JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
1813–2235/2005/01–1–20–24
http://www.ijabjass.org

Forecasting and Growth Trends of Production and Export of Kinnow from Pakistan

BURHAN AHMAD, ABDUL GHAFOOR AND HAMMAD BADAR
Department of Marketing and Agribusiness, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

The present study was undertaken to estimate the past growth trend in production and export of Kinnow and to forecast the production and export of Kinnow. The log lin model was applied to estimate the past trend in production and export of Kinnow. ARIMA model was used to forecast the production and export of Kinnow for next 20 years. The forecast value of production and export of Kinnow for 2022-23 is 2617.45 thousand tons and 1.11081 x 10^6 tons, respectively.

Key Words: Production; Export; Kinnow; Pakistan

INTRODUCTION

Pakistan is producing and exporting a large variety of fruits that include Mango, Apple, Dates, Pine nuts, Banana, Grapes and Guava etc. Among all the fruits, citrus has got a supreme position with respect to area, production and export (Table I).

The major markets for Pakistani kinnow include Bahrain, Dubai, Saudi Arabia, Kuwait, Qatar, Oman, UK, Netherlands, Indonesia, Malaysia and Singapore (GOP, 2003). The major export markets for Pakistani kinnow are mostly developing countries and only 2.6% of total kinnow exports from Pakistan enter in the markets of developed countries (Anonymous, 2002).

Table I. Area, Production and Export of Citrus

Year	Area (000' hectares)	% Age change	Production (000' tons)	% Age change	Export (000' tons)	Export Value (million Rs.)
1990-91	173.3	-	1609	-	112	935
1991-92	176.2	1.673	1630	1.305	125	966
1992-93	176.2	-	1665	2.147	121	1179
1993-94	185.0	4.994	1849	11.0151	127	1324
1994-95	190.7	3.081	1933	4.543	139	1256
1995-96	193.6	1.1521	1960	1.394	135	1487
1996-97	194.4	0.413	2003	2.194	219	2776
1997-98	196.1	0.874	2037	1.697	202	2793
1998-99	197.0	0.458	1862	-8.591	181	2773
1999-00	197.7	0.355	1943	4.35	240	4130
2000-01	198.7	0.506	1865	-2.316	260	4586
2001-02	194.2	-	1830	0.052	216	3958

Source: Federal Bureau of Statistics (2001-02)

Present study was planned to (i) estimate the growth in Production and Export of Kinnow, (ii) forecast the production and export of Kinnow for next 20 years, and (iii) suggest the policy guidelines to boost production and export of Kinnow and improve its marketing system.

METHODOLOGY

Twenty-two years time series data of citrus (Kinnow) production and export were used for the present study. Thus, the secondary data were obtained from various government publications and institutions such as Federal Bureau of Statistics, Ministry of Agriculture and Commerce etc. The secondary data collected, were processed and analysed by using appropriate statistical techniques as follows:

Growth trend. The growth trend in export (Production) of Kinnow was estimated through log-lin model.

Suppose: X_t = Export (Production) of citrus in 2002, X_o = Initial value of export (1982)

A well known compound interest formula can be written as: $X_t = X(1+r)^t$

Where r is the compound (i.e., over time) rate of growth of X. Taking the natural logrithm of above equation we can write:

Now letting $\beta_0 = \ln Xo$, $\beta_1 = \ln(1+r)$

We can write above equation as $LnXt = \beta_0 + \beta_1 t$

Adding the disturbance term to above equation we obtain $\text{Log } X_I = \beta_0 + \beta_1 t + u_t$

This equation is known as log-line model. It is a linear regression model like other linear regression models because the parameters β_1 and β_2 are linear. The only difference is that regressand is the logarithm of X and the regressor is "time". This model is also called semi log model because only one variable (in this case the regressand) appears in the logarithmic form. For descriptive purposes a model in which the regressand is logarithmic will be called a log lin model (Gujarati, 2003)

The growth rate was estimated by taking the anti-log of X_t, i.e., $X_t = \text{antilog}(\beta_0 + \beta_1 t)$.

