Volume-2, Issue-2, July 2009, ISSN No.1998 - 7889 *Eastern University Journal*

Forecasting Estimated Gram Crops in Rainfed Agriculture of Bangladesh

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Abstract

Sustainability of the cereal based cropping systems has become a critical issue for agriculture in Bangladesh. Pulses play an important role for sustainability of cereal based cropping systems through biological nitrogen fixation in the soil. They are also important for the nutritional security of the people, specially the children and the lactating women. Pulses are important sources of protein to the diet in Bangladesh and also improve soil quality. Pulses are the best supplements for cereals. Results in this study are derived from pulses (gram) production in ten districts namely Faridpur, Dhaka, Mymensingh, Barisal, Jessore, Khulna, Kushtia, Dinajpur, Pabna and Rajshahi district. The overall growth of gram in the ten districts over time was not uniform. On average of entire period, gram supply has been declining at sharply. Thus, there is a considerable lag between the introduction of advanced technology and the time when it is in general use and generally has been adapted to the peculiarities of the local environment. The declining rate increases, which indicates that the main cause is adequate environmental resources, although in some areas specific agricultural policies and practices may also, contribute. Pulses or legumes in general must be incorporated, only to complement these systems and not considered as competing crops to any of the components of these systems. This policy will just invigorate the exhausted soil and ensure national food security of the poor people of Bangladesh at least for protein.

Key words: Forecasting, growth model, sustainability, non-cereal crop

1. Introduction

Pulses are important plant protein for human nutrition, although they cover only around 6.48% of the total cultivable land in Bangladesh (BBS 2007). Dried edible seeds of certain plants are called pulses. Split pulses are known as dals. Pulses are good sources of proteins and B vitamins. Even though vitamin C is not present in pulses, sprouting of pulses makes it a very good source of vitamin C. Pulses are the best supplements for cereals. Generally pulses contain about 20 to 28 per cent of protein but these are inferior in quality compared to animal foods (Begum, 1996).

Bangladesh is an agricultural country. About 80% of the total population live in rural areas. The contribution of agriculture to the gross domestic product is 30%. Rice is the major food crop while jute, sugarcane and tea are the main cash crops. Other important

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crops are wheat, tobacco, pulses, vegetables and fruits. Overall productivity in Bangladesh is stagnating or declining. The implication of yield stagnation or declining productivity is severe, since these trends have occurred despite rapid growth in the use of chemical fertilizers. Depletion of soil organic matter is the main cause of low productivity, which is considered one of the most serious threats to the sustainability of agriculture in Bangladesh (Hossain, 2001, Afzal et al., 2004). Pulses are very a important group of crops which play a significant role in the Bangladeshi diet and in rainfed agriculture. The area under pulses is gradually declining with the expansion of rice crop. Consequently, soil health is deteriorating (Rahman et al., 1995).

The nutritionally important food crop, pulses has suffered an appreciable decline in production during the last decade. Although yield has improved but the area harvested has decreased. The production of all varieties of pulses was 530.455 thousand M.T. in 1994 and 517.515 thousand M.T. in 1998. Whereas Gram was 61.535 thousand M.T. in 1994 and 599.000 thousand M.T. in 1998 (BBS, 1998), Masur was 167.615 thousand M.T. in 1994 and 162.775 thousand M.T. in 1998, Khesari was 188.310 thousand M.T. in 1994 and 182.745 thousand M.T. in 1998. Pulses are generally considered as green revolution casualty in Asia.

As a result of replacing pulses by wheat and rice the nitrogen fixing capacity of crops was lost, so more fertilizers were needed. As Kang (1982) has cautioned, "This process implies a downward spiralling of agricultural land use – from legume to wheat to rice to wasteland". Genetic erosion caused by: (i) mixtures and rotation of diverse crops like wheat, maize, millets, pulses and oil seeds were replaced by monocultures of wheat and rice, (ii) the introduced wheat and rice varieties reproduced over large-scale as monocultures came from a very narrow genetic base, compared to the high genetic variability in the populations of traditional wheat or rice plants (Shiva, 1991) which resulted in explosive growth of pests in the crops.

