Oryza Vol. 53 No.2, 2016 (181-186)

Growth, export performance and competitiveness of basmati and non-basmati rice of India- an markov chain approach

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Received : 13 January 2016 Accepted : 6 April 2016 Published : 20 July 2016

ABSTRACT

Rice is one of the most important staple food crops of more than 60 per cent of the world population with a significant contribution to Agriculture. India is the one of the largest producer of rice and emerged as major player in the worlds rice exports. Factors like introduction of high yielding and quality varieties along with suitable rice production technologies during the Green Revolution period has enhanced the Indian rice production and also trade liberalization has positively influenced the Indian rice export. The value of exports of basmati rice has increased from Rs. 3.30 Crores to Rs. 51.29 Crores between 2003-04 to 2013-14, meanwhile the value of exports of non basmati rice has increased from Rs. 3.28 Crores to Rs. 25.19 Crores. In this paper, the trend and stability of rice production, dynamics of changes in terms of value of exports of basmati and non basmati rice from India to different export markets have been measured by employing the Markov-Chain model. The results revealed that the rice area, production and productivity have seen a significant improvement during study period (1955-2014). Iran and Saudi Arab are found to be stable destinations for Indian basmati rice exports from Markov-Chain results. Whereas, Benin, Bangladesh and Senegal are found to be major destinations for non basmati rice exports. The most unstable markets among the non basmati rice importing countries were South Africa and Liberia with the zero per cent retention. So the policies should aim at developing good trade relations with the stable destinations to benefit from them.

Key words: *Basmati, Exports, green revolution, rice and stable*

The theme of "Rice is life" is a sign of the importance of rice as a primary food and income source especially in many developing countries (Thanh and Singh 2006). Rice constitutes around 44 per cent of total foodgrain consumption in the country and it occupies 23 per cent of gross sown area of India. Production of rice has tremendous impact on food and nutritional security, not only in India but also throughout the world (Mishra *et al.* 2014). Rice is positively influenced by trade liberalization and it is emerged as significant export crop. Traditionally, India used to export basmati rice and a small quantity of non basmati rice. The share of non basmati rice was below 10 per cent until 1989-90 and it has witnessed a quantum jump and its share in the total rice export increased to 54 per cent after trade liberalization (Chand 1999). The present study attempts to assess the trend and instability in area, production, productivity of rice and also examines the trade directions and stability of exports of basmati and non basmati rice to various destinations with a suitable econometric model, which may help us to quantify the shifts in the shares to different markets as well as between the markets over a period of time, which is of policy matter.

MATERIALS AND METHODS

The time series data on area, production and yield of rice from 1955 to 2014 (60 years) at the national level is obtained from Indiastat.com and other published issues. The data was divided into six sub-periods and each period had 10 years (decade wise). The decade wise compound growth rates and coefficient of variation for area, production and productivity of rice were computed for the study period.

Compound growth rate analysis

The decade wise compound growth rates for area, production and productivity of rice were computed.

The compound growth function is specified in the following form.

$$Y_t = ab^t e^u \text{———————————} (1)$$

Where,

Y_t = Area in the year t

t = Time period

a = Intercept value (value of y when t = 0)

b = (1+r), 'r' being the growth rate

u = Error term

Equation (1) was converted into the natural logarithmic form in order to facilitate the use of linear regression. Taking logarithms on both sides we obtain,

$$\text{Ln } Y_t = \text{Ln } a + t \text{ Ln } b + u \text{ ----------(2)}$$

Ln a and Ln b are obtained by application of ordinary least squares (OLS) procedure to equation (2) and the growth rate r is computed as below:

$$r = (\text{Anti Ln of Ln } b - 1) \text{ X } 100 \text{ ————} (3)$$

Instability analysis

The instability was measured by estimating the coefficient of variation of production, area and yield of rice. The coefficients of variation of these parameters were calculated as under:

$$CV (\%) = (\text{Standard deviation/Mean}) \times 100$$

Analysis on the contribution of area and productivity in total production

Decomposition analysis which has given by Minhas and Vaidyanathan (1965) was carried out to measure the contribution of area and productivity in total production, which has been applied by Hazell (1984), Thanh and Singh (2006) in their study. The observed increase in production of a crop could be decomposed into different components, i.e. (i) change in area, (ii) change in productivity and (iii) the interaction between area and productivity. The decomposition measures the contribution of area, yield and their interaction effects in the change in production of rice during the period from 1955 to 2014. The contribution of area, productivity and their interaction in rice production is estimated as below:

Change in production = Area effect + productivity effect + Interaction effect (area and productivity)

$$\Delta P = Y'\Delta A + A'Y + \Delta A\, \Delta Y$$

Where,

ΔP= Difference in production from the base year to last year (periods)

ΔY= Difference in productivity from the base year to last year (periods)

ΔA =Difference in area from the base year to last year (periods)

A' = Area in the base year (of each period)

Y' = productivity of rice crop during base year (of each period)

Thus, there are three sources of changes in production ΔP. $Y'\Delta A$ is called as 'area effect', A'DY is called 'productivity effect' DA DY is an 'interaction effect', which arises from the simultaneous occurrence of changes in productivity and area.

