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STRUCTURAL CHANGES IN TRADING OF INDIAN GRAPES: A MARHKOV APPROACH

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ABSTRACT:

This study examines the long-term growth patterns and structural changes in the area, production, productivity, and trade of grapes in India over a 25-year period from 1994–95 to 2019–20. The analysis employs both compound and simple growth rate techniques to assess trends in area, output, yield, export quantity, and export value. To evaluate the dynamics and stability of international trade, transition probability matrices were constructed using a linear programming approach for major grape-export destinations of India as well as for countries exporting grapes to India. This methodological framework enabled a systematic assessment of market stability and trade diversification.

The results reveal notable variations in the stability of export markets for Indian grapes. Germany emerged as the most stable destination despite a relatively low retention probability, whereas markets such as the Netherlands, the United Kingdom, Bangladesh, the United Arab Emirates, Hong Kong, Thailand, and Nepal were comparatively unstable. Although India is the world's largest grape producer, the growth rate of domestic production (5.84 percent) was lower than the growth in global import demand. The Netherlands, the United Kingdom, Russia, Bangladesh, and Germany were identified as the leading importers, recording higher growth in export value relative to export quantity. Overall, the findings indicate considerable export potential for Indian grapes across major international markets, offering opportunities for increased export earnings and improved income for grape producers.

Keywords: Area, Exports, Production, Productivity, Structural changes, Trade, Transition matrix.

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INTRODUCTION:

Grapes (*Vitis vinifera* L.), widely recognized as the "queen of fruits", represent a significant commercial fruit crop in India. Among fruit crops, grapes rank third in terms of cultivated area and production, after citrus and banana. At the global level, grape production is estimated at around 68.9 million tonnes, underscoring its importance among major fruit crops. India has attained a notable position in global viticulture by achieving the highest average productivity among nearly 90 grape-growing countries, with mean yields of approximately 30 t/ha.

In India, grape cultivation is geographically concentrated in a limited number of states. Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu together contribute over 90 percent of the country's total grape area and production. During 2017–18, grapes were grown on about 139 thousand hectares, with total production estimated at nearly 2.92 million tonnes (NHB). Other states, including Punjab, Haryana, western Uttar Pradesh, Rajasthan and Madhya Pradesh, also cultivate grapes; however, their contribution remains comparatively marginal.
Agriculture is central to the Indian economy, supporting nearly 65 percent of the population and employing about 52 percent of the national workforce. However, a substantial proportion of farmers, particularly small and marginal holders, remains economically vulnerable, partly due to the dominance of perishable commodities such as fruits and vegetables, which are prone to post-harvest losses and low value realization.

India occupies a leading position in global agricultural production, ranking first in food grain output and second in fruits and vegetables, while also being the world's largest milk producer. These patterns underscore the need to enhance productivity, value addition, and post-harvest management, especially for high-value crops such as grapes.

OBJECTIVES:

1. To study the export potential for grapes and its processed products.

METHODOLOGY:

Trends in Quantity and Value of Grapes Export:

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The time series data on quantity and value of grapes export will comply from the authentic source viz; from various Government departments, institutes, online portals and from various Government publications.

1. Compound Growth Rates (CGR)

The compound growth rate analysis will be worked out to ascertain the growth in quantity and value of grapes export from India and Maharashtra by fitting an exponential function as given below,

$$Yt = ab^t u$$

Where,

Y = Quantity and value of grapes export from Maharashtra and India

A = Intercept

B = Regression coefficient

T = Time period (years)

U = Error term with zero mean and constant variance

Logarithmic transformation of provided estimating equation is,

$$\ln (Y_t) = \ln (a) + t \ln (b) + \ln (u)$$

The equation is estimated by ordinary least square technique (OLS). From the coefficient values, the Compound Growth Rate (CGR) was then estimated using the formula,

$$CGR(r) = [\text{Antilog } (b) - 1] \times 100$$

Where,

r = Compound growth rate in percent

The 't' test will be used to test the significance.