Agronomists have not given due attention to the production of pulses. In Bangladesh there is a real potential of producing pulses in abundance but lack of research is hampering progress. Khesari is a common pulse in Bangladesh and can be grown anywhere without much effort. It is a nutritious pulse (about 30% protein) and already accounts for one third of the total production of pulses. But the neuro toxic factor & present in it poses a big hazard in its consumption. Trials are already underway to produce toxin-free Khesari in Bangladesh as in other countries (GOB, 1995).

A vast majority of Bangladeshi people use pulses in their daily diet and current consumption of pulses is 12.5 g/day per person whereas in India it is 45 g/day per person. The current status of pulse requirement and their availability in the country is shown in Table-1.

Table-1: Production and Requirement of Pulses in Bangladesh (Asian Productivity Organization, 1994).

Total Quantity Produced ('000 M.T.)	Total Import ('000 M.T.)	Total Requirement ('000 M.T.)	Shortfall ('000 M.T.)
535	14.4	3630	3080.6

In the near past pulses were almost an essential food in the daily Bangladeshi diet. Previously pulses were inexpensive crops which could be affordable for the common people in comparison with the animal protein. But in the process of time, pulses production has declined and because of deficit it is becoming an expensive crop. Pulses not only have twice as much protein as cereals but also contain more on weight basis than eggs, fish and meat. The per capita daily consumption of pulses is only 10-16 gram in Bangladesh which in neighbouring India is 45-50 gram.

In recent years, the area devoted to these crops accounted for about 2.35% of the total cropped area. In Bangladesh, pulses are traditionally grown during dry winter months under rainfed conditions. Pulses are grown in almost all the districts of Bangladesh. Some districts are prominent than others. (1) greater Pabna for khesari and masur, (2) greater Rajshahi for khesari, (3) greater Jessore for masur, (4) greater Faridpur for masur and khesari and (5) greater kushtia for masur.

Out of the total area planted of pulses, khesari constitutes 30% and masur 25%. Area and yields have also experienced a significant decline during the last few years. There are some important reasons behind declining cultivation and production of pulses such as follows: (i) competition for land, (ii) lack of high yield variety seeds, (iii) suitable technology package, (iv) poor crop management, (v) lack of provision for support service, (vi) subsistence cultivation, (vii) poor consumption, and (viii) lack of production and marketing credit facilities.

2. Gram Pulses

Gram is rabi crop which is grown almost all over the world specially in Turkey, India, Spain, Mexico, Iran, Burma. The low yield is ascribed to lack of improved variety. A chickpea variety called "Nabin" with yield of 3 mt/ha was developed at BARI but that vaiety has lost its resistance to wilt caused by Rhizoctonia solani. The "hyproola" variety of chickpea released by BINA is reported to be higher in protein content. The variety is reported to be yellow virus resistent. There is also good prospect of tissue culture in the improvement of pulses. This crop is used as dal and it has a demand in the commercial sector such as confectioneries and different sweet factories. In attaining self-sufficiency in pulses in Bangladesh, NGOs have made a remarkable contribution. It has created a momentum in pulse production in the country. The activity pattern of the legume promotion project in Bangladesh can be taken as a model in attempting any new

legume development program. The project has made a great deal of progress in coordinating research, development and NGO activities. Further expansion of such activities could lead the country towards increasing pulse production many fold, thereby increasing daily intake of pulses and improving human nutrition (Afzal and Bakr, 2002).

3 Methodology

3.1 Forecasting Method by the Use of Quadratic Trend Analysis

The growing competition, rapidly of change in circumstances and the trend towards automation demand that decisions are not based purely on guesses and hunches rather on a careful analysis data concerning the future course of events. When estimates of future conditions are made on a systematic basis, the process is referred to as "forecasting" and the figure or statement obtained is known as a "forecast". Forecasts are statements of expected future conditions, definitive statements of what will actually happen are potentially impossible. Expectations depend upon the assumptions made. If the assumptions are plausible, the forecast has a better chance of being useful. Forecasting aims at reducing the areas of uncertainty that surround management decision-making with respect to demand, supply, production, pricing and so on. Forecasts are made in order to assist management determine a strategy and alternative strategies. Forecasting will not only help in the short-term control of operations, its greatest contribution probably will come when it is able to improve short and long-term corporate strategies.

