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State-wise Production Performance of Basmati and Non-Basmati Rice in India

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Authors' contributions

This work was carried out in collaboration among all authors. Author MU performed the statistical analysis and wrote the first draft of the manuscript. Author KRK has wrote the protocol, compilation of methodology and finalized the paper. Authors MT and KRA also involved designed and appropriate suggestions and modifications in the manuscript. The paper was developed from the MU PhD research work under the guidance of author KRK. All authors read and approved the final manuscript.

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ABSTRACT

The present study was designed to evaluate the state wise Basmati and non-Basmati rice production performance in India. The study is based on the time series data on area production and yield which were compiled from various sources for a period of 39 years (1980-81 to 2018-19). The sate wise analysis considers for the major basmati and non-basmati production sates by merging the newly divide states to parents' sates like Telangana to AP etc. While considering overall period in basmati area (6.01%) production (10.55%) and yield (4.28%) shows positive growth rate with 1 per cent level of significance. Allover India shows positive growth rate like area (0.24%), production (1.95%) and Productivity (1.70%) with 1 per cent level of significance. For India, in overall period it is more stable as Area (2.89), Production (6.07) and yield (4.5) give low instability percent. Special attention program is need to enhance the production of rice in Assam and Orissa were two states are in lowest category in terms of productivity, so effects may be taken to increase the productivity in Assam and further increase from medium to high productivity states in case of Andhra Pradesh.

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1. INTRODUCTION

Rice is the most broadly used staple food in large part of the world population, especially in Asia. It's the commodity with the maximum global wide production after sugarcane and maize [1]. Rice adds up to 780 and 689 kcal/capita/day of the food supply in Asia and India, respectively–[2] Moreover, India is the biggest nation as far as energy utilization from farming and rice constitute a significant portion in it.

India is the second-largest producer of rice (24%) in the world after China (30%), with greater than 11% of the world production along with the share of the other country like, Bangladesh (7%), Indonesia (7%), Vietnam (5%) and Thailand (4%) – [3]. West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadu, Odisha, and Bihar are the major rice producing states in India.

Among the various classes of rice, basmati and non-basmati maintain a special area in the consumer's heart. Basmati rice is completely unique species which is originating from India. Like all other species of rice, Basmati rice is also available in white and brown versions, it relies upon at the milling process. This rice grains are longer than non-basmati varieties. Cooked basmati rice is identified without any difficulty through its perfume as no other rice in international has this specific traits. (Statista, 2018-19).

Basmati is lengthy, fragrant rice grown for centuries in the unique geographical region of the Himalayan foot hills of Indian sub-continent. India contributes more than 70 per cent of the overall global production and the rest is produced through Pakistan in particular from Punjab and Sindh states. (Sidhu et al, 2014). In India, Haryana, Punjab, U.P, Uttarakhand, and J&K are the basmati growing states with an annual production of about 5.1 Million metric tonnes (mt) from 1.5 Million hectares (mha) during 2018-19. Beside, Non-Basmati rice production accounts 107.8mt from 42.2 Million hectares during 2018-19 [1].

Rice being a staple crop for 70% of the planet and thus the demand for rice is predicted to still grow in future. The food security concerns everywhere in the planet is driving the expansion of the Indian industry, which is attained by exporting the rice to various countries in contribution towards the global food security of rice. Global consumption of rice has a small increase over the last decades from 437.18mt to 490.27mt. The measure of the worldwide rice industry is around US$275 billion, of which, Basmati industry accounts for US$5.8 billion (2.1%). Worldwide Basmati Rice consumption showcase is driven by Center East which is the biggest locale consumption accounting about 27.08% of worldwide consumption of Basmati Rice [4].

Basmati Rice consumption shows a steady growth. In 2023, the consumption of Basmati Rice is estimated as 0.176mt [4]. Basmati rice is becoming the selection across consumer groups mainly due to its superior taste and aroma that's highly pleasing to the senses. This provides India with the huge potential for Basmati rice export around the world.

