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Study on Forecasting and Instability of Banana Export from India

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ABSTRACT

The international demand for banana is an opportunity for India to increase its export. The data on export quantity and value of banana in India from the period of 1990-91 to 2017-18 were considered with the aim to carry out time series modeling for Indian banana export and value and to forecast the Indian banana export and its value for next five years. The Indian banana with respect of growth in quantity exhibited as positive growth rate of 22.14 per cent annum. The quantum of banana exported exhibited less variability with coefficient of variation at 121.32 per cent while it was maximum in the banana value during study period with coefficient of variation at 146.14 per cent. The instability index of banana export and value was 38.85 and 48.53 per cent respectively. The forecasted banana export and their value revealed rising trend. It was predicted that banana export are estimated to increase from 1.01 lakh tons in 2017 to 1.32 lakh tons in 2023. Similarly export value from banana will raise from Rs. 34,877 lakh in 2017 to Rs. 57,815 lakh. Hence, it is suggested that there is a need to give more concentration on export. ARIMA (3,1,6) and Brown's exponential smoothing model was found best fit for banana export and its total value.

Key words: Banana, Export, Price, Instability, Forecasting

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1. Introduction

Banana is the second most main fruit crop in India next to mango. Its year round availability, taste, nutritive and medicinal value makes it the preferred fruit among all classes of people. India produces a total of 23 per cent of the entire world production of banana. Because of its abundant production, it is predicted that the potential of export seems to be attractive. The total area under banana cultivation in India during the year 2020-21 was 923 thousand ha with production of 33379 thousand MT (*source: agricultural statistics at a glance, 2021*). Achmad (2019) studied the forecasting of OAV Equitas mutual fund NAV price movements for one year data by using two different methods Brown's double exponential smoothing and Holt's double exponential smoothing method and showed that Holt method has a smaller forecasting error level as compared to browns method. Bhagat *et* al. (2021) studied the forecasting and instability of

grape export from India and found that Netherland was found the most stable market among the major importer of Indian grape. While Bangladesh, UK and UAE are seemed to be moderately stable. The maximum gainer among importers of Indian grape was Germany. Brown's and Holt's exponential smoothing models are recommended to use for grape export and its total value in future from India. Bhagat *et* al. (2022) studied the export prospectus of banana in India and concluded that UAE and Maldives were found most stable markets among the major importer studied for Indian banana. However, the countries like Nepal, Oman and other countries are as moderately stable.

The foremost states in production of banana in the country are Tamil Nadu, Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh and Karnataka, while importers of Indian bananas are the UAE, Saudi Arabia, Oman, Bahrain and Nepal. India being the largest producer of banana at about 28 per cent of world production, does not account as one of the banana trading nations because major production is utilized for domestic consumption. The worldwide demand for banana is an opportunity for India to increase its export and there is enormous potential in this area. Therefore, an attempt has been made in this study to carry out time series modeling for Indian banana export and value and to forecast the Indian banana export and its value for next five years.

2. Materials and Methods

2.1 Source of data

The time series data on export quantity and value of banana in India from the period of 1990-91 to 2017-18 were obtained from website of Directorate General of Commerce, Industries and Statistics, Kolkata and Indian Horticulture Database of NHB.

2.2 Statistical Analysis

2.2.1 Mann-Kendall Test

The Mann-Kendall test is used to determine whether a time series has a monotonic increasing or decreasing trend. Test interpretation is H_0: There is no trend in the series and H_1: There is a trend in the series. The time series $x_1, .., x_n$, the Mann-Kendall test uses the following
Formula

$$S = \sum_{i=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_i)$$

if $S > 0$ then later on observations in the time series tend to be larger than those that appear before in the time series, while the reverse is true if $S < 0$.

The variance of S is given by

$$\frac{1}{8}\left[n(n-1)(2n+5) - \sum_t f_t(f_t - 1)(2f_t + 5) \right]$$

Where, t is set of tied ranks and f_t is the number of times that the rank t appears.

The Mann-Kendall test uses the following formula

$$z = \begin{cases} (S-1)/se, & S > 0 \\ 0, & S = 0 \\ (S+1)/se, & S < 0 \end{cases}$$

Where, *se* is the square root of *var*, $z \sim N(0, 1)$, i.e. z is the standard normal distribution.