2. Estimation of variability of quantity and value of grapes export

The variability in export quantity and values of grapes will be worked out by estimating the values of coefficient of variation. The coefficient of variation in export quantity and values of grapes will be worked out by using following formula,

$$C.V.(\%) = [\, SD / (\Sigma X / n) \,] \times 100$$

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Where,

C.V. = Coefficient of variation

S.D. = Standard deviation

X = Grapes export quantity and values

n = No. of years

RESULTS AND DISCUSSION:

The process of export would play an important role in Indian economy by earning foreign income to the farmer which is the gain to India. The import of grapes from other countries shows the opportunities to increase the production of grapes in India. Therefore, the study was undertaken to see the growth rates and coefficient of variation for export quantity and value of grapes from India to various countries. Also, the study was conducted for growth rates and coefficient of variation for import of grapes to India from various countries.

The annual export and import data was used to analyze the growth rates and year to year variation using exponential trend function. This data was used analyze direction of trade and changing pattern of Indian grape export using Markov chain analysis. Markov chain analysis was employed to analyze the structural changes in any system whose progress through time can be measured in terms of single outcome variable. In the present study, the dynamic nature of trade pattern i.e. the gains in export of grapes in major importing countries and losses in import of grapes from major exporting countries was examined using Markov chain model. It shows the transitional probability of exports or imports switching from one country to the other. It also measures the probability of an exporting country retaining its market share in the importing nation.

Growth Performance of Various Aspects of Grapes in India:

The grapes segments growth was analyzed using compound growth rates and results have been presented in the following table 1.

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Table 1: Compound Growth Rates regarding different aspects of grapes from India, 1994-95 to 2018-19

Particulars	CGR (Per cent per annum)
Area	6.48***
Production	5.84***
Productivity	- 0.61^{NS}
Export Quantity	13.19***
Export Value	20.01***

***, ** and * represent significance at 1 percent, 5 percent and 10 percent

Upward growth rate was found for area (6.48), production (5.84), productivity (-0.61), export quantity (13.19) and value of export (20.01) at 1 percent level of significance. The growth rate for productivity of grapes shows decreasing rate of -0.61 per cent which is not significant due to continuous change of climate which affects on the yield of grapes. The compound growth rate for export quantity and export value were 13.19 and 20.01 percent respectively at 1 percent level of significance. The growth rates for export value of grapes are found significantly higher than the export quantity which was beneficial to India to earn more earnings to the farmers. Both the growth rates indicates that the export quantity and export value of grapes increases at higher rate for the period of 25 years. The growth rates in quantity and value of grapes export showed a positive future for Indian grapes exports while the international trade growth indicator export indicate higher percentage for export quantity and value.

Changing Demand in Major Export Destinations:

The top countries consuming Indian grapes exports were identified. These were Netherland, UK, Russia, Bangladesh, Germany, UAE, Saudi Arab, Hong Kong, Thailand and Nepal. The annual growth rates of quantity and value of exports during 1994-95 to 2018-19 of these nations individually have been presented in the following table 2.

Table 2: Destination-wise growth rates in export of grapes from India, 1994-95 to 2018-19

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Sr. No.	Country	Export Quantity			Export Value		
		CGR (%)	CV (%)	R^2	CGR (%)	CV (%)	R^2
1	Netherland	21.67***	101.81	0.87***	29.15***	126.92	0.93***
2	UK	4.19***	40.20	0.52***	11.12***	84.33	0.88***
3	Russia	20.69**	46.87	0.56**	25.34**	52.04	0.66**
4	Bangladesh	13.87***	99.74	0.36***	20.40***	132.76	058***
5	Germany	19.09***	151.78	0.71***	26.40***	193.91	0.83***
6	UAE	6.86***	47.04	0.81***	12.47***	80.71	0.95***
7	Saudi Arab	16.35***	105.05	0.69***	23.92***	132.06	0.85***
8	Hong Kong	17.02***	136.37	0.56***	26.95***	163.20	0.63***
9	Thailand	27.97***	87.89	0.73***	51.10***	109.85	0.81***
10	Nepal	11.80***	53.06	0.60***	22.71***	80.43	0.83***
	Others	14.04***	97.38	0.89***	22.85***	133.61	0.94***
	India	13.19***	81.96	0.87***	20.01***	121.00	0.96***

***, ** and * represent Significance at 1 percent, 5 percent and 10 percent

Structural Changes in India's Trade of Grapes:

