FORECASTING MANGO PRODUCTION IN PAKISTAN AN ECONOMETRIC MODEL APPROACH

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ABSTRACT

Production of Mango in Pakistan has increased due to use of improved farm inputs and better management practices. Despite an increased production and rising demand in the export market, the potential of Mango export has, however, not been fully achieved. Pakistan has comparative advantage in the production of Mango and enormous potential exists for its export in the vast Middle East market. The study was undertaken to forecast production of Mango for the years 2005 through 2024. The Log linear and ARIMA models were used to forecast production of Mango. The predicted value of production of Mango for the year 2024 worked out as 1431010 metric tons, which means that an increased output of Mango would be available for consumption as well as for export. The paper underlines the need for taking measure to increase export of Mango by improving its quality, packaging and complying with international standards required under the WTO regime.

INTRODUCTION

Mango is the second largest fruit grown after citrus in Pakistan. It occupies 14 percent of the total area (734.6 thousand hectares) under all fruits (GOP, 2004). Of a total area of 103.1 thousand hectares under mango in the country, 52.66% is in Punjab, where Multan and Bahawalpur Divisions are the predominant mango growing districts. The area under mango in Sindh is 45.68% of the total area of mango cultivation in the country. Hyderabad and Mirpurkhas are the major mango growing tracts in Sindh (GOP, 2004).

The share of Punjab in the total production of mango was 67 percent and that of Sindh 32 % during 2003-04 (GOP, 2004). The production of mango increased from 766000 metric tons in 1990 to 1673900 metric tons in 2005, showing an increase of 54% during the said period (Table I). This means that considerable attention has been paid by mango growers to increase production of the fruit by adopting improved farm management practices.

The present study was undertaken with the following objectives:

i. To estimate growth trends in the Production of Mango.
ii. To forecast production of Mango for the period 2005 through 2024.
iii. To suggest policy measures for increasing production of Mango

MATERIALS AND METHODS

Time series data for the years 1982-2004 were used for the present study. The data were collected from the Food and Agriculture Organization Website (www.fao.org). Log Linear Model was used for estimating growth trends (Gujrati, 2003).

The equation used is:

$$\text{Ln}X_t = \beta_0 + \beta_1 T + u_t$$

Where: X_t is the Production of Mango in year t and T is a trend variable. The growth rate, which we get from this equation, will be instantaneous (r) (at a point in time). The compound growth rate (over a period of time) (R) for mango will be estimated by taking anti-log of X_t, i.e.,

$$X_t = \text{antilog}\,(\beta_0 + \beta_1 t).$$

Given the type of data, nature of research and reliability of forecast, ARIMA model was selected from amongst available time series models for forecasting Production of Mango.

A non-seasonal ARIMA model is denoted by ARIMA (p,d,q), (Box and Jenkins, 1976).

Where: p is the order of the auto regressive process, d is the order of homogeneity, ie., the number of differences to make the series stationary, q is the order of the moving average process.

The general form of ARIMA is:

$$\Delta^d Z_t = C + (\varnothing_1 \Delta^d Z_{t-1} + \ldots + \varnothing_p \Delta^d Z_{t-p}) - (\Phi_1 a_{t-1} + \ldots + \Phi_p a_{t-p}) + a_t$$

Where 'C' is a constant, Δ is a difference operator such that

$$\Delta Z_t = Z_t - Z_{t-1},$$
$$\Delta^2 Z_{t-1} = \Delta Z_t - \Delta Z_{t-1}$$

$Z_{t-1} \ldots Z_{t-p}$ are past series values (lags), the $\varnothing$ is the coefficient to be estimated by auto-regressive model.

The auto-regressive model of order 'p' denoted by AR (P) is:

$$Z_t = C + \varnothing_1 Z_{t-1} + \varnothing_2 Z_{t-2} + \ldots + \varnothing_p \Delta^d Z_{t-p} + a_t$$

Where: a_t is a random variable with zero mean and constant variance.

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Φ is coefficient in the moving average (MA) model. The Moving Average Model is of order 'q' or MA (q) which can be written as:

$Z_t = a_t - \Phi_1 a_{t-1} - \Phi_2 a_{t-2} - \ldots - \Phi_p a_{t-p}$

This model was employed for analyzing quantitative relationship of data and for forecasting future trend of Mango production for the period, 2005 to 2024.