3.2 Quadratic Trend Analysis

In the past 20 years, vagaries of weather have caused quite a number of shortfalls in particular gram pulses production which is one of the key pulses crops in Bangladesh. These shortfalls have had a pronounced negative impact on the balance between food supply and demand. Data shows that advanced technology continues to make a positive contribution to yield growth in the country. However, in some areas this growth has recently slowed, while other areas have maintained a high rate of yield growth. These different rates arise primarily from the impact of the interaction between climate and technology on yield growth.

3.3 Modelling Approach

A second degree polynomial regression model

$$\text{Log}_e Y = A_0 + A_1 T + A_2 T^2 + e \qquad (1)$$

Where, y is the yield, t is the time trend variable and A_0 , A_1 , A_2 are the regression coefficients and e is the residual term. The coefficients A_0 , A_1 and A_2 represent the initial level in time, the rate of increase and changes in this rate over time, respectively. The quadratic coefficient (A_2) in particular shows the curvilinear in trend time required to estimate the climate limitations to increase. Thus, this coefficient is suggested as an

index describing climate-technology interaction. The value and sign of this coefficient are a reflection of the degree and direction of the climate-technology interaction change. The larger this value, the greater is the input provided by this interaction. A positive coefficient is an indicator of compatibility between climate and technology or, in other words, shows that climate resources meet the requirements of the technology so as to maintain an increasing rate of growth. Conversely, a negative coefficient indicates that climate imposes certain constraints on the technology applied and contributes to reduce levels or at least limits the rate of increase.

When extreme weather conditions hit an area, causing a considerable shift considerably from the established long-range technologically induced trend in observed several years in succession the standard regression technique cannot provide an adequate formalization of the trend, especially at the end of time series. To overcome this problem a special statistical procedure has been developed. This procedure utilizes analysis of fluctuation of quadratic coefficients from the time series (Kogan, 1985). Gradual changes in dynamics of the quadratic coefficients over time indicate an absence of periods with abnormal weather. Conversely, a considerable shift from this dynamic condition, especially if it resulted in changes not only of the magnitude but also in sign of the coefficient indicates a presence of abnormal weather impact. In the second case, the trend should be estimated without the period with abnormal weather; a special procedure was developed to handle this problem (Kogan, 1985).

3.4 Sources of Data

Estimation of the model required the historical crop supply data. This study was an attempt to determine the nature and extent of relationship of these variables. The nature of data obtained from the BBS and DAE constrained estimation of the model in both spatial and temporal dimensions. Thus for each district/region the data of 21 year (1980/1981-1999/2000) had been considered in this study.

4. Results and Discussion

Sustainability of the cereal based cropping systems has become a critical issue for the totality of agriculture in Bangladesh. Pulses play an important role for sustainability of cereal based cropping systems through biological nitrogen fixation in the soil. They are also important for the nutritional security of the people, specially the children and the lactating women. Pulses are an important source of protein to the diet in Bangladesh and also improve soil quality. Pulses in general are drought tolerant. These reflect the inability of pulses to withstand excessive water. These complaints suggest areas where extension services can be effective in reducing risks to pulse production.

Results for this study provided for gram pulses for ten districts namely Faridpur, Dhaka, Mymensingh, Barisal, Jessore, Khulna, Kushtia, Dinajpur, Pabna and Rajshahi district. The overall growth of gram supply of the ten districts over time was not uniform. On average of the entire period, gram supply has been declining at sharply falling rates.

Thus, there is a considerable lag between the introduction of advanced technology and the time when it is in general use and generally has been adapted to the peculiarities of the local environment. As seen the declining rate increase, indicates that the main cause is adequate environmental resources, although in some areas specific agricultural policies and practices may also contribute.

