Production analysis including exogenous variable for coconut and its availability and utilization in Bangladesh

S.C. Barman[1] and Mahmuda Akter[2]

In Bangladesh coconut is grown all over the country and is suited with the existing climate. The variety that has been extensively cultivated in Bangladesh is "typica" a long lived tall form. Economic life of the coconut trees usually ranges between 50-60 years. Presently Bangladesh has 0.41 million hectares of land area under coconut groves which is about more than 500 times higher than the area that was under coconut in 1947-48 and about 60 per cent higher than the area of coconut at the time of Independence.

Abstract

The study was done to estimate the growth rate of area, production and productivity of coconut including abiotic factors, availability and utilization level especially in oil form, and forecast the future coconut production at the national level. The times series data of 35 years were analyzed with exponential econometric model and it was found that annual compound growth rate (CGR) in area expansion was 0.90 per cent and its contribution was significantly greater than that of yield components indicating the absence of modern management technique for increasing coconut yield in production sector. The analysis shows with power function model that the coefficients of different components such as area and yield were different and their magnitudes also varied and significant at different levels. This was found to be positive except the coefficient associated with binary/ dummy variable for cyclone *i.e.* this abiotic factor has negative effect on coconut production and averagely more than 10 percent of the production was destroyed each time by storms and cyclones in Bangladesh. This functional analysis also showed decreasing return to scale. The estimated productions were 88111.51 m.tons and 8811.15 m. tones in normal and cyclonic years/periods respectively. From the time series data for 21years (1984-85 to 2004-05) on coconut oil availability and utilization, it is found that the quantity used has been increasing with a CGR of -2 per cent. It is reflected that the utilization level of imported coconut oil has been decreasing indicating a stage of cutting down of import due to continuous increasing and instantly higher price in the international market and also an indication of more stress in the use of locally available product. Therefore, sound policy is necessary to protect coconut groves owners, traders as well as the national interest.

Introduction

It was found that the MAPE in the reported annual coconut production level varies from estimation on an average by 18.6 per cent and it was highest in 2004-05, the period considered for study and forecasting in 2004-05, the period

[1] *Chief Scientific Officer , Research Wings, and*
[2]*Scientific Officer Agril. Econ Division respectively BARI, Joydevpur,Gazipur 170,Bangladesh.*

considered for the study and forecasting.

The coconut palm(*Cocos nucifera L*) with its tall slender and uniformly thick stem and massive crown with large number of leaves bearing bunches of nuts in their axils is one of the most beneficial and useful trees in the world. Although coconut trees are grown in many parts of the world it is mainly concentrated in Asia and Oceanic regions. In these two regions it is mostly a small farms crop and millions of people depend on this crop for livelihood(Sebastian 1991). Coconut can tolerate and grow well in saline soil. A humid atmosphere and moderate temperature are conducive for coconut cultivation. In Bangladesh coconut is grown all over the country and is suited with the existing climate and particularly fits well in the coastal regions. The variety that has been extensively cultivated in Bangladesh is "typica" a long lived tall form. Economic life of the coconut trees usually ranges between 50-60 years (Kaul and Das,1986). But on several occasions the crop is affected by severe cyclonic storms in Bangladesh. However, presently Bangladesh has 0.41 million hectares of land area under coconut groves which is about more than 500 times higher than the area that was under coconut in 1947-48 and about 60 per cent higher than the area of coconut at the time of Independence.

Most of the groves at the farmers' level have mixed plantation of betel nut plants in between coconut palms (Barman 1993). This practice helps the farmers in the intensive use of garden area. Though it is true that several modern technologies are available for coconut production it is managed to a greater extent in Bangladesh as it was managed earlier. However, the production of coconut increased from 0.20 million m.tons in 1947-48 to 1.33 million m.tons in 2003-2004 (BBS.1966, & 2005). This was mainly due to area expansion rather that adoption of new technologies at a greater extent at farm level. The local market demand for green coconuts as fresh drink and dry coconut for preparing food items having extracted kernels have been met from the country production. However, to meet the demand for coconut oil, Bangladesh have to import copra and kernel and unrefined coconut oil from foreign countries. Most of the local produces are utilized directly as fresh drink or dried nuts. The kernel from dried coconut are used in the preparation of different food items in rural Bangladesh. People also have the practice of extracting oil in traditional method in a very limited scale for their household use only in coastal district in Bangladesh (Barman 1993). Besides, in Bangladesh coconut, copra and kernels extracted from it have been used in industries and oil as cosmetic requisites especially for patented hair oil, face creams, soaps shampoos etc.

