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Past Trends and Future Prospects in Production, and Export Scenario of Tea in India

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ABSTRACT

India has played a vital role in tea basket of world. India is the largest producer of black tea as well as the largest consumer of tea in the world. This study also focuses on forecasting the cultivated area and production of tea in India using Autoregressive Integrated Moving Average (ARIMA) model. The analyses forecast that in India tea production for the year 2020 would be about 1066299 '000'kg from a forecasted area of 612035 hectares with average forecasted yield of 1818 kg/ha. In case of export of tea both in (quantity and value) would be 181 million kg and 32157 million rupees in the year 2020.These projections will help information of good policies with respect to relative production, price structure as well as tea market in the country.

Keywords: ARIMA, Export, Forecasting, Production, Trend, Tea.

INTRODUCTION

Tea had got tremendous medicinal importance on life. Tea is globally one of the most popular and lowest cost beverages, next only to water. Tea is consumed by a wide range of age groups in all levels of society. More than three billion cups of tea are consumed daily worldwide. Tea is considered to be a part of the huge beverage market, not to be seen in isolation just as a 'commodity'. Tea active ingredients are of interest to functional foods markets. Africa, South America, the Near East and especially the Asian region produces a varied range of teas, this, together with a reputation in the international markets for high quality, has resulted in Asia enjoying a share of every importing market in the world. With nearly 6 lakh hectares under tea cultivation, the Indian subcontinent has a definitive advantage and ranks as the second

largest tea producing nation in the world. There are many producing regions of black, green teas and specialty teas in the country. The most popular are Darjeeling in the North, Assam in the North East, Auto Regressive Integrated Moving Average (ARIMA) is the most general class of models for forecasting a time series. Appearance of lags of the forecast errors in the model is called "moving average". (ARIMA) model was introduced by Box and Jenkins in 1976 for forecasting variables. Sher and Ahamd (2008) made wheat production in Pakistan forecasts for 2015 using time series data covering the period of 1979-2006 using ARIMA model. Yaseen, *et al.* (2006) studied forecasting the cultivated area and production of sugarcane in Pakistan using Autoregressive Integrated Moving Average (ARIMA) model using time series data covering the period of 1947-2002 and forecasted area, production and yield for year 2008.

METHODLOGY

Present study data related to area, production and yield of tea in India since 1918 to 2010 and export both in (value and Quantity) since 1980 to 2010 were collected from various issues of agriculture at a glance. Statistical tools used to describe the above series are minimum, maximum, average, standard error, skewness, kurtosis; Box-Jenkins ARIMA modelling has been used to forecast series under consideration.

Descriptive statistics

To examine the nature of each series these have been subjected to get various statistics. Descriptive statistics are used to describe patterns and general trends in a data set. It is numerical and graphic procedure to summarize a collection of data in a clear and understandable way. Statistical tools used to describe the above series are minimum, maximum, average, standard error, skewness, kurtosis. Simple growth rates have been calculated using the following formula:

$$SGR\% = \frac{(Y_t - Y_0)}{Y_0 n}.100$$

where, Y_t and Y_0 are the values of the last year and the first year of the series; n is the number of years.

To trace the path of production process different parametric trend models as given in table below are used. Among the comparative trend models, the best models are selected based on their goodness of fit (measured in terms of R^2) value and significance of the parameters.

Different trend models used

Polynomial Model	$Y_t = b_0 + b_1 t + b_2t^2 + b_2t^3 + \ldots\ldots\ldots\ldots + b_kt^k$
Linear Model	$Y_t = b_0 + b_1t$
Quadratic Model	$Y_t = b_0 + b_1t + b_2t^2$
Cubic Model	$Y_t = b_0 + b_1 t + b_2t^2 + b_2t^3$

Compound Model	$Y_t = b_0 b_1^t$
Exponential Model	$Y_t = b_0 e^{(b_1 t)}$
Logarithmic Model	$Y_t = b_0 + b_1 \ln(t)$
Growth Model	$Y_t = e^{b_0 + b_1 \ln(t)}$
Power Model	$Y_t = a t^b$

Auto-Regressive Integrated Moving Average (ARIMA) Model:
A stochastic model which can be extremely useful in the representation of certain practically occurring series is the so called autoregressive model. In this model, the current value of the process is expressed as a finite, linear aggregate of previous values of the process and a shock μ_t. ARIMA models stands for Autoregressive Integrated Moving Average models. Integrated means the trends has been removed; if the series has no significant trend, the models are known as ARMA models.

