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Structural changes in Indian tomato exports– a Markov chain approach

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ABSTRACT

Tomato is an important vegetable crop of India which ranks second in area and production. India has its huge export potential both in fresh and processed forms. Tomato exports from India are confined to few countries. Hence it is essential to examine the direction of trade of tomato exports which pave the way for identifying the loyal market to be focused. Hence an attempt has been made in this view. Secondary data were collected for a period of 10 years from 2004-05 to 2013-14. Markov chain analysis was employed to study the direction of trade of Indian tomato. The transitional probability matrix revealed Pakistan as the loyal market. Further the projected value of exports also revealed that majority of the exports would be confined to neighbouring countries alone. Hence efforts are needed to improve the efficiency of production and quality in order to stabilize the markets and also to make the product acceptable and price competitive in European countries.

Keywords: Direction of trade; loyal market; transitional probability matrix; neighbouring countries

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is one of the most popular and versatile vegetable crops grown universally because it is a recognized source of vitamins and minerals and offers raw material for a wide range of processing industries (Gould 1974). It is originated from South America. The major tomato growing countries in the world are China, India, USA, Turkey and Egypt. China leads the area with 9.27 lakh hectares and production of 5.05 crore tonnes. In India tomato occupied an area of 8.79 lakh hectares during 2013-14 which was 3.5 lakh hectares in 1993-94. The production of tomato has increased from 0.49 to 1.87 crore tonnes during the same period. India ranks 13th among the major tomato exporting countries. The country has exported nearly 4 lakh tonnes of fresh tomato in 2013-14. Sometimes the surplus production of tomato causes glut in the market causing distress sale and low profit to the growers. One of the probable solutions to the problem of this glut is to export the surplus tomato production in fresh or processed form (Kumar and Rai 2007). The future prospects for raising the level of exports of agricultural products depend largely on the extent to which these products meet the changing demand in the world market (Kokkalki 2011). In this connection it is important to identify the direction of trade of Indian tomato exports.

METHODOLOGY

The present study is based on secondary data. The data pertaining to the export of Indian tomato to various countries over the years were collected from various published issues of National Horticulture Board and APEDA for 10 years from 2004-05 to 2013-14.

Direction of trade- Markov chain model

Markov chain analysis is employed to analyze the structural change in any system whose progress through time can be measured in terms of single outcome variable (Dent 1967). In this study the structural change in export of fresh tomato was examined by using first order Markov chain approach (Laxminarayana 1993). The data on quantity of tomato exported to various countries from 2004-05 to 2013-14 were taken for Markov chain analysis. The annual export quantity of top five countries and pooling all other countries export as 'other countries' were formulated into a linear proogramming (LP) problem under the

method of minimization of mean absolute deviations. To get the transition probability matrix this LP was solved using LINDO (version 10) package (Arulanandu 2007).

This econometric analysis was used to find the trend in sustaining existing market and the shift in shares from one country to another over a period of time. The model is a stochastic process which describes the finite number of possible outcomes Si (i = 1,2,…..r) which is a discrete random variable Xt (t=1,2 . . .T)

Assumptions

- The probability of an outcome on the t^{th} trial depends only on outcome of the preceding trial
- This probability is constant for all time periods

Central to Markov chain analysis is the estimation of the transition probability matrix P; the element P_{ij} of this matrix indicates the probability that exports will switch from country i to country j with the passage of time. The diagonal element P_{ij} (where i= j) measures the probability that the export share of a country will be retained. Hence an examination of the diagonal element indicates the loyalty of an importing country to a particular country's exports (Atkin and Blandford 1982).