Economic Importance of Coconut

The coconut palm yields many useful products to mankind than any other tree. Its importance is not limited to the production of oil. There are many non-traditional by products derived from coconut which have export potential and could enhance the household employment and income. Coconut milk, coconut water derived from tender nuts, dried coconut kernel flakes etc, are a few of them. The tender coconut supplies a very popular refreshing and satisfying beverage (Barman and Ahmed, 1998). Besides, there are many non-edible uses of coconut which are not exploited in the country. The shell based activated carbon (charcoal) and coir products are in demand in both the domestic and world market and can accelerate the foreign earning.

Raw kernel is an important food article. The oil from dried kernel is used in cooking and in the manufacturing of soap and other toilet requisites. The extracted oil form the main product of coconut industry. Fibers, shell and pith are by-products that can be used in making of coir, ropes and mats. The wood is used in constructing houses and furniture making and the leaves are used to thatch the houses. The importance of this palm lies in the fact that it not only supply food, and shelter but also provides raw material for a number of industries (Balagopal and Menon, 1987). The products of commercial importance are copra, oil cake and fiber. Coconut is the highest energy supplier (662 kilo calories per 100gm. edible parts) among food products of different oil crops (Anon 1980). The economic importance of coconut also lies at a higher degree with the nutritional value of different coconut products (Table-1).

Bangladesh is having an edible oil deficit of 65-70 percent (Elias and *et.al.*,1983). Oils and fats are concentrated sources of calories. Oils of plant origin are nutritionally superior to that of animal origin. Among various oil seeds production in Bangladesh coconut ranked the first and rape and mustard are the

Table 1 Food value of different coconut products

Products	In percentage					
	Moisture	Fat	Protein	Carbohydrate	Minerals	Fiber
Coconut water	93	1	1	5	1	-
Green soft pulp	93	1	1	3	1	-
Green firm pulp	82	2-3	1	2-3	1	-
Coconut milk	52	27	4	16-18	1	1
Kernel (wet)	42-48	36	4	7-20	1	2
Copra No.1	6-7	63-64	7-8	16	2	3-4
Coconut flour	5-6	7	20	52	5	9

Source : Brian, 1975.

So in this context it is worthwhile to study the coconut economy and production scenario with regard to expansion rate of changes in area, production, productivity and causative factors including exogenous variables over time and present availability and utilization level in Bangladesh. However, this study has been designed with the following objectives:-

Objectives:

(i) To identify the growth rate of coconut area, production and productivity over several decades and possible causal factors to these components.

(ii) To estimate the coconut yield/ production level including abiotic factors.

(iii) To estimate and forecast the future coconut production at national level

(iv) To estimate the availability and utilization level especially in oil form in Bangladesh

Materials and Method

Data collection

To meet the objectives of the study, data were collected from secondary sources. Data on coconut national level area, production and productivity for several decades were collected from BBS reports and Ministry of Planning including exogenous variable related climatic data like cyclonic storms and their occurrence and numbers etc., over 35 years from Weather Department, Ministry of Defense.

Analytical Technique

The collected data were analyzed applying statistical tools and techniques. The growth rates of area, production and productivity of coconut were done with the help of exponential growth and power function model $G = AE^{BiTi}$ and transformation technique (Wonnacott and *et.al.*1979). To study the time series data of 35 years on coconut area, production and yield analysis power function model and transformation technique was employed. The choice of the functional form was based on its theoretical fitness to the agricultural sector and its computational manageability. Further, most of the production studies in agricultural sector have used this function (Sahota, 1968, Dhawn and Bansal, 1977, Barman and Chaudhry, 2000). The model specified and used was represented by

$$Y = A X_1 b^1 ..... X b^n n .....(1)$$

Where Y was the dependent variable (coconut production) and X_1 through X_n were the explanatory variables, coconut area, yield and range of a biotic or exogenous factors in several years in this study, 'A' was the constant and b^1 through b_n were the production coefficients of the respective components respectively. The production function was converted to logarithmic form so that it could be solved by least squares method i.e.