The notation AR (*p*) refers to the autoregressive model of order *p*. The AR (*p*) model is written

$$X_t = c + \sum_{i=1}^{P} \alpha_i X_{t-i} + \mu_t$$

where $\alpha_1, \alpha_2 .... \alpha_p$ are the parameters of the model, *c* is a constant and μ_t is white noise. Sometimes the constant term is omitted for simplicity.

Moving Average model: The notation MA (*q*) refers to the moving average model of order *q*:

$$X_t = \mu + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t$$

where the $\theta_1, ..., \theta_q$ are the parameters of the model, μ is the expectation of X_t (often assumed to equal 0), and the ε_t is the error term.

$$MAE = \frac{\sum_{i=1}^{n} \left| X_i - \hat{X}_i \right|}{n}, \quad RMSE = \sqrt{\frac{\sum_{i=1}^{n} \left(X_i - \hat{X}_i \right)^2}{n}},$$

$$MAPE = \frac{\sum_{i=1}^{n} \left| \frac{X_i - \hat{X}_i}{X_i} \right|}{n} \times 100$$

$$R^2 = \frac{\sum_{i=1}^{n} \left(\hat{X}_i - \bar{X} \right)^2}{\sum_{i=1}^{n} \left(X_i - \bar{X} \right)^2}$$

With the help of SPSS 16 computer package ARIMA models was found to be estimated for tea in India.

Model Formulation

The whole period under consideration (1918-2010) has been divided into two parts.

- The model formulation period (1918-2006)
- Model validation period (2007-2010)

On the basis of best fitted model forecasting has been made up to 2020.

RESULT AND DISCUSSION:

Descriptive Statistics

From the table 1, since 1918 the area under tea has increased from 237574 ha to 570000 ha registering a growth of almost 1.16%.The average area under tea being 371537 ha. In fact the effect of green revolution is being reflected. The effect of expansion of area is clearly visible in the production scenario of tea. With a mere 124405 '000' kg of production it has reached to 991000 '000' kg in year 2010. Platykurtic nature of production indicates that there has been continuous force on enhancing production of these crops during the period. Increased production of tea would not been possible without a substantial increasing per ha yield of the crop. In India yields for tea were highest at 1865 kg/ha in 2010 and lowest at 444 kg/ha in 1918.Thus the joint effect of expansion area and yield has resulted in a brighter picture of tea production scenario in India. The average export of tea in quantity being 193 million kg and export in value of tea registering a growth of almost 15.33%.

Table1: Per *se* performance of tea production in India

	area	production	yield	export (Q)	export(V)
Mean	371537.500	454612.859	1146.326	193.033	13781.667
Standard Error	8132.243	27411.557	47.634	3.992	1280.885
Kurtosis	0.768	-0.966	-1.505	-0.004	-0.644
Skewness	1.226	0.612	0.077	-0.785	0.393
Minimum	237574	124405	433.582	140	3600
Maximum	570000	991000	1865.167	224	30387
SGR (%)	1.157	4.950	1.827	-0.712	15.330

Area (A) and production (P) are in hectare and ′000' kg respectively; yield (Y) in kg/ha Export quantity (EQ) and Export values (EV) are in million kg and million Rs respectively

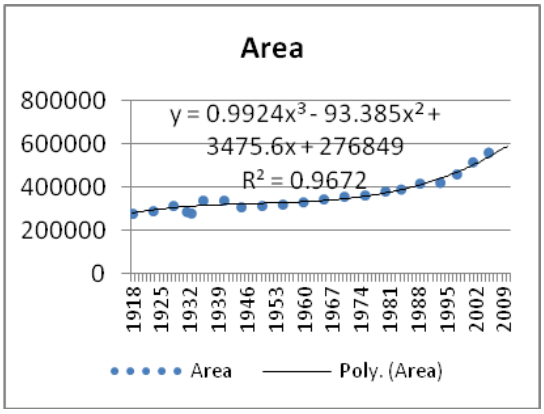
Trends in production behaviour of Tea

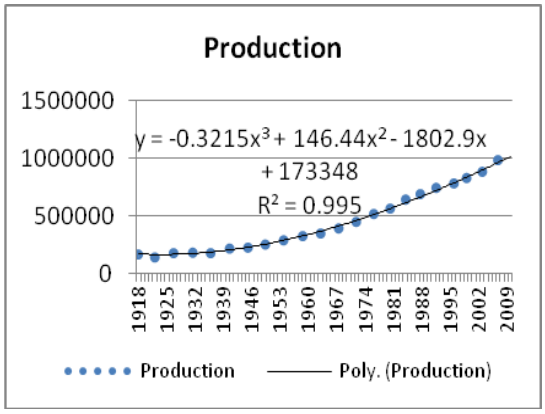
Knowing the above overall performance, now it is imperative to work out the trends in area, production yield and export of tea in India different parameter model like Linear, Logarithmic, Quadratic, Cubic, Compound, growth, and Exponential model