Annual export data for the period of 1994-95 to 2018-19 and import data for a period ranging from 2008-09 to 2019-20 was used to analyze the direction of trade and changing pattern of Indian grape export using Markov chain analysis. Markov chain analysis is employed to analyze the structural changes in any system whose progress through time can be measured in terms of single outcome variable (Dent, 1967). In the present study, the dynamic nature of trade patterns i.e. the gains and losses in export/import of grapes in/from major importing/exporting countries was examined using this specific model. It involves developing a transitional probability matrix 'P', whose elements, P indicate the probability of exports/imports switching from country 'i' to country 'j' over time. The diagonal element P where i=j, measures the probability of a country retaining its market share or in other words, the loyalty of an importing country to another country's exports. Regarding import of grapes the diagonal element P where i=j, reflects the probability of an exporting country retaining its

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market share in the importing nation. In terms of export, the row elements in the transitional probability matrix provide the information on the extent of loss in trade to the competing countries depicted in the respective top columns. The column element indicates the probability of gains in volume of trade from other competing countries and the diagonal element indicates the probability of retention of the previous year's trade volume by the respective country.
The numerals in probability matrix can be converted into percentage for interpretation by multiplying with 100.

In the context of current application, structural change was treated as a random process with ten major importing/exporting countries for grapes. The assumption was that, the average export of grapes from India amongst importing countries in any period depends only on the export in the previous period and this dependence was same among all the periods. Similarly, regarding imports the assumption was that, the average imports of grapes from importing nations to India in any period depends only on the import in the previous period and this dependence too, was constant among all the periods.

The growth rates for export values shows increasing trend at very high level for all 10 major countries for 25 years of study period. The growth rates of export value for Netherland (29.15 percent), UK (11.12 percent), Russia (25.34 percent), Bangladesh (20.40 percent), Germany (26.40 percent), UAE (12.47 percent), Saudi Arab (23.92 percent), Hong Kong (26.95 percent), Thailand (51.10 percent) and Nepal (20.01 percent) was shows highly significant. It shows the top countries consuming Indian grapes were identified. The top 5 countries consuming Indian grapes were Netherland, UK, Russia, Bangladesh and Germany. These countries also have the highest growth rates in terms of value which shows higher earnings to India for less quantity. It indicates positive future for export of Indian grapes. None of the countries showed negative growth rates in terms of quantity as well as export value for grapes export from India. It demonstrates the export potential at higher growth rate for export of grapes to these 10 major importing countries from India with the highest earnings to the Indian farmers.

Transitional Probability Matrix for Grapes Export to 10 Major Countries from India:

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Below given the table for transitional probability matrix showing for grapes export quantity from India to major countries, which gives countries loosing, gaining and retaining Indian grapes market share.

The retention probability matrix was developed using Markov chain analysis for the top-most nations where Indian grapes are consumed through imports. The results are presented in table. It showed that Germany though with low retention probability, was the most stable export destination of Indian grapes. On the other hand, Netherland, UK, Bangladesh, UAE, Hong Kong, Thailand and Nepal were seen to be the most unstable markets. Thailand and Nepal had probably lost its complete share to the countries categorized as 'others'.

CONCLUSIONS:

When the parameters indicating domestic and international trade scenario were calculated for grapes in India, the parameters such as area, production, productivity, export quantity and value of exports all showed upward growth over the study period for last 25 years by analyzing the export statistics of grapes from India, major customers came out to be its neighbours such as Bangladesh, Nepal and others customers are Netherland, UK, Russia, Germany, UAE, Saudi Arab, Hong Kong and Thailand. The export market was seen barely improving over the past situation. India has earned a unique distinction of being the largest exporter of grapes. This tag has always brought a huge balance of trade deficit along with it.
It revealed that Germany though with low retention probability, was the most stable export destination of Indian grapes. On the other hand, Netherland, UK, Bangladesh, UAE, Hong Kong, Thailand and Nepal were seen to be the most unstable markets.

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It is also evident that, as there is comparatively marginal increase in area, production and productivity, a lot of efforts is needed to be invested in improving grapes production and productivity so as to earn more benefits to Indian farmers i.e. feeding the growing domestic demand, keeping its prices low along with increasing farmer's income.

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It shows the top countries consuming Indian grapes were identified. Netherland, UK, Russia, Bangladesh and Germany were the top 5 countries consuming Indian grapes.

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