$$\log Y = \log A + b1 \log X_1 + ... + b_n \log X_n$$

In least squares multiple regressions of time series data over several years for coconut a dummy or binary variable was used for exogenous or abiotic factor for identifying the effect of rainfall and cyclonic storms that greatly affect the coconut production in Bangladesh. Abiotic components

Table 2. Total Area and Production of Coconut in Comparison to Other Oil Seed Crops in Bangladesh (2004-2005)

Oil seed crops	Area '000' (ha) '000' (m tons)	%	Production	%
Rape and Mustard	241.54	63.00	191.38	31.00
Coconut	41.61	11.00	307.26	49.00
Ground nut	28.85	7.00	38.88	6.00
Till	38.92	10.11	37.26	6.00
Soybean	25.82	7.00	36.52	6.00
Other oil seeds	7.93	2.00	10.68	2.00
Total	384.67	100	621.98	100

Other oil seed includes the non edible oil crops
Source: BBs, Summary crop statistics. 2005-06.

are non-living components of biosphere. In this case weather i.e. cyclones and occurrences of tornadoes were considered. So the dummy variable was considered as one of the regressors assigning a value 1 (one) for the observatory year in which cyclonic storms occurred accompanied with heavy rains and 0(zero) other wise i.e. for non-cyclonic years over 35 years (from 1971 to 2005).

Therefore, the specified function followed for this study is presented in the following form i.e.,

$$\log Y = \text{Log } A + b_1 \log X_1 + b_2 \log X_2 + b_3 X_3 + e$$

Where Y = Total production of coconut (in M.tons)

X_1 = Total area of coconut (hectares)

X_2 = Coconut yield (m.tons)/ha. and

X_3 = Dummy variable, 'A' was the constant i.e. intercept terms.

(b_1 to b_2) production coefficients and b_3 = coefficient of dummy variable,

e error terms for other factors.

($A + b_3$) = Intercept indicating differences due to effect of exogenous variable.

In specifying and executing the process of analysis the complete data set (1971 to 2005) were splited into two groups. The first group of 31 years (1971-2001) was used in model specifying and remaining 4 years (2001-2005) was used in forecasting and testing the model.

Problem of Multicollinearity and Auto Correlation

Production analysis of any types of data (either times series or cross sectional) may lead to the problem of multicollinearity which is the linear relationship between variables. However, for this study a thumb rule was applied to visualize the magnitude of multicollinearity. ie. "The correlation coefficient between a pair of explanatory variables was treated serious and irrelevant if it is greater than 0.8" (Heady and Dillon 1961). Therefore, to ascertain the problem of multicollinearity, a zero order correlation matrix for explanatory variables was obtained for this production function. Auto correlation also checked with statistical tools i e. with Durbin-Watson Statistic and critical level of D-Value for identifying the problem of auto correlation among the explanatory variables and validating the model.

Besides the R2, the statistical significance of explanatory variables is also considered in the model development and significance of explanatory variables is also considered in the model development and selection. The t-statistic is commonly used to measure the statistical significance of an explanatory variable. A greater t-value is associated with more significant variables included in specified model.

Results and Discussion

Growth in Area, production and productivity of coconut:

The time series data of 35 years (from 1970-71 to 2004-05) on coconut area, production and productivity/yield were analyzed

Table 3. Compound growth rate (CGR) of area, production and productivity of coconut (1970-71 - 2004-05)