The above facts relating to basmati rice exports from India indicate that India has enough potential to grow more of basmati rice and can be a major exporter as well. There exists vast potential to bring more area under basmati rice production and increase in productivity. Through scale economy, India's basmati can effectively compete in the global market. Increased exports of basmati rice can be justified since it does not affect domestic food security adversely. Most of the recent studies have analyzed the performance of rice of a country, hence this study is attempted to analyze the special difference in basmati and non-basmati rice performance (Area, Production and Yield) with four-decade time serious data, with the following specific objectives. Hence, the present study attempts to assess the trend and stability in area, production and productivity of basmati and non-basmati rice.

2. OBJECTIVES

This study is to analyze the performance of basmati and non- basmati rice as the export of basmati and non – basmati rice have been increased in recent years and also to analyse the stability in area production and yield of basmati and non –basmati rice.

1. To analyze the trend and in stability in basmati and non-basmati rice in difference state and India.
2. To assess the state –wise production potential and group the country producing

states for developing suitable rice production policies.

3. DATA AND METHODOLOGY

The study was based on the time series data on area production and yield which were compiled from various sources for a period of 39 years (1980-81 to 2018-19). Considering the recent drift in Indian rice production and export Trend performance after 2010-11, the trend analysis was covered for the period of 1980-81 to 2018-19. Further, the study period was divided into three sub-periods: 1980-81 to 1994-95 (period I), 1995-96 to 2009-10 (period II) and 2010-11 to 2018-19 (period III) corresponding broadly to pre- and post-reform periods and non-basmati rice exporting shifting period, respectively. The sate wise analysis considers for the major basmati and non-basmati production sates by merging the newly divide states to parents' sates like Telangana to AP etc.

3.1 Trend Analysis

For growth analysis, the total period was subdivided into three periods as in production, growth rates were calculated by fitting exponential growth function to the time series data. Compound growth rate analysis were done using the following non liner growth function.

$$Y_t = ab^t$$

Where, Y_t=Dependent variable for which growth rate will be estimated (area, production and yield in year't'); a=Intercept; b= coefficient of log linear function; t=Year which takes values 1, 2,….n;
The equation is transformed into log-linear and written as

$$\ln Y_t = \ln a + \ln b_t$$

Where ln Y is natural logarithm of Y, ln a and ln b are similarly defined. The compound growth rate was computed by using the relationship

$$CGR = \{Exp(b) - 1\} \times 100$$

The significance of the regression coefficient was tested using the student's 't' test. [5-6].

3.2 Cuddy-Della Valle (Instability index)

Instability index is a simple analytical technique to find out the fluctuation or instability in any time series data [7-8]. The formula suggested by Cuddy-Della Valle was used to measure instability, which is used as measure of instability in time series data [9-10]. This method corrects the coefficient of variation, if data are scattered around the negative or positive trend line. The Cuddy-Della Valle Index is given follows.

$$I = CV *(1-R^2) ^0.5$$

Where, CV is coefficient of variation defined as the ratio of sample standard deviation to its mean and R^2 is the corrected coefficient of determination of the log linear trend function that fits the time series. If the F-test is significant at 5 per cent level of significance, then the Index is calculated by using R^2. When test statistics is not significant or $R^2 < 0$ (the value of R^2 is lies between 0 to 1; in the above log-log function, R^2 cannot be negative), then CV is chosen to measure instability index.

4. RESULTS AND DISCUSSION

4.1 Triennium Ending (TE) of Major Rice Producing States in India

The triennium ending of the major rice producing states in India is given in Table 1. Among the total rice producing states, 94% of the area is covered by major 12 States like Uttar Pradesh (14%), Madhya Pradesh (13.5%), West Bengal (12%) and Bihar (11%) etc., shown in Fig. 1.The Triennium Ending was calculated for three periods like TE1982, TE1998 and TE2018. Based on the results of Triennium Ending, the area under the crop rice in various states continuously increases during three Triennium Endings like Uttar Pradesh, Punjab, Madhya Pradesh, Haryana and Maharashtra likewise the area under the crop rice in various states declines when compared to the previous year in and around over 500 thousand ha like West Bengal, Odisha and Tamil Nadu.