RESULTS AND DISCUSSION

Growth Trends

Growth trends were estimated by employing log linear Model:

$$LnX_t = \beta_0 + \beta_1 T + u_t$$

Where: $\mathbf{X_t}$ is Production of Mango in year t and T is a trend variable.

LnX_t	=	β_0 +	$\beta_1 t$
LnX_t	=	13.356 +	0.0221 T
S.E.	=	(0.009)	(0.001)
t	=	(1414.86)	(32.172)
R^2	=	0.98	
β_1	=	0.0221	

Growth rate (r) = 2.21 %

The results illustrate that production under Mango grew at a rate of 2.21% per year for the period, 1982-2004. The estimated growth rate (r) for mango is an instantaneous (at a given point in time) rate of growth and not the compound (over period of time) rate of growth. Compound growth rate (R) for mango was estimated from instantaneous rate of growth (r) by taking its antilog such that:

Compound rate of growth = R = Anti ln $\beta_1 - 1$

Compound rate of growth = R = 2.812 %

The compound rate of growth for export worked out to be 2.812%. The Standard Error (SE) of the slope coefficient was 0.001**,** which is very low and confirms reliability of results. Estimated coefficients were found significant at one percent level of significance. The calculated value of R^2 was 0.98 which shows that 98% regressand (X_t) is explained by the regressor (t), thereby confirming reliability of the estimated model.

Forecasting Production of Mango

Time series data for the period, 1982-2004 was analyzed by employing ARIMA model in four steps (Box and Jenkins, 1970). Correlogram of the first differenced series ("d") showed appropriate stationary behaviour than the second differenced series ("d"). The selected value of 'd' was '1'. The selected value of parameters 'p' and 'q' were also found '1' and '1' respectively. As such, ARIMA (1, 1, 1) model was selected and estimated, by using E - View and Stat Graphic Computer Programmes.

Augmented Dickey – Fuller (ADF) unit root test was applied to confirm reliability and fitness of the selected model. The absolute value of ADF test-statistic (3.467891) was found greater than the critical values at both 5% (3.0659) and 10% (2.6745) levels of significance. This established that time series was stationary for the ARIMA (1, 1, 1). Hence, ARIMA (1, 1, 1) was found as the best fit for forecasting.

Forecasts for mango production (with 95% confidence intervals) were generated by using ARIMA (1, 1, 1) model for the period 2005 to 2024. Forecasts (with their upper & Lower Limits at 95% confidence intervals) are presented in Table-IV and plotted in Fig. 1. Data presented in Table IV show that production of Mango would increase and Predicted production of Mango (Forecast Values) will range between 1077630 and 1431010 metric tons during the period, 2005-2024. This means that an increased quantity of Mango will be available in future for domestic consumption and export (Mustafa, 2003).

The reliability of the estimated model was also checked for the period, 1982-2004. The observed and predicted (forecast) values are presented in Table V and plotted in Fig.2. Minor differences ranging from 1 % to 6 % were observed, however, the results reconfirmed that the estimated model is the best fit for forecasting production of mango in Pakistan.

CONCLUSION AND RECOMMENDATIONS

Well-organized and properly managed Mango orchards can ensure sustainable production of the fruit and prove instrumental in enhancing export of mango from Pakistan. Following measures are suggested for increasing production of Mango in the country.

i. The forecast establish that increased production of mango will be forthcoming in future. Given the trend, Government should create supportive infrastructure for handling surplus production of the fruit.
ii. Incentive should be provided to the stakeholders for the growth of packaging and processing industries. Improved infrastructure (better roads, refrigerated transportation and cold storages) will ensure increased marketed surplus. A well conceived Production and Marketing Plan can guarantee prosperous future for Mango.
iii. There is need to launch a campaign for boosting exports of Mango. New markets should be identified and a culture of value addition promoted.
iv. Government should devise a Plan to cope with the emerging challenges of the WTO regime

(Mustafa, K et' al, 2006). Measures should be undertaken to improve post- harvest management practices and complying with International Standards.

