

Stability analysis of Indian sapota export markets – Markov chain approach

D.K. Kusuma¹, H. Basavaraja² and Shreeshail Rudrapur³

Department of Agril Economics, University of Agricultural Sciences, Dharwad 580 005, Karnataka, India

(Received April 12, 2014; accepted 21 June, 2014)

ABSTRACT

Sapota (*Acharas zapota*) is one of the important tropical fruits belonging to the family Sapotaceae. Sapota occupies the 8th position among all fruits production in the country accounting for 2.51 per cent of total fruit production. Maharashtra stands first with highest sapota area of about 70,000 hectares contributing about 43.75 per cent of the total sapota area of the country. The paper attempts to quantify the changing structure of Indian mango exports. Data for analysis was taken for a period of 12 years from 2001-2 to 2012-13 from various published issues of APEDA. Compound growth rate (CGR) and instability index was used for analyzing the nature and magnitude of growth in sapota area, production, productivity, export quantity and export value over the years. The markov chain analysis was attempted through linear programming method to assess the transition probabilities for the major sapota. The major sapota export markets were, UAE, UK, Bahrain, Saudi Arabia and Qatar. The major sapota export markets were categorized as stable market (U.A.E, Bharain and other countries) and unstable markets (Saudi Arabia and Qatar) based on the magnitude of transition probabilities. Though the country has a good potential for export of sapota inadequate processing, storage, handling and transportation are hindering the progress. In order to address these issues in an integrated way the present study was attempted with the following specific objectives. 1. To analyse the nature and magnitude of growth and instability in area, production and productivity of sapota in India. 2. To examine the direction of sapota export trade.

Key words : Compound growth rate, Instability index, Structural change, Direction of trade and markov chain.

Introduction

Sapota (*Acharas zapota*) is one of the important tropical fruits belonging to the family Sapotaceae. It is called by many names viz., chikku, sapodilla plum, zapota, and nose-berry. It is said to be the native of southern parts of Mexico and it spread to other countries such as Philippines, Malaysia, United States, Sri Lanka, India and Caribbean Islands. Sapota is mainly valued for its sweet and delicious

fruits. It has high sugar content (20%) in addition to vitamins A, B1, B2 and C. Sapota is also grown for its edible milky latex known as "gutta-percha", from which chewing gum is manufactured. Many processed products such as jam, jelly, candy, marmalade, toffee, fruit bar, flakes and wines are prepared from fruits. Of late, sapota cultivation has attracted many farmers of this region on account of its better adoption to diversified soil and climatic conditions. Some of the important varieties of sapota are

¹Corresponding author's email: kusuma3836dk@gmail.com

¹Dr. Kusuma, D.K. C/o Thejomurthy, D.D.P.I Office, Davanagere 577001 (Karnataka) Mob: 09482988128
Professor and Univ. HOD, Department of Agricultural Economics, UAS Dharwad 580005 (Karnataka)
Ph. D Scholar, Department of Agricultural Economics, UAS Dharwad 580005 (Karnataka)

Kalipatti, Cricket ball, Calcutta round, CO-1, CO-2 and Thagarampudi. Hybrids released by UAS, Dharwad are DHS-1, DHS-2 and PKM 1 from TNAU, Coimbatore.

Sapota occupies the 8th position among all fruits production in the country accounting for 2.51 per cent of total fruit production. It is next to Guava, Apple and Pineapple in terms of production. Maharashtra stands first with highest sapota area of about 70,000 hectares contributing about 43.75 per cent of the total sapota area of the country. Though the country has a good potential for export of sapota inadequate processing, storage, handling and transportation are hindering the progress. Therefore, policy interventions are required for enhancing production and export of fruits in the country.

In order to address these issues in an integrated way the present study was attempted with the following specific objectives.

1. To analyse the nature and magnitude of growth and instability in area, production and productivity of sapota in India.
2. To examine the direction of sapota export trade.

Materials and methods:

The study is based on time series data on area, production, productivity and exports of sapota from India was obtained from various published issues of APEDA for a period of twelve years from 2001-02 to 2012-13.

The compound growth rate analysis was carried out to ascertain the growth in area, production, productivity and exports of grapes from India. The structural change and direction of change in the export of grapes was analyzed using markov chain analysis.

a. Growth rate analysis

For computing compound growth rate of area, production and productivity of selected fruit crops, the exponential function of the following form was used.

$$Y = a b^t e^{U_t} \quad \dots (1)$$

Where,

Y = Area/Yield/Production; a = Intercept; b = Regression coefficient; 'a' and 'b' are the parameters to be estimated; t = time period; U_t = Disturbance term in year 't'; The equation (1) was transformed into log linear form and written as;

$$\log Y = \log a + t \log b + U_t \quad \dots (2)$$

Equation (2) was estimated by using Ordinary Least Squares (OLS) technique.

