Original Research Article

Growth and Instability in production of Basmati rice in India

ABSTRACT

Basmati rice is a novel cereal crop with distinct characteristics like long grain, superior aroma and unique flavour. Basmati rice is also stated to be the Pearl of Rice. India accounts for over 70% of the world's basmati rice production. So the present study was undertaken with the aim to assess the growth and instability in the area, production and productivity of Basmati rice in India. The secondary data on area, production and productivity of basmati rice were collected for a period of 20 years from 2000 to 2019. The growth performance in production was analysed by using exponential method and instability for the same was worked out of using Coefficient of Variation and Coppock's Instability Index. The study period was further divided into two sub periods and overall period. The compound growth rate analysis showed that during the overall period, area, production and productivity witnessed a positive and statistically significant growth rate at one per cent level of significance. Production witnessed highest positive growth rate followed by area and productivity. Instability analysis suggested that period I was the most unstable period under study. Coppock's Instability analysis revealed that during the overall period, variation was highest in production, followed by area and least variation was observed in productivity. The study concluded that efforts must be taken up by the farmers, traders and government to enhance the production and productivity of basmati rice and also explore the possibility of expansion of area under basmati rice cultivation.

Keywords: Production; Compound Growth Rate; Variation and CII.

1. INTRODUCTION

Rice (*Oryza sativa* L.*)* maintains a significant place in the Agricultural Economy of India and food security. It serves as the staple food for almost 65 per cent of the Indian population and also as a source of economy to the households and the nation. More than half of the world's population depend on rice for more than 20 per cent of their daily calories [1]. According to Ayurveda, Basmati rice is pure, nourishing and easy to digest. The unique fragrance and flavour of basmati is due to the presence of a chemical compound called 2-acetyl-1-pyrroline which makes it unmatched to any other aromatic rice in the world [2]. Basmati rice is characterized by extra-long, superfine slender grains having a length to breadth ratio of more than 3.5, sweet taste, soft and fluffy texture, delicate curvature, superior aroma, unique flavour and an extra elongation with least breadth-wise swelling on cooking [3].India is the major producer of basmati rice in the world by constituting more than 70 per cent of the total world basmati rice production followed by Pakistan [4]. Himalayan foothills of Indian sub-continent are the major belt of basmati production that includes Punjab, Haryana, Delhi,

Uttarakhand, Himachal Pradesh, Jammu & Kashmir and Western Uttar Pradesh. While the original Basmati area of Pakistan's lies between the Ravi and Chenab rivers in the Kalar bowl. Haryana and Punjab together constitute about 75 per cent of the total production. The share of Haryana to the total production was about 44 per cent followed by Punjab and Uttar Pradesh. The farmers in Punjab, Haryana and Uttar Pradesh prefer Pusa Basmati 1121 and Basmati CSR 30 over other notified varieties in view of their higher yield and remunerative prices. Pusa Basmati 1121 is grown on about 70 per cent of basmati area in the country [5].

Table 1. Major Basmati Rice growing districts in India

Punjab	Amritsar, Fazilka, Firozpur, Gurdaspur, Kapurthala, Ludhiana, Muktsar, Sangrur, Tarantaran
Haryana	Ambala, Fatehabad, Hisar, Jind, Karnal, Kurukshetra, Palwal, Panipat, Rohtak, Sirsa, Sonepat
Uttarakhand	Dehradun, Haridwar, Nainital, Udham Singh Nagar
Himachal Pradesh	Kangra, Mandi
Western UP	Aligarh, Bulandshahr, Mathura, Mainpuri, Muzaffarnagar, Pilibhi, Rampur, Saharanpur
Jammu & Kashmir	Jammu, Kathua, Samba

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With Indian Basmati rice gaining momentum in the global market and fetching higher returns, the production level has also showed a steady growth in the past years [6].High preference should be given to enhance the production and productivity level of basmati rice as there is an increasing demand in the domestic market owing to its health benefits as well as to meet the persistent supply in the global market. Keeping this in view, the current study was undertaken to study the growth performance of basmati rice in terms of production and also analyse the instability in area, production and productivity of basmati rice in India.

