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RESEARCH PAPER

Navigating trade routes: A comprehensive analysis of India's fruit crop trade dynamics

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Abstract: This study has been conducted to analyze the trade dynamics of major fruit crops in Indiaand explore their export trends and market destinations. The trends and variations in the fruit crops export have been analyzed using CAGR and Transitional Probability matrix for the period 2013-14 to 2022-23.The results of the study revealed that major export destinations for Indian fresh fruit are UAE, Bangladesh, Nepal, Malaysia, Netherland, Sri Lanka, UK, Qatar, Oman, and Iraq, they are the stable trade partners for Indian exports. Countries like Saudi Arabia, UK, Singapore Hong Kong, Germany and Baharain have been considered non-stable trade partners for Indian fruit exports. The study also examined the importance of understanding trade dynamics in India's fruit crop sector which helps policy makers and decision-makers to make better choices in identifying key markets for fruit export, realizing trade patterns and enhancing export competitiveness.

Key words: Compound annual growth rate, Markov chain, Trade direction, Trade partners

Introduction

Exports are one of the key elements of any thriving economy and act as a crucial aspect of a country's economic growth and development. It helps to enhance the productivity of the nation due its advantages such as access to new global markets, efficient and feasible technologies, and greater opportunities. Exports also help countries to specialize in areas where they have a comparative advantage, thus boosting their competitiveness and driving economic growth. Raman *et al.,* (2023) signified that exports facilitate diversification and that countries can reduce the impact of economic shocks. This reduces the vulnerability of the economy and helps to ensure long-term growth and stability India's diverse climate ensures the availability of all varieties of fresh fruits and vegetables. It ranks second in fruit and vegetable production in the world after China. India's fruit production during 2021-22 was 107.24 million metric tonnes and 204.84 million metric tonnes of vegetables (Anonymous 2022, National Horticulture Board). The area under cultivation of fruits stood at 7.05 million hectares while vegetables were cultivated at 11.35 million hectares (Anon, 2023).

India is the second largest producer of fruits in the world after China and is known as fruit basket of the world. India is endowed with a remarkably heterogeneous area characterized by a great diversity of agroclimatic zones, allowing for the production of a variety of horticultural crops such as fruits, vegetables, flowers, spices, plantation crops, root and tuber crops, and medicinal and aromatic crops (Gondalia *et al.,* 2017). The vast production base offers India with tremendous opportunities in both export and processing. During 2022-23, India exported fresh fruits and vegetables worth ₹ 13,185.30 crores (1635.95 USD Million) which comprised fresh fruits worth ₹ 6,219.46 crores (770.70 USD Million) and vegetables worth ₹ 6,965.83 crores (865.24 USD Millions). The major fruit categories such as Grapes, Pomegranates, Mangoes, Bananas, and Oranges account for the larger portion of fruits exported from the country (Anon, 2023). It is estimated that all the horticulture crops put together cover nearly 23,417 thousand hectares area with an annual production of 2,83,468 thousand tones. However, these crops occupy hardly 8.00 per cent of the cropped area in India with approximately 30.00 per cent contribution to agricultural GDP (Gopala *et al.,* 2017). India produces around 12.00 per cent of the global fruit and vegetables market but its global market share is still only about one per cent. But its horticulture products are becoming increasingly popular due to advancements in cold chain infrastructure, extensive research, proper post-harvest technologies, supportive governmental policies and quality control procedures (Parte *et al*., 2023). Considering the major issue explained above the study has been conducted and obtained results such as the trade dynamics of major fruit crops in India and Markov analysis.

Material and methods

Compound annual growth rate, coefficient of variation and transitional probability matrix have been used to estimate the trends, variations and trade direction in the export of major fruit crops in India. Secondary data on the export quantity of major fruit crops has been collected from Agricultural and Processed Food Products Export Development Authority (APEDA) for the period of 2013-14 to 2022-23.

Compound Growth Rate

$Y=ab^t$

Where,

Y= export quantity

a= constant/intercept

b= regression coefficient

t= time variable in year

Table 1. Trends and variations in the export of major fruit crops (2013-14 to 2022-23)

	Banana	Grapes	Mango	Orange	Pomegranate
CAGR	27.44	9.58	-6.64	19.24	13.53
Mean	170657.44	199093.15	39103.81	67585.30	57197.51
SD	119621.33	58017.93	11512.29	47396.63	23188.13
CV	70.09	29.14	29.44	70.13	40.54

Source: Author's calculation

Then compound growth rate (r) was computed by

using the relationship:

CGR(r) = (antilog of log b-1) x100

The significance of the growth rate was judged by students 't-test

This methodology was used by Prakash and Venkataramana (2023) to analyse growth of maize ecosystem in India and Karnataka.