2.2.2 Export Performance

Export growth of banana is examined by fitting compound growth rate is $Y = ab^t$

Where, Y = Export or value qty., a = Intercept, b = Regression coefficient, t = Time variable

2.2.3. Export Instability

Cuddy-Della Valle index is used to measure the instability in export and its value in banana by the formula $CDVI = C.V.\text{X}\sqrt{(1 - R^2)}$

Where, C.V. is the coefficient of variation in per cent; R^2 is the coefficient of determination from time trend regression adjusted by the number of degrees of freedom.

2.3. ARIMA Forecasting Model of Banana Export

Autoregressive Integrated Moving Average (ARIMA) was used for the time series modeling and forecasting of banana export quantity for five leading years. It includes AR and MA terms with their respective order p, d, q respectively. Differencing eliminates trends and seasonality and stabilizes mean of the time series. The first order differencing was used in order to make the

series stationary. The non-seasonal ARIMA (p,d,q) model for the predicted value of banana export (y) in period t based on the data up to period t-1 was used as follows

$$y_t = \mu + \varphi_1 y_{t-1} + \cdots + \varphi_p y_{t-p} - \theta_1 e_{t-1} - \cdots - \theta_q e_{t-q}$$

Where , μ is the constant, φ_k is the autoregressive (AR) coefficient at lag k, θ_k is the moving average (MA) coefficient at lag k and $e_{t-k} = y_{t-k} - \hat{y}_{t-k}$ is the forecast error that was made at period t-k.

The main steps of ARIMA modeling are model identification, parameter estimation, diagnostic checking and forecasting.

2.3.1 Forecasting of Banana Value by using Brown's Linear (i.e. Double) Exponential Smoothing: Brown's double exponential smoothing which uses two different smoothed series that are centered at different points in time. Let S'denote single-smoothed series obtained by applying simple exponential smoothing to series $Y$and S''denote the double-smoothed series obtained by applying simple exponential smoothing (using the same constant smoothing factor, α) to series S'

$St'=\alpha Yt + (1-\alpha)St-1'$

$St''=\alpha St'+(1-\alpha)St-1''$

Then, the forecast for $Yt+k$, for any $k>1$, is as follows

$Ft+k = Lt+kTt$

where Lt is the estimated level at time t, and Tt is the estimated trend at time t,

$Lt=2St'-St''$,

$Tt= (\alpha/1-\alpha) (St'-St'')$,

2.3.2 Results and Discussion

The results of Mann-Kendall trend test is depicted in Table 1. The results indicated that there was an increasing positive trend of banana export from India during the study period.

Table 1 Mann-Kendall trend test of banana export (MT)

Particular	value
Kendall's tau	0.882
S	358.0
Var(S)	2842.0
p-value (Two-tailed)	0.000
Z	6.70
alpha	0.05

The performance of banana exports was examined from the period 1990-91 to 2017-18 and the results are depicted in Table 2. The Indian banana with respect of growth in quantity exhibited as positive growth rate of 22.14 per cent annum which was statistically significant at 1 per cent level of significance. The similar results were reported by Bhagat *et* al. (2021), Mokashi *et* al. (2014) and Kiran *et* al. (2016).

Table 2 Export performance and instability of banana export quantity and value.

Particulars	banana export (MT)			
	Growth rate/instability	C.V. (%)	R^2	Adj. R^2
Compound	22.14**	--	0.90	0.89
Cuddy Della Valle Index (export)	38.85	121.32	--	--
Cuddy Della Valle Index (value)	48.53	146.14		