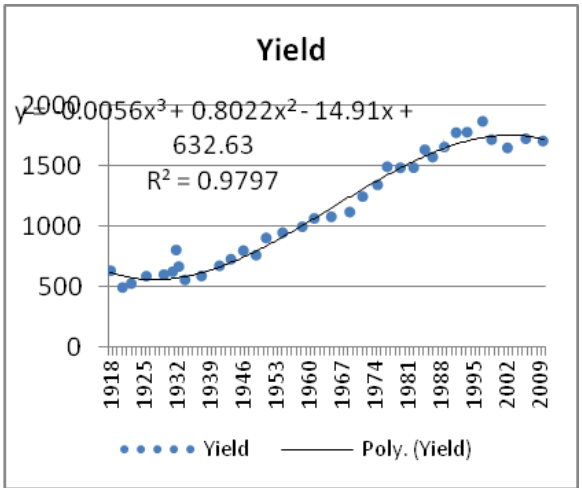
where attempted to among the competitive models..The best model was selected on the basis of the maximum R^2 value, significance of the model and its coefficient. Except the export in value of tea cubic model well fitted in area, production, yield and export in quantity in tea in India(Table 2).. In most of the cases the non-linear patterns (Fig-A) are revealed. This may be due to the changes in policies and its execution at different point of times.

Table: 2 Trends in area, production and yield of tea in India

	Model	R^2	F	Significance	Constant	b_1	b_2
A	Cubic	0.967	875.289	0.00	276849.252	3475.600	-93.385
P	Cubic	0.995	5949.397	0.00	173348.072	-1802.859	146.438
Y	Cubic	0.980	1430.082	0.00	632.717	-14.915	0.802
EQ	Cubic	0.728	3.376	0.033	235.387	-7.349	0.314
EV	Exponential	0.888	230.863	0.00	4285.914	0.062	