2. METHODOLOGY

The present study is entirely based on time series data on area, production and productivity of Basmati rice in India and the data required to meet the objectives were collected from the statistical reports of Agricultural and Processed Food Product Export Development Authority (APEDA) and Indiastat website for a period of 20 years (1999-2000 to 2018-2019). For better understanding, the study period was divided into two sub-periods and an overall period viz., Period-I (1999-2000 to 2008-2009), Period-II (2009-2010 to 2018-2019) and Overall period (1999-2000 to 2018-2019). The growth and instability in area, production and productivity were analysed using analytical tools such as compound growth rate, coefficient of variation and Coppock's Instability Index (CII). For accuracy and efficient result, R statistical software was used to analyze the data to effectively work out the growth rate.

2.1 Growth Rate Analysis

The growth in area, production and productivity of basmati rice were studied using an exponential model. The model was fitted to the time series data and the growth was assessed using non linear function [7].The following exponential growth function was used to calculate the growth rate

$$\mathbf{Y = a.b^t}$$

Where,

Y = Area, production and productivity of Basmati rice

a = Intercept

b = Regression Coefficient

t = Time variable (in years)

The compound growth rate was estimated using the given formula based on the value obtained from the exponential growth function:

CGR (r) = [Antilog (log b) - 1] × 100

Where,

r = Compound growth rate

2.2 Instability Analysis

The level of Instability in Area, production and productivity were analysed by using Coefficient of Variation (CV) and Coppock's Instability Index (CII)

2.2.1 Coefficient of Variation (CV)

Coefficient of variation measures the instability or fluctuation in a data around the mean. Coefficient of variation is defined as the ratio of sample standard variation to its mean [8].

The coefficient of variation was worked out by using the following formula:

$$\mathbf{CV = \frac{\sigma}{\bar{x}} \times 100}$$

Where,

$$\sigma = \frac{\sqrt{\Sigma\,(X - \bar{X})^2}}{n-1}$$

σ = Standard deviation

$\bar{x}$ = Arithmetic mean

X = Variable

n = Number of observations

2.2.2 Coppock's Instability Index (CII)

Beside coefficient of variation, Coppock's Instability Index (CII) was used to measure the degree of instability in area, production and productivity of basmati rice. Coppock's Instability Index (CII) is a close approximation of the average year to year adjusted for the trend [9].

According to Coppock (1962), the annual instability index equals the antilog of the square root of the logarithmic variance. Coppock's Instability Index (CII) with higher numerical value represents greater instability and vice-versa. The values derived from this are more apparent than the absolute variation.

This method was employed for working out the instability as it is a trend free measure of variability and is more appropriate for single commodity analysis.

The following formula of Coppock's Instability Index (CII) was used to work out the coefficient of instability:

$$\textbf{CII} = [\textbf{Antilog}\ (\sqrt{\textbf{Vlog}})\textbf{-1}]\textbf{×100}$$

Where,

Vlog = $\frac{\Sigma\left(\log\frac{X_{t+1}}{X_t}-m\right)}{N}$

X_t= Area/ Production/ Productivity of Basmati rice in year t

N = Number of years minus one

m = Arithmetic mean of the difference between the log of $X_1$and X_{t-1}, X_{t-2}, etc.

V log = Logarithmic variance of the series

3. RESULTS AND DISCUSSION

3.1 Growth rate in area, production and productivity of Basmati rice

During the study period, there was a continuous fluctuation in the area under cultivation with maximum area recorded in the year 2014 i.e. 2134 thousand hectares. Basmati rice witnessed steady downfall in its production in the initial years of study. From the year 2007, there was a gradual increase in the production level of basmati rice and by the end of the study period there was a steady decline in the production owing to the decrease in the area under cultivation. While productivity witnessed increasing trend from the year 2000 i.e. 1750.27 kg/ha to 4427 kg/ha in the year 2011 which is the maximum productivity level during the entire study period. Thereafter there has been a gradual but steady decrease in the productivity level of basmati rice.

The results of annual growth rate in Table 2, revealed that production of basmati rice witnessed highest positive and significant compound growth rate of 17.40 per cent per annum followed by productivity at 9.55 per cent per annum at one per cent level of significance in period I (1999-2000 to 2008-2009) while area witnessed a growth rate of 7.16 per cent per annum which was statistically significant at ten per cent level of significance.