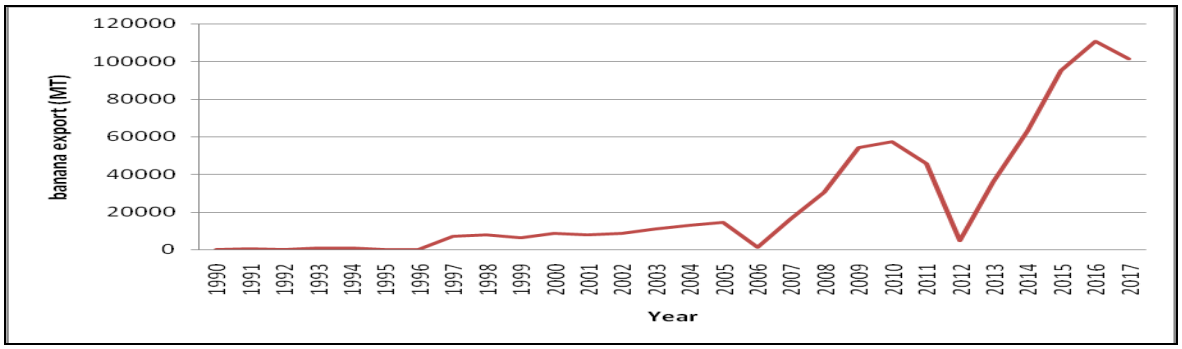


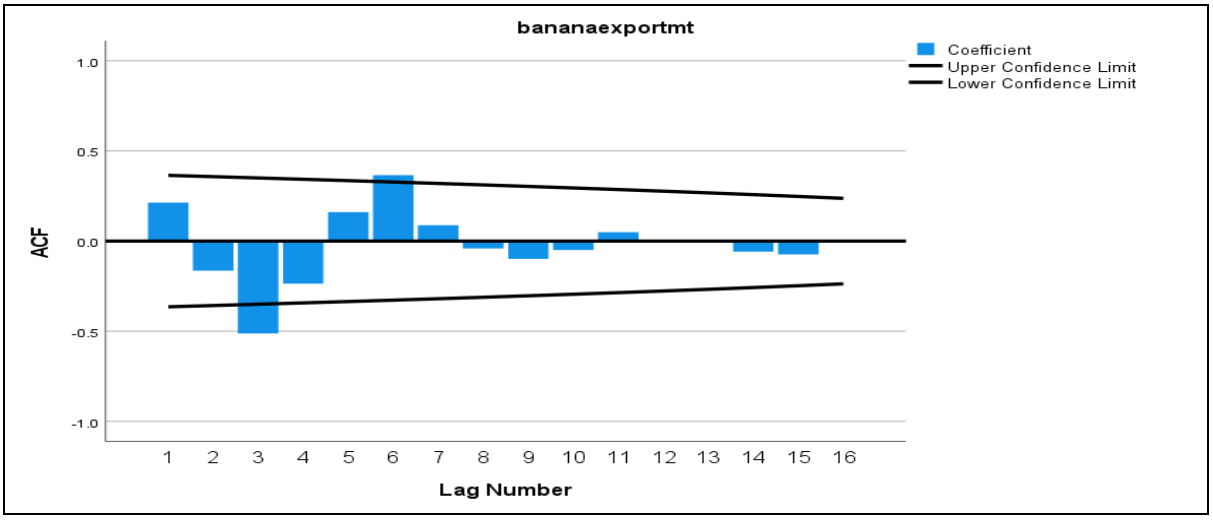
Fig. 1 Year wise export of banana from India during 1990-91to 2017-18

It could be seen from Table 2 that the quantum of banana exported exhibited less variability with coefficient of variation at 121.32 per cent while it was highest in the banana value during study period with coefficient of variation at 146.14 per cent. The instability index computed for export and value of banana by using Cuddy Della Valle index is presented in Table 2. The instability index of banana export and value was 38.85 and 48.53 per cent respectively. The similar results

are in same line with the findings by Bhagat *et* al. (2021), Shabana *et* al. (2018) and Harshita *et* al. (2017).

2.3.3. Forecasting of banana export with ARIMA model

The time series modeling of banana export quantity from India was done with the help of ARIMA. The stationary series was necessary for application of the models and this was achieved by differencing the series by first order. The identification of orders of p and q was done by using Auto correlation Function (ACF) and Partial Auto Correlation Function (PACF) which indicated the orders of p and q.