Co-efficient of variation

$$CV = \frac{SD}{Mean} \times 100$$

Where,

CV = Coefficient of variation and SD = Standard Deviation (Weber and Sievers, 1985)

Transitional probability matrix

Annual export data for the period 2013-14 to 2022-23 were used to study the direction of trade and changing patterns of major fruits in Indian export. The major Indian fruit importing countries considered were based on the import quantity. Estimation of the exports was done for the study period using Markov chain analysis.

Markov chain analysis was employed to analyze the structural change in any system whose progress through time can be measured in terms of a single outcome variable (Dent, 1967). In the present study, the dynamic nature of trade patterns that is the gains and losses in export of fruit crops in major importing countries was examined using the Markov chain model. Markov chain analysis involves developing a transitional probability matrix 'P', whose elements, P_{ij} indicate the probability of exports switching from country 'i' to country 'j' over time. The diagonal element P_{ij} where i=j, measures the probability of a country retaining its market share or in other words, the loyalty of an importing country to a particular country's exports.

In the current application context, structural change was treated as a random process with importing countries for fruits. The assumption was that the average export of fruits from India amongst importing countries in any period depends only on the export in the previous period and this dependence was the same among all the periods (Nithin, 2016).

This wa s algebraically expressed as

$$Eji = \sum_{i=1}^{n} (E(it-1) * Pij + ejt)$$

E_{jt} = Exports from India to the j^{th} country in the year t

Ei_{t-1} = Exports of i^{th} country during the year t =1

P_{ij}= The probability that exports will shift from ith country to jth country

e_{jt} = The error term this is statistically independent of Ei_{t-1}

N = the number of importing countries

The transitional probabilitiesP_{ij}, which can be arranged in a (column*row) matrix, have the following properties.

$$\sum_{n=1}^{n} (Pij) = 1 \; and \; 0 \leq Pij \leq 1$$

The transitional probabilities, which can be arranged in a (column row) matrix, have the following properties: Thus, the expected export share of each country during the period is obtained by multiplying the exports to these countries in the previous period with the TPM. The linear programming (LP) framework was used for estimation of the TPM through a method called the minimization of mean absolute deviation (Zahid and Saleem, 2022).

Subjected to, Min OP*+Ie,

XP*+V=Y,

GP* = 1 and P*≥ 0

Results and discussion

Trends in the export of major fruit crops

The major fruit crops cultivated in India are Banana, Orange, Mago, Pomegranate and Grapes. Among the above fruit crops Banana exports (27.44%) are growing annually with highest variation of 70.09 followed by Orange (19.24%) which has lower growth rate compared to banana but higher dispersion in the data over years. The annual growth rate of Pomegranate and Grapes are 13.53 per cent and 9.58 per cent, respectively. Except for Mango all the crop has positive growth rates (Table 1).

Export performance of major fruit crops

India is not only growing a large variety of fruits successfully and substantially but is also exporting it to global markets. With modern packaging and fruit treatment technologies, there is a considerable value-added attached to the exportation of fresh fruits. A small number of fruits like litchi, guava, pineapple and papaya are also in demand in the export market. Mangoes and grapes contributed the maximum in total export of fruits from India (Vikrant and Dhawan, 2017).

To know the trade direction, stable and non-stable trade partners for major fruit crops *viz-a-viz*., mango, grape, banana, pomegranate and orange based on their export quantity has been analyzed.

