: Holt's linear smoothing parameter approach

As mentioned earlier that ARIMA model does not give an efficient forecast value, and as such, Holt's linear method was used for the same, which has given the reasonably minimum errors of the forecast value. In order to select a Holt's linear method for forecasting wheat production we take the first value of the original series as initial value i.e.,$L_1 = Y_1$, and the difference between the first and second observation of the original series as an estimate of the slope of the series, i.e., $b_1 = Y_2 - Y_1$.

We consider different values for smoothing of parameters α and β ranging from 0 to 1 and calculate the forecasted series for each value of α and β. Then the error series by subtracting the forecasted series from the original series is obtained. We select the values α and β as smoothing parameter which gives the minimum MSE. Following this procedure, we obtain α= 0.754 and β= 0.055 which minimize the MSE.

The forecasted value of wheat production from the year 2007 to 2016 using Holt's Linear Exponential Smoothing Method with parameters α= 0.754 and β= 0.055 is given in Table 7.

Table 7: Wheat production, 2007-2016

Year	**Forecast value (in thousand Mt)**
2007-2008	741.20
2008-2009	727.97
2009-2010	714.74
2010-2011	701.51
2011-2012	688.28
2012-2013	675.05
2013-2014	661.82
2014-2015	648.59
2015-2016	635.36

C. Food gaps between production and requirement of rice and wheat

The food gap is defined as gap between food grain production and requirement. The forecasted value of food grain production, requirement and gaps from the year 2007/08 to 2015/16 is given in Table 8.

Table 8: Food Gaps between Production and Requirement of Rice and Wheat from 2007/08 to 20015/16:

Year	Gross Domestic Production (rice and wheat)	Net Production (after11.58% deduction for seed, animal feed and wastage)	Mid-year Population (in million)	Food grain Requirement	Food Gap(-)/ Surplus(+)
2007/08	28473	25176	145	25880	-704
2008/09	28969	25614	147	26237	-623
2009/10	29461	26049	149	26594	-545
2010/11	29953	26484	151	26951	-467
2011/12	30444	26919	152	27130	-211
2012/13	30936	27354	154	27487	-133
2013/14	31427	27788	156	27844	-56
2014/15	31917	28221	158	28201	+20
2015/16	32107	28654	160	28558	+96

It is revealed from Table 8 that the food gap in 2007/08 was the highest one and it is gradually declining and there will be a marginal surplus of 0.96 million tons of food grain in the year 2015/16. But this amount is not sufficient to reduce the number of under nourished people by half as set in the millennium development goals. The requirements of food grains were forecasted on the basis of 160 million people for the year 2015/16 by using the current consumption level of 491 grams of rice and wheat per person per day. If the current consumption level is increased the gap will be increased if the production level is not proportionately increased. However the encouraging feature is that the gap is gradually decreasing and in 2014/15 and 2015/16 there will be some surplus of food grains.

V. HOUSEHOLD FOOD SECURITY

Availability of food is examined at the national level, but food security has a meaning only at the household level or individual members of the household. Household and individual level analysis on food security helps us in identifying the factors for achieving balanced food intake and thereby determining the appropriate interventions at the household or individual level for food security. Food availability at the national level has a limited, but an important role to play in ensuring food security among the households. Thus the household food security refers to the ability of a household to ensure all its members access to sufficient quantity and good quality of food at all the times. But household income level may not always be sufficient to ensure sufficient food for all its members for the reason that national food availability does not necessarily translate into household food security. Moreover, every year Bangladesh suffers from food deficiency which affects the household food security. Thus individual and household food security is affected by insufficient income, inadequate food availability and consequently high price of food grain. There are a number of inherent problem in addressing household food insecurity effectively through country's food availability. Among the inherent problems scarce employment opportunity, lack of skill training, lack of assets, lack of earning income, socially vulnerability etc. are important. Different Households Income Expenditure Surveys (HIES) conducted by the BBS show the food insecurity situation in Bangladesh. For the household and individual context, the security is measured in terms of calorie intake (2122 kcal/person/day). Households or individuals whose calorie intake is less than the recommended food consumption based poverty line (2122 kcal/person/day are deemed to be insecured in food consumption. Table 9 shows the trend in household food insecurity in Bangladesh.