Table 2. Compound Growth Rate of Area, Production and Productivity of Basmati rice in India

Particulars	CGR	R^2	SE	t value
Area				
Period I	7.16*	0.22	0.045	1.52
Period II	-0.37	0.009	0.014	-0.27
Overall Period	5.62***	0.52	0.013	4.45
Production				
Period I	17.40***	0.66	0.04	3.93
Period II	-1.65	0.104	0.027	-0.96
Overall Period	8.53***	0.63	0.014	5.54
Productivity				
Period I	9.55***	0.85	0.014	6.71
Period II	-12.16	0.30	0.007	-1.87

Overall Period	2.75***	0.44	0.007	3.73

**** and * denotes significance at 1% and 10% level, respectively*

In period II (2009-2010 to 2018-2019), annual growth rate in area, production and productivity was found to be negative and statistically non-significant with the compound growth rate of - 0.37 per cent, - 1.65 per cent and -12.16 per cent per annum, respectively. During the overall study period, area, production and productivity reported positive compound growth rate. Production witnessed highest and positive compound growth rate of 8. 53 per cent per annum followed by area at 5.62 per cent and productivity at 2.75 per cent per annum at one per cent level of significance. Growth in production over the study period can be attributed to the increase in cultivable area under basmati rice, introduction and promotion of high yielding varieties like Pusa 1121 and adoption of modern technologies by the farmers. The results obtained are in close association with the findings of Satishkumar e*t al.*[10] who concluded that during the overall period, there was a positive growth in production and productivity of rice.

3.2 Instability in area, production and productivity of Basmati Rice

In order to study the extent of fluctuations in area, production and productivity of Basmati rice, coefficient of variation (CV) and Coppock's instability index (CII) were worked out.The result of coefficient of variation revealed that the production and area of Basmati rice exhibited more variability in period I (1999-2000 to 2008-2009) with coefficient of variation at 61.66 per cent and 44.21 per cent, respectively whereas productivity showed comparatively least variation with coefficient of variation at 26.48 per cent. In period II (2009-2010 to 2018-2019), area, production and productivity witnessed least variation as compared to other two sub periods. Area, production and productivity exhibited variability with coefficient of variation at 11.97 per cent, 15.65 per cent and 7.25 per cent, respectively. During the overall period, the results revealed that production of Basmati rice witnessed higher instability with coefficient of variation at 46.77 per cent followed by area with 36.57 per cent and productivity with 20.04 per cent. The results suggested that Period I (1999-2000 to 2008-2009) was the most unstable period under study. The results can be correlated with the findings of Singh e*t al*. [11].

Table 3. Instability of Area, Production and Productivity of Basmati Rice in India

Period	Particulars	Area	Production	Productivity
Period I	Mean	1042.614	3456.044	3188.682
	SD	461.0303	2130.828	844.3181
	CV (%)	44.22	61.66	26.48
	CII (%)	53.46	48.86	14.31
Period II	Mean	1785.084	6948.2	3882.326
	SD	213.6721	1087.524	281.3115
	CV (%)	11.97	15.65	7.25
	CII (%)	15.15	20.84	9.82
Overall Period	Mean	1413.849	5202.122	3535.504
	SD	517.0845	2433.148	708.3633

	CV (%)	36.57	46.77	20.04
	CII (%)	36.80	37.09	13.18

Coppock's Instability Index (CII) was also employed as it is more pronounced than the absolute variation. The results suggested that the highest variation observed in production was 48.86 per cent in period I. Area and productivity also exhibited high variation in period I with 53.46 per cent and 14.31 per cent. In period II, area, production and productivity showed comparatively least variation with CII at 15.15 per cent, 20.84 per cent and 9.82 per cent respectively. Coppock's Instability Index (CII) during overall period was 36.80 per cent, 37.09 per cent and 13.18 per cent for area, production and productivity, respectively.

4. CONCLUSION

The present study concluded that the growth rate in production of basmati rice showed positive and significant growth rate as there has been a considerable increase in the area under basmati rice cultivation. The initial period of study showed highest fluctuation in area, production and productivity and gradually there was a decline in the variation. Basmati rice has great commercial value and application of new advance technologies as well as increasing opportunities for investment in this sector will increase the productivity of basmati rice. To achieve the breakthrough, a systematic and long term planning at the state as well as national levels must be initiated.

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