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AA Bhagat
Assistant Professor,
Department of Statistics,
ZARS, Ganeshkhind, Pune,
Maharashtra, India

RS Bhoge
Assistant Professor,
Department of Entomology,
PGI, MPKV, Rahuri,
Maharashtra, India

BJ Shete
Assistant Professor,
Department of Horticulture,
ZARS, Ganeshkhind, Pune,
Maharashtra, India

Stability analysis of Indian onion export: A Markov chain approach

AA Bhagat, RS Bhoge and BJ Shete

Abstract
The study was carried out to analyze the export prospects of onion in India by using the Markov chain model. The secondary data on export quantity of onion in India from the period 1990-91 to 2018-2019 (29 years) were obtained from website of Directorate General of Commerce, Industries and Statistics, Kolkata. The analysis revealed that the countries *viz.* Bangladesh and Malaysia were the most stable markets for Indian onion export. While Nepal, UAE and Oman export markets are moderately stable. The major gainer among importers of Indian onion has been Kuwait gained from Qatar, Singapore and other countries. The increase in exported quantity and value of onion over the base year was 31.16 and 49.56 per cent respectively during the period of last ten years.

Keywords: Stability, Markov chain, onion and export

Introduction
Onion is an important bulb crop grown and consumed widely across the world. There is a steady increase in the demand for onion across the world. Onion is among the high value agricultural commodities that show tremendous potential for export. India is a traditional exporter of onion. Onion is cultivated all over the country for domestic consumption as well as for export purpose. The country was exporting over 5000 tons of onion during first and stared expanding, rapidly during the sixties and reached a peak level of 427 thousand tons in 1996-97. Over the years there has been a progressive increase in the export of onion from India. Major exporting onion varieties are Pusa Red, Agrifound Light Red, N-2-4-1 Agrifound Dark Red, N-53, Nashik Local etc. The major export destinations of Indian onion are Bangladesh, Malaysia, UAE, SriLanka and Nepal. Being a traditional exporter, India exported 21,83,766 MT onion with total value of Rs. 3,46,887 lakh during 2018-19. Major onion growing states in India are Maharashtra, Uttar Pradesh, Karnataka, Gujarat, Bihar, Madhya Pradesh, Tamil Nadu, Rajasthan and Andhra Pradesh. Maharashtra is the leading onion producing state and Nashik, Ahmednagar, Pune Sangli, Dhule, Jalgaon and Solapur are the major onion growing districts. The global demand for onion is an opportunity for India to increase its export. Therefore, an attempt has been made in this study to analyze the direction of trade and future prospectus of onion trade in India.

Materials and Methods
Source of data
The secondary data on export quantity and its value of onion in India from the period 1990-91 to 2018-2019 (29 years) were obtained from website of Directorate General of Commerce, Industries and Statistics, Kolkata and publications of Indian Horticulture Database also used for obtaining relevant data.

Statistical Analysis
Markov Chain Model
The structural change in the share of export of onion was examined by estimating the transition probability using Markov chain model. The data on export of onion from India to different countries from 1990-91 to 2018-2019 were taken for Markov chain analysis. It is the stochastic process. The finite number of possible outcomes S_i (I = 1, 2,….r) which is a discrete random variable X_t (t= 1, 2,……t) and which assumes that the probability of an outcome on the tth trial depends only on outcome of the preceding trial and this probability is constant for all time periods.

Corresponding Author:
AA Bhagat
Assistant Professor,
Department of Statistics,
ZARS, Ganeshkhind, Pune,
Maharashtra, India

P is the estimation of transition probability matrix, P_{ij} is the probability that exports will switch over from country i to country j with passage of time and the diagonal element of P_{ij} measures the probability that the export share of a country will be retained. In this study, the average exports to a particular country was considered to be a random variable which depends only on its past exports to that country and which can be denoted as.

$$E_{jt} = \sum_{i=1}^{r} (E_{it-1})P_{ij} + e_{jt}$$

Where,
E_{jt} is the exports from India during the year t to j^{th} country
E_{it-1} is the exports to i^{th} country during the year t-1
P_{ij} Probability that exports will shift from i^{th} country to j^{th} country

E_{jt} error term ehich is statistically independent of E_{ij-1}
R is the number of importing countries
The transition probability matrix (c x r) satisfying the following properties
$0 \leq P_{ij} \leq 1$