Compound growth rate (g) was then computed

$$g = (b - 1) 100 \quad \dots (3)$$

Where,

g: Compound growth rate in per cent per annum

b: Antilog of log b

The standard error of the growth rate was estimated and tested for its significance with 't' statistic.

b. Instability analysis

The coefficient of variation was used as measure to study the variability in production and export of selected fruits from India. The coefficient of variation or index of instability was computed by using the following formula

$$CV = \frac{\text{Standard Deviation } (\sigma)}{\text{Mean } (X)} \times 100$$

Linear trend were fitted to the original data of area, production, productivity and export trade of selected fruits, for the period of 10 years from 2001-02 to 2010-11. The trend coefficients were tested for their significance. Whenever the trend of series found to be significant; the variation around the trend rather than the variation around mean was used as an index of instability. The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend. That is Coefficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (r^2) in the cases where r^2 was significant to obtain the Instability Index.

$$\text{Instability index} = \frac{\text{Standard Deviation } (s)}{\text{Mean } (X)} \times 100 \times \sqrt{1-r^2}$$

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 single outcome variable (Dent, 1967). In the present study, the dynamic nature of trade patterns that is the gains and losses in export of selected fruits 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 context of current application, structural change was treated as a random process with importing countries for fruits the assumption was that the average export of selected fruits 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. This was algebraically expressed as

$$E_{jt} = \sum_{i=1}^n [E_{it-1}] P_{ij} + e_{jt}$$

Where,

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

E_{it-1} = exports of 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}

n = the number of importing countries

The transitional probabilities P_{ij} , which can be arranged in a $(c \times n)$ matrix, have the following properties.

$$\sum_{i=1}^n P_{ij} = 1 \quad \text{and } 0 \leq P_{ij} \leq 1$$

Thus, the expected export share of each country during period 't' is obtained by multiplying the exports to these countries in the previous period (t-1) with the transitional probability matrix. The probability matrix was estimated for the period 2001-02 to 2010-11.

Thus transitional probability matrix (T) was estimated using linear programming (LP) framework by a method referred to as minimization of Mean Absolute Deviation (MAD).

$$\begin{aligned} & \text{Min, } OP^* + I e \\ & \text{Subject to} \\ & X P^* + V = Y \\ & GP^* = 1 \\ & P^* \geq 0 \end{aligned}$$

Where,

P^* is a vector of the probabilities P_{ij} ; O is the vector of zeros; i is an appropriately dimensional vectors of areas; e is the vector of absolute errors; Y is the proportion of exports to each country; X is a block diagonal matrix of lagged values of Y ; V is the vector of errors; G is a grouping matrix to add the row elements of P arranged in P^* to unity; Prediction of quantity of fruits export were made by using the Transitional Probability Matrix.

$$B_t = B_0 * T$$

$$B_{t+i} = B_{t+i-1} * T$$

Where,

B_0 = Quantity exported in Base years

B_t = Quantity exported in next year (prediction)

T = Transitional probability matrix

Table 1. Compound growth rates and instability index of production and export of sapota from India during 2001-02 to 2012-13

Sl. No	Particulars	2001-02	2012-13	CGR (%)	Instability Index (%)
1	Area (000 Ha)	52	163.9	7.91	15.51
2	Production (000 mt)	396.2	1495	8.48	15.40
3	Productivity (mt/ha)	14.6	9.1	-1.93	19.33
4	Quantity of Export (mt)	998	2606	12.96	32.60
5	Value of Export (Lakhs)	197	615	12.44	37.68

Table 2. Transitional probability matrix of Indian sapota export (2001-02 to 2012-13)

	UAE	UK	Bahrain	Saudi Arabia	Qatar	Others
UAE	0.7434	0.1285	0.0000	0.0608	0.0028	0.0645
UK	0.0576	0.4193	0.1445	0.0816	0.1121	0.1849
Bahrain	0.2855	0.0000	0.6402	0.0000	0.0744	0.0000
Saudi Arabia	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Qatar	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000
Others	0.2266	0.0000	0.0415	0.0000	0.0000	0.7319

Results and Discussion

The estimated growth rates and instability index of area, production and productivity of sapota in India and export quantity and export value for the period 2001-02 to 2012-13 are depicted in Table 1. The results revealed that area (7.91 %) and production (8.48 %) was growing at a positive rate, while, productivity (-1.93 %) of sapota was found to be negatively growing. This negative growth in productivity of sapota may be due to poor management practices by the producers. The study also depicted the growth in the value of export was increasing at 12.44 per cent per annum and quantity of export was increasing at 12.96 per cent per annum. Compared to production, export of grapes was growing at a positive and significant growth. Instability was found to be highest in value of export of sapota (37.68%) followed by quantity of export (32.60%), productivity (19.33%), area (15.51%) and production (15.40%). These results are in line with findings of Mokashi (2012).

