

A Study on Growth, Instability and Forecasting of Grape Export from India

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Abstract: Grape is an important fruit in the World. It is sub- tropical crop and is cultivated under tropical conditions. Productivity of grape in India is maximum among the grape growing countries of the world. The enormous global demand for grape is a chance for India to increase its export. Present study attempts to perform time series modeling for export and value of grape from India and also to forecast the export and value of grape for next five years. The study was based on secondary data on export quantity and value of grape in India during the period from 1990-91 to 2018-2019 (29 years) and it was analyzed by using Mann- Kendall test, Compound growth rate, Coefficient of Variation, Cuddy Della Valle Index, different exponential smoothing models and Markov Chain analysis.

The results indicated that there was an upward positive trend of grape export from India during the study period. The performance of Indian grape with respect to growth in quantity exhibited a positive growth rate of 12.81 per cent per annum which was statistically significant at 1 per cent level of significance. The instability index of grape export and value was 29.47 and 23.37 per cent respectively. The exported quantity of Indian grape has shown an increase of 30.77 per cent and export value of grape has been increased by 22.91 per cent over the base year 2009-10 during period of last ten years. 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.

Key Words: Grape, export, prediction, exponential smoothing models and instability index.

I. INTRODUCTION

Grape is an important fruit in World. It is sub- tropical crop and is cultivated under tropical conditions. The area under grape was 139 thousand ha with a total production 2920 thousand metric tons in India during the year 2017-18 (NHB, 2018). Productivity of grape in India is utmost among the grape growing countries of the world. There is enhance in the production of

grape because the use of diverse modern technology (Shinde, 2016). Maharashtra is a principal state of India in grape production. Nasik and Sangli districts are the most important grape growing districts of Maharashtra. Apart from these two foremost districts, grape is also grown in Ahmednagar, Pune, Satara, Solapur and Osmanabad districts. In Maharashtra, grape area is 86 thousand ha. with production is around 774 thousand tons. India has exported 108.58 thousand MT of grapes during the year 2011-12 with of Rs. 602.88 crores, out of which, nearly 80 per cent grapes are exported from Maharashtra. This indicates that Maharashtra is absolute leader of this crop and has great potential. Kusuma *et al.* (2014) made an effort to study the growth in mango export and its value from India (2001-02 to 2010-11) by using compound growth rate and markov chain analysis. Darekar *et al.* (2017) used ARIMA model was employed to predict the future prices of paddy.

The enormous worldwide demand for grape is an opportunity for India to amplify its export. Therefore, an attempt has been made in the present study to perform time series modeling for export and value of grape from India, to forecast the export and value of grape for next five years and also to recommend the best fit forecasting model for export and its value of grape from India.

II. MATERIALS AND METHODS

The data on export quantity and value of grape in India during the period from 1990-91 to 2018-2019 (29 years) were obtained from website of Directorate General of Commerce, Industries and Statistics, Kolkata and publications of National Horticulture Board "Indian Horticulture Database" from NHB used for obtaining relevant data.

A. Statistical analysis

1) Mann-Kendall Test

The Mann-Kendall test was applied to see the presence or absence of trend in export of grape from India. Test interpretations are H_0 : There is absence of trend in the series and H_1 : There is a presence of trend in the series.

If observations $X_1, X_2, \dots, X_n$ then the test statistic is as follows:

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

if $S > 0$ then later observations tend to be larger than those that appear earlier in the time series, otherwise it is true if $S < 0$.

The var (S) is given by

$$\text{Var}(S) = \frac{1}{18} [n(n-1)(2n+5) - \sum_t f_t(f_t-1)(2f_t+5)]$$

Where, t represents the variation over the set of tied ranks and f_t represents the frequency that the rank t appears.

The test statistic is as follows:

$$z = \begin{cases} \frac{S-1}{se} & ; S > 0 \\ 0 & ; S = 0 \\ \frac{S+1}{se} & ; S < 0 \end{cases}$$

Where, se denote the square root of var . If there is absence of trend (H_0), then for time series with more than ten observations, $z \sim N(0, 1)$, i.e. z represents the standard normal distribution.

2) Export Performance

Export performance of grape is examined by fitting compound growth rate as below

$$Y = ab^t$$

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

3) Export Instability

If the time series data demonstrate any trend, the variation measured by Coefficient of variation (CV) can be over-estimated, that is the region which has rising production are at constant rate will score high in instability of production if Coefficient of Variation (CV) is applied for measuring instability. As against that, Cuddy-Della Valle Index (CDVI) attempts to de-trend the CV by using coefficient of determination (R^2). Thus, it is a improved measure to capture instability in agricultural production.

$$CDVI = C.V. \times \sqrt{(1 - R^2)}$$

Where,

C.V. represents per cent coefficient of variation.