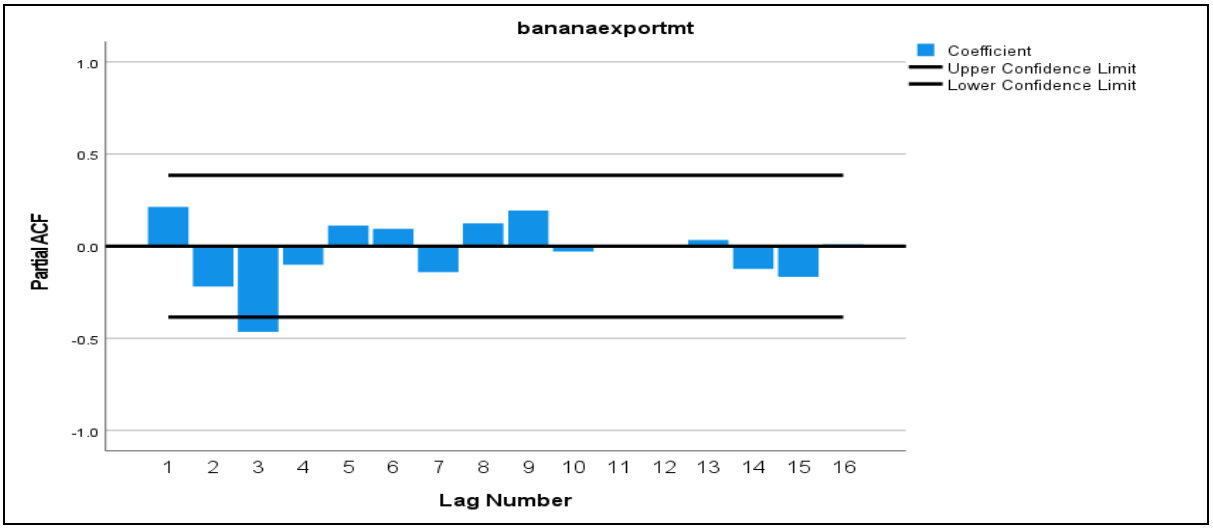


Table 3 Results of ARIMA models fitted to banana export 1990-91 to 2017-18.

Particulars	(3,1,3)	(3,1,6)	(3,1,0)	(0,1,6)
Stationary R^2	0.43	0.60	0.36	0.57
R^2	0.89	0.92	0.87	0.92
RMSE	12802.33	11683.32	12665.40	11044.41
MAPE	450.05	406.91	412.81	476.80
MaxAPE	3959.71	3892.74	3404.43	3948.33
MAE	7981.12	6857.20	7990.50	7140.19
MaxAE	30159.99	20349.32	33762.16	22714.47
Normalized (BIC)	19.77	19.25	19.38	19.47
Ljung-Box Q(18)	7.58	7.78	7.52	8.49

Table 4 Parameter estimates of the best fitted ARIMA model (3, 1, 6) banana export

Variable	Coefficient	SE	t	P value
Constant	3720.883	2646.241	1.406	.178
AR(1)	.074	.488	.152	.881
AR(2)	-.056	.483	-.115	.910
AR(3)	-.239	.549	-.435	.669
MA(1)	1	60.079	-.001	.999
MA(2)	-.048	44.884	.002	.998
MA(3)	.105	9.922	.030	.976
MA(4)	.299	38.696	.002	.998
MA(5)	.095	63.293	-.001	.999
MA(6)	-.071	66.533	-.015	.988