Export performance of Indian rice

The export performance is assessed based on time series data on export of basmati and non basmati rice from India obtained from various published issues of APEDA. Annual export data for period 2003-04 to 2013-14 were used to analyze the direction of trade and changing pattern of Indian basmati and Non basmati rice export. The major importing countries considered were Iran, Saudi Arab, Iraq, Kuwait and UAE for Basmati rice export. Whereas, Benin, Bangladesh, Senegal, South Africa and Liberia for Non-basmati rice export from India. Similar studies on different crops were conducted by Mahadevaiah *et al.* (2005) and Tejaswi *et al.* (2006) by using Markov chain analysis.

The average export to particular country was considered to be a random variable following a first order Markov process.

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

Where,

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

E_{it-1} = Exports to i^{th} country during the period t-1

P_{ij} = 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 = Number of importing countries

The transitional probability P_{ij}, which can be arranged in a (c x r) matrix, have the following properties.
$0 \leq P_{ij} \leq 1$

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

Thus the expected export share of a country during the period 't' was obtained by multiplying the actual exports in the previous period (t-1) by the transitional probability matrix. The transitional probability matrix is estimated in the linear programming (LP) framework by a method referred to as minimization of mean absolute deviation (MAD).

The linear programming formulation is stated as,

Min OP* + Ie
Subjected to
XP* + V = Y
GP* = 1
P* 0

Where,
0 is the vector of zeros
P* is the vector in which probability Pij are arranged
I is an apparently dimensioned vector of area e is the vector of absolute errors (|U|)
Y is the vector of export to each country.
X is the block diagonal matrix of lagged values of Y
V is the vector of errors
G is the grouping matrix to add the row elements of P arranged in P* to unity.

RESULTS AND DISCUSSION

Trend in area, production and yield of rice in India

The decade wise (10 years average) trend in rice area, production and yield in India are presented in the Table 1. The Table revealed that, there is considerable change in area, production and yield of rice in India from 1955 to 2014. The area under rice has increased gradually from 33.99 m ha in 1955-64 to 43.18 m ha in 2005-14. The production and yields also increased from 32.44 m tons and 951.40 kg/ha in 1955-64 to 98.81m tons and 2262.90 kg/ha in 2005-14, respectively. There was a sudden increase in area, production and yield of rice during second decade (1965-74) and this could be attributed to introduction of high yielding varieties and adoption modern technologies during the green revolution period. Thanh and Singh (2006) reported the increased rice yield on usage of high yielding and quality varieties along with suitable rice production technologies.

Compound growth rates in area, production and yield of rice (1955 to 2014)

Compound growth rates for area under rice in India are presented in the Table 2. The results indicate that though there was a positive growth rate under area during first to fourth decade, under study the trend in growth rates turnout to be negative during the later decades. The negative growth rate of 0.37 and 0.68 per cent per annum in area were observed in India, respectively during fifth and sixth decade. The overall growth in area during study period is 0.49 per cent per annum.

The growth rates in production and yield were positive for all the decades. The trend in rice production is either influenced by area or by yield or both. The increases in rice yield and rice harvested areas have contributed positively to the increased in rice production in most countries (Sawaneh 2013). The sources of growth of crop production have been achieved primarily from yield increases, especially since the introduction of the green revolution technology, Mishra *et al*. (2014).

Table 1. Area, production and yield of rice from 1955 to 2014 (10 years average)

Year	Area (m ha)	Production (m tons)	Yield (kg/ha)
1955-64	33.99	32.44	951.40
1965-74	37.00	38.70	1043.60
1975-84	39.97	51.19	1278.30
1985-94	41.75	70.93	1695.60
1995-04	43.50	84.08	1927.10
2005-14	43.18	98.81	2262.90

Table 2. Decade wise compound growth rates in area, production and productivity of rice (1955 to 2014)

Year	Area	Production	Productivity
1955-64	1.64	4.16	2.49
1965-74	0.77	3.33	2.55
1975-84	0.38	2.32	1.92
1985-94	0.63	3.47	2.83
1995-04	-0.37	0.58	0.82
2005-14	-0.68	1.71	1.76
Overall	0.49	2.40	1.87

The low growth rate of 0.58 and 0.82 per cent per annum where observed in production and yield of rice during V decade. The overall growth rate is 2.40 and 1.87 per cent per annum in production and yield of rice, respectively.