$\hat{\alpha}$ represent the adjusted value of coefficient of determination.

4) Forecasting of grape export by using Brown's Linear (i.e. double) exponential Smoothing model

Brown's Double Exponential Smoothing, also known as Brown's Linear Exponential Smoothing, is one type of double exponential smoothing which uses two different smoothed series that are centered at different points in time.

Let S' represents the single-smoothed series obtained by implementing simple exponential smoothing to series Y and S'' represents the double-smoothed series obtained by implementing simple exponential smoothing with same constant α smoothing factor to series S'

$$S'_t = \alpha Y_t + (1 - \alpha)S'_{t-1}$$

$$S''_t = \alpha S'_t + (1 - \alpha)S''_{t-1}$$

Then, the forecast for Y_{t+k} , for any $k \geq 1$, is given by

$$F_{t+k} = L_t + kT_t$$

where L_t is the expected level at time t , and T_t is the expected trend at time t ,

$$L_t = 2S'_t - S''_t$$

$$T_t = (\alpha/1 - \alpha)(S'_t - S''_t)$$

5) Forecasting of grape value by using Holt's exponential smoothing model

Holt extended simple exponential smoothing to permit the forecasting of data with a trend. This method involve a forecast equation and two smoothing equations that is one for the level and other for the trend.

$$\text{Forecast equation } \hat{y}_{t+h|t} = l_t + hb_t$$

$$\text{Level equation } l_t = \alpha y_t + (1 - \alpha)(l_{t-1} + b_{t-1})$$

$$\text{Trend equation } b_t = \beta^*(l_t - l_{t-1}) + (1 - \beta^*)b_{t-1}$$

Where, l_t denotes an estimate of the level of the series at time t , b_t denotes an estimate of the trend (slope) of the time series at time t , α is the smoothing parameter for the level, $0 \leq \alpha \leq 1$, and β^* is the smoothing parameter for the trend, $0 \leq \beta^* \leq 1$.

III. RESULTS AND DISCUSSION

The result of Mann-Kendall trend test is depicted in "Table I". The results indicated that there was an increasing positive trend of grape export from India during the study period. As the computed p-value is lower than the significance level $\alpha=0.05$, one should reject the null hypothesis H_0 , and accept the alternative hypothesis H_1 .

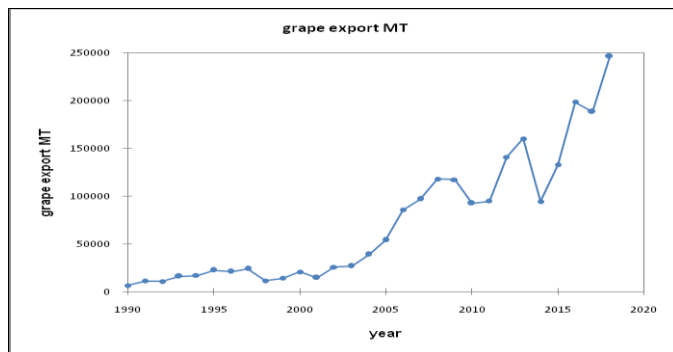
Table I. Mann-Kendall trend test of grape export (MT)