Table 9: Households Suffered from Food Insecurity (Consuming Below 2122 kcal/person/ day)

(in million)

Year	National	Rural	Urban
2005	10.87	7.96	2.91
2000	10.21	7.79	2.42
1995-96	10.04	8.33	1.71
1991-92	9.33	8.15	1.18

It is revealed from Table 9 that in HIES 2005, 10.87 million households at the national level failed to consume the recommended daily energy requirement of 2122 kcal/person/day from food indicating that these households suffered from food insecurity. This figure was 10.21 million in 2000, 10.04 million in 1995-96 and 9.33 million in 1991-92. In absolute term food insecurity is increasing at the national level over the period. Though there is a sign of improvement in food security situation in rural areas, the number of households consuming less than 2122 kcal in increasing in urban area. Thus the increase in domestic food grain production and food consumption pattern at the household level do not complement each other.

VI. CONCLUSION

The rural economy is agro based and subsistence in nature and nearly half of its people are poor. Population in Bangladesh is increasing and consequently the cultivable lands is decreasing gradually. The current levels of food production, population size and land available for cultivation have created a complex environment for national food security. Food security at household level depends on the household's capacity to produce, household's capability to purchase food from the market and availability of food at local markets.

In order to achieve food security at the national level, greater efforts to be given on overall development of agriculture to enhance domestic food production. Income level of the poor and distressed people to be increased to enhance their access to food. It is, therefore, essential to take different short-term and long-term programmes to create employment opportunities and increase real income of the poor to enhance purchasing power and to ensure food security. In additional to the efforts for adequate food-grain availability, a number of programmes should be taken by the government for direct transfers of food or the cash proceeds from food aid monetization. Economic growth is a key element for the food security. Higher growth enhances the demand for labor which in turn increases income and employment opportunities and thereby reduce food insecurity. The Government needs to stimulate growth in agricultural and industrial sectors through various policies. These include introduction of new technology and credit provision for these sectors. Accelerated growth with social justice should be encouraged through improve economic management and increased investment in agriculture and industry sectors.

REFERENCES

1. Abraham, Bobas and Johans Ledolter: "Statistical Methods for Forecasting", John Whily & Sons. Inc., (1983)
2. Bangladesh Bureau of Statistics (BBS) (1988): Report of the Bangladesh Household Expenditure Survey, (1985-86).
3. Billah, Baki: "Model Selection for Time Series Forecasting Models", Department of Econometrics and Bussiness Statistics, Monash University, Australia.
4. Gujarati, DamadorN.: " Basic Econometric", McGraw-Hill Book Co, New York, (1995).
5. Households Income and Expenditure Surveys (HIES) (1991-1992, 1995-96, 2000, 2005)
6. Mahabub Hossain, Firdousi Naher, and Quazi Shahabuddin,: "Food Security and Nutrition in Bangladesh: Progress and Determinants" Journal of Agriculture and Develop Economics, Vol. 2, No. 2, pp. 103-132. (2005)
7. M.M. Rahman and S.I. Khan : "Food Security in Bangladesh: Food Availability" Paper Presented in the National Workshop, 19-20 October 2005, IDB Bhaban, Agargaon, Dhaka, Bangladesh. (2005)
8. Pindyck, Robert S. and Rubinfeld, Daniel.: "Econometric Models and Econometric Forecasts" McGraw-Hill Book Co, New York, 1981. (1981)
9. Statistical Pocket Book of Bangladesh (2007).
10. World Food Programme: Bangladesh Food Security in Brief, August (2005).