There are some major importing countries for each of the commodities. In the context of the current application the average exports to a particular country were considered to be a random variable which depends only on its past exports to that country and which can be denoted algebraically as:

$$E_{jt} = \sum_{i=1}^{r} E_{i\,t-1} P_{ij} + e_{jt}$$

where E_{jt}= Export of tomato from India to j^{th} country during the year t, $E_{i\,t-1}$= Export of tomato from India to i^{th} country during the year t-1, P_{ij}= The probability that exports will shift from i^{th} country to j^{th} country, e_{jt}= The error term which is statistically independent of E_{it-1} and r= The number of importing countries

The transition probabilities P_{ij} which can be arranged in a (c x r) matrix have got the following properties:

$$0 < P_{ij} < 1 \text{ and } \sum_{i=1}^{r} P_{ij} = 1 \text{ for all i}$$

Thus the expected export shares of each country during the period t were obtained by multiplying the exports to these countries in the previous period (t × 1) with the transition probability matrix.

The transition probability matrix is estimated in the linear programming (LP) framework by a method referred to as minimisation of mean absolute deviation (MAD); the LP formulation (Veena et al 1994) is stated as:

Min O/P* + Ie

Subject to:

XP* + V= Y
GP*= 1
P* >0

where P*= Vector of the probabilities P_{ij} to be estimated, O= A vector of zeros, I= An appropriately dimensional vector of areas, e= The vector of absolute errors (|U|), Y= The vector of exports to each country, X= A block diagonal matrix of lagged values of Y, V= The vector of errors, G= A grouping matrix to add the row elements of P arranged in P* to unity

The export quantity of selected commodities to major importing countries and all other countries total referred as 'other countries' were taken for analysis. These data were converted into a linear programming (LP) problem by a method referred to as minimisation of mean absolute deviation (MAD) and then solving the LP problem and arrived the transition probability matrix elements.

RESULTS and DISCUSSION

Country-wise export of tomato from India during 2013-14

Tomato is exported to 16 countries from India. The major importing countries are presented in Table 1.

It is obvious from the data that the country has exported 3.44 thousand tonnes of fresh tomato in 2013-14. Around 99 per cent of the Indian fresh tomato was exported to Pakistan, UAE, Bangladesh, Oman, Nepal and Maldives alone. Among these countries the share of Pakistan was highest with 80.77 per cent in 2013-14. The average price of Indian fresh tomato per kg was found to be Rs 20. The major port for exporting tomato was Nhava Sheva sea port of Mumbai. In India

Table 1. Country-wise export of tomato from India during 2013-14

Country	Quantity		Value		Unit value (Rs/kg)
	Tonnes	% Share	Rs in lakhs	% Share	
Pakistan	344508	80.77	73931	85.88	21
UAE	40834	9.57	6757	7.85	17
Bangladesh	20786	4.87	3140	3.65	15
Oman	11680	2.74	908	1.05	8
Nepal	6606	1.55	781	0.91	12
Maldives	644	0.15	224	0.26	35
Saudi Arabia	538	0.13	180	0.21	33
Qatar	618	0.14	109	0.13	18
Singapore	88	0.02	22	0.03	25
Bahrain	126	0.03	19	0.02	15
Others	109	0.03	20	0.02	18
Total	426536	100.00	86091	100.00	20

tomatoes are available for export throughout the year. The farmers are cultivating in quite a large scale the F_1 hybrids which are high yielding varieties. All the state agricultural universities and national research institutes are providing commendable research supports.

Direction of trade

The direction of trade of fresh tomato exports was computed through transition probability matrix and is presented in Table 2.

As indicated by high value of diagonal element of 0.7982 Pakistan was found to be the loyal market for fresh tomato export from India. This loyal market is considered as the gainer in importing from India (Sreenivasamurthy and Subramanyam 1999). This implies that this country retained about 80 per cent of the share of the previous period. The remaining share of Pakistan market was absorbed by UAE (10.57%). Bangladesh was the next loyal market retaining the share of about 35 per cent. The strategies for export may be oriented towards these countries for stabilizing the export of tomato (Kumaresh and Sekar 2013). It is also evident that fresh tomato exports to Nepal and Maldives could not be retained by India. India retained only 6.4 per cent of exports to Oman and lost 68.95 per cent of its share to UAE alone and remaining to Pakistan. This observation is in line with the findings of Kumar et al (2007) and Yeledhalli et al (2012).