Years	Areas		
	Co-efficient	t - value	Calculated CGR (%)
1970-71 to 1979-80	0.014***	9.047	1.40
	(0.0017)		
1980-81 to 1989-90	0.0120***	13.309	1.20
	(0.0008)		
1990-91 to 2000-2001	0.0009	0.526	0.09
1970-71 to 2004-05	0.0090**	8.920	0.90
	(0.0010)		
	Production		
1970-71 to 1979-80	0.1523**	2.069	15.23
	(0.0736)		
1980-81 to 1989-90	0.0092***	3.220	0.92
	(0.0028)		
1990-91 to 2000-2001	0.0077*	1.306	0.77
	(0.0059)		
1970-71 to 2004-05	0.0220**	2.437	2.20
	(0.0090)		
	Productivity		
1970-71 to 1979-80	0.0127***	5.926	1.27
	(0.0021)		
1980-81 to 1989-90	-.0022	0.993	-0.22
1990-91 to 2000-01	0.0068	1.301	0.68
	(0.0052)		
1970-71 to 2004-05	0.0070***	5.813	0.70
	(0.0010)		

Figures in the parentheses are standard error *** = Significant at 1% level, ** = Significant at 5% level, * = Significant at 10% level.

with exponential model and transformation technique to work out compound growth rates for each components in coconut production. It was found that the growth rate in area expansion was positive during all decades starting from the 70's to 2005. A maximum growth rate of 1.40 percent was recorded during the 70's. While in the subsequent periods during each decade the compound growth in area showed a decreasing trend (Table 3). If we look into the productivity and production components of coconut over 35 years, it is found that except during the eighties the growth rates in productivity and production were positive during all the other decades. These were 0.70 and 2.20 percents for yield and production respectively. During the eighties, there was a negative growth rate of productivity which was attributed mainly due to the occurrence of cyclonic storms in each year (Barman & et.al.1998) and due to the spread of several diseases on senile coconut palms in Bangladesh (Zaman and et.al.1996). However, when the increase in coconut production (from 1970-71 to 2004-05) was considered in Bangladesh, it was found that compound growth rate in area expansion and its contribution was significantly greater than that of the yield component. It indicate that the application of modern management techniques for increasing coconut yield was absent in the production field.

However, the regression analysis that was done for 31 observatory years with specified model and the obtained coefficients help to predict the marginal effect of respective components of coconut production. It also helps in making a precise statistical conclusion about the effect. The estimated function and other related statistics obtained from the function are presented in Table-4. The coefficients of different components and their magnitudes varied from each other and significant at different levels. The coefficients of coconut area and yield were observed to be 0.46 and 0.64 respectively and they have a positive effect on coconut production but are significant at different levels. However, the coefficient associated with binary/dummy variable for cyclonic devastation i.e, causal effect of abiotic factor on coconut production over study period showed the negative effect i.e, on an average more than 10 percent production of coconut destroyed each time by tornados / cyclones in Bangladesh.

Table 4. Regression equation including binary for exogenous variable related to cyclone and tornado and related statistics of coconut production analysis

Parameters	Regression coefficients and related statistics	t-value
Intercept:	6.124a	5.152
	6.021b	
Gross production (Y)c	88111.51	
	8811.15	
Area (X1)	0.457***	5.092
	(0.090)	
Yield (X2)	0.636**	1.626
	(0.391)	
Dummy for a-biotic factor (X3)	-0.103	1.101
	(0.094)	
Sum of coefficients	0.99	
R2	0.59	
Adj R2	0.54	
F-statistic	12.757***	
DW statistic	1.292	
Auto correlation = (n = 31, K = 3)	no autocorrelation	

Figures in the parentheses indicate the standard error of the coefficients.
a = Intercept for non cyclonic years, b = Intercept for cyclonic years.
c = Estimated Gross Production (Y) = 88111.51 M.tons in normal period, 8811.15 M.tons in cyclonic period.
***Significant at 1% level . ** Significant at 5% level and * Significant at 10% level.

The sum of elasticity of specified regression model is 0.99 i.e, less than one. This implied that the coconut production sector experienced a decreasing return to scale. The F-statistic was found to be highly significant at 1 percent level and R^2 value was 0.59 also more than conventional value of 50%. It implied that the explanatory variables considered in time series data of coconut production analysis were important, good and fit to the model. The correlation coefficient between independent variables considered in model specification was found to be low and none of the correlation value was greater than 0.8. Thus satisfied the criterion for non-seriousness of multi-co linearity (Table 5).