Table 2a shows that the summary statistics of growth supply of gram in Faridpur district is statistically significant (R^2 = .672). Figure 1a shows that the actual and forecasting trend of gram supply for Faridpur district is a declining trend. Also Table 2b shows that the summary statistics of growth supply of gram in Dhaka district is statistically significant (R^2 = .661). Figure 1b shows that actual and forecasting trend of gram supply for Dhaka district is a declining trend. Also Table 2c shows that the summary statistics of growth supply of gram in Mymensingh district is a statistically significant (R^2 = .713). Figure 1c shows that actual and forecasting trend of gram supply for Mymensingh district is a declining trend. Also Table 2d shows that the summary statistics of growth supply of gram in Barisal district is statistically significant (R^2= .607) Figure 1d shows that actual and forecasting trend of gram supply for Barisal district is a declining trend. Similarly Table 2e shows that the summary statistics of growth supply of gram in Jessore district is statistically significant (R^2 =.705). Figure 1e shows that actual and forecasting trend of gram supply for Jessore district is a declining trend. Also Table 2f shows that the summary statistics of growth supply of gram in Khulna district is statistically significant (R^2 = .554). Figure 1f shows that actual and forecasting trend of gram supply for Khulna district is a declining trend. Also Table 2g shows that the summary statistics of growth supply of gram in Kushtia district is statistically significant (R^2 = .381). Figure 1g shows that actual and forecasting trend of gram supply for Kushtia district is a declining trend.

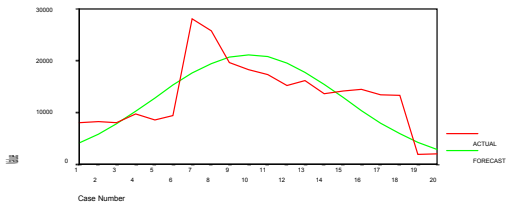
Table 2: Summary Statistics of Growths Supply of Gram Pulses in Ten Districts during 1980/81 to 1999/2000 (Quadratic Trend Analysis)

Districts	Variables	Quadratic Trend Estimates				
		Coefficient	t-ratio	F-ratio	R^2	Estimator
Faridpur (Tab:2a)	Constant	8.238	26.257	17.434	.672	O.L.S
	T	.348	5.062			
	T^2	-1.795E-02	-5.639			
Dhaka (Tab:2b)	Constant	5.452602	8.877676	15.60915	0.661148	O.L.S
	T	0.447984	3.527154			
	T^2	-0.0247	-4.38163			
Mymensingh (Tab:2c)	Constant	3.332202	5.07256	19.94103	0.713683	O.L.S
	T	0.795527	5.856224			
	T^2	-0.03755	-6.22904			
Barisal (Tab:2d)	Constant	5.233322	11.45678	12.39542	0.607755	O.L.S
	T	0.463265	4.904353			
	T^2	-0.02085	-4.97405			
	Constant	7.543013	22.25321			

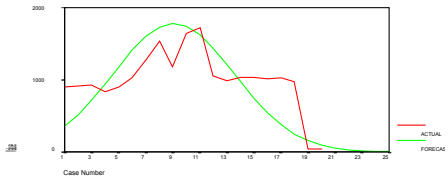
Jessore (Tab:2e)	T	0.433721	6.187645	19.14824	0.705322	O.L.S
	T^2	-0.01886	-6.06203			
Khulna (Tab:2f)	Constant	4.630264	7.182644	9.94994	0.554316	O.L.S
	T	0.592083	4.441483			
	T^2	-0.02618	-4.42622			
Kushtia (Tab:2g)	Constant	8.559262	26.24769	4.941221	0.38182	O.L.S
	T	0.130152	1.930072			
	T^2	-0.00725	-2.4215			
Dinajpur (Tab:2h)	Constant	4.27148	5.907038	13.88346	0.634427	O.L.S
	T	0.728737	4.873368			
	T^2	-0.03445	-5.19171			
Pabna (Tab:2i)	Constant	7.936987	18.26563	40.50057	0.835053	O.L.S
	T	0.143995	1.602483			
	T^2	-0.01388	-3.48179			
Rajshahi (Tab:2j)	Constant	7.952294	51.55592	16.36556	0.671668	O.L.S
	T	0.132801	4.163451			
	T^2	-0.00696	-4.9142			

Where, T = Year – 1979.