In case of production, the 12major rice producing sates covers around 92% of the total rice production like West Bengal (13.5%), Uttar Pradesh (12%), Andhra Pradesh (11%), Punjab (11%) and Bihar (10%) etc., Results of Triennium Ending shows that except Tamil Nadu and Karnataka all other states shows an increasing Production which is doubled at TE 2018 when compared to TE 1982. The rice production and productivity increased tremendously since the first 1970s, after the introduction of genetically

improved high yielding varieties (HYV) during the mid-1960s. The widespread adoption of high-yielding varieties (HYVs) also as crop and farm management practices; policy support to enhance irrigation facilities, market infrastructure, and therefore the supply of chemical fertilizers and agricultural credit; subsidies on farm inputs; and farmers' enthusiasm to adopt HYVs were the main drivers of the impressive growth in production and productivity of rice in India. (Aldas Janaiah,

Results of Triennium Ending shows that an increasing yield which is doubled at TE 2018 when compared to TE 1982. The highest yield recorded in Punjab (4.11 tonnes) followed by Andhra Pradesh (3.38 tones), Haryana (3.15 tonnes) and Tamil Nadu (3 tonnes) shows the Fig. 2.

4.2 Trend in Area, Production and Yield of Major Rice Producing States in India

Area production and productivity of rice were analyzed by computing the CGR and the data from 1980-81 to 2018-19 were subdivided to three periods viz., P1, P2 and P3. The compound growth rate of area, production and productivity for major rice producing states were given in Table 2. It could be seen from the table that Haryana gives growth rate in area in all the three periods like 3.64%, 1.69% and 2.34% with 1 per cent level of significance in P1, P2 and P3 respectively. Likewise, Punjab (4.2%, 1.3% and 1.1% with 1 per cent level of significance in P1, P2 and P3 respectively), and Uttar Pradesh shows positive growth rate. In Area Tamil Nadu (0.7%), Karnataka (4.7%), Maharashtra (0.7%), Andhra Pradesh (1.25%) and Odisha (1.14%) shows negative growth rate during P3.

While considering the production of rice in major states Punjab leads in production with growth rates 5.2%, 3.0% and 2.49with 1 per cent level of significance in P1, P2 and P3 respectively, followed by West Bengal 5.24%, 1.15% and 1.72%with 1 per cent level of significance in P1, P2 and P3 respectively. Followed by Haryana 3.9%, 3.2% and 3.17% with 1 per cent level of significance in P1, P2 and P3 respectively. In Production Karnataka (3.74%) and Tamil Nadu (1.41%) shows negative growth rate during P3.