Further more presence of any serial correlation in residuals and auto correlation were examined by using Durbin-Wastson statistic i.e., D value. The critical value of D will be somewhere between D_L and D_y

Table 5, Zero order correlation matrix of the variables included in the model

Variables	Production (Y)	Area (X)	Yield (X)	Binary/Dummy (X)
Y	1.00	0.70	0.18	-0.43
X	1.00	-0.12	-0.31	
X	1.00	-0.31		
X	1.00			

Table-6.Measuring the performance of the specified model and estimation of coconut product level in (2001-2002 to 2004-2005)

Years	Total coconut Production reported (M.tons)	Total estimated gross production (M.tons) production (%)	Difference between reported and estimated
2001-2002	87000.00	88111.22	1.28
2002-2003	88000.00	89270.29	1.27
2003-2004	132900.00	111911.88	-15.79
2004-2005	307260.00	119201.69	-61.20
MAPE	18.6%		

for auto correlation. The Durbin-Watson statistic obtained from the regression analysis of specified model was 1.29. The tabulated value of D at 1 percent level of significance with N =31 and K=3 degrees of freedom were $(4\text{-}D_L) = 2.97$ and $(4\text{-}D_u) = 2.58$ respectively. Our calculated result falls outside the $(4\text{-}D_2)$ and $(4\text{-}D_u)$ respectively. It indicated that there is no auto correlation in the used data and confirm the independence of the residuals. Hence the underlying assumptions of the regression analysis were satisfactorily met and therefore, the specified model was treated as validated and can be used for forecasting the coconut production level correctly in Bangladesh and satisfied the major objectives of the study. However, with the specified model the coconut production level was estimated and forecasted for the years from 2001-02 to 2004-05 and is presented in Table 6. In measuring the performance of the model the mean absolute percent errors (MAPE) was used. It was found that the MAPE in the reported annual coconut production level varied from estimation on an average by 18.6 per cent and it was highest in 2004-05, ie the period considered for the study and forcasting.

Estimation of Coconut oil Availability and Utilization Level.

The estimation of coconut oil availability at national level was calculated considering the quantity of oil contained in matured dry coconut of total production adding with total quantity of imported coconut oil. A total of 8.09 percent oil content (Tabibullah and Ahmed, 1976) was considered in total produced from matured coconut in each year in Bangladesh. Thus the quantity of coconut oil locally available and imported quantity have been estimated from time series coconut production and imported coconut oil data at macro level for 21 years (1984-85 to 2004-2005). For identifying the trend and growth rate in coconut oil utilization/consumption statistical tools were also applied. Imported coconut oil in a particular year in fact, may be over flown in utilization in the subsequent year. However, total quantity imported was considered as quantity consumed in each year in the analysis.

Coconut oil is used for several purposes. It is used as lubricant and in manufacturing hydraulic breaks for aero-planes, tanks, trucks, automobiles and in chemical warfare and in other industrial products of toilet and cosmetics (Menon and et al 1958). In Bangladesh it has been used more in cosmetic industries rather than for manufacturing purposes and in parts of heavy transports. This oil has been used as toilet and cosmetic requisites such as in manufacturing of patented hair oils, face creams, soups, shampoos, etc. Coconut oil has also been used as edible oil in a limited way at household level particularly in coastal areas in Bangladesh (Barman, 1993).

However, from the time series data on coconut oil utilization over the past two decades in Bangladesh it was found that the quantity used has been on an increasing trend with a compound growth rate of 1.2 per cent and the coefficient of variation was about 9 per cent (Table - 7). This growth rate for locally available coconut oil was 2.6 per cent while for imported oil it was negative 2 per cent. It reflected that the utilization level of imported coconut oil has been decreasing. It also indicated the continuous increasing and instantly higher price of oil in the international markets.