Forecast. Forecasts can be made by various methods like purely judgmental approaches, structural economic models, univariate time series models, multivariate time series models and econometric models. Economic models require detailed information to specify functional relations among different variables. Functional forms, which minimise subjective aspects of model construction, are becoming increasingly popular as a tool of data analysis among economists. Many economists have applied time series models for generating forecasts. Keeping in mind the nature of study, available data, efficiency of the model to forecast, ARIMA model had been selected among the various available time series models to forecast the Production and Export of Kinnow.

The acronym ARIMA stands for "Auto Regressive Integrated Moving Average" model showing a combination of auto regressive and Moving average model. Lags of the differenced series appearing in the forecasting equation are called, 'auto regressive' terms, lags of the forecast errors are called moving averages and a time series which needs to be differenced is said to be integrated version of stationary series. This method has been used extensively in economic research. This is a gradual approach as the more complex models are built with the results of simpler ones.

A non-seasonal ARIMA model is denoted by ARIMA (p,d,q), according to 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

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

$Z_{t-1} \ldots Z_{t-p}$ are past series values (lags), the ∅ 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. $\varnothing_s$ are coefficient in the moving average (MA) model, where as moving average model is of order 'q' or MA (q). This can be written as:

$$Z_t = a_t - \varnothing_1 a_{t-1} - \varnothing_2 a_{t-2} - \ldots - \varnothing_p a_{t-p})$$

This model was employed to analyze the quantitative as well as qualitative relationship of data and to forecast the future trend of Kinnow production and export up to year 2023.

RESULTS AND DISCUSSION

Growth Trends of Production and Export of Kinnow.

Growth trend of production. As mentioned in methodology, the equation for estimating the growth rate is:

$$\text{Ln } X_t = \beta_o + \beta_1 t$$

Where: X_t = Production, t = Time

Regression was run on the time series data about the production of citrus (Kinnow) for the last 22 years and estimated equations are given below:

$\text{Ln } X_t = 7.041 + 0.02874t$ S.E. (0.038) (0.003)

In this model β_1, the slope coefficient, measures the relative change in X for a given change in the value of the regressor (in this case the variable "t"), that is:

$$\beta_1 = \frac{\text{Relative change in regressand } (X_t)}{\text{Absolute change in regressor } (t)}$$

If we multiply the relative change in X_t by 100, we will get %age change or growth rate in X for an absolute change in t, the regressor.

Relative change is:

β_1 = 0.02874
Growth rate = β_1. 100
Growth rate = 0.02874 x 100
Growth rate = 2.874%

It illustrates that over the period 1981-2002, the area under citrus (Kinnow) grew at the rate of 2.874% per year.

This growth rate is an instantaneous (at a point in time) rate of growth and not the compound (over period of time) rate of growth. Compound growth rate (r) can be estimated from the instantaneous rate of growth, that is:

Instantaneous growth rate = 0.02874

We know that Ln (1 + r) = β_1 (As discussed in methodology)

Ln (I + r) = β_1
Ln (I + r) = 0.02874
(I + r) = Anti-Ln 0.02874
1 + r = 1.02916
r = 1.02916 – 1
r = 0.02916

Compound rate of growth = r = 0.02916 x 100
r = 2.916%

Over the period, 1981-2002, the compound rate of growth of production under citrus (Kinnow) was about 2.916%. This growth rate is slightly greater than the instantaneous growth rate.

Reliability of the results. Following estimated values, describes the reliability of the results.