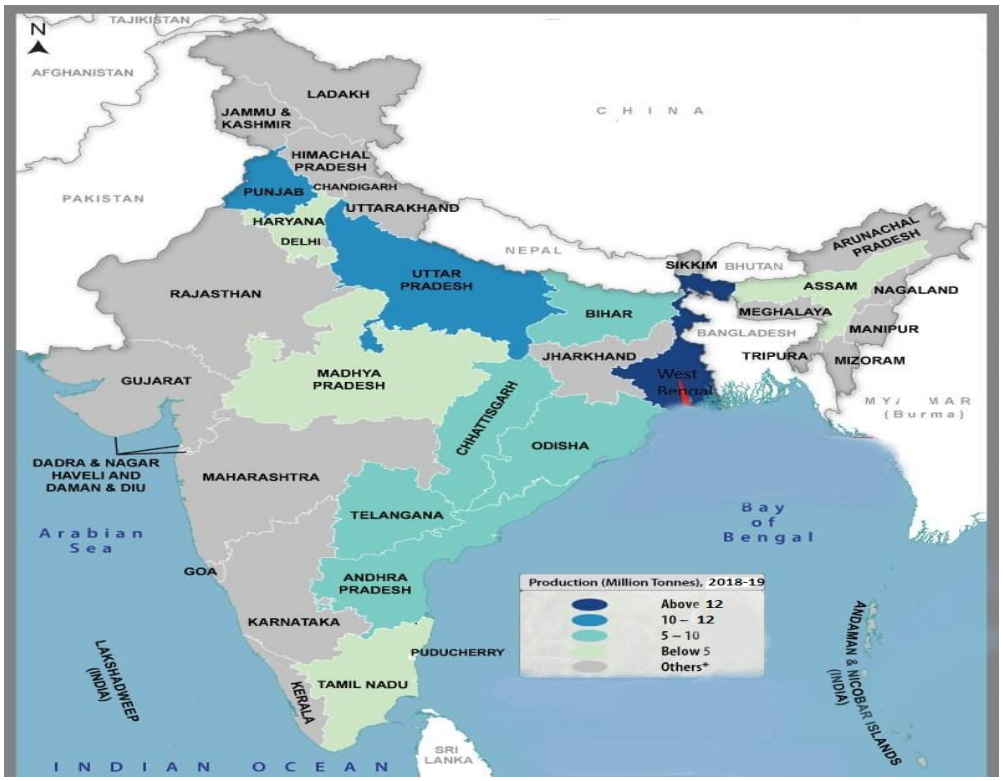

Fig. 1. Percentage share of rice production in India
Source: Author drawn boundary, DES production (2018-19)