Instability analysis in area, production and yield of rice (1955 to 2014)

The coefficient of variation is used to measure the stability and instability in area, production and yield of rice. Similarly, Hasan *et al*. (2008) measured the change and instability in area, production and productivity of two major cereal crops *viz*, wheat and maize in Bangladesh using coefficient of variation.

The results in Table 3 shows that in case of rice area, the coefficient of variation is most stable during period III (1975-84, CV is 2.58 %) as compared to others periods. The period I (1955-64, CV is 4.94 %) was observed as most instable due to high growth rate in this period, followed by period VI (2005-14, CV is 3.83 %), period V (1995-04, CV is 3.16 %), period IV (1985-94, CV is 2.88 %) and period II (1965-74, CV is 2.80 %).

In case of rice production, it was observed that the most stable growth was in the period VI (2005-14, CV is 6.46 %) and period V (1995-04, CV is 7.43 %). The most instability was found in periods I (CV is 13.39), followed by period II (CV is 12.20 %), period III (CV is 11.95 %) and period IV (CV is 11.50 %). The instability in these sub periods is due to the high growth rates in rice production in these periods.

The stability of rice yield is observed during the period V (CV is 5.64 %) followed by period VI (CV is 6.05 %). The slight growth in yield during these periods is the reason for stability. Whereas, the other sub periods indicated instability in the growth of yield. The CV ranges from 9.14 to 9.88 per cent during these periods.

For the overall study period (1955-14), instability analysis shown high instability as compared to each sub periods. The high instability was observed in rice production (CV is 39.70 %), followed by rice yield (CV is 32.33 %) and rice area (CV is 9.23 %). The results indicate that there was considerably increase in rice production followed by rice yield and rice area during the study period.

Decomposition Analysis

The change in area or the change in yield may be the reason for the change in production. Sometimes area and yield both affects the production. In order to know the contribution of area and yield in total production of rice the decomposition analysis was used. Decomposition of output growth is not a new concept in the field of agricultural growth analysis (Kakali and Partha 2005)**.**

The decomposition analysis results are presented in the Table 4. It was observed from the table that, during period I (1955-64), rice production was contributed mainly by interaction effect which explained of 36.62 per cent followed by yield effect of 32.64 per cent and area effect of 30.74 per cent.

In the sub periods II, III and IV, the yield effect has significantly contribute to the production (71.96, 75.11 and 82.23 %, respectively). The area effect has reduced in these periods (23.13, 21.69 and 14.43 %) as compared to sub period I. Similarly, the interaction effect also reduced as compared to period I.

In the sub period VI (2005-14), the yield effect has contributed majorly to rice production, which explained of 737.54 per cent. Whereas, the area and interaction effect has negatively contributed to rice

Table 3. Coefficient of variation in area, production and productivity of rice (Per cent)

Period	Area	Production	Productivity
1955-64	4.94	13.39	9.14
1965-74	2.80	12.20	9.88
1975-84	2.58	11.95	9.77
1985-94	2.88	11.50	9.17
1995-04	3.16	7.43	5.64
2005-14	3.83	6.46	6.05
Overall	9.23	39.70	32.33

Table 4. Contribution of area and yield in total production from 1955 to 2014

Periods	Area Effect Y'Δ A	Yield Effect A'Δ Y	Interaction Effect ΔAΔY
1955-64	30910(30.74)	32816 (32.64)	36820(36.62)
1965-74	2086(23.13)	6491(71.96)	443(4.91)
1975-84	2075(21.69)	7185(75.11)	306(3.20)
1985-94	2592(14.43)	14769(82.23)	600(3.34)
1995-04	-1671(-27.10)	8011(129.92)	-174(-2.82)
2005-14	-9060(-564.73)	11832(737.54)	-1168(-72.81)
Overall	6843(10.40)	47248(71.77)	11737(17.83)

production (-564.73 and -72.81 per cent, respectively). Except in this period, the area and interaction effect has shown positive effect in all other sub periods.

For the entire study period (1955-14), it was observed that, the yield effect has mainly contributed to the production (71.77 %) followed by interaction effect (17.83 %) and area effect (10.40 %). It can be said that from results, that the yield component is the major concern for the increase in the rice production in India. The change in yield has been the dominant source of total variation in production of rice in Gujarat state (Singh *et al*. 2014). The findings of Chand and Raju (2009) aptly support the findings of the study.