$\text{Ln } X_\tau$	=	7.041	+ 0.02874 t
S. E.	=	(0.038)	(0.003)
t	=	(186.604)	(10.002)
R^2	=	0.833	

As standard error explains the variability in the data set, i.e., higher the S.E. higher will be the variability in the data set and vice versa, therefore, a low value of S.E. is necessary for the reliability of the results. In the present study, S.E. of slope coefficient is 0.003 which is very low and confirms the reliability of the results. Secondly, significance of the coefficients is a vital part. Estimated coefficients reflects that they are significant at 1% level of significance i.e., coefficients are highly significant.

R^2 exhibits the value of regressand which is explained by the regressor. Calculated value of R^2 i.e., 0.833 shows that 83.3% regrssand (X_t) is explained by the regressor (t). It means that dependent variable is highly dependent on the independent variable. This also confirms the reliability of the estimated results.

Growth trend in export. Similarly, as in case of Area and production, Growth rate of Export was estimated by running the regression on the time series data about the Export of citrus (Kinnow) for the last twenty two years. The regression equation is: $\ln X_t = \beta_o + \beta_1 t$

Where, X_t = Export of citrus and t = time period

The estimated equation is given as:

$X_t = 9.860 + 0.04706t$

S.E. (0.189)(0.014) t (52.223)(3.273) R^2 0.349

The instantaneous growth rate of export of citrus is 4.706%. It exhibits that over the period 1981 – 2002, export of citrus fruits (Kinnow) grew at a rate of 4.706% per year. The compound rate of growth of export is 4.818%.

Reliability of the results. Very low value of the S.E. of both of coefficient indicates the lesser variability in the data set. Estimated value of t test describes that coefficients are statistically significant at 1% significance level. Value of R^2, 0.349, shows that 34.9% regressand (export) is explained by the regressor (time period). All these results confirm the reliability of the estimated results.

Forecasting of Production and Export of Kinnow

Forecasting of production of kinnow. As mentioned earlier, one of the objectives of the present study was to forecast production and export of Kinnow to the year 2023. Using time series data, ARIMA model was applied in four steps as proposed by Box and Jenkins (1970) for the purpose of forecasting. These steps are as follows:

1. Model Identification: It was the specification of p, d, q.

2. Model estimation: It consisted of estimating the parameters of the model.

3. Diagnostic checking: It consisted of the application of a variety of tests to see whether the estimated model fits the data adequately.

4. Forecasts: Forecasts obtained at 95% confidence interval with lower and upper limits.

Model identification. Because most of the economic time series vary in a systematic way, the first step in identification was to choose and to check that the data were stationary or not. The time series data about Kinnow production was analysed and auto-correlation function & partial auto-correlation function were estimated.

Originally, the time series was non-stationary. Auto correlation function did not fall as quickly as the lag K increases. To know the order of homogeneity of the time series data i.e., how many times the time series be differenced to have a stationary series, differenced time series and the auto correlation function of the differenced series were taken.

Correlogram of first differenced series of the auto-correlation function showed the properties of the stationary series.

To check the further stationarity, second differenced time series also observed. Correlogram of the first differenced series showed appropriate stationary behaviour than the second differenced series. Auto correlation function fell as quickly as the lag K increased. Thus the selected value of "d" was 1.

The selected value of parameters "p" and "q" was 3 and 2 respectively. After the determination of parameters p, d, q, appropriate model estimated was ARIMA (3, 1, 2).

Model estimation. The model ARIMS (3, 1, 2) was estimated using the E-view and Stat Graphic computer programs. The whole estimation of the output is given in the Table II.

Table II. Estimates of the parameters

Parameter	Estimate	S. E.	t-ratio	P-value
AR (1)	0.477126	0.250846	1.90207	.076542
AR (2)	-0.606181	0.265412	-2.28392	0.076542
AR (3)	0161758	0.258265	0.626325	0.540517
MA (1)	0.517793	0.1581	-9.15	0.000000
MA (2)	-0.922593	0.10083	1.46389	0.163866
Mean	42.071	28.73931	1.46389	0.163866
Constant	40.6952			

Estimated white noise variance = 8533.53 with 15 degrees of freedom.
Estimated white noise standard deviation = 92.377

Diagnostic checking. Augmented Dickey - Fuller unit root test on time series data of production was applied, and the following results were obtained.