Table 2. Transition probability matrix for mango export (2013-14 to 2022-23)

Country	UAE	U K	U S A	Qatar	Kuwait	Oman	Canada	Singapore	Baharain	Others
UAE	0.680	0.021	0.008	0.000	0.012	0.242	0.005	0.019	0.013	0.000
UK	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
USA	0.131	0.027	0.213	0.000	0.000	0.000	0.244	0.000	0.004	0.381
Qatar	0.183	0.000	0.000	0.569	0.072	0.148	0.000	0.028	0.000	0.000
Kuwait	0.000	0.000	0.000	0.067	0.515	0.301	0.000	0.048	0.069	0.000
Oman	0.611	0.024	0.042	0.000	0.000	0.000	0.041	0.037	0.028	0.218
Canada	0.000	0.098	0.783	0.000	0.000	0.000	0.119	0.000	0.000	0.000
Singapore	0.000	0.000	0.000	0.000	0.055	0.000	0.000	0.000	0.002	0.943
Baharain	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000
Others	0.000	0.028	0.229	0.000	0.000	0.000	0.319	0.000	0.030	0.393

Source: Author's calculation

Table 3. Transition probability matrix for grapes export (2013-14 to 2022-23)

Country	Netherland	Bangladesh	UAE	UK	Russia	Germany	Hong Kong	Saudi Arabia	Turkey	Others
Netherland	0.141	0.301	0.085	0.047	0.051	0.065	0.017	0.066	0.000	0.228
Bangladesh	0.280	0.255	0.000	0.091	0.116	0.027	0.000	0.181	0.000	0.051
UAE	0.808	0.000	0.000	0.078	0.000	0.114	0.000	0.000	0.000	0.000
UK	0.794	0.000	0.000	0.000	0.082	0.000	0.099	0.000	0.025	0.000
Russia	0.636	0.000	0.000	0.000	0.364	0.000	0.000	0.000	0.000	0.000
Germany	0.000	0.000	0.085	0.915	0.000	0.000	0.000	0.000	0.000	0.000
Hong Kong	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Saudi Arab	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Turkey	0.000	0.000	0.000	0.000	0.441	0.000	0.322	0.000	0.237	0.000
Others	0.000	0.174	0.294	0.000	0.000	0.000	0.000	0.000	0.000	0.533

Source: Author's calculation

Export performance of mango

To analyse the trade directions of mango export from India transitional probability matrix was worked out using the Markov chain framework using the annual export data for the period of 2013-14 to 2022-23, the results shown that UAE, Qatar, Kuwait, USA and Canada were the loyal markets with retention percentage of 68, 56.90, 51.50, 21.30 and 11.90 per cent, respectively. The countries like UK, Oman, Singapore and Baharain were found to have zero retention in mango imports, hence decided to be non-stable trade partners of mango (Table 2).

Export performance of grapes

To analyse the trade directions of grapes export from India transitional probability matrix was worked out using the Markov chain framework using the annual export data for the period of 2013-14 to 2022-23, the results shown that Russia, Bangladesh, Turkey and Netherland were the loyal markets with retention percentage of 36.40, 25.50, 23.70 and 14.10 per cent, respectively. Countries like UAE, UK, Germany, Hong Kong and Saudi Arab were found to have zero retention in grape imports, hence decided to be non-stable trade partnersof grapes (Table 3).

Export performance of banana

To analyse the trade directions of banana export from India transitional probability matrix was worked out using the Markov chain framework using the annual export data for the period of 2013-14 to 2022-23, the results shown that Iran, Iraq, Qatar, Kuwait and Saudi Arabia were the loyal markets with retention percentage of 53.60, 23.80, 26.10, 16 and 11.80 per cent, respectively. The countries like UAE, Oman and Nepal were found to have zero retention in banana imports, hence decided to be non-stable trade partners of banana (Table 4).

Export performance of pomegranate

To analyse the trade directions of pomegranate export from India transitional probability matrix was worked out using the

Table 4. Transition probability matrix for banana export (2013-14 to 2022-23)

Country	Iran	Iraq	UAE	Oman	Uzbekistan	Saudi Arabia	Nepal	Qatar	Kuwait	others
Iran	0.536	0.000	0.341	0.000	0.024	0.000	0.098	0.000	0.000	0.000
Iraq	0.038	0.238	0.000	0.248	0.000	0.002	0.000	0.455	0.019	0.000
UAE	0.386	0.282	0.000	0.000	0.123	0.156	0.036	0.000	0.017	0.000
Oman	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Uzbekistan	0.100	0.000	0.000	0.690	0.090	0.000	0.032	0.000	0.088	0.000
Saudi Arab	0.000	0.000	0.098	0.000	0.706	0.118	0.079	0.000	0.000	0.000
Nepal	0.382	0.552	0.066	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Qatar	0.014	0.000	0.000	0.094	0.000	0.000	0.000	0.261	0.000	0.631
Kuwait	0.000	0.000	0.000	0.840	0.000	0.000	0.000	0.000	0.160	0.000
others	0.079	0.000	0.000	0.000	0.000	0.000	0.000	0.820	0.000	0.101