Kendall's tau	0.818
S	332
Var(S)	2842
p-value (Two-tailed)	0.001
alpha	0.05

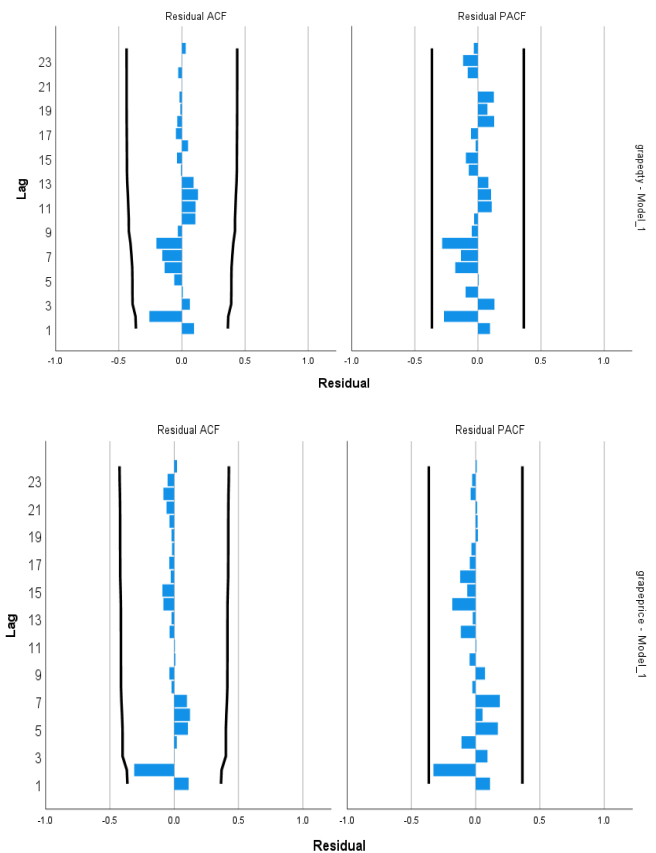
The performance of grape export was examined from the period 1990-91 to 2018-19 (29 years) by using compound growth model. The results are depicted in “Table II”. The performance of Indian grape with respect to growth in quantity exhibited a positive growth rate of 12.81 per cent per annum which was significant at 1 per cent level of significance. The similar results were reported by Mokashi *et al.* (2014), Koujalagi *et al.* (2014) Kiran *et al.* (2016), Daya *et al.* (2017) and Jagtap *et al.* (2018).

Table II. Export performance and instability of grape export quantity and value.

Particulars	Grape export (MT)			
	Growth rate/Value	C.V.	R ²	Adj. R ²
Compound	12.81**	--	0.90	0.89
Cuddy Della Valle Index(export)	29.47	92.47	--	--
Cuddy Della Valle Index (value)	23.37	134.41	--	--

**Fig. 1. Annual export of grape from India during 1990-91 to 2018-19**

It could be seen from “Table II” that the quantum of grape exported exhibited less variability with coefficient of variation at 92.47 per cent while it was highest in export value during study the period with coefficient of variation at 134.41 per cent. The instability index computed for export and value of grape by using Cuddy della valle index are presented in “Table II”. The instability index of grape export and value was 29.47 and 23.37 per cent respectively. The similar results are in same line with the findings by Shrinivasmurthy *et al.* (1999), Shabana *et al.* (2018) and Harshita *et al.* (2017).

**Fig. 2. ACF and PACF of fitted models****Table III. Model fit statistics for three fitted models to grape export and value data (1990-91 to 2018-19).**

Model fit statistics	Export quantity (MT)			Export value (Rs. Lakh)		
	Brown's	ARIMA (0,1,0)	Holt's	Brown's	ARIMA (0,1,0)	Holt's
Stationary R ²	0.56	0.00	0.54	0.54	0.00	0.62
R ²	0.87	0.86	0.86	0.93	0.91	0.94
RMSE	24878.07	25149.83	24675.59	17813.93	19460.93	16563.74
MAPE	29.92	33.77	34.30	27.76	93.878	36.48
MaxAPE	154.00	180.86	187.12	219.64	400.12	253.20
MAE	16501.16	16836.26	16202.69	9328.66	13109.39	8279.72
MaxAE	66099.02	74440.46	66231.38	49807.08	54734.18	64199.84
Normalized BIC	20.36	20.38	20.46	19.69	19.87	19.66

The three different models that are Brown's linear double exponential smoothing, ARIMA (0,1,0) and Holt exponential smoothing model were tested to grape export quantity and value.

Out of these three models the best fitted model was used for forecasting of grape export quantity and value. In case of grape export Brown's double exponential smoothing model was best fit and for the value Holt's linear exponential smoothing was the best fit. The results are in line with the findings by Kumbhar *et al.* (2019), Meera *et al.* (2017) and Robert *et al.* (2009).

The actual and predicted export quantities and values of grape are presented in "Table IV" and forecasted quantity and value of export of grape is given in "Table V". It was observed that there will be increasing trend of annual grape export and value in next five years. The actual quantum of export of grape and value has shown increasing trend with some minor fluctuations over the study period. The estimation of exported quantity for the year 2023 suggested an increase from 2.46 lakh tons in 2018 to 3.11 lakh tons. Also, the estimated value of grape for the year 2023 suggested an increase from Rs. 2,33,525 lakhs in 2018 to Rs. 3,68,972 lakhs.

Table IV. Actual, predicted and per cent gap of grape export quantity and value.