ADF–Test statistic = -5524261

1% critical Value = -3.8572

5% critical Value = -3.0400

10% critical Value = -2.6608

As the absolute value of ADF test-statistic is grater than the critical values at 10% level of significance, therefore, time series is stationary of the ARIMA (3, 1, 2). Hence, ARIMA (3, 1, 2) is fit for the forecasting. The detail of unit root test is given in the Table III.

Forecast for the production of kinnow. The twenty years ahead forecasts of Kinnow production i.e. upto year 2023 and their 95% confidence intervals were generated by using ARIMA (3, 1, 2) model. Forecasts with their upper and Lower Limits at 95% confidence interval are given in Table IV. Table shows the quantity of Kinnow in thousand tons. It is quite evident from the table that quantity of production of Kinnow in the next years is increasing. The quantity of production of Kinnow will be 1867.69 thousand tons in 2002 – 2003, with a minimum production of 1670.89 thousand tons and with a maximum production of 2064.68 thousand tons. In year 2022-23 Kinnow export will attain a level of 2617.45 thousand tons.

Forecasting of export of kinnow. Like forecasting of production of Kinnow, ARIMA model was again applied in four steps as proposed by Box and Jenkins (1970) for the purpose of forecasting of Export quantity of Kinnow. These steps are as follows:

1. Model Identification: It was the specification of p, d, q.

2. Model estimation: It consisted of estimating the parameters of the model.

3. Diagnostic checking: It consisted of the application of a variety of tests to see whether the estimated model fits the data adequately.

Table III. Augmented Dickey-Fuller Unit Root Test on D (production, 2)

ADF Test Statistic	**-5.524261**	**1%**	**Critical Value***	**-3.8572**
		5%	Critical Value	-3.04
		10%	Critical Value	-2.6608

* MacKinnon critical values for rejection of hypothesis of a unit root

Augmented Dickey-Fuller Test Equation — Dependent Variable: D(PRODUCTION, 3)

Method: Least Squares

Variable	**Coefficient**	**Std. Error**	**T-Statistic**	**Prob**
D(production(-1),2)	-2.282855	0.411431	-5.524261	0.0001
D(production(-1),3)	0.389264	0.230185	1.691094	0.1115
C	-16.32202	21.476290	-0.760002	0.4590
R-squared	0.850634	Mean dependent var.		4.072222
Adjusted R-Squared	0.830719	S.D dependent var.		218.3162
S.E. of regression	89.82359	Akaike info criterion		11.98458
Sum squared residual.	121024.2	Schwarz criterion		12.13298
Log likelihood	-104.8613	F-statistic		42.71229
Durbin-Watson stat	2.180273	Prob. (F-statistic)		0.000001

4. Forecasts: Forecasts obtained at 95% confidence interval with lower and upper limits.

Model identification. Because most of the economic time series vary in a systematic way, the first step in identification was to choose and to check that the data were stationary or not, the time series data about Kinnow export was analysed and auto-correlation function and partial auto-correlation function were estimated.

Originally, the time series was non-stationary. Auto correlation function did not fall as quickly as the log K increases. To know the order of homogeneity of the time series data i.e., how many times the time series be differenced to have a stationary series, differenced time series and the auto correlation function of the differenced series were taken.

Correlogram of first differenced series of the auto-correlation function showed the properties of the stationary series.

To check the further stationarity, second differenced time series also observed. Correlogram of the second differenced series showed appropriate stationary behaviour than the first differenced series. Auto correlation function fell as quickly as the lag K increased. Thus the selected value of "d" was 2.

The selected value of parameters "p" and "q" was 2 and 2 respectively. After the determination of parameters p, d, q, appropriate model estimated was ARIMA (2, 2, 2).