Conclusion

The measures of growth in area, production and productivity in

Table 7. Annual coconut oil utilization/consumption in Bangladesh over several ylears (1984-85 to 2004-2005)

Year	Oil Consumption level (Qty) 000 M tons imported	Locally available	Total Qty (M tons)
1984-85	21.68	6.72	28.4
1985-86	31.24	6.74	37.98
1986-87	28.95	6.68	25.63
1987-88	26.3	6.96	33.26
1988-89	28.94	6.77	35.71
1989-90	29.94	6.77	36.54
1990-91	8.92	6.6	15.06
1991-92	3.97	6.14	10.37
1992-93	2.99	7.5	10.49
1993-94	3.35	7.59	10.94
1994-95	3.81	7.71	11.52
1995-96	4.21	7.23	11.44
1996-97	1.75	7.22	8.97
1997-98	73.63	7.23	80.86
1998-99	34.99	7.2	42.19
1999-2000	97-96	7.19	105.15
2000-2001	107.34	7.2	114.54
2001-2002	23.14	7.06	30.02
2002-2003	3.67	7.11	10.78
2003-2004	4.53	10.75	15.28
2004-2005	9.93	26.36	36.29
Mean	13.39	7.61	24.78
SD	3.51	1.37	2.20
CV(%)	26.18	18	8.88
CGR(%)	-2	2.6	1.2

Sources:1996,1998,2001,2002,2005-2006, BBS Foreign Trade Statistics of Bangladesh a/+8.09 percent of oil was considered in total lproduction of each year in Bangladesh (Tabibillah and Ahmed, 1976)

terms of compound growth rates (CGR), it was found that over the whole period of 35 years area expansion and yield both have positive contributions in production of coconut. But while it is compared to the growth rates of different production components of coconut in different decades it is apparent that the CGR of each component during early period of independence was much greater than the recent one which was attributed mainly due to the occurrences of tornado cyclone, spread of several diseases on senile and old aged coconut palms in the maximum groves in Bangladesh. As such in the attempt of identifying the adverse effect of exogenous variable like tornado/storms was identified with a specified econometric model and it was found that this exogenous variable averagely damages 110 percent production each time over the period of 31 years. The total sum of production elasticities of coconut production sector experienced a decreasing return to scale.

However, in the analysis of coconut oil availability and utilization it was found that the total quantity of coconut oil utilization at national level has been increasing with a annual growth rate of 1.2 percent having 24.61 per cent coefficient of variation reflecting the continuous increasing demand for coconut oil in industries as toilet and cosmetic requisites in the country. This analysis also revealed that imported coconut oil utilization has changed with a negative growth rate of 2 per cent annually and indicated a cut down of imported coconut oil in utilization sector and due to instantly higher price in the foreign markets. With the positive growth rate of total utilization, this situation is also an indication that coconut utilization of locally available product has been going on with more stress and proper use than the previous period. However, such analysis helps the policy makers and private traders those are involved in coconut oil product and utilization activities. Local coconut traders do not have extended activities for processing and extracting oil until now due to the absence of sound public policy for protecting them. So, support of public authority with sound policy for supplying oil extraction and by products processing plant for small scale entrepreneurs will be helpful in protecting coconut grove owners and traders as well as the national interest.

References:

Anon.1980.Nutrition status of local food. Institute of Nutrition and Food Science. Dhaka University, Dhaka 1000

Balagopal T.S and D.Menon.1987, Coconut shell and pith in building construction. *Indian Coconut Journal.* Vol.XVIII,No.4.

Barman S.C and Dr.M.Ahmed, 1998. Coconut and its Tread in Area, production and productivity in Bangladesh, *Indian Coconut Journal.* Vol.XXIX.No.2PP 6-10

Barman S.C 1993. Coconut Production and Oil Extraction at Household Level in Selected Area of Bangladesh Agril.Economics Division, BARI. Regional Agril.Research Station,

Hathazari, Chittagong. Report No.1 pp.1.35.

Barman S.C. & M.A.Khan Chaudhury.2000. Form size and resource use efficiency in wheat production: Evidence from an micro-level study. Bangladesh Journal of Agricultural Research Vol.25 No.2.PP.349-358

BBS 1966. Agricultural Production Levels in Bangladesh (1947-72),Statistics Division. Ministry of Planning, Government of the People's Republic of Bangladesh; Dhaka.