Year	Quantity (MT)			Value (Rs. lakh)		
	Actual	Predicted Brown's	Percent gap	Actual	Predicted Holt's	Percent gap
1990	6408	16276	154.00	1008	3560	253.17
1991	11147	11955	7.25	1862	2320	24.60
1992	10801	12510	15.82	2179	1408	-35.38
1993	15932	12388	-22.24	3393	895	-73.62
1994	16877	15522	-8.03	4085	1228	-69.94
1995	22414	17603	-21.46	5476	2204	-59.75
1996	20999	22093	5.21	5265	3918	-25.58
1997	23808	23232	-2.42	6601	5516	-16.44
1998	11525	25347	119.93	3789	7279	92.11
1999	14083	18095	28.49	5555	7428	33.72
2000	20648	15785	-23.55	8298	7526	-9.30
2001	14606	18857	29.10	6021	8308	37.98
2002	25667	16482	-35.79	11010	8020	-27.16
2003	26711	22450	-15.95	10537	9386	-10.92
2004	38898	26178	-32.70	12644	10614	-16.06
2005	53908	35903	-33.40	21383	12425	-41.89
2006	85563	50453	-41.03	30059	17414	-42.07
2007	96723	78136	-19.22	31707	25670	-19.04
2008	118133	98762	-16.40	36706	33813	-7.88
2009	117338	121895	3.88	43106	41905	-2.79
2010	92437	131434	42.19	39101	49899	27.62
2011	94860	117930	24.32	51676	53332	3.20
2012	140967	110675	-21.49	98204	58262	-40.67
2013	160256	135893	-15.20	143707	79507	-44.67
2014	94377	160476	70.04	97277	118450	21.77

2015	132648	128429	-3.18	136226	136076	-0.11
2016	198471	135345	-31.81	178171	157998	-11.32
2017	188221	181292	-3.68	189995	187962	-1.07
2018	246134	197204	-19.88	233525	214704	-8.06

Table V. Forecasted values of grape export and value from India.

Year	Quantity (MT)	Value (Rs. lakh)
2019	241365	248570
2020	258728	278670
2021	276092	308771
2022	293455	338872
2023	310819	368972

The percent of grape exported quantity and value from India exhibited fluctuating trend over the period from 2009-10 to 2018-19 at the base year 2009-10 ("Table VI and VII"). The exported quantity of Indian grape has shown an increase of 30.77 per cent and export value of grape has been increased by 22.91 per cent over the base year during period of last ten years.

Table VI. Grape export (MT) for different countries over the years.

Years	Netherland	Bangladesh	Russia	U K	U.A.E.	Saudi Arab	Germany	Nepal
2009-10	28822	44419	746	14309	10054	3656	1605	4443
2010-11	18187	38052	2036	6911	8975	3239	650	4412
2011-12	18382	35640	4611	6564	10142	4277	599	4624
2012-13	35915	32562	15885	14829	13769	5906	1464	3648
2013-14	46082	31109	23277	16701	10446	7242	2419	3600
2014-15	32824	3476	12345	13194	11545	3805	2558	2080
2015-16	50390	7832	12446	17598	11693	5487	4222	5283
2016-17	55010	38107	22341	13580	14597	7309	10467	7060
2017-18	58457	5073	27434	18594	13575	9483	16450	7764
2018-19	72262	46419	30293	17597	12772	9204	15739	5974

Contd..

Years	Thailand	Hong Kong	Others	Total	% share of top 10 countries	% share of other countries	% increase over base year
2009-10	876	61	8347	117338	92.89	7.11	
2010-11	1280	672	8023	92437	91.32	8.68	-21.22
2011-12	1807	641	7573	94860	92.02	7.98	2.62

2012-13	2957	1571	12461	140967	91.16	8.84	48.61
2013-14	3749	1640	13991	160256	91.27	8.73	13.68
2014-15	2260	1141	9149	94377	90.31	9.69	-41.11
2015-16	3146	1056	13495	132648	89.83	10.17	40.55
2016-17	4510	2095	23395	198471	88.21	11.79	49.62
2017-18	5043	1969	24379	188221	87.05	12.95	-5.16
2018-19	3919	4039	27916	246134	88.66	11.34	30.77

Table VII. Grape export value (Rs. Lakh) earned from different countries over the years.

