

# Statistical Analysis of Current Guava Production and Its Prospect in Bangladesh

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## ABSTRACT

Agriculture is an important sector for the overall development of any country like Bangladesh. Guava is a major crop of Bangladesh, which has a significant demand in the local market. In this research, we have made a market study of guava by using time series agricultural data. The aim of the research is to know the cultural practices of guava and to study market model of guava in Bangladesh and to identify the best model that may be used for forecasting purposes. Three models (CLRM, ANCOVA and Log-Lin regression model) have been considered in this study. Ordinary least square (OLS) procedures have been used for estimation purpose. Reliable parameter estimates of the CLRM, ANCOVA and Log-Lin regression (Shil & Nath, 2008) model with minimum standard errors, high explanatory power have been obtained in this research

**Keywords:** Guava, Production, Prospect, Bangladesh.

**JEL Classification Code:** Q110

## 1 INTRODUCTION

Bangladesh is one of the least developed countries in the world and facing numerous economic problems. The majority of its people depend on agriculture for earning their living. The agriculture sector is the mainstay of the Bangladesh economy. Agricultural development is still synonymous with the economic development of Bangladesh. All efforts will, therefore, be geared to provide the thrust necessary for boosting agricultural production. So the overall economic development depends on the proper development of our agricultural sector to a great extent. (Jimmy Wales, 2008).

It is often marketed as "Super-fruits" being rich in vitamin A and C. A single apple guava contains over four times the vitamin C as a single Orange. The "Strawberry Guava" notably contains only 30-40 mg of vitamin C per 100 mg serving. Practically a tenth of the vitamin C found in more common varieties. Vitamin C content in the "Strawberry Guava" is still a high percentage (62%) (Sun-tornsuk, L., et al 2002). Guava is very delicious fruit. Many favorite and tasty items are made from guava and these products are imported by many country. Such as, guava jelly, guava syrup, guava cheese, roll etc. (K.Y. and M. G. Brown 1980). A few years ago, guava may have been domesticated in our country but not cultivated commercially. We have seen that in our in our country maximum houses had one or two guava plants in their house yard naturally. Now it is cultivated commercially in our country. It is an important fruit in many parts of the world for its production. It is only the commercially fruit. Mainly two types of guava are cultivated commercially.

1. Kazi Peara (guava) 2. Bari Peara (BARI, 2003). In our country there is no storage policy for this fruit and there

is no industry is built-up on the basis of guava fruit. For this reason all the production comes to the market as supply. Hence, this study is mainly concerned with a general overview of supply function, law of supply, factors affecting the supply function and regression analysis used for empirical investigation. Here, we shall also discuss the Dummy variable regression model and Analysis of Covariance (ANCOVA) model for used in an admixture data (i.e. qualitative and quantitative variables) (Gujrati, D.N; 1972).

## 2. MATERIALS AND METHODS

A basic economic hypothesis is that for many commodities as price rises, the corresponding quantity supplied rises; as price falls, the quantity supplied also falls. That, is there is a direct relationship between price of the commodity and the quantity supplied.

By considering the economic hypothesis in the present research we attempt to construct a market model for guava in Bangladesh with supply model.

The specific objectives are,

- (i) Considering the importance of the guava, we want to know the cultural practices of our agriculturists who produce guava.
- (ii) We want to study market model of guava in Bangladesh and to identify the best model that may be used for forecasting purpose.

The considered supply model is

$$Y_{it} = \beta_1 + \beta_2 X_{it} + u_{it} \dots\dots\dots(1)$$

Where,  $Y_{it}$  = total production of guava for i-th administrative division at the t-th year in Bangladesh

$X_t$  = prices of guava in t-th year  
 $u_{it}$  = disturbance terms

$\beta_1$  and  $\beta_2$  are known as the regression coefficient. They also called as intercept and slope coefficients, respectively.