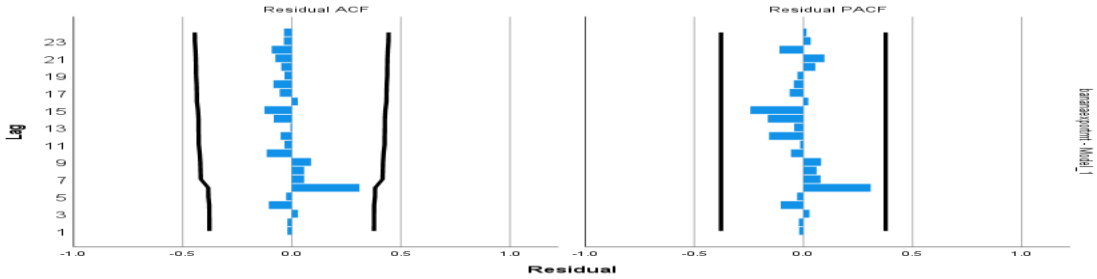


Fig 2. Residuals of fitted ARIMA model for banana export

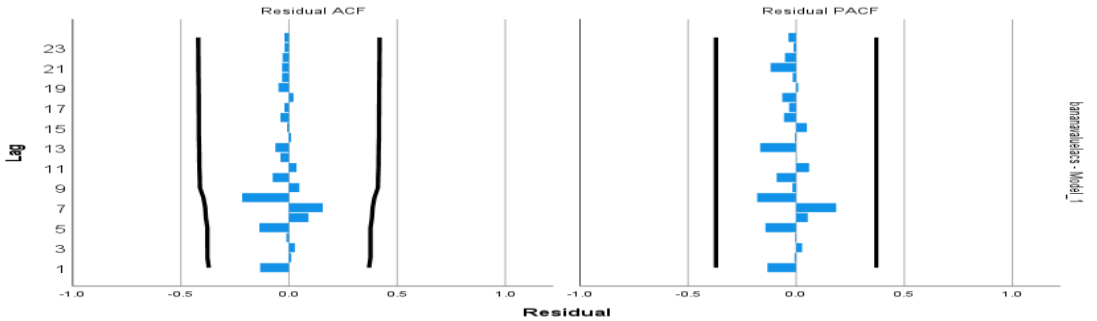


Fig 3. Residuals of fitted Brown's model for banana value

2.3.4. **Forecasting of banana value with Brown's Linear (i.e. double) exponential smoothing model**

The three different models that are brown's, holt's and simple exponential smoothing were tested for forecasting of banana value and subsequently best model was used for forecasting purpose. The highest value of stationary R^2 and lowest value of normalized Bayesian Information Criteria (BIC) indicated that the best model fit. The least BIC value was observed in ARIMA (3,1,6) that was best fit for quantity and while in case of value browns exponential smoothing model was found best fit. These two best fit models were used for forecasting of banana export and value respectively. The results are in line with the findings by Bhagat *et* al.(2021), Kumbhar *et* al. (2019) and Meera *et* al. (2017).

Table 5 Results of banana value (1990-91 to 2017-18)

Particulars	banana value (Rs. Lakh)		
	Brown's exponential smoothing	Simple exponential smoothing	Holt's exponential smoothing
Stationary R^2	0.63	0.06	0.61
R^2	0.86	0.84	0.82
RMSE	4467.70	4803.16	4447.46
MAPE	367.40	313.60	391.90
MaxAPE	5620.18	5140.18	3623.51
MAE	2583.11	2761.58	2511.33
MaxAE	11820.18	12432.58	11699.71
Normalized (BIC)	16.93	17.07	17.04
Ljung-Box Q(18)	5.46	5.27	6.13

Brown's linear exponential smoothing model is a way to behavior of sequence of values over time. The forecasted quantity and value of export of banana is given in table 6. It was observed that there will be increasing trend of annual banana export and value in next five years.

The actual quantum of export of banana and it's value has shown increasing trend with some minor fluctuations over the study period. The estimation of exported quantity for the year 2022, suggested an increase from 1.01 lakh tons in 2017 to 1.32 lakh tons. Also, in value terms the estimated value of banana for the year 2022, suggested an increase from Rs. 34,877 lakh in 2017 to Rs. 57,815 lakh.

Table 6 Forecasted values of banana export and value from India.

Years	Quantity (MT)	Value (Rs. lakh)
2018	79492	41927
2019	90269	45899
2020	101209	49871
2021	114360	53843
2022	132430	57815