Export performance of Indian rice

The share of basmati and non basmati rice export in total rice export is presented in the Table 5. The share of basmati rice has increased from 22.61 per cent in 2003-04 to 34.50 per cent in 2013-14. Whereas, the share of non basmati rice has decreased from 77.39 per cent in 2003-04 to 65.50 per cent in 2013-114. However, the average share of basmati rice is 43.70 per cent and non basmati rice is 56.30 per cent in total rice export during the study period. The share of non basmati rice was below 10 % until 1989-90 and it has witnessed a quantum jump and its share in the total rice export increased to 54 per cent after trade liberalization (Chand 1999).

Transitional probability matrices

The changing pattern of Indian basmati and non basmati rice export were estimated by obtaining the transitional probability matrices for the annual export data in terms of volume for the period 2003-04 to 2013-14. The row elements in the transitional probability matrix provide the information on the extent of loss in 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 (Kusuma and Basavaraja 2014).

Table 5. Share of basmati and non basmati rice in total rice exports from India (2003-04 to 2013-14)

Year	Basmati Rice	Non Basmati Rice
2003-04	22.61	77.39
2004-05	24.34	75.66
2005-06	28.54	71.46
2006-07	22.02	77.98
2007-08	18.29	81.71
2008-09	62.55	37.45
2009-10	93.53	6.47
2010-11	95.93	4.07
2011-12	44.29	55.71
2012-13	34.09	65.91
2013-14	34.50	65.50
Average	43.70	56.30

The major basmati rice importers from India, i.e. Iran, Saudi Arab, Iraq, Kuwait and UAE were considered for analysis. The remaining exporting countries were pooled under 'other countries'. It is evident from the Table 6, that Iran and Saudi Arab were the stable markets among the major importers of Indian basmati rice as reflected by the probability of retention at 92.77 per cent and 85.21 per cent. The UAE, Iraq and Kuwait retained 65.76, 58.78 and 17.64 per cent of total export from India. The remaining countries retained 75.86 per cent of export from India. The results are in corroboration with the results from study of Anup and Sekhon (2014).

The major Non-basmati rice importers from India, *i.e*. Benin, Bangladesh, Senegal, South Africa, Liberia were considered for analysis. Here also the remaining exporting countries were pooled under 'other countries'. The Table 7 revealed that Benin, Bangladesh and Senegal countries retained 51.55, 39.87 and 38.62 per cent of total export from India. The most unstable markets among the importing countries were South Africa and Liberia with the zero per cent retention. The remaining countries retained 77.24 per cent of export from India.

The area under cultivation of Rice cannot be increased overnight as it requires more water requirement than other field crops. As the study decomposed the productivity contributing maximum towards production, hence efforts should be made in supplying quality high yielding varieties with least water requirement and also can extend sustainable irrigation infrastructure facilities. As the results clearly indicated share of basmati rice in total rice exports is increasing by replacing the non-basmati rice. Efforts should be made to promote the cultivation of basmati rice without hindering the activities like buffer stocking in the wane of food security of the country. Export earnings of rice are a major source of foreign exchange with regard to agriculture which stabilizes the Balance of Payment of the country. Basmati Rice export from India has

Table 6. Transitional Probability Matrix for Basmati rice export from India (2003-04 to 2013-14)

	Iran	Saudi Arab	Iraq	Kuwait	UAE	Others
Iran	0.9277	0.0000	0.0723	0.0000	0.0000	0.0000
Saudi Arab	0.0000	0.8521	0.0000	0.0908	0.0017	0.0554
Iraq	0.4122	0.0000	0.5878	0.0000	0.0000	0.0000
Kuwait	0.0000	0.0000	0.0000	0.1764	0.8236	0.0000
UAE	0.0605	0.0000	0.0000	0.0552	0.6576	0.2267
Others	0.0198	0.1648	0.0038	0.0530	0.0000	0.7586

Table 7. Transitional probability matrix for Non-Basmati rice export from India (2003-04 to 2013-14)

	Benin	Bangladesh	Senegal	South Africa	Liberia	Others
Benin	**0.5155**	0.0000	0.2116	0.0000	0.2729	0.0000
Bangladesh	0.0000	**0.3987**	0.0000	0.0000	0.0000	0.6013
Senegal	0.4972	0.0000	**0.3862**	0.0000	0.1166	0.0000
South Africa	0.0000	0.3313	0.3696	**0.0000**	0.0117	0.2874
Liberia	1.0000	0.0000	0.0000	0.0000	**0.0000**	0.0000
Others	0.0121	0.0985	0.0000	0.1170	0.0000	**0.7724**

indicated Iran and Saudi Arab as the stable destinations for basmati rice export. For non basmati rice export Benin, Bangladesh and Senegal have been indicated as important destinations. Therefore, appropriate export promotion strategies have to be envisaged to encourage exports and to minimize market risks.

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