The transitional probability matrix presented in Table 2 depicted change in the direction of trade of Indian sapota from 2001-02 to 2012-13. UAE, UK, Bahrain, Saudi Arabia, and Qatar were the major countries importing Indian sapota. During the study period, UAE was the most stable market which retained about 74.34 per cent from the previous year. It lost its share to UK (12.85%), Saudi Arabia (6.08%), Qatar (0.28%) and other countries (6.45%). UAE gained from UK (5.76%), Bahrain (28.55%), and Other countries (22.66%). Other countries were stable markets which retained about 73.19 per cent from the previous year. It lost its share to UAE (0.22%) and Bahrain (4.15%). Other countries gained from UK (18.49%) and UAE (6.45%). Bahrain was the moderately stable market which retained about 64.02 per cent from the previous year. It lost its share to UAE (28.55%) and Qatar (7.44%). Bahrain gained from UK (14.45%), and Other countries (4.15%). UK was another moderately stable market which retained about 41.93 per cent from the previous year. It lost its share to UAE (5.76%), Bahrain (14.45%), Saudi Arabia (8.16%), Qatar (11.21%) and other countries (18.49%). UAE gained from UK (5.76%), Bahrain (28.55%), and Other countries (22.66%). Saudi Arabia and Qatar were the most unstable markets with zero per cent retention from the previous year. These results are in line with findings of Sreenivasamurthy and Subrahmanyam (1999).

The projection of the Indian sapota export to different countries was computed using the transitional probability matrix and the results of actual and projected exports of Indian sapota are presented in Table 3. The actual and estimated share of sapota to UAE decreased from 42.72 per cent to 40.57 per cent and from 45.56 per cent to 45.15 per cent respectively. But, the projected market share is expected to increase from 45.15 per cent in 2011-12 to 49.60 per cent in 2015-16. In the case of UK, the actual and estimated share decreased from 7.51 per cent to 5.12 per cent and from 8.64 per cent to 7.36 per cent respectively. The projected market share is expected to increase from 7.36 per cent in 2011-12 to 10.44 per cent in 2015-16. The estimated share of Bahrain increased drastically from 8.59 per cent to 25.17 per cent. But, the projected market share is expected to decrease from 25.17 per cent in 2011-12 to 16.27 per cent in 2015-16. In the case of Saudi Arabia, the actual export had increased from 2.52 per cent to three per cent and the estimated value was decreased from the same period and the projected market share is expected to increase during 2012-13 to 2015-16 from 2.88 per cent to 3.79 per cent. The actual and estimated share Qatar increased from 1.25 per cent to 6.62 per cent and from 1.50 per cent to 2.67 per cent respectively. But, the projected market share is expected to decrease from 2.67 per cent in 2011-12 to 2.58 per cent in 2015-16. In the case of other countries, the share decreased drastically from 38.73 per cent to 18.04 per cent and from 32.49 per cent to 16.77 per cent respectively. But, the projected market share is expected to increase from 16.77 per cent in 2011-12 to 17.32 per cent in 2015-16. The increasing share of other countries clearly shows the need to explore and exploit the market potential of other countries. Efforts are also 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 other importing countries.

These results are in line with findings of Yeledalli and Vilas (2009).

References

- Cuddy, J. and Della Valle, P. 1978. Measuring the instability of time series data, *Oxford Bulletin of Economics and Statistics*. 40: 79-85.
- Dent, W.T. 1967. Application of Markov Analysis to International Wool Flows. *Rev. Econ. Stat.* 49(2) : 613-616.