Model estimation. The model ARIMS (2, 2, 2) was estimated using the E-view computer programme. The whole estimation of the output is given in the Table V.

Diagnostic checking. Augmented Dickey - Fuller unit root test on time series data of export was applied, and the following results were obtained.

ADF–Test statistic = -2.105817
1% critical Value = -3.8304
5% critical Value = -3.8304
10% critical Value = -3.8304

As the absolute value of ADF test-statistic is grater than the critical values at 10% level of significance, therefore, time series is stationary of the ARIMA (2, 2, 2).

Table IV. Forecasts for the Production of Kinnow

No.	**Year**	**Forecasts (tons)**	**Lower 95% Limit**	**Upper 95% Limit**
1.	2002-03	1867.79	1670.89	2064.68
2.	2003-04	1872.42	1599.89	2145.27
3.	2004-05	1886.76	1518.47	2255.05
4.	2005-06	1937.60	1454.93	2420.27
5.	2006-07	1994.61	1423.08	2566.13
6.	2007-08	2034.01	1400.4	2667.61
7.	2009-10	2067.16	1377.62	2756.71
8.	2010-11	2109.02	1360.94	2857.10
9.	2011-12	2155.96	1325.05	2959.87
10,	2012-13	2199.04	1346.04	3025.04
11.	2013-14	2238.61	1340.46	3136.76
12.	2014-15	2279.66	1337.23	3222.09
13.	2015-16	2322.93	1337.33	3308.53
14.	2016-17	2365.78	1339.33	3392.23
15.	2017-18	2407.34	1342.14	3472.53
16.	2018-19	2448.88	1346.14	3551.62
17.	2019-20	2491.14	1351.78	3630.50
18.	2020-21	2533.53	1358.73	3708.4
19.	2021-22	2575.56	1366.51	3784.62
20.	2022-23	2617.45	1375.11	3859.78

Table V. Estimates of the parameters

Parameter	**Estimate**	**S. E.**	**t ratio**	**P value**
AR (1)	0.154667	0.291805	0.530034	0.603846
AR (2)	-0.299391	0.240627	-1.24421	0.232514
MA (1)	1.3049	0.159301	8.19142	0.000001
MA (2)	-0.863518	0.134684	-6.41142	0.000012
Mean	1220.5	1874.74	0.651024	0.524880
Constant	1397.13			

Estimated white noise variance = 2.96267×10^8 with 15 degrees of freedom.
Estimated white noise standard deviation = 17212.4

Hence, ARIMA (2, 2, 2) is fit for the forecasting. The detail of unit root test is given in the Table VI.

Forecast for the export quantity of kinnow. The twenty years ahead forecasts i.e. upto year 2023 and their 95% confidence intervals were generated by using ARIMA (2, 2, 2) model. Forecasts with their upper and Lower Limits at 95% confidence interval are given in Table VII.

Table VI. Augmented Dickey-Fuller Unit Root Test on Export

ADF Test Statistic	**-5.38304**	**1%**	**Critical Value***	**-3.857**
		5%	Critical Value	-3.04
		10%	Critical Value	-2.661

* MacKinnon critical values for rejection of hypothesis of a unit root
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXPORT_QT_01,3)
Method: Least Squares

Variable	**Coefficient**	**Std. Error**	**T-Statistic**	**Prob**
D(EXPORT_QT_01(-1),2)	-2.25704	0.419287	-5.38304	0.0001
D(EXPORT_QT_01(-1),3)	0.429124	0.248464	1.727109	0.1047
C	-3005.179	4368.008	0.687998	0.502
R-squared	.833217	Mean dependent var.		-247.9
Adjusted R-Squared	.810979	S.D dependent var.		42458
S.E. of regression	18459.16	Akaike info criterion		22.636
Sum squared residual.	5.11E+09	Schwarz criterion		22.784
Log likelihood	-200.7197	F-statistic		37.469
Durbin-Watson stat	2.179015	Prob. (F-statistic)		0.000001