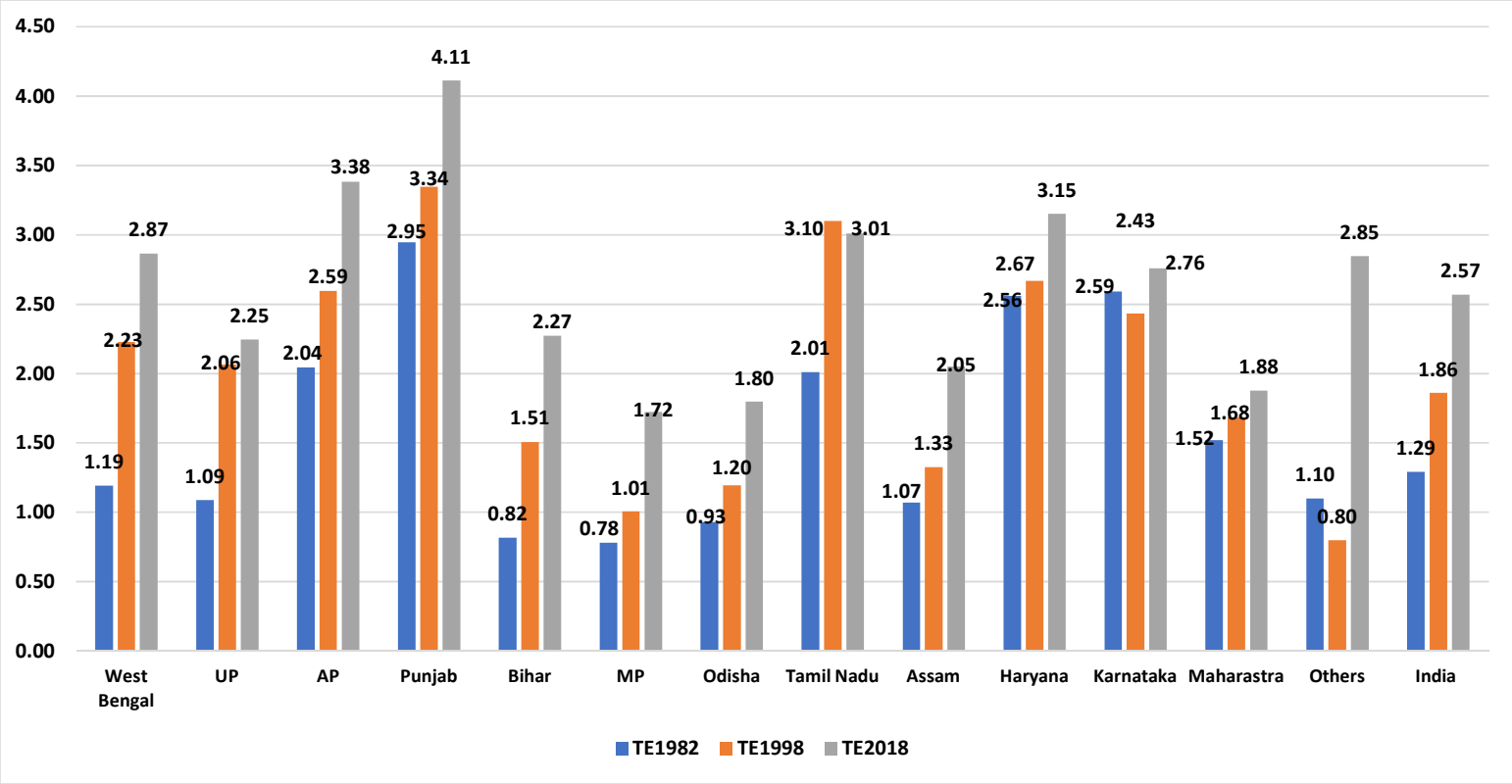

Fig. 2. Triennium ending for rice yield - major rice producing states in India

Table 1. Triennium Ending (TE) in area, production and yield of rice at major producing states in India

State	Area ('000' ha)				Production ('000' tones)			
	TE 1982(P1)	TE 1998(P2)	TE 2018(P3)	% Share	TE 1982(P1)	TE 1998(P2)	TE 2018(P3)	% Share
West Bengal	5083	5868	5379	12.23	6081	13063	15408	13.63
Uttar Pradesh	5170	5725	6148	13.98	5620	11806	13815	12.22
Andhra Pradesh	3697	3975	3704	8.42	7556	10358	12563	11.11
Punjab	1256	2318	2979	6.77	3708	7739	12264	10.85
Bihar	5152	3594	4972	11.31	4259	5419	11312	10.01
Madhya Pradesh	4796	5302	5918	13.46	3755	5328	10222	9.04
Odisha	3970	4470	3854	8.76	3715	5344	6917	6.12
Tamil Nadu	2186	2236	1757	4.00	4436	6947	5508	4.87
Assam	2262	2502	2462	5.60	2425	3322	5046	4.46
Haryana	489	943	1387	3.15	1251	2484	4374	3.87
Karnataka	1141	1380	1046	2.38	2951	3360	2881	2.55
Maharashtra	1478	1487	1496	3.40	2245	2502	2811	2.49
Others	3027	3437	2875	6.54	3329	2743	9908	8.77
India	**39707**	**43239**	**43980**	100.00	**51332**	**80416**	**113029**	**100**

Source: Directorate of economics and statistics 2018-19

Table 2. Growth (%) in area ('000 Ha), production ('000 Tones) and yield (tones/ha) of rice at major states and at all–India level; 1980-81 to 2018-19