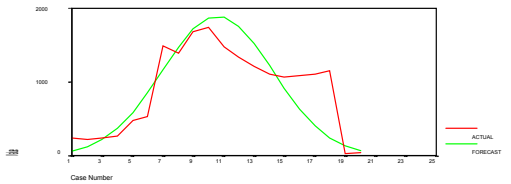
Figure 1: Comparison of Actual and Forecasting Trend of Supply of Gram for Ten Districts using Quadratic Trend Analysis



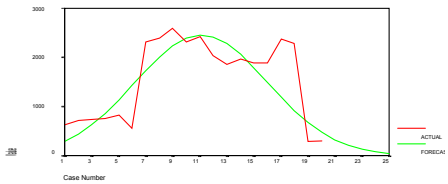
Trend of Supply of Gram for Faridpur District (Fig:1a)



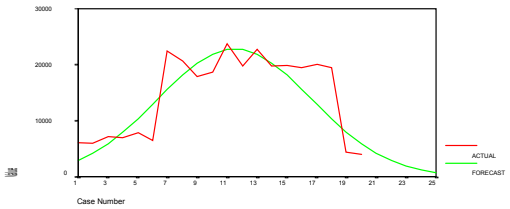
Trend of Supply of Gram for Dhaka District (Fig:1b)



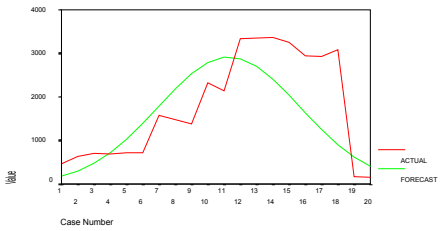
Trend of Supply of Gram for Mymensingh District (Fig:1c)



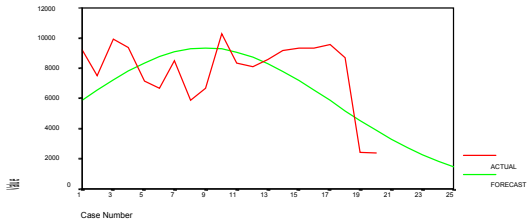
Trend of Supply of Gram for Barisal District (Fig:1d)



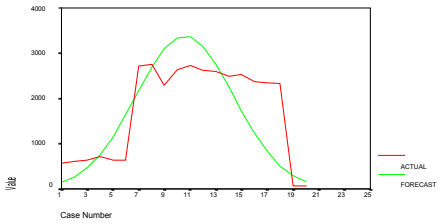
Trend of Supply of Gram for Jessore District (Fig:1e)



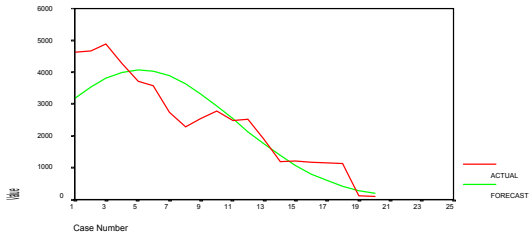
Trend of Supply of Gram for Khulna District (Fig:1f)



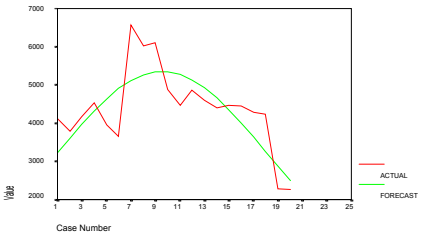
Trend of Supply of Gram for Kushtia District (Fig:1g)



Trend of Supply of Gram for Dinajpur District (Fig:1h)



Trend of Supply of Gram for Pabna District (Fig:1i)



Trend of Supply of Gram for Rajshahi District (Fig:1j)

Table 2h shows that the summary statistics of growth supply of gram in Dinajpur district is statistically significant (R^2 = .634). Figure 1h shows that actual and forecasting trend of gram supply for Dinajpur district is a declining trend. Also Table 2i shows that the summary statistics of growth supply of gram in Pabna district is statistically significant (R^2 = .835). Figure 1i shows that actual and forecasting trend of gram supply for Pabna district is a declining trend. Also Table 2j shows that the summary statistics of growth supply of gram in Rajshahi district is statistically significant (R^2 = .671). Figure 1j shows that actual and forecasting trend of gram supply for Rajshahi district is a declining trend.

