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Export performances of fresh papaya in India: Markov chain approach

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Abstract
Papaya is among the most traded tropical fruits following bananas, mangoes, and pineapples. Demand for the fruit is increasing day by day nationwide and also in International markets. A study was undertaken into consideration entitled "Export performance of fresh papaya in India" to know the status and possibility of future success with the main objective to study the direction of trade and changing export pattern of fresh papaya in India. The study period was divided into two periods *i.e.* Period-I: 2000-01 to 2009-10, Period-II: 2010-11 to 2019-20. The results revealed that, in the period-I: Qatar was most stable market for the import of Indian fresh papaya. In the period-II Nepal was most stable market for the import of Indian fresh papaya.

Keywords: direction, trade, Markov chain, transitional, papaya

Introduction
India is known as basket of fruits and vegetables in the world. Its diverse climate ensures availability of all varieties of fresh fruits & vegetables round the year. As per database published by National Horticulture Board, during 2019-20, India produced 99069.2 thousand MT of fruits and 191769.11 thousand MT of vegetables. India is the largest producer of ginger and okra among vegetables and ranks second in production of potatoes, onions, cauliflowers, brinjal, cabbage, etc. Amongst fruits, the country ranks first in production of Bananas (25.7%), Papayas (43.6%) and Mangoes (including mangosteens and guavas) (40.4%). The immense production base offers India tremendous opportunities for export of fruits. Papayas are among the most traded tropical fruits following bananas, mangoes, and pineapples. Approximately 75 percent of the world's papayas are produced in only ten countries Brazil (25%), Nigeria (15%), India (12%), Mexico (11%), Indonesia (10%), Ethiopia (4%), Congo (4%), Peru (3%), Venezuela (3%) and China (2%). It ranked third with 11.22 Mt or 15.36 percent of the total tropical fruit production behind mango with 38.6 Mt (52.86%) and pineapple with 19.41 Mt (26.58%). Demand for the fruit is increasing day by day nationwide and also in International markets, due to its availability throughout the year and cheap price that any common can purchase and consume. Papaya is gaining in popularity worldwide. The area under papaya cultivation in India was 143 M ha., with production 6216 metric tons as per the reports of DEC 2017-18. In India, about 24 states are growing papayas; the major producing states in India are Andhra Pradesh, Maharashtra, Chhattisgarh, West Bengal, Assam, Tamil Nadu, Jharkhand.
In order to know the importance of export of fresh papaya, a study was undertaken into consideration entitled "Export performance of fresh papaya in India" to know the status and possibility of future success with the main objective to study the direction of trade and changing export pattern of fresh papaya in India.

Material and Methods
The required necessities like secondary data for the present study of export of fresh papaya was collected from 2000-01 to 2019-20 which includes 20 years data. The aim to compare, the study period was divided into two periods *i.e.* Period-I: 2000-01 to 2009-10, Period-II: 2010-11 to 2019-20. The data had been gathered from DGCIS (Directorate General of Commercial Intelligence and Statistics, Govt. of India), NHB (National Horticulture Board), www.indiagristat.com, www.apeda.com, India trade and commerce.

Analyitical tool
The trade directions of export were analyzed using the first order Markov chain approach.

Central to Markov chain analysis is the estimation of the transitional probability matrix Pij. The elements Pij of the matrix P indicates the probability that export will switch from ith country to jth country with the passage of time. The diagonal elements of the matrix measure the probability that the export share of a country will be retained. Hence, an examination of the diagonal elements indicates the preference of an importing country to a particular country's exports. In the context of the current application, structural changes were treated as a random process with selected importing countries. The average exports to a particular country was considered to be a random variable which depends only on the past exports to that country, which can be denoted algebraically as

$$Ejt=\sum_{i=1}^{r} E_{it-1} \times Pij + ejt$$

Where,
Ejt=Exports from India to j th country during the year t.
Eit-1 = Exports from India to i th country during the period t-1.
Pij= Probability that the exports will shift from ith country to jth country.
Ejt = The error term which is statistically independent of Eit-1.
t = Number of years considered for the analysis
r =Number of importing countries
The transitional probabilities Pij which can be arranged in a (c x r) matrix has the following properties.

$$O \leq Pij \leq 1$$

$$\sum_{j=1}^{r} P_{ij} = 1 \text{ for all } i$$

Thus, the expected export of each country during period 't' were obtained by multiplying the export to these countries in the previous period (t-1) with the transitional probability matrix.

Estimation of the Pij

In the present study, Minimum Absolute Deviations (MAD) estimation procedure was employed to estimate the transitional probability, which minimizes the sum of absolute deviations (Fisher, 1967; Wagner, 1959).The conventional linear programming technique was used, as this satisfies the properties of transitional probabilities of non-negativity restrictions and row sum constraints in estimation.
The linear programming formulation is stated as

Min OP* + Ie
Subject to,
XP* + V=Y
GP* = 1
P*e≥0
Where,
0 =vector of zeroes.
P* =vector in which probability Pij are arranged.
I= appropriate dimensioned column vector of units.
e=vector of absolute error (|U|).
Y =vector of export to each country.
X =block diagonal matrix of lagged values of Y
V =vector of errors
G =grouping matrix to add the row elements of Pas arranged in P* to unity.
After calculating the transitional probability matrix, the expected shares of export were calculated by

$$Yjt=\sum_{j=1}^{r} y_{it-1} \times Pij \ (j=1,2,3\ldots r)$$

Where,
Yjt=Predicted proportions of jth country's share at time 't'.
Yt-1= Observed proportion of ith country share at time't-1'.
Pij=Estimated transitional probability matrix.
This analysis was done with the help of Excl and Lingo 18.0 software available at the department.