States	Period 1 (1980-81 to 1994-95)			Period 2 (1995-96 to 2009-10)			Period 3 (2010-11 to 2018-19)			Overall (1980-81 to 2018-19)		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
West Bengal	1.11***	5.24***	4.09***	-0.22 NS	1.15***	1.37***	0.46 NS	1.72**	1.26***	0.07 NS	2.22***	2.14***
Uttar Pradesh	0.45 **	4.74***	4.27***	0.21 **	0.02 NS	-0.19 NS	0.03*	1.07 *	1.1 NS	0.47***	2.28***	1.80***
Andhra Pradesh	0.09 NS	1.94***	1.85***	-0.33 NS	1.47 NS	1.82***	-1.25 NS	0.78 NS	2.06**	0.18**	1.61***	1.43***
Punjab	4.22***	5.20***	0.94**	1.34***	3.09***	1.72***	1.17***	2.49***	1.30**	2.14***	3.09***	0.92***
Bihar	-1.23**	1.22 NS	2.47**	2.71**	1.51 NS	-1.15 NS	2.52*	6.82 NS	4.2 NS	-0.28 NS	2.03***	2.31***
Madhya Pradesh	0.70***	3.32***	2.59***	-0.09 NS	1.48 *	1.57 NS	1.43***	3.57**	2.11*	0.54***	2.44***	1.89***
Odisha	0.79***	3.87***	3.05***	-0.12 NS	3.18**	3.30**	-1.14**	1.45*	2.62**	-0.13 **	1.55***	1.69***
Tamil Nadu	-0.49 *	3.02***	3.54***	-1.58*	-2.45 NS	0.89 *	-0.75 **	-1.41 NS	-0.68 NS	-0.72***	0.04**	0.76***
Assam	0.89***	2.93***	2.02***	-0.62*	0.57 NS	1.20**	-0.60***	1.24*	1.85**	0.14**	2.06***	1.92***
Haryana	3.64***	3.90***	0.25 NS	1.69***	3.24***	1.53**	2.34***	3.17***	0.81 *	2.96***	3.69***	0.70***
Karnataka	1.23***	1.18 NS	-0.05 NS	0.39 ***	0.87 **	0.48 *	-4.70***	-3.74**	0.99 NS	0.30**	1.11***	0.80***
Maharashtra	0.30 NS	0.83 *	0.53 NS	0.15 **	0.04 ***	-0.11**	-0.71*	0.85 NS	1.57 NS	0.03 **	0.88***	0.85***
India	0.52***	3.50***	2.96***	-0.07 NS	1.18***	1.24***	0.24 NS	1.57***	1.33***	0.24***	1.95***	1.70***

*Note: Figures within the parentheses indicate standard error in respective values ***, ** and * denote significance at 1 per cent, 5 per cent, and 10 per cent levels, respectively*

In yield West Bengal leads with 4.09%, 1.37% and 1.26% with per cent level of significance in P1, P2 and P3 respectively. Followed by Andhra Pradesh with 1.85%, 1.82% with 1 per cent level of significance in P1and P2 respectively and 2.06% with 5 per cent level of significance in P3.

India shows growth rate in area 0.52% with 1 per cent level of significance in P1, while in Production 3.5%, 1.18% and 1.57% and Productivity 2.16%, 1.24% and 1.33% shows positive growth rate with 1 per cent level of significance in P1, P2 and P3 respectively.

While considering overall period in area Haryana (2.96%) and Punjab (2.14%) shows highest positive growth rate with 1 per cent level of significance. While Tamil Nadu (0.72%) and Odisha (0.13%) shows negative growth rate with 1 and 5 per cent level of significance respectively. Production shows positive growth rate in all major rice producing states in which Haryana (3.69%) and Punjab (3.09%) with 1 per cent level of significance. Productivity shows positive growth rate in all major rice producing states in which West Bengal (2.14%) and Bihar (2.31%) shows highest growth rate with 1 per cent level of significance.

All over India shows positive growth rate like area (0.24%), production (1.95%) and productivity (1.70%) with 1 per cent level of significance. Nivetina Laitonjam [11].

4.3 Instability in Rice Production

India being largest producer of rice, in over the period there was a fluctuation in the area, production and yield of rice, so the instability indices were employed for the rice area, production and productivity and the result were given in the Table 3. Based on the instability indices, comparing the instability percent of area for states in P1 and P3shows more stability when compared to P1 like Haryana (10.6, 2.52), Punjab (4.02, 1.56), Uttar Pradesh (4.6, 1.7) and Odisha (4.34, 2.56) respectively. While Tamil Nadu, Karnataka and Andhra Pradesh shown more instability over the period.

In production aspect, the instability per cent of major rice producing states was continuously decreasing which implies that the stability was improved over the period like West Bengal (8.71, 4.42 ,4.07) , Punjab (8.15, 2.93, 4.10) and Haryana (13.94, 5.78, 2.26) expect Tamil Nadu (12.67 , 21.03, 28.78) and Odisha (13.64, 16.58, 12.64) for P1, P2,P3 respectively. Considering the yield aspect, the instability percent was decreased in all the periods which means it is more stable for states like West Bengal (8.33, 2.87, 1.65), Punjab (5.64, 2.96, 2.97) and Karnataka (15.39, 7.31, 5.53) for P1, P2, P3 respectively except Tamil Nadu and Bihar whose stability decreased over the period.