BBS;1966. Agricultural Production Levels in Bangaladesh (1976-77). Statistics Division. Ministry of Planning, Govt.of the Peoples Republic of Bangladesh.,Dhaka

BBS., 2005-06 Summary Statistics, Statistics Division, Ministry of Planning, Govt.of the Peoples Republic of Bangladesh., Dhaka.

BBS 2006. Foreign Trade Statistics, Statistics Division. Ministry of Planning, Govt. of the People's Republic of Bangladesh., Dhaka

Brian E. Grimwood, 1975. Coconut Palm Products, Their Processing in Developing Countries, FAO, United Nations, Rome,FAO Agricultural Development Paper No.99,PP.1.261

Dhawn K.G. and P.K.Bansal., 1977, Rationality of the use of various factors of production of different sizes of farm in the Punjab, Indian Journal of Agricultural Economics Vol.32 No.3 PP.121-130

Elias S M, M.S.Hussian and S.C Barman 1983. Agro-Economic study of ground nut in some selected area of Bangladesh. Division of Agricultural Economics, BARI.Joydebpur, Dhaka No.82-6

Heady E.O and J.L.Dillon, 1961. Agricultural Production Function. Down State University Press,Iowa, USA. PP.1-667.

Kaul A.K. and M.L. Das, 1986. Oil seeds in Bangladesh. Bangladesh Canada Agricultural Sector Team. Ministry of Agriculture, Govt.of the Peoples Republic of Bangladesh, Dhaka. PP 1-323.

Menon K.P.V. and K.M.Pandalai, 1958. The Coconut Palm: a monograph. Indian Central Coconut Committee. Ernakulam, South India. PP.1-384.

Sahota G.S.1968. Efficiency of resource allocation in Indian Agriculture. American Journal of Agricultural Economics, Vol.50 No.I.PP.584-599

Sebastian, 1991. Agronomical aspect of Coconut. A Bibliography. Indian Journal of Coconut. Vo..21,No.12

Tabibullah M.and Kamaluddin Ahmed 1976, Performance of the exotic typica coconut cultivars as compared with a local one. Bangladesh Horticulture.Vol.4 No.2.PP.II-17

Wonnacott R.J and Thomas H.Wonnacott.1979. Econometrics 2nd Edition John Wiley and Sons, USA PP.1-580

Zamam K.M.M.Hussian and A.K M.Z.Rahman, 1996, Effect of Potassium fertilizer on the incidence of leaf spot of coconut. Annual report, Plant pathology Section, HRC, BARI, Joydebpur, Gazipur, Bangladesh, PP.1-39

RECIPE

COCONUT PAK WITH CHOCOLATE LAYER

Ingredients:

Grated coconut	-	250 gm
Sugar	-	125 gm
Icing sugar	-	150 gm
Butter	-	50 gm
Coca powder	-	1 tsp

To garnish : Fresh fruits like chopped mango, banana, grapes and also with cherry

Method : Put the sugar in a pan with little water just enough to soak it. Boil to a syrup. Add coconut and mix well. Set in a well greased plate. Let if cool. Mean while cream the cocoa, icing sugar and butter till fluffy and light. Apply the icing on the set oak evenly. Cut into desired shapes when a knife inserted comes out clean.

CUTLETS

Ingredients:

Milk of coconut	-	1 cup
Eggs	-	2
Maida	-	½ kg
Salt	-	1tsp
Butter	-	60gm
Ghee/oil	-	for frying

Method: Rub the butter into the flour till reduced to crumbs. Lightly beat the eggs and mix into the flour mixture with salt. Add the powdered sugar and sufficient coconut milk to form a stiff dough. Cover with a slightly damp cloth and keep for an hour or so. Make small balls. Press on forks. Roll and fold. Fry in oil or ghee till light brown.

COCONUT BASKETS

Ingredients:

For Basket:	
Butter	90gms
Maida	180 gms
Water	to mix
For handles	
Flour	40gms
Salted cold water	

Method: Mix all the basket ingredients to form a dough. Make small balls and line small patty tins thinly. Bake in a moderate oven at 350o F for 15 minutes. Kneed into a stiff dough. Roll out to form thin 2 handles and bake with the baskets.

-Indu Narayan