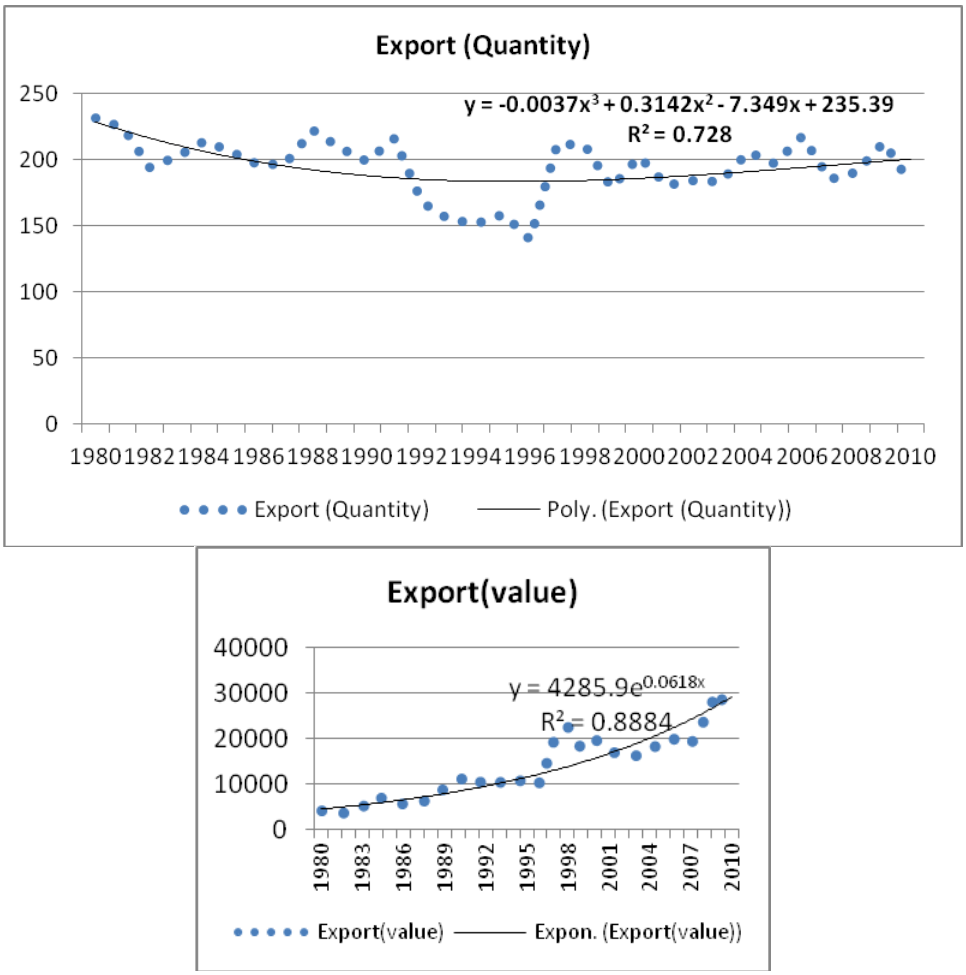


Fig.A: Past trends of area, production, yield and export (quantity and value) of tea in India Area (A) and production (P) are in hectare and ′000’ kg respectively; yield (Y) in kg/ha Export quantity (Q) and Export values (V) are in million kg and million Rs respectively

Box-Jenkins modeling and forecasting:

With the knowledge of trend in production of tea next task is to forecast the series for the years to come. For the purpose as discussed earlier Box –Jenkins methodology is used. Initial examination of the series clearly indicates that none of the series is stationary in nature and first order differencing is required for all the series With the differenced series, ARIMA models are tried and among the competitive models the best models is selected based on the minimum values of RMSE, MAE, MSE, MAPE and maximum value of R^2 which are given in table 3. ARIMA model offers a good method for predicting the magnitude of any variable. ACF and PACF graphs of area, production yield and export of tea presented in figure (C).After diagnostic checks of the respective models for white noise of their error; these are used for forecasting purposes. . From the forecast values obtained the regression model, Now, the above best fitted models are used to get the forecasting values for years to come, as done by

Yaseen, *et al.* in sugarcane and Wankhade *et.al*. 2010 in pigeon pea (Table 4). Table-4 gives the results for observed and predicated values during model validation periods and also predicated values for years to come. It is clear from the observed and predicated values, and also from the figures (Fig-B) that by and large the models have adequately been identified. From the forecast values obtained, it can be said that forecasted area will increases from 612035 hectare during 2020-21.. In case of production of tea, it is clear from the table that there will be consistent increase in production coupled with almost stagnation in all India area but increase in areas in association with increase in productivity. The study expects to have 1066299 '000' kg production of tea with an average productivity of 1818 kg/ha during 2020-21. India has to play a major role in tea basket of world while the contribution of marginal countries will further reduce. In 2010-11 export of tea respectively both in quantity and value was 180 million kg and 24505 million rupees. Up to the year 2020-21 it will be 181 million kg and 32157 million rupees. These projections will help information of good policies with respect to relative production, price structure as well as tea market in the country.

Table 3: Forecasting ARIMA models for area, production yield and export of tea in India

	Best fitted ARIMA models(p,d,q)	R^2	RMSE	MAPE	MAE	MaxAPE	MaxAE	Normalized BIC
Area	(0,1,4)	0.967	14540.00	2.188	7611.00	36.61	87000.00	19.47
P	(1,1,4)	0.996	18050.00	3.53	13040.00	35.55	52290.00	19.94
Y	(1,1,5)	0.981	65.90	4.95	45.83	41.30	247.24	8.76
EQ	(1,1,3)	0.796	21.556	7.72	14.08	29.97	47.07	6.82
EV	(1,1,5)	0.896	2602.00	13.73	1645.00	37.64	7005.00	16.63

Table 4: Model validations and forecasting of area, production yield and export of tea in India

	2007		2008		2009		2010		2015	2020
	Observed	Predicated	Observed	Predicated	Observed	Predicated	Observed	Predicated	Predicated	Predicated
A	567999	567710	570000	570267	570000	571715	570000	571844	591191	612035
P	987000	987115	973000	982505	991000	1004749	967000	974541	1023663	1066299
Y	1738	1736	1707	1724	1739	1747	1696	1720	1768	1818
EQ	185	183	190	197	213	207	180	187	186	181
EV	18887	19233	23818	24112	30387	31345	24505	24976	28552	32157