Years	Netherland	Bangladesh	Russia	U K	U.A.E.	Saudi Arab	Germany	Nepal
2009-10	16755	5213	598	8166	4189	1538	632	477
2010-11	12696	5142	1943	5051	4444	1507	287	470
2011-12	14198	10032	3870	5319	6243	2438	407	813
2012-13	32480	5262	12438	15363	9445	3433	1101	1143
2013-14	52663	7507	21621	20571	9216	3141	2723	1262
2014-15	36148	1203	11124	15809	10867	3286	3010	572
2015-16	58589	3204	12705	20654	9794	4681	4994	1244
2016-17	61224	10285	23467	15544	11695	6306	11914	1932
2017-18	64753	1438	27734	22194	10972	7117	18092	1450
2018-19	79486	20216	31069	21319	11210	7520	17778	1488

Contd..

Years	Thailand	Hong Kong	Others	Total	% share of top 10 countries	% share of other countries	% increase over base year
2009-10	741	42	4755	43106	88.97	11.03	
2010-11	1371	480	5710	39101	85.40	14.60	-9.29
2011-12	1851	504	6001	51676	88.39	11.61	32.16
2012-13	3421	1766	12352	98204	87.42	12.58	90.04
2013-14	4962	2404	17637	143707	87.73	12.27	46.34
2014-15	2874	1655	10729	97277	88.97	11.03	-32.31

2015-16	4012	1424	14925	136226	89.04	10.96	40.04
2016-17	5923	3060	26821	178171	84.95	15.05	30.79
2017-18	6554	2833	26858	189995	85.86	14.14	6.64
2018-19	5574	5699	32166	233525	86.23	13.77	22.91

The transition probability matrix presented in “Table VIII” facilitates relationships existing among importing countries of Indian grapes. The row elements in transitional probability matrix give the information on the amount of loss of trade, a relation of competing countries. The column element represents the probability of gains in quantity of trade from other competing countries and the diagonal element represents probability of retention of previous year trade quantity of respective countries. It is revealed that Netherland was most stable market among the major importer of Indian grape and it was followed by Russia, UK and UAE. Fresh grape export to Netherland, Russia, UK and UAE was retained to the tune of 90.00, 44.00, 40.00 and 40.00 per cent respectively of its earlier years share in the current period. The remaining countries such as Bangladesh, Saudi Arab, Thailand and Nepal had retention of 30.00, 20.00, 22.00 and 20.00 per cent, respectively of its original share. The major gainer among importers of Indian grapes over a period of time has been Germany, which has a gaining probability of 0.50 from Hong Kong, 0.22 from Thailand, 0.20 from UAE and Saudi Arab respectively. Similar results were also reported by Yeledhalli *et al.* (2012), Kusuma *et al.* (2014), Bisht *et al.* (2015) and Kiran *et al.* (2016).

Table VIII. Markov chain analysis of grape export quantity from India to different countries.

Count ries	Netherland	Bangladesh	Russia	U K	U.A.E.	Saudi Arab	Germany	Nepal	Thailand	Hong Kong	other
Nethe rland	0.90	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bangl adesh	0.10	0.30	0.10	0.30	0.00	0.10	0.00	0.10	0.00	0.00	0.00
Russia	0.00	0.11	0.44	0.11	0.12	0.22	0.00	0.00	0.00	0.00	0.00
U K	0.00	0.10	0.10	0.40	0.30	0.00	0.00	0.10	0.00	0.00	0.00
U.A.E	0.00	0.00	0.10	0.10	0.40	0.10	0.20	0.00	0.00	0.00	0.10
Saudi Arab	0.00	0.20	0.10	0.00	0.10	0.20	0.20	0.00	0.00	0.00	0.00
Germ any	0.00	0.00	0.00	0.14	0.00	0.29	0.00	0.29	0.00	0.14	0.14
Nepal	0.00	0.10	0.00	0.00	0.10	0.20	0.00	0.20	0.30	0.00	0.10

Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hong Kong	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
other	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

IV. CONCLUSIONS

Netherlands was found the most stable markets 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 and it has gained from UAE, Saudi Arab, Thailand and Hong Kong. The exported quantity of Indian grape has shown an increase of 30.77 per cent and export value of grape has been increased by 22.91 per cent over the base year during period of last ten years. The forecasted of grape export and value from India revealed the increasing trend in five leading forecasted years i.e. from 2019 to 2023. It was predicted that quantum of grape export are expected to increase from 2.46 lakh tons in 2018 to 3.11 lakh tons in 2023. Also export value of grape will increase from Rs. 2,33,525 lakhs in 2018 to Rs. 3,68,972 lakhs in 2023. Hence there is a need to have more attention on export encouragement activities to tap the potential. Brown's and Holt's exponential smoothing model are recommended to use for grape export and its total value in future from India.

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