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

Results and Discussion
The per cent of onion 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 1 and 2). The exported quantity of Indian onion has shown an increase of 31.16 per cent and export value of onion has been increased by 49.56 per cent over the base year during period of last ten years.
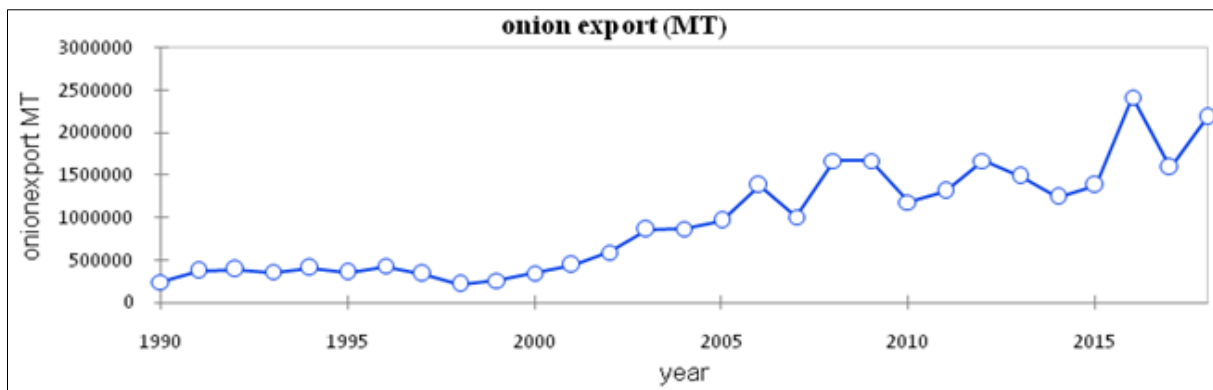

Fig 1: Annual export of onion from India during 1990-91 to 2018-19

The transition probability matrix presented in Table 3, it provides a broad indication of changes in the direction of export of onion from India for the study period (1990-91 to 2018-19). The major Indian onion importing countries were Bangladesh, Malaysia, Nepal, UAE, Oman, Sri Lanka, Indonesia, Singapore and Kuwait. The row elements in the transition probability matrix provide the information on extent of loss of trade, on account of competing countries. The columns element indicates the probability of gains in volume of trade from other competing countries and the diagonal element indicates probability of retention of the previous year's trade volume by the respective country.
Markov chain analysis reveals that, Indian onion export retain their maximum export share in Bangladesh, Malaysia followed by Nepal, UAE, Oman, Sri Lanka, Indonesia, Singapore and Kuwait. Similar results were reported by Kusuma et al. (2014) [2] in case of mango export, Prabakar

(2020) [6] for coconut export and Mohammadullah et al. (2021) [4] for grape export from India. Bangladesh and Malaysia were most stable markets among the major importer of Indian onion as reflected by the high probability of retention at 0.70. Similar results were reported by Patil et al. (2018) [5] and observed that Bangladesh was most stable importer of Indian mango followed by UAE, Baharain and other countries respectively. Joshi et al. (2015) [3] for Indian spices exports from India. Bangladesh lost 30 per cent market share to Malaysia while Malaysia lost 20 per cent market share to Bangladesh and remaining 10 per cent share to Sri Lanka. Moderate stability shown by the countries like Nepal, UAE and Oman having 55.60, 50.00 and 50.00 per cent retention probability respectively. The major gainer among importers of Indian onion over a period of time has been Kuwait, which has a gaining probability of 0.333 from Qatar, 0.286 from Singapore and 0.188 from other countries.

Table 1: Onion export (MT) for different countries over the years.