EQ.(1) can be written as follows:

$$Y_{it} = \hat{\beta}_1 + \hat{\beta}_2 X_t + \hat{u}_{it} \dots\dots\dots(2)$$

$$= \hat{Y}_{it} + \hat{u}_{it} \dots\dots\dots(3)$$

Where  $\hat{Y}_{it}$  is the estimated value of  $Y_{it}$   
 Now we can write from eq. (3)

$$\hat{u}_{it} = Y_{it} - \hat{Y}_{it}$$

$$= Y_{it} - \hat{\beta}_1 - \hat{\beta}_2 X_t \dots\dots\dots(4)$$

$$\sum \hat{u}_{it}^2 = \sum (Y_{it} - \hat{Y}_{it})^2$$

$$= \sum (Y_{it} - \hat{\beta}_1 - \hat{\beta}_2 X_t)^2 \dots\dots\dots(5)$$

If  $\sum \hat{u}_{it}^2$  is as small as possible we can estimate the coefficient  $\beta_1$  and  $\beta_2$  as follows:

$$\sum Y_{it} = n\hat{\beta}_1 + \hat{\beta}_2 \sum X_t \dots\dots\dots(6)$$

$$\sum Y_{it} X_t = \hat{\beta}_1 \sum X_t + \hat{\beta}_2 \sum X_t^2 \dots\dots\dots(7)$$

Solving the normal equations simultaneously, we obtain

$$\hat{\beta}_2 = \frac{n\sum X_t Y_{it} - \sum X_t \sum Y_{it}}{n\sum X_t^2 - (\sum X_t)^2}$$

$$= \frac{\sum (X_t - \bar{X})(Y_{it} - \bar{Y})}{\sum (X_t - \bar{X})^2}$$

$$= \sum x_t y_{it} / \sum x_t^2 \dots\dots\dots(8)$$

Where,  $\bar{X}$ ,  $\bar{Y}$  are the sample means of X and Y. we define  $x_t = (X_t - \bar{X})$  and  $y_{it} = (Y_{it} - \bar{Y})$ .

and  $\hat{\beta}_1 = \frac{\sum X_t^2 \sum Y_{it} - \sum X_t Y_{it}}{n\sum X_t^2 - (\sum X_t)^2}$

$$= \bar{Y} - \hat{\beta}_2 \bar{X} \dots\dots\dots(9)$$

The regression models containing of quantitative and qualitative variables are called analysis of covariance (ANCOVA) models. ANCOVA models are an extension of the ANOVA models. This provides a method of statistically controlling the effects of quantitative regressors or

control variables (Gujrati, D.N; 1995).

This research considers the annual time series data for the period 1997-98 to 2006-07 and over six divisions of Bangladesh. Realizing the limitations of data availability, only eight variables are considered in the present research. Total production of guava is taken as the dependent (endogenous) variable. Price of the guava and six divisions are considered as independent (exogenous) variables. The number of variables to be included in the model depends on the nature of the phenomenon under consideration and the purpose of the research. In this research the total production of guava and the prices of guava are quantitative variables and Divisions are qualitative variables. So for the present analysis we considered analysis of covariance (ANCOVA) model.

For our present analysis, let us consider the following dummy variable regression model

$$Y_{it} = \beta_1 + \beta_3 D_3 + \beta_4 D_4 + \beta_5 D_5 + \beta_6 D_6 + \beta_7 D_7 + X_t + u_{it} \dots\dots(1)$$

Where  $Y_{it}$  = total production of guava for it-h administrative Division at the t-h year in Bangladesh

$$D_3 = 1, \text{ when Chittagong}$$

$$= 0, \text{ otherwise}$$

$$D_4 = 1, \text{ when Sylhet}$$

$$= 0, \text{ otherwise}$$

$$D_5 = 1, \text{ Barisal}$$

$$= 0, \text{ otherwise}$$

$$D_6 = 1, \text{ Khulna}$$

$$= 0, \text{ otherwise}$$

$$D_7 = 1, \text{ Rajshahi}$$

$$= 0, \text{ otherwise}$$

$u_{it}$  = disturbance terms

$X_t$  = prices of guava in t-h year

Here, Dhaka is the Reference category

### 3. RESULTS AND DISCUSSION

Estimation of linear regression model

Estimating the parameters by OLS, we get

Supply:  $\hat{Y}_{it} = 25.55 + 9.30 X_t$ ;  $R^2 = 0.70 \dots\dots\dots(i)$   
 (0.143) (0.002)

Interpretation (i)

The multiple coefficient of determination  $R^2$  is 0.70. This indicates that 70% of the total variation of the dependent variable has been explained by the independent variables respectively. This result also suggests that, if the whole sale price increases Thousand Taka per ton then production/supply will increase on the average by 9.3 thou-

sand metric ton.