Table 3 shows that the rate of growth gram trend supply is increasing in only two districts namely Khulna and Kushtia but in the other six districts namely Faridpur,

Dhaka, Mymensingh, Barisal, Jessore, Dinalpur, Pabna and Rajshahi districts the rate was decreasing during the period from 1987-1997.

Table 3 : Rate of Growth Gram Supply for ten Districts of the Period 1987-1997

District	Level of supply (MT) 1987	Level of supply (MT) 1997	Supply increase/ decrease (% to the beginning level)
Faridpur	25741	13270	-48.448
Dhaka	1538	975	-36.606
Mymensingh	1393	1150	-17.4444
Barisal	2396	2285	-4.63272
Jessore	20648	19440	-5.85045
Khulna	1472	3090	109.9185
Kushtia	5888	8710	47.92799
Dinajpur	2751	2330	-15.3035
Pabna	2290	1135	-50.4367
Rajshahi	6031	4240	-29.6966

Calculated as follows: $(y_{1997} - y_{1987}) / y_{1987}) \times 100\%$, where y is the supply trend.

In this regard pulses should get priority attention and need a to be encouraged for crop diversification effects during the rabi season. Variety improvement proved as an effective means of productivity improvement reducing per unit costs of production. Farmers in cultivation preferred high value crops and improved crop cultivators. To attain efficiency in crop productivity, effective dissemination of knowledge and on-farm farmers training should also get priority attention and increased resource allocations. Pulses or legumes in general must be incorporated, only to complement these systems and not considered as competing crops to any of the components of these systems.

5. Conclusion

Sustainability of the cereal based cropping systems has become a critical issue for totality of agricultural development in Bangladesh. Pulses play an important role for sustainability of cereal based cropping systems through biological nitrogen fixation in the soil. They are also important for the nutritional security of the people, specially the children and the lactating women. Pulses are an important source of protein to the diet in Bangladesh and also improve soil quality and are also the best supplements for cereals. A wide variety of pulses are currently grown in Bangladesh, typically in rabi season under rainfed conditions. They are susceptible to waterlogging and flooding, but can be grown on lowlands if well drained; several pulses tolerate slightly saline soils. The study suggests that with light irrigation and sufficient inputs, yields can increase, although even these yields do not become significantly more attractive than rice. Among

the major cultivation problems posed by pulses, untimely rains and sensitivity to flooding, susceptibility to diseases stand out. Pulses in general are drought tolerant. Susceptibility to pests/diseases and difficulty in identifying and treating them as well as excessive weeds, are also important cultivation problems. These complaints suggest areas where extension services can be effective in reducing risks to pulse production.

Results for this study provided for gram pulses for ten districts namely Faridpur, Dhaka, Mymensingh, Barisal, Jessore, Khulna, Kushtia, Dinalpur, Pabna and Rajshahi district. The overall growth of gram supply of the ten districts over time was not uniform. On average of entire period, gram supply has been declining at sharply fallen rates. Thus, there is a considerable lag between introduction of advanced technology and the time when it is in general use and generally has been adapted to the peculiarities of the local environment. As declining rates increase, which indicates that the main cause is in adequate environmental resources, although in some areas specific agricultural policies and practices may also, contribute.

Pulses should get priority attention and needs to be encouraged for crop diversification during the rabi season. Variety improvement proved as an effective means of productivity improvement reducing per unit costs of production. Farmers in cultivation preferred high value crops and improved crop cultivators. To attain efficiency in crop productivity, effective dissemination of knowledge and on-farm farmers training should also get priority attention and increased resource allocations. It is essential that pulses are to be made integral components of cereal based cropping systems in Bangladesh. Pulses or legumes in general must be incorporated, only to complement these systems and not be considered as competing crops to any of the components of these systems. This policy will just invigorate the exhausted soil and ensure the national food security of the poor people of Bangladesh including protein concerns.

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