In India, the instability index percent for area (2.48, 2.89, and 1.06), production (5.85, 6.36, and 2.46) and yield (3.98, 4.15, 2.29) shows improvement in P3 when compared to P1 with a slight increase in instability in P2.

In overall period, in area the states like Madhya Pradesh, Maharashtra, Assam, Uttar Pradesh and Punjab shows high stability whereas Karnataka, Bihar, Andhra Pradesh and Tamil Nadu shoes low stability. In production and yield states like West Bengal, Punjab and Haryana shows high stability whereas Tamil Nadu, Madhya Pradesh and Bihar shows low stability.

For India, in overall period it is more stable as area (2.89), production (6.07) and yield (4.5) give low instability percent.

4.4 Triennium Ending (TE) for Major Basmati Rice Producing States in India

Triennium Ending (TE) for major Basmati rice producing states in India was given in Table 4. In India, the major state producing Basmati rice are Haryana (44%), Punjab (38%), Uttar Pradesh (14%) and Jammu and Kashmir (2.3%) shown in Fig 3. These states account around 99% of the total production in India. As the data availability of Basmati rice is only from 1995 to 2018 the total period of TE is taken as TE 1998 and TE 2018. In Area, among the two TE period it shows an increasing area coverage under the Basmati rice in which Punjab leads with an increase around 400 thousand ha followed by Haryana 260 thousand ha and UP150 thousand ha. In India the area is doubled over the period (834 thousand ha).

While in production, in all the states the production is increased almost 7 times when compared to first TE1998 like Punjab (317.7, 2147.7), Haryana (647.5, 2490) and UP (156, 809.4) for the TE1998 and TE 2018 respectively. In India the production (1224, 5608.6) for the TE1998 and TE 2018 respectively has increased over 4 times when compared to TE 1998.

Table 3. Cuddy-Della Valle-Instability index (%) for rice in major states and all–India level; 1980-81 to 2018-19

States	Period 1 (1980-81 to 1994-95)			Period 2 (1995-96 to 2009-10)			Period 3 (2010-11 to 2018-19)			Overall (2010-11 to 2018-19)		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
West Bengal	2.469	8.710	8.336	2.927	4.426	2.877	3.614	4.079	1.657	5.443	9.738	5.984
Uttar Pradesh	4.639	9.519	6.091	5.819	9.808	6.227	1.718	8.006	7.795	4.680	11.144	9.445
`Andhra Pradesh	7.771	11.067	5.517	13.514	16.081	5.206	10.334	11.381	4.925	10.837	13.152	5.705
Punjab	4.020	8.159	5.646	3.698	2.993	2.964	1.567	4.010	2.978	5.492	5.619	4.597
Bihar	8.544	19.127	15.072	14.726	20.914	15.237	7.517	20.649	15.614	13.566	23.151	18.324
Madhya Pradesh	1.804	11.120	10.390	2.575	20.202	19.589	2.463	9.983	7.807	3.010	20.061	17.863
Odisha	4.349	13.643	11.278	1.583	16.588	15.842	2.561	12.643	11.427	5.579	15.904	14.964
Tamil Nadu	10.558	12.677	10.137	10.053	21.307	14.571	10.446	28.785	21.825	10.437	22.625	17.258
Assam	2.241	7.451	6.698	4.209	10.169	6.265	0.954	4.326	4.634	4.209	10.020	8.529
Haryana	10.595	13.944	7.091	7.254	5.780	9.003	2.528	2.265	4.229	7.261	7.884	7.555
Karnataka	5.344	18.357	15.397	9.092	13.429	7.315	6.703	9.609	5.535	11.640	16.506	10.705
Maharashtra	3.133	11.968	11.477	1.596	13.458	12.808	2.601	7.432	6.406	2.813	11.890	11.428
India	2.480	5.850	3.980	2.890	6.360	4.150	1.060	2.460	2.290	2.890	6.070	4.500

Table 4. Triennium Ending (TE) in Area, Production and Yield of Basmati rice at major producing states in India