### Estimation of ANCOVA model

Estimating the parameters we get the following table,

Reference category	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$\hat{\beta}_5$	$\hat{\beta}_6$	$\hat{\beta}_7$	$R^2$	$\hat{\beta}$
Dhaka	11.609		-1.843	-17.837	-6.975	-8.49	-9.339	0.67	1.555
Chittagong	9.765	1.843		-15.639	-5.139	-6.65	-7.496	0.67	1.555
Sylhet	-5.874	17.483	15.639		10.508	8.988	8.163	0.67	1.555
Barisal	4.634	6.975	5.132	-10.508		-1.52	-2.634	0.67	1.555
Khulna	3.114	8.495	6.652	-8.988	1.52		-0.844	0.67	1.555
Rajshahi	2.269	9.340	7.496	-8.143	2.365	0.845		0.67	1.555

#### Interpretation (ii)

For all reference category the multiple coefficient of determination ( $R^2$ ) is 0.67. This indicates that 67% of the total variation of the dependent variable has been explained by the independent variables respectively. It can be said that the goodness of fit of the supply function is good on the average.

This result also suggests that, if the whole sale price increases Thousand Taka per ton then production/supply will increase on the average by 1.555 thousand metric ton.

#### Considering Dhaka Division as the reference category

The intercept value  $\hat{\beta}_1$  represents the mean value of reference category, i.e; Dhaka division. Hence, in the regression the intercept value of about 11.609 thousand metric ton represents the mean production guava in Dhaka division.

$\hat{\beta}_3$  tells us the mean production of guava in Chittagong division is lower by about 1.843 thousand metric ton than the mean production of about 11.609 thousand metric ton for the reference category, Dhaka division.

$\hat{\beta}_4$  gives the result that the mean production of guava in Sylhet division is smaller by about 17.483 thousand metric ton than the mean production of about 11.609 thousand metric ton for the reference category, Dhaka division.

$\hat{\beta}_5$  shows that the mean production of guava in Barisal division is higher by about 6.975 thousand metric ton than the mean production of about 11.609 thousand metric ton for the reference category, Dhaka division.

$\hat{\beta}_6$  tells us the mean production of guava in Khulna division is higher by about 8.495 thousand metric ton than the mean production of about 11.609 thousand metric ton for the reference category, Dhaka division.

$\hat{\beta}_7$  represents the mean production of guava in Rajshahi division is lower by about 9.339 thousand metric ton than the mean production of about 11.609 thousand metric ton for the reference category, Dhaka division.

This result also suggests that, if the whole sale price increases thousand taka per ton then production/supply will increase on the average by 1.555 thousand metric ton

#### The interpretation of dummy variables in semi logarithmic regressions:

Estimating the parameters we get the following table;

Reference category	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$\hat{\beta}_5$	$\hat{\beta}_6$	$\hat{\beta}_7$	$R^2$	$\hat{\beta}$
Dhaka	5.964		-0.165	-1.691	-0.788	-0.655	-0.629	0.711	0.465
Chittagong	5.799	0.165		-1.526	-0.623	-0.490	-0.464	0.711	0.465
Sylhet	4.273	1.691	1.526		0.903	1.036	1.062	0.711	0.465
Barisal	5.176	0.788	0.623	-0.903		0.133	0.159	0.711	0.465
Khulna	5.309	0.655	0.490	-1.036	0.133		0.026	0.711	0.465
Rajshahi	5.335	0.629	0.464	-1.062	-0.159	-0.026		0.711	0.465

#### Interpretation (iii)

The multiple coefficient of determination  $R^2$  is 0.711, which indicates that 71% of the total variation of the dependent variable has been explained by the independent variables.

This result also suggests that, if the whole sale price increases 1% per ton then production/supply will increase on the average by 0.465%.

#### Considering Dhaka Division as the reference category

The intercept value  $\hat{\beta}_1$  represents the mean value of reference category, i.e; Dhaka division. Hence, in the regression the intercept value is 5.964. Taking the antilog of 5.964, we find 389.164, which is the median production of Dhaka division.

Taking analog  $\{(5.964-0.165) = 5.799\}$ . We obtained 329.969. This is the median production of Chittagong division. Thus, the production of guava in Chittagong division is lower by about 15% than the Dhaka division.

Taking analog  $\{(5.964-1.691) = 4.003\}$ . We obtained 54.762. This is the median production of Chittagong division. Thus, the production of guava in Sylhet division is lower by about 85% than the Dhaka division.

Taking analog  $\{(5.964-0.788) = 5.176\}$ . We obtained 176.973. This is the median production of Chittagong division. Thus, the production of guava in Barisal division is lower by about 54% than the Dhaka division.