The projection of fresh tomato exports to major importing countries were worked out using the transition

Table 2. Transition probability matrix of fresh tomato exports from India (2004-05 to 2013-14)

Country	Pakistan	UAE	Bangladesh	Oman	Nepal	Others
Pakistan	**0.7982**	0.1057	0.0542	0.003	0.0237	0.0094
UAE	0.9885	**0.0115**	0	0	0	0
Bangladesh	0.5578	0	**0.3537**	0.0026	0.0702	0.0011
Oman	0.936	0	0	**0.064**	0	0
Nepal	0.3105	0.6895	0	0	**0**	0
Others	1	0	0	0	0	**0**

Table 3. Forecast for export of fresh tomato from India (quantity in tonnes)

Year	Pakistan	UAE	Bangladesh	Oman	Nepal	Others
2014-15	341410.32	42075.89	26035.83	1823.73	9611.08	3264.49
2015-16	336588.49	45505.02	27724.91	1197.52	9906.28	3241.35
2016-17	336554.09	45289.38	28060.90	1147.59	9910.74	3197.92
2017-18	33418.77	45295.36	28177.89	1145.18	9933.51	3197.98
2018-19	336374.25	45295.08	28211.94	1144.93	9938.52	3196.94

probability matrix for the period 2014-15 to 2018-19. The projected export of fresh tomato to top five importing countries is given in Table 3.

It is inferred from Table 3 that the projected export quantity of about 3.41 lakh tonnes to Pakistan decreased to 3.36 lakh tonnes whereas it increased from 42000 tonnes in 2014-2015 to 45295 tonnes in 2018-19 for UAE. The projected export quantity to Bangladesh has also increased from 26035.83 tonnes in 2014-15 to 28211.94 tonnes in 2018-19. The export quantity to Oman, Nepal and Maldives is expected to be stable for the next five years.

CONCLUSION

The performance of Indian fresh tomato export has been examined for the period from 2004-05 to 2013-14. The results of the study showed that there has been a continuous export of tomato from India especially to the neighbouring countries. Pakistan was found to be the loyal market for Indian tomato exports. Despite of a huge production base India is found to be competitive in tomato exports only for the recent few years. Efforts are needed to make Indian tomato acceptable in European countries for high unit value realization.

REFERENCES

Arulanandu U 2007. An economic analysis of international and domestic trade of spices. PhD thesis, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India.

Atkin M and Blandford D 1982. Structural changes in import market shares for apples in the United Kingdom. European Journal of Agricultural Economics **9(1):** 313-326.

Dent WT 1967. Application of Markov analysis to international wool flows. Review of Economics and Statistics **49(2):** 613-616.

Gould WA 1974. Tomato production, processing and quality evaluation. The Avi Publishing Company, New York, USA.

Kokkalki GV 2011. Structural changes in imports and exports of agricultural commodities. Asia Pacific Journal of Research in Business and Management **2(7):** 120-125.

Kumar NR and Rai M 2007. Performance, competitiveness and determinants of tomato exports from India. Agricultural Economics Research Review **20(Conference Issue):** 551-562.

Kumar P, Badal PS and Achoth L 2007. Changing direction of Indian mango exports. Indian Journal of Agricultural Marketing **21(1):** 130-137.

Kumaresh K and Sekar C 2013. Export performance and competitiveness of fresh mangoes and mango pulp in India. International Journal of Commerce and Business Management **6(2):** 154-159.

Laxminarayana TJ 1993. Export trade pattern of Indian silk goods. MSc thesis, University of Agricultural Sciences, Bangalore, Karnataka, India.

Sreenivasamurthy D and Subramanyam KV 1999. Structural change and instability in onion exports. Agricultural Economics Research Review **12(2):** 111-128.

Veena UM, Suryaprakash S and Achoth L 1994. Changing direction of Indian coffee exports. Indian Journal of Agricultural Economics **49(3):** 426-431.

Yeledhalli RA, Patil HP, Patil C and Naik VR 2012. Changing direction and magnitude of India's major fruit export to Middle East countries. International Journal of Agricultural Statistical Sciences **8(2):** 651-658.