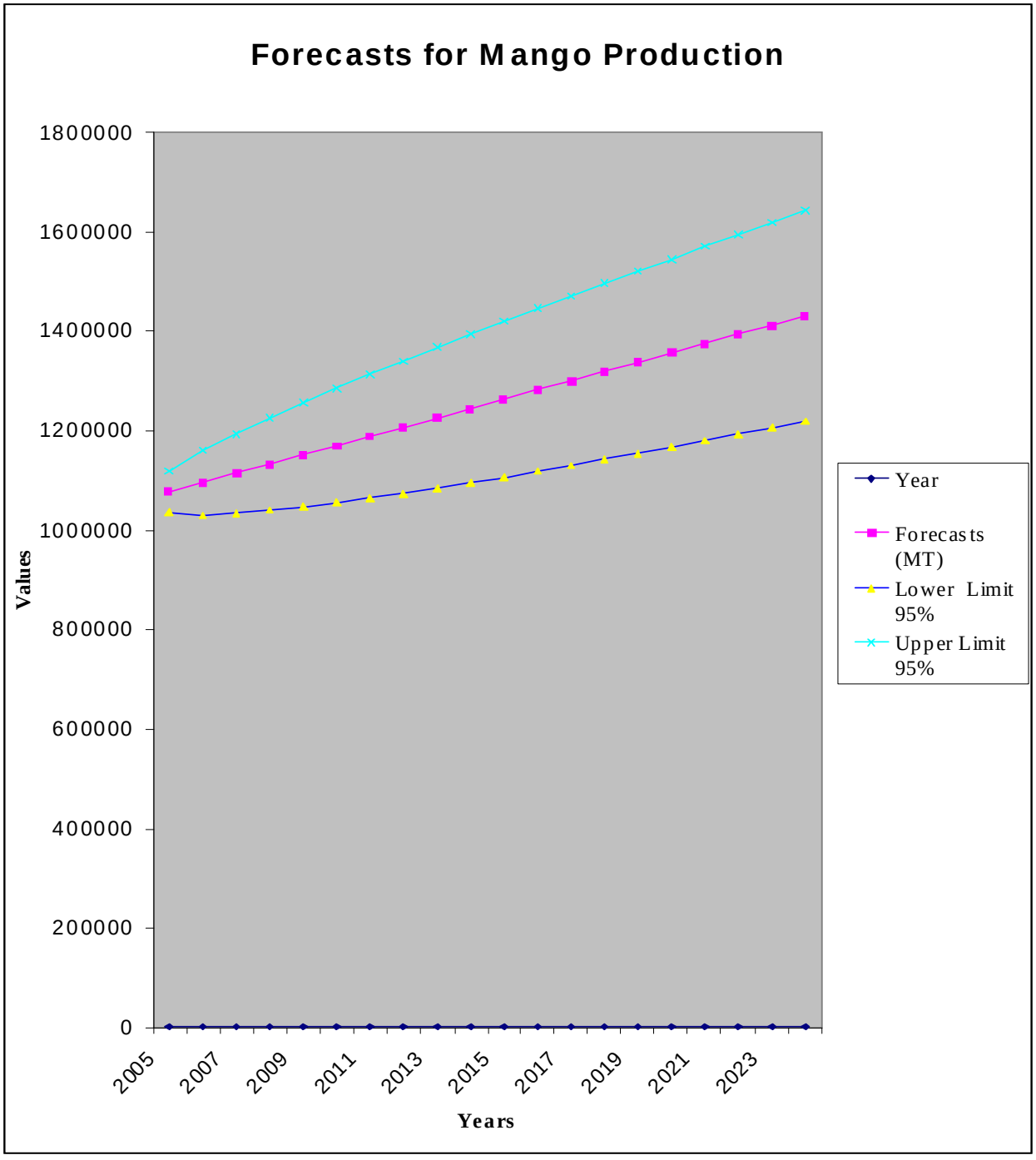

Fig. 1 Forecast for Mango production in Pakistan 2005 -2024

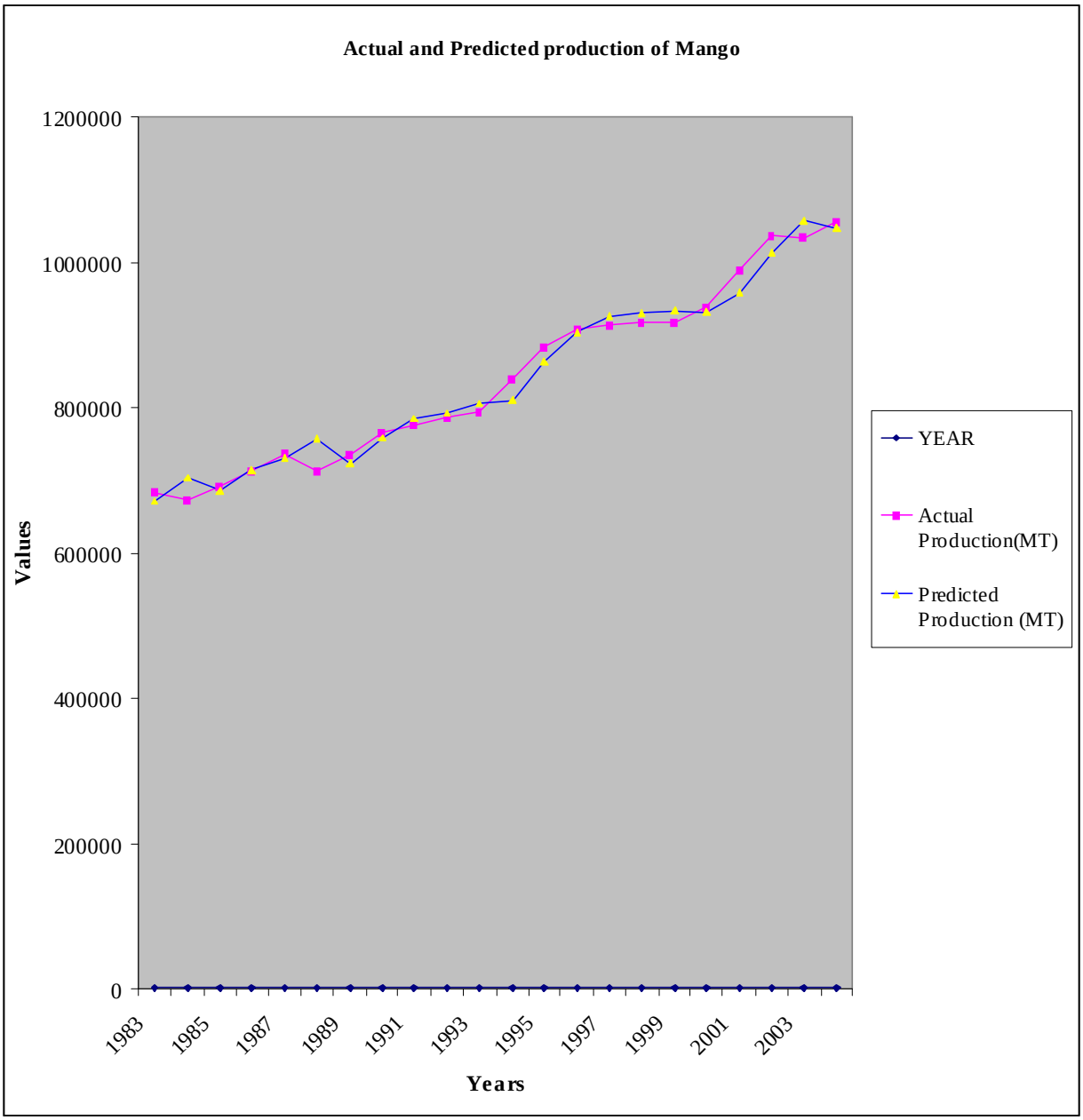

Fig 2. Actual and predicted production of Mango in Pakistan 1982-2004

Table I ***Production of mango in Pakistan***

Year	Production (Metric tons)	Percent change
1982	651701	
1983	682602	4.74
1984	673070	-1.40
1985	691899	2.80
1986	713314	3.10
1987	736549	3.26
1988	712900	-3.21
1989	735000	3.10
1990	766000	4.22
1991	776000	1.31
1992	787,271	1.45
1993	793,652	0.81
1994	839,307	5.76
1995	883,674	5.28
1996	907,778	2.73
1997	914,492	0.74
1998	916,826	0.26
1999	916,454	-0.04
2000	937,705	2.32
2001	989,790	5.55
2002	1,037,145	4.78
2003	1,034,581	-0.25
2004	1,055,987	2.07