Taking analog  $\{(5.964-0.655) = 5.09\}$ . We obtained 207.473. This is the median production of Chittagong division. Thus, the production of guava in Khulna division is lower by about 48% than the Dhaka division.

Taking analog  $\{(5.964-0.629) = 5.335\}$ . We obtained 202.147. This is the median production of Chittagong division. Thus, the production of guava in Rajshahi division is lower by about 46% than the Dhaka division.

This result also suggests that, if the whole sale price increases 1% taka per ton then production/supply will increase on the average by 0.465%.

### 4. CONCLUSION

Finally we have concluded that the production of guava in Bangladesh is increasing day by day. The soil and weather condition of our country is good for guava cultivation. From this analysis it is clear that the quantity supplied is responsive to its price. Economic theory suggests that the coefficient of price for supply equation is positive. That is, as expected price rises, the corresponding supply rises. This indicates that there is a direct relationship between expected price of guava and the quantity supplied.

The present analysis also provides the following figure:

Division	Production Ranking
Dhaka	1
Chittagong	2
Barisal	3
Khulna	4
Rajshahi	5
Sylhet	6

This table tells us the maximum and minimum production of guava is in Dhaka and Sylhet Division respectively.

Comparison between three models:

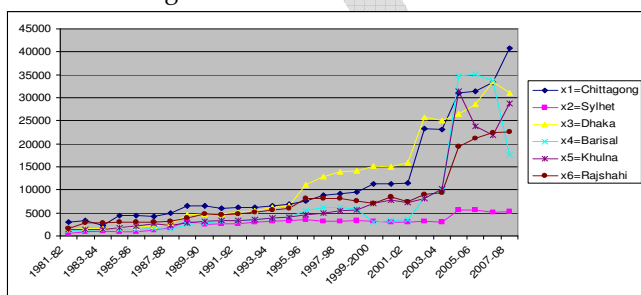
Model	R <sup>2</sup>
Linear	0.70
ANCOVA	0.67

#### Discussion:

From the above three model, we can say that the Log-Lin model is the best for the present analysis because by this model we can determine not only the coefficient of determination but also we can compare among the division about their production. Again the coefficient of determination obtained by this model is greater than other two models.

FIGURE & TABLE

Production of guava in six divisions



It is apparent from the graph that the production of guava in six divisions is increasing year to year. For the Chittagong and Dhaka division the production has sharply increased in the year 2001-02. Again for Barisal, Khulna and Rajshahi divisions the production has harshly in-

creased in the year 2003-04. And for the Sylhet division production is rising gradually.

Table (i)

Calories	36-50
Ascorbic acid (vitamin c )	200-400 mg
Carotene vitamin a	200-400 I .u
Thiamin vitamin b1	.046 mg
Riboflavin vitamin b2	0.03-0.04 mg
Niacin vitamin b3	0.6-1.068 mg
Moisture	77-86 mg
Dietary fib	2.8-5.5 mg
Protein	0.9-1.0 mg
Fat	0.1-0.5 mg
Ash	0.43-0.7 mg
Carbohydrates	9.5-10 mg
Calcium	9.1-17 mg
Phosphorus	17.8-30 mg
Iron	0.30-0.70 mg

Guava, per 100 sg of edible protion (Morton, J. 1987.)

Table (ii)

Fruit	Food calories	Protein	Fat	Carbohy drate	Fiber	B1	B2	C
Banana	100	1.2	0.3	26.1	0.6	.03	.04	14
Guava	69	1.0	0.4	17.6	5.6	.05	.04	132
Mango	62	0.6	0.3	15.9	0.5	.06	.05	36
Orange	40	0.8	0.2	9.9	0.4	.07	.04	43
Pineapple	47	0.7	0.3	11.6	0.5	.06	.03	22
Papaya	45	0.5	0.1	11.8	0.5	.03	.05	73

#### Comperative study among different fruits

From the above data we have seen that, guava is a rich source of vitamin C. It contains three to six times more vitamin C than Oranges, 10-30 times more than Bananas, and 10 times more than Papaya. (Healthaliciousness.com 2008)

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**Table A.1: Production of guava, 1981-82 to 2007-08**