Results and Discussion

Direction of trade of fresh papaya export to major importing countries from India during the period-I of study (2000-01 to 2009-10)

The trade direction of fresh papaya export was examined by using Markov chain model. The structural changes were recorded and studied by using transitional probability matrix. The transitional probability matrix was obtained for the period of 10 years from 2000-01 to 2009-10 named as period-I using the actual proportion of exports to major fresh papaya importing countries. Sequentially year wise export of fresh papaya in quantity of major 9 countries *viz*., UAE, Saudi Arabia, Netherlands, Qatar, Kuwait, Bahrain, Nepal, Oman, Germany and others were taken into consideration. Other includes all the remaining countries except the major importing countries of fresh papaya in the world. The matrix obtained would give us an indication of direction of Indian fresh papaya export. The row and column elements have special importance in the table, as rows in the transitional probability matrix indicates us the extent of loss in trade, while columns indicate the probability of gains in quantity of volume in trading activity and the diagonal point out the probability of retention of previous year's trade quantity in volume by the respective country. The transitional probability matrix of fresh papaya exports from India to major importing countries is presented in below Table 1.
It is evident from the Table 1 that, Qatar was the country having most stable market for the import of Indian fresh papaya. The probability that Qatar retained the export share of fresh papaya over the study was 72.52 per cent followed by Saudi Arabia 65.02 per cent, UAE 60.13 per cent, Bahrain 51.58 per cent, Kuwait 32.67 per cent and remaining all countries most unstable market and Kuwait was moderately stable market.

Table 1: Direction of trade of fresh papaya export to major importing countries from India during the period-I of study (2000-01 to 2009-10)

Countries	UAE	Saudi Arabia	Netherland	Qatar	Kuwait	Bahrain	Nepal	Oman	Germany	Others
UAE	0.6013	0.0568	0.0372	0.0332	0.0278	0.0276	0.1012	0.000	0.0024	0.1121
Saudi Arabia	0.0572	0.6502	0.000	0.0055	0.0360	0.0653	0.000	0.0188	0.000	0.1666
Netherland	0.3444	0.5479	0.000	0.000	0.000	0.000	0.0591	0.000	0.0484	0.000
Qatar	0.000	0.000	0.000	0.7252	0.1929	0.0817	0.000	0.0	0.0	0.0
Kuwait	0.6732	0.000	0.000	0.000	0.3267	0.000	0.000	0.000	0.000	0.000
Bahrain	0.000	0.000	0.2100	0.0836	0.1346	0.5158	0.000	0.0557	0.000	0.000
Nepal	1.000	0.000	0.000	0.0	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
Germany	0.1610	0.6124	0.1424	0.000	0.0840	0.000	0.000	0.000	0.000	0.000
Others	0.6837	0.000	0.000	0.000	0.0023	0.000	0.3017	0.0122	0.000	0.000

Direction of trade of fresh papaya export to major importing countries from India during the period-II of study (2010-11 to 2019-20).

The transitional probability matrix was obtained for the period of 10 years from 2010-11 to 2019-20 named as period-II using the actual proportion of exports to major fresh papaya importing countries. The transitional probability matrix of fresh papaya exports from India to major importing countries is presented in below Table 02.

It is evident from the table 2 that, Nepal was most stable market for the import of Indian fresh papaya *i.e*., 89.10% followed by UAE 60.10%, Saudi Arabia 57.32%, Qatar 51.26%, Oman 0.1825, Kuwait 0.1708 and remaining all countries namely Netherlands, Bahrain, Germany and Others most unstable market for fresh papaya export from India.

Table 2: Direction of trade of fresh papaya export to major importing countries from India during the period-II of study i.e. 2010-11 to 2019-20.

Countries	UAE	Saudi Arabia	Netherland	Qatar	Kuwait	Bahrain	Nepal	Oman	Germany	Others
UAE	0.6010	0.1391	0.000	0.0770	0.1100	0.0359	0.0120	0.000	0.000	0.0247
Saudi Arabia	0.000	0.5732	0.2367	0.000	0.000	0.1500	0.0225	0.0174	0.000	0.000
Netherland	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Qatar	0.000	0.294	0.000	0.5126	0.0877	0.000	0.3702	0.000	0.000	0.000
Kuwait	0.1185	0.0321	0.000	0.0490	0.1708	0.1818	0.000	0.000	0.0116	0.4360
Bahrain	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nepal	0.000	0.000	0.000	0.000	0.000	0.000	0.8910	0.1089	0.000	0.000
Oman	0.000	0.000	0.000	0.000	0.000	0.000	0.8174	0.1825	0.000	0.000
Germany	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000
Others	0.000	0.4604	0.2511	0.000	0.000	0.2884	0.000	0.000	0.000	0.000

Conclusion

In the period-I of study, Qatar was most stable market for the import of Indian fresh papaya The probability that Qatar retained the export share of fresh papaya over the study was 72.52 percent followed by Saudi Arabia with the retention of 65.02 per cent, UAE 60.13 percent, Bahrain 51.58 percent, Kuwait 32.67 percent and remaining all countries *viz;* Netherlands, Nepal, Oman, Germany and others most unstable market and Kuwait was moderately stable market for fresh papaya export from India. In the period-II of study, Nepal was most stable market for the import of Indian fresh papaya 89.10% followed by UAE 60.10%, Saudi Arabia 57.32%, Qatar 51.26%, Oman 18.25%, Kuwait 0.1708 and remaining all countries *viz;* Netherlands, Bahrain, Germany and Others most unstable market for fresh papaya export from India.

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