Year	Bangla desh	Malaysia	UAE	Sri Lanka	Nepal	Indonesia	Kuwait	Qatar	Oman	Singapore	others	Total	% share of top 10 countries	% share of other countries	% increase over base year
2009-10	764103	303138	147165	129328	38985	9607	11506	16457	19835	24622	200176	1664922	87.98	12.02	
2010-11	391550	281360	127265	120379	29981	44377	16593	15894	18041	21227	115657	1182324	90.22	9.78	-28.99
2011-12	313634	301314	179050	153267	34857	48511	25256	26749	26597	30661	170029	1309925	87.02	12.98	-21.32
2012-13	489877	385275	211755	149394	17422	48824	39968	37606	37197	35007	214548	1666873	87.13	12.87	0.12
2013-14	404885	240490	172074	223697	38908	78726	32790	23050	31017	28413	208449	1482499	85.94	14.06	-10.96
2014-15	456735	215194	131630	131646	70543	45629	24874	25414	15082	28598	92758	1238103	92.51	7.49	-25.64
2015-16	422076	244273	131630	199136	81147	11046	36402	33574	20658	25468	177550	1382960	87.16	12.84	-16.94
2016-17	846870	371972	302360	207481	133530	81872	65246	67895	48935	38701	250877	2415739	89.61	10.39	45.10
2017-18	333165	276162	226248	227965	100151	65478	52082	53942	43339	30196	180258	1588986	88.66	11.34	-4.56
2018-19	578112	332451	258492	229712	139495	62273	74715	75293	74739	34583	323901	2183766	85.17	14.83	31.16

Table 2: Onion export value (Rs. Lakh) for onion in different countries over the years

Year	Bangla desh	Malaysia	UAE	Sri Lanka	Nepal	Indonesia	Kuwait	Qatar	Oman	Singapore	others	Total	% share of top 10 countries	% share of other countries	% increase over base year
2009-10	112620	41330	17904	19304	3182	1330	1242	1863	2344	3435	27389	231943	88.19	11.81	
2010-11	57233	49187	16574	17842	2530	9384	2082	1858	2267	2937	16035	177929	90.99	9.01	-23.29
2011-12	38621	44345	22190	17464	4346	8732	2671	3290	3415	3911	23315	172300	86.47	13.53	-25.71
2012-13	43756	49106	23821	20492	3960	6694	4485	3833	4037	4715	31764	196663	83.85	16.15	-15.21
2013-14	88914	63935	32940	39249	6614	24250	5919	4188	5646	7419	37887	316961	88.05	11.95	36.65
2014-15	77965	41622	24773	25839	13940	5789	5027	5303	2892	6002	20902	230054	90.91	9.09	-0.81
2015-16	95014	58642	32728	44909	19664	1755	6652	6911	3608	5585	34253	309721	88.94	11.06	33.53
2016-17	97591	49309	39929	26421	16311	11430	8909	9138	6134	5714	39720	310606	87.21	12.79	33.91
2017-18	59952	58859	41555	56039	14363	11130	7442	10350	6367	6336	36489	308882	88.19	11.81	33.17
2018-19	105814	51770	37305	35900	14635	9430	10980	10731	10584	5454	54284	346887	84.35	15.65	49.56

Table 3: Markov chain analysis of onion export quantity from India to different countries

	Bangladesh	Malaysia	UAE	Sri Lanka	Nepal	Indonesia	Kuwait	Qatar	Oman	Singapore	other
Bangladesh	0.700	0.300	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Malaysia	0.200	0.700	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UAE	0.000	0.000	0.500	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sri Lanka	0.000	0.000	0.500	0.400	0.000	0.000	0.000	0.000	0.000	0.000	0.100
Nepal	0.000	0.000	0.000	0.000	0.556	0.000	0.000	0.111	0.000	0.333	0.000
Indonesia	0.000	0.000	0.000	0.000	0.143	0.286	0.000	0.143	0.000	0.000	0.428
Kuwait	0.000	0.000	0.000	0.000	0.250	0.000	0.125	0.250	0.125	0.125	0.125
Qatar	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.000	0.167	0.000	0.500
Oman	0.000	0.000	0.000	0.000	0.000	0.167	0.000	0.000	0.500	0.000	0.333
Singapore	0.000	0.000	0.000	0.000	0.143	0.143	0.286	0.000	0.000	0.143	0.285
other	0.000	0.000	0.000	0.000	0.000	0.250	0.188	0.125	0.063	0.125	0.249

Conclusions

1. Bangladesh and Malaysia were the most stable markets for Indian onion export while Nepal, UAE and Oman export markets are moderately stable.
2. The gainer among importers of Indian onion has been Kuwait gained from Qatar, Singapore and other countries.
3. The increase in exported quantity and value of onion over the base year was 31.16 and 49.56 per cent respectively during the period of last ten years.

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