Source: www.fao.org

Table II ***Correlogram for production of Mango***

Autocorrelation	Partial Correlation		*AC	**PAC	***Q-Stat	****Prob
. |* . |	. |* . |	1	0.087	0.087	0.1906	0.662
.**| . |	***| . |	2	-0.317	-0.327	2.8467	0.241
.**| . |	.**| . |	3	-0.291	-0.255	5.1979	0.158
. | . |	. | . |	4	0.045	-0.022	5.2566	0.262
. | . |	. *| . |	5	0.022	-0.177	5.2717	0.384
. | . |	. | . |	6	0.049	-0.019	5.3508	0.500
. |* . |	. |* . |	7	0.131	0.113	5.9522	0.545
. | . |	. *| . |	8	-0.024	-0.077	5.9749	0.650
. *| . |	. | . |	9	-0.070	0.033	6.1742	0.722
. *| . |	. | . |	10	-0.058	-0.012	6.3231	0.787
. |* . |	. | . |	11	0.077	0.046	6.6084	0.830
. |* . |	. |* . |	12	0.070	0.070	6.8654	0.866

* Autocorrelation
** Partial Autocorrelation
***Q test Statistics
****Probability Values

The estimated values for the ARIMA (1, 1, 1) are presented in Table III.

Table III ***Estimates of the parameter***

Parameter	Value	Estimate	S. E.	t-ratio	P-value
AR (p)	1	-0.304869	1.24808	-0.24427	0.809640
MA (d)	1	-0.486644	1.17096	-0.415591	0.682365
Mean		18635.6	4820.52	3.86589	0.001041
Constant		24317.1			

Table-IV ***Forecast for the production of Mango in Pakistan***

Year	Forecast (Metric tons)	Lower 95% Limit	Upper 95% Limit
2005	1077630	1035890	1119370
2006	1095350	1030730	1159970
2007	1114270	1034360	1194180
2008	1132820	1039740	1225890
2009	1151480	1046980	1255980
2010	1170110	1055290	1284920
2011	1188740	1064470	1313020
2012	1207380	1074320	1340440
2013	1226010	1084710	1367320
2014	1244650	1095560	1393740
2015	1263290	1106790	1419780
2016	1281920	1118360	1445480
2017	1300560	1130230	1470890
2018	1319190	1142350	1496040
2019	1337830	1154700	1520960
2020	1356460	1167260	1545660
2021	1375100	1180010	1570190
2022	1393740	1192940	1594530
2023	1412370	1206020	1618720
2024	1431010	1219250	1642770

Table V ***Observed and predicted (forecast) values***

YEAR	Observed values (Mt)	Predicted Values (Mt)	Difference	% Difference
1982	651701			
1983	682602	671363	11239	1.646494
1984	673070	702968	-29898	-4.44203
1985	691899	685744	6155	0.889581
1986	713314	713471	-157	-0.02201
1987	736549	731026	5523	0.749848
1988	712900	756470	-43570	-6.11166
1989	735000	723224	11776	1.602177
1990	766000	758310	7690	1.003916
1991	776000	784608	-8608	-1.10928
1992	787271	793079	-5808	-0.73774
1993	793652	805325	-11673	-1.4708
1994	839360	810343	29017	3.457039
1995	883674	863800	19874	2.249019
1996	907778	904136	3642	0.401199
1997	914492	926519	-12027	-1.31516
1998	916826	930909	-14083	-1.53606
1999	916454	933578	-17124	-1.86851
2000	937705	932551	5154	0.54964
2001	989790	958051	31739	3.20664
2002	1037150	1013670	23480	2.263896
2003	1034580	1058450	-23870	-2.30722
2004	1055990	1048070	7920	0.750007

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