Area (A) and production (P) are in hectare and ′000' kg respectively; yield (Y) in kg/ha Export quantity (EQ) and Export values (EV) are in million kg and million Rs respectively

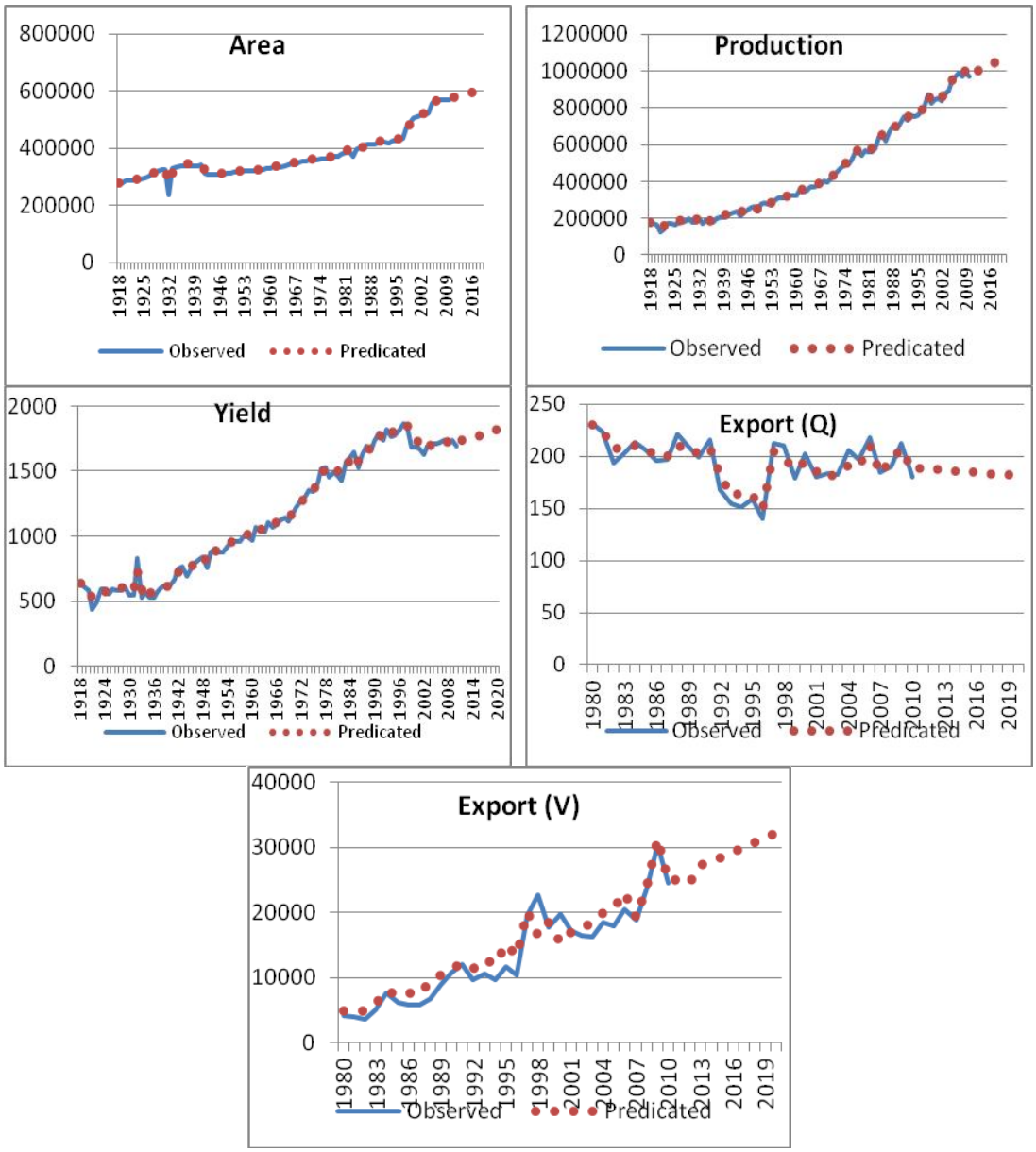


Fig.B: Observed and forecasted area, production, yield and export of tea in India
Area (A) and production (P) are in hectare and ′000’ kg respectively; yield (Y) in kg/ha Export quantity (Q) and Export values (V) are in million kg and million Rs respectively

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