Source: Author's calculation

Table 5. Transition probability matrix for pomegranate export (2013-14 to 2022-23)

Country	UAE	Bangladesh	Nepal	Netherland	Qatar	Switzerland	Saudi Arab	Malaysia	Oman	Others
UAE	0.659	0.000	0.079	0.044	0.000	0.010	0.000	0.017	0.019	0.172
Bangladesh	0.212	0.692	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nepal	0.000	0.830	0.118	0.000	0.000	0.000	0.000	0.000	0.002	0.050
Netherland	0.000	0.525	0.000	0.429	0.000	0.046	0.000	0.000	0.000	0.000
Qatar	0.000	0.000	0.000	0.965	0.035	0.000	0.000	0.000	0.000	0.000
Switzerland	0.652	0.000	0.000	0.047	0.146	0.154	0.000	0.000	0.000	0.000
Saudi Arab	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Malaysia	0.000	0.000	0.597	0.000	0.000	0.403	0.000	0.000	0.000	0.000
Oman	0.000	0.721	0.000	0.000	0.000	0.000	0.279	0.000	0.000	0.000
Others	0.000	0.001	0.295	0.000	0.000	0.000	0.085	0.045	0.206	0.367

Source: Author's calculation

Table 6. Transition probability matrix for orange export (2013-14 to 2022-23)

Country	Bangladesh	Nepal	Bhutan	UAE	Baharain	Singapore	Maldives	USA	Oman	Others
Bangladesh	0.925	0.072	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Nepal	0.455	0.530	0.000	0.000	0.000	0.000	0.008	0.000	0.000	0.007
Bhutan	0.000	0.000	0.167	0.000	0.167	0.000	0.667	0.000	0.000	0.000
UAE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
Baharain	0.936	0.000	0.000	0.000	0.000	0.064	0.000	0.000	0.000	0.000
Singapore	0.354	0.000	0.000	0.000	0.000	0.000	0.646	0.000	0.000	0.000
Maldives	0.702	0.000	0.135	0.000	0.093	0.021	0.016	0.034	0.000	0.000
USA	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Oman	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Others	0.000	0.477	0.018	0.000	0.000	0.000	0.505	0.000	0.000	0.000

Source: Author's calculation

Markov chain framework using the annual export data for the period of 2013-14 to 2022-23, the results shown that UAE, Bangladesh, Netherland, Switzerland, Nepal and Qatar were the loyal markets with retention percentage of 65.90, 69.20, 42.90, 15.40, 11.80 and 3.50 per cent, respectively. Countries like Saudi Arabia, Malaysia and Oman were found to have zero retention in pomegranate imports, hence decided to be non-stable trade partners of pomegranate (Table 5).

To analyse the trade directions of orange export from the Indiatransitional probability matrix was worked out using the Markov chain framework using the annual export data for the period of 2013-14 to 2022-23, the results shown that Bangladesh, Nepal, Bhutan and Maldives were the loyal markets with retention percentage of 92.50, 53, 16.70 and 1.60 per cent, respectively. The countries like UAE, Baharain, Singapore, USA and Oman were found to have zero retention in orange imports, hence decided to be non-stable trade partners of orange (Table 6).

Conclusion

The results from the paper reveal that bananasare performing better in the international market followed by oranges, pomegranates and grapes while mango has a negative growth rate. From the study, it is also evident that UAE, Bangladesh, Nepal, Malaysia, Netherland, Sri Lanka, UK, Qatar, Oman, and Iraq are the major destinations for Indian fresh fruit exports and hence considered stable trade partners and countries like Saudi Arabia, UK, Singapore Hong Kong, Germany and Baharain have been considered as non-stable trade partners.

Police recommendation

India should concentrate on developing its infrastructure, negotiating bilateral trade agreements, and finding new markets in order to take use of its export potential. Focused efforts to increase banana, pomegranate, and grape exports and production could have a major positive economic impact. To lessen dependency on unstable trade partnerships, export markets must be diversified outside established partners.

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