Table VII. Forecast for the Export of Kinnow

No.	Year	Forecasts (tons)	Lower 95% Limit	Upper 95% Limit
1.	2002-03	142691	106004	179379
2.	2003-04	183435	135291	231580
3.	2004-05	229727	167241	292214
4.	2005-06	272363	183405	361322
5.	2006-07	314170	191234	437106
6.	2007-08	358340	198825	517855
7.	2009-10	404521	205933	603110
8.	2010-11	451703	210823	692583
9.	2011-12	499834	213593	786076
10,	2012-13	549210	214981	883440
11.	2013-14	599891	215263	984520
12.	2014-15	651799	214426	$1.08917x10^6$
13.	2015-16	704903	212519	$1.19729x10^6$
14.	2016-17	759221	209665	$1.30878x10^6$
15.	2017-18	814767	205967	$1.42357x10^6$
16.	2018-19	871536	201489	$1.54158x10^6$
17.	2019-20	929523	196292	$1.60275x10^6$
18.	2020-21	988731	190434	$1.78703x10^6$
19.	2021-22	$1.04916x10^6$	183970	$1.91435x10^6$

Table shows the quantity of Kinnow in tons. It is quite evident from the table that quantity of export of Kinnow in the next years is increasing. The quantity of export of Kinnow will be 142691 tons in 2002 – 2003, with a minimum export 106004 tons and with a maximum export of 179379.00 tons. In year 2022-23 Kinnow export will attain a level of 1.11081 x 10^6(1110810) tons.

SUGGESTIONS

The agrarian economy of Pakistan has a lot of potential in general and in the production of fruits in particular. In the category of fruits, citrus occupied a supreme position. A well-organized citrus culture in Pakistan means a well-organized fruit sector, which will be acting as a gateway towards prosperous agriculture. So in this context, for the improvement of citrus culture, following measures are suggested.

1. The analysis of growth trends provide us with the past behaviour on growth pattern of Kinnow in Pakistan and forecast give a picture about future prospects. So it is suggested that govt. should also undertake activities to expand its supportive infrastructure keeping in view the future picture of Kinnow crop in Pakistan.
2. The govt. should also give incentive for the growth and promotion of input industry required for Kinnow production, and also allied industries like packaging, processing, transportation and storage industries. A well integrated allied network would guarantee a prosperous future for Kinnow.
3. Pakistan also needs to start a campaign to boost up its exports. The right strategy in this respect is to identify the new markets with diversification of existing product portfolio. In this context, we also need to develop a culture of value addition in Kinnow. This strategy will enhance total receipts from the exports in future.
4. Pakistan also needs to take some strategic steps in order to cope with changing environment under upcoming WTO regime. We need to modernize and updated the existing production, harvesting, and post harvest management practices. In order to increase exports from Pakistan, we also need to ensure the authenticity of quality certificate. Packaging is also another important issue and we need to focus on packaging industry as a priority area. In addition to all these, we also need to start a campaign to build up good image of Pakistani Kinnow in international markets.

REFERENCES

Anonymous, 2002. *Demand for Seedless Kinnow*. Small and Medium Enterprises Development Authority, Government of Pakistan

Box, G.E.P. and G.M. Jenkins, 1976. *Time Series Analysis*: Forecasting and Control, Holdon–Day, San Francisco. USA

Government of Pakistan, 2002. *Pakistan Statistical Year Book*. Federal Bureau of Statistics, Statistics Division, Islamabad. Pakistan

Government of Pakistan, 2003. *Pakistan Statistical Year Book*. Federal Bureau of Statistics, Statistics Division, Islamabad. Pakistan

Gujarati, N.D., 2003. *Semi–log Models: Log–lin and Lin–log Models. Basic Econometrics*, 4th Int. Ed. McGraw Hill, Inc. Singapore

(Received 10 October 2004; Accepted 29 November 2004)