Table 3. Actual and expected quantity of sapota export from India to selected countries (2001-02 to 2012-13)

	UAE		UK		Bahrain		Saudi Arabia		Qatar		Others	
	A	E	A	E	A	E	A	E	A	E	A	E
2001-02	426.56 (42.72)	454.99 (45.56)	75.02 (7.51)	86.27 (8.64)	72.54 (7.26)	85.78 (8.59)	25.21 (2.52)	32.05 (3.21)	12.45 (1.25)	15.01 (1.50)	386.78 (38.73)	324.47 (32.49)
2002-03	458.32 (44.78)	481.35 (47.03)	88.46 (8.64)	95.98 (9.38)	87.89 (8.59)	96.83 (9.46)	32.87 (3.21)	35.08 (3.43)	13.58 (1.330)	17.74 (1.73)	342.35 (33.45)	296.48 (28.97)
2003-04	543.80 (50.09)	542.52 (49.97)	80.87 (7.45)	103.78 (9.56)	85.23 (7.85)	94.32 (8.69)	35.48 (3.27)	39.66 (3.65)	14.56 (1.34)	16.94 (1.56)	325.65 (30.00)	288.37 (26.56)
2004-05	647.90 (68.12)	569.99 (59.93)	90.93 (9.56)	121.38 (12.76)	88.41 (9.30)	87.34 (9.18)	42.90 (4.51)	46.81 (4.92)	14.87 (1.56)	18.59 (1.95)	66.14 (6.95)	107.02 (11.25)
2005-06	904.70 (76.61)	746.69 (63.23)	33.85 (2.87)	130.44 (11.05)	70.81 (6.00)	72.57 (6.15)	21.89 (1.85)	57.77 (4.89)	16.84 (1.43)	11.61 (0.98)	132.85 (11.25)	161.87 (13.71)
2006-07	869.53 (41.62)	888.18 (42.51)	624.88 (29.91)	373.76 (17.89)	103.86 (4.97)	270.02 (12.92)	113.68 (5.44)	103.83 (4.97)	101.81 (4.87)	80.23 (3.84)	275.67 (13.19)	373.42 (17.87)
2007-08	914.36 (42.51)	975.17 (45.34)	384.83 (17.89)	278.86 (12.97)	277.85 (12.92)	331.96 (15.43)	106.87 (4.97)	86.98 (4.04)	82.54 (3.84)	66.38 (3.09)	384.39 (17.87)	411.48 (19.13)
2008-09	1602.30 (38.96)	1807.77 (43.96)	429.50 (10.44)	385.98 (9.39)	825.60 (20.08)	823.90 (20.03)	150.20 (3.65)	132.45 (3.22)	195.60 (4.76)	114.05 (2.77)	909.10 (22.11)	848.15 (20.62)
2009-10	2121.00 (50.53)	2083.22 (49.63)	240.10 (5.72)	373.20 (8.89)	839.20 (19.99)	847.49 (20.19)	108.00 (2.57)	148.55 (3.54)	249.00 (5.93)	95.29 (2.27)	640.40 (15.26)	649.95 (15.48)
2010-11	788.00 (38.64)	921.02 (45.16)	78.20 (3.83)	134.04 (6.57)	631.60 (30.97)	480.42 (23.56)	49.40 (2.42)	54.29 (2.66)	46.30 (2.27)	57.95 (2.84)	445.80 (21.86)	391.57 (19.20)
2011-12	1216.44 (45.16)	1279.65 (47.50)	203.77 (7.56)	241.75 (8.97)	608.35 (22.58)	515.57 (19.14)	72.77 (2.70)	90.58 (3.36)	75.23 (2.79)	71.51 (2.65)	517.15 (19.20)	494.66 (18.36)
2012-13	1057.10 (40.57)	1176.54 (45.15)	133.50 (5.12)	191.81 (7.36)	694.58 (26.65)	655.88 (25.17)	78.20 (3.00)	75.16 (2.88)	172.44 (6.62)	69.59 (2.67)	470.12 (18.04)	436.96 (16.77)
2013-14		1247.08 (47.86)		231.60 (8.89)		535.30 (20.54)		87.18 (3.35)		73.59 (2.82)		431.18 (16.55)
2014-15		1278.10 (49.05)		257.35 (9.88)		467.62 (17.94)		94.72 (3.63)		69.28 (2.66)		438.86 (16.84)
2015-16		1292.60 (49.60)		272.14 (10.44)		424.03 (16.27)		98.70 (3.79)		67.22 (2.58)		451.25 (17.32)

Note: A-Actual exports in tons. P- Predicted exports in tons. Figures in parenthesis indicate exports share in percent

Mokashi, P. 2012. *An economic analysis of export potential of grapes from Northern Karnataka*. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India).

Sreenivasamurthy, D. and Subrahmanyam, K. V. 1999. Onion export markets and their stability for increas-

ing India's exports: Markov chain approach. *Agric. Econ. Res. Rev.* 12(2): 118-128.

Yeledalli, R. A. and Vilas K. 2009. Direction of trade and export competitiveness of onion. *Agril. Updates.* 4(3): 237-243.