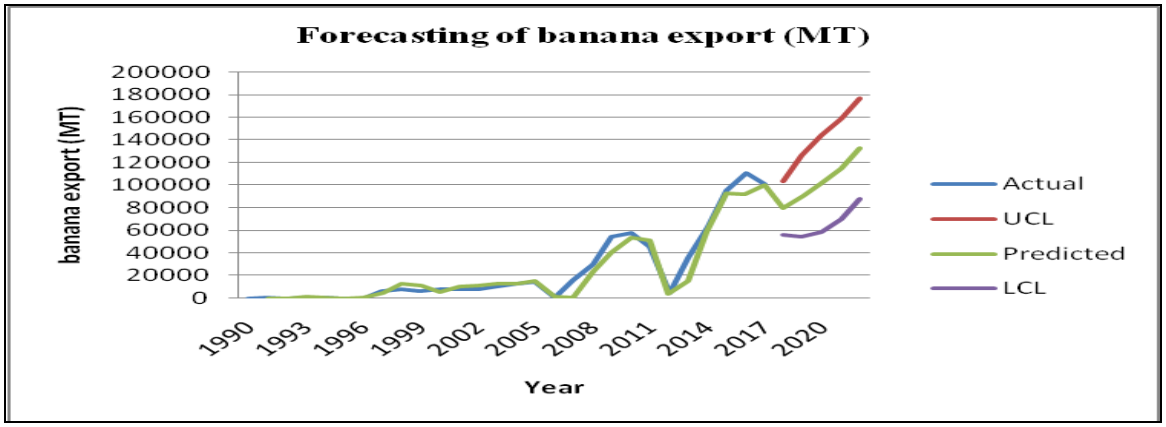


Fig 4. Forecasting of banana export quantity from India

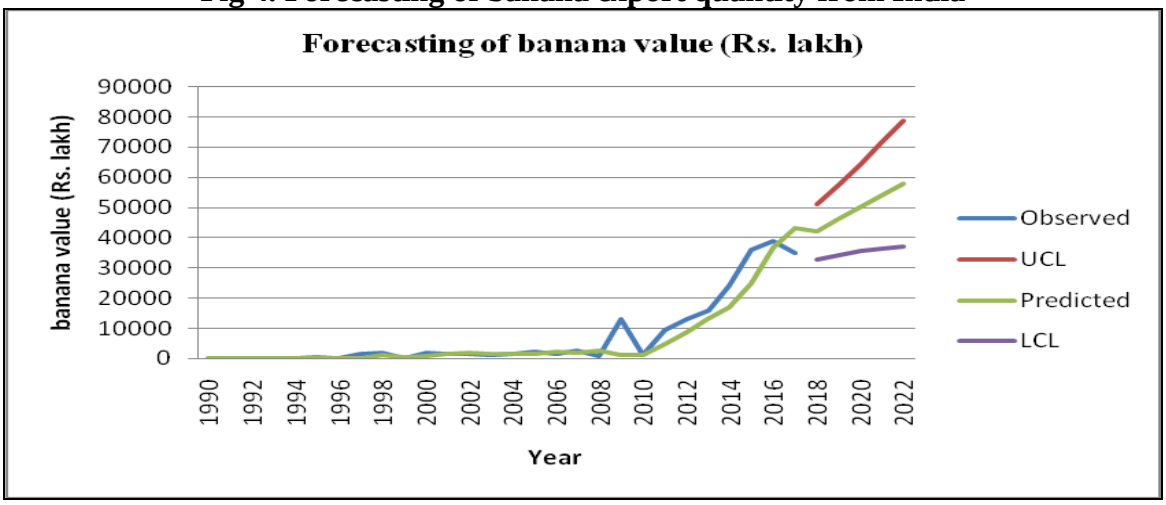


Fig 5. Forecasting of banana value (Rs. lakh) from India.

3. Conclusions

1. The Indian banana with respect of growth in quantity exhibited as positive growth rate of 22.14 per cent annum.
2. The banana exported exhibited less variability with coefficient of variation at 121.32 per cent while it was highest in the banana value during study period with coefficient of variation at 146.14 per cent.

3. The instability index of banana export and value was 38.85 and 48.53 per cent respectively.
4. The forecasted banana export and their value revealed increasing trend. It was predicted that quantum of banana export are expected to increase from 1.01 lakh tons in 2017 to 1.32 lakh tons in 2023. Similarly, export value from banana will increase from Rs. 34,877 lakh in 2017 to Rs. 57,815 lakh. Hence, it is suggested that there is a need to give more attention on export.
5. ARIMA (3,1,6) and Brown's exponential smoothing model was found best fit for banana export and its total value.

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