Year	Chittagong	Sylhet	Dhaka	Barisal	Khulna	Rajshahi
1981-82	2930	558	1445	1318	1360	1535
1982-83	3272	945	1555	1229	1407	2751
1983-84	2264	984	1604	1344	1491	2903
1984-85	4348	945	1734	1452	1801	2953
1985-86	4381	940	1896	1499	2092	2948
1986-87	4190	1205	2145	1570	2570	3080
1987-88	4890	1680	2585	1455	2305	3195
1988-89	6609	3156	4567	2476	2810	3966
1989-90	6582	2440	4730	2820	3120	4795
1990-91	5920	2595	4815	3125	3290	4670
1991-92	6130	2665	5115	3155	3305	4770
1992-93	6225	3055	5465	3525	3545	5205
1993-94	6580	3205	6195	3810	3795	5665
1994-95	6840	3350	6540	4130	4080	6065
1995-96	7575	3535	11050	5410	4570	8145
1996-97	8740	3240	12940	6170	4960	8135
1997-98	9250	3190	13885	6235	5400	8140
1998-99	9480	3410	14095	5810	5660	7525
1999-00	11295	3135	15090	2950	7140	7140
2000-01	11310	3055	15010	3310	7680	8400
2001-02	11485	3055	15880	3615	7310	7340
2002-03	23255	3095	25680	8340	8060	9085
2003-04	23035	3060	25035	9900	10160	9335
2004-05	31065	5733	26480	34685	31340	19475
2005-06	31405	5590	28655	35100	23825	21110
2006-07	33340	5205	33545	33660	21830	22410
2007-08	40757	5271	30991	17657	28801	22600

Source: Agriculture Statistics, BBS

- Production of guava in six divisions
- Production in Metric ton

**Table A.2: cultivated area of guava, 1981-82 to 2007-08**

Year	Chittagong	Sylhet	Dhaka	Barisal	Khulna	Rajshahi
1981-82	1690	315	1110	780	1020	1535
1982-83	1865	500	1245	785	1060	1685
1983-84	2170	540	1315	835	1095	1765
1984-85	3740	984	1604	1344	1491	2903
1985-86	2560	600	1590	960	1370	1720
1986-87	2085	745	1760	985	1405	2140
1987-88	2790	935	1965	1075	1460	2310
1988-89	2882	955	2159	1101	1456	2368
1989-90	2985	975	2235	1200	1505	2390
1990-91	3060	1020	2380	1265	1685	2450
1991-92	3210	1080	2540	1315	1815	2565
1992-93	3400	1215	2710	1470	1965	2850
1993-94	3570	1250	3680	1585	2096	3055
1994-95	3825	1295	3275	1705	2275	3305
1995-96	4325	1350	5600	2300	2610	4785
1996-97	4790	1345	6365	2485	2925	4945
1997-98	5000	1395	6850	2580	3185	5120
1998-99	5165	1565	7155	2575	3575	4540
1999-00	5495	1565	7125	1505	3950	4885
2000-01	5570	1530	7330	1730	4230	5000
2001-02	5715	1545	7405	1980	4310	5110

2002-03	12850	1555	11735	3450	4765	5575
2003-04	13115	1495	12020	3601	5585	5750
2004-05	2865	1555	3655	2480	1923	2055
2005-06	3052	224	4116	2633	2384	2032
2006-07	3005	175	3923	2401	2564	1783
2007-08	2617	210	5581	2738	2054	1890

Source: Agriculture Statistics, BBS

- Cultivated area of six divisions. From the year 2004-05 is considered only fruit bearing Garden.
- Area in acres.

Table A.3: Production and Prices of guava, 1997-98 to 2006-07

Year	Chittagong	Sylhet	Dhaka	Barisal	Khulna	Rajshahi	Price
1997-98	9250	3190	13885	6235	5400	8140	1150
1998-99	9480	3410	14095	5810	5660	7525	3970
1999-00	11295	3135	15090	2950	7140	7140	1200
2000-01	11310	3055	15010	3310	7680	8400	4180
2001-02	11485	3055	15880	3615	7310	7340	5870
2002-03	23255	3095	25680	8340	8060	9085	6400
2003-04	23035	3060	25035	9900	10160	9335	7250
2004-05	31065	5733	26480	34685	31340	19475	8350
2005-06	31405	5590	28655	35100	23825	21110	9000
2006-07	33340	5205	33545	33660	21830	22410	15310

Source: Directorate of Agriculture Marketing, Bangladesh Agriculture Develop Council(BADC), Khamar Bari, Farm-gate, Dhaka-1215.

- Production in metric tons
- Prices are in taka per metric ton