States	Area		Production		Yield	
	('000' ha)		('000' tones)		(tones)	
	TE 1998	TE2018	TE 1998	TE2018	TE 1998	TE2018
Haryana	406	668.7	647.5	2490	1.62	3.71
Punjab	152.3	552.7	317.7	2147.7	2.09	3.89
UP	123	272.7	156	809.4	1.27	2.97
Others	48.6	69.5	102.8	161.5	2.12	2.32
India	729.9	1563.4	1224	5608.6	1.69	3.58

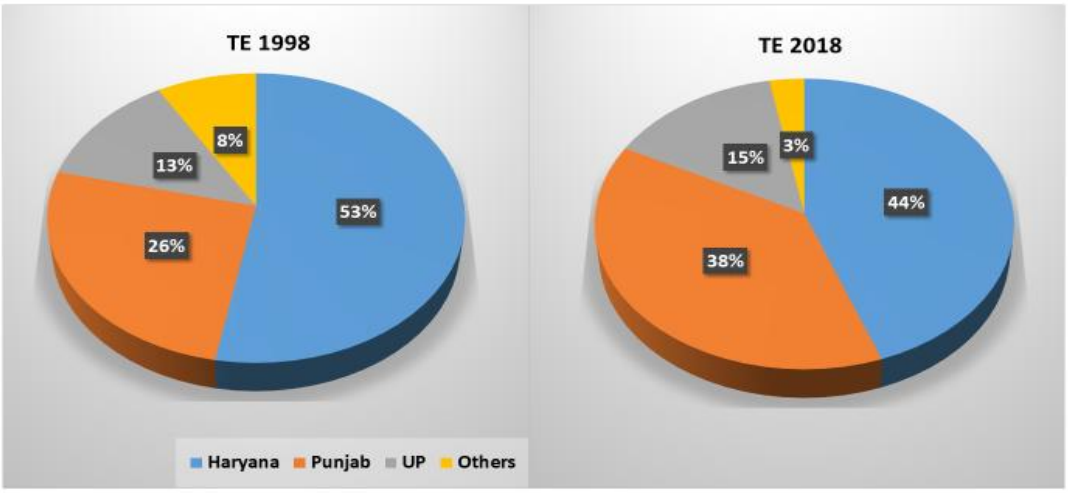

Fig. 3. Percentage Share of basmati rice production in India

In yield, for all the states it is almost doubled like Punjab (2.09, 3.89), Haryana (1.62, 3.71) and UP (1.27, 2.97) for the TE1998 and TE 2018 respectively. In India, yield is doubled (1.69, 3.58) for the TE1998 and TE 2018 respectively.

4.5 Triennium Ending (TE) for Non-Basmati Rice Producing States in India

Triennium Ending (TE) for non-Basmati rice producing states in India was given in Table 5. As the basmati rice is majorly produced in 3 states and rest of the states are producing only non-Basmati rice so the total rice and non-basmati rice are same for the remaining states. As we have already discussed about total rice production of various major states, to avoid overlapping here the 3 states which produce rice in which non- basmati rice is discussed.

When compared between two TE in area there is a gradual increase in Haryana (537, 718), Punjab (2166, 2426) and UP (5602, 5875) for TE 1998 and TE2018 respectively. In India, land area covered has been decreased as the area under the basmati increased. While in production, in all the states the production is increased when compared to first TE1998 like Punjab (7421, 10116) for the TE1998 and TE 2018 respectively followed by Haryana and UP. In India the Production (79191, 107420) for the TE1998 and TE 2018 respectively has increased when compared to TE 1998. In yield, for all the states it is almost doubled like Punjab (3.43, 4.17) for the TE1998 and TE 2018 respectively followed by Haryana and UP. In India, yield is increased when compared to TE1998 like (1.86, 2.53) for the TE1998 and TE 2018 respectively.

4.6 Growth Analysis of Basmati Rice and Non-basmati Rice

The Production performance of rice in terms of basmati rice and non-basmati rice for Area, production and productivity were analyzed by computing compound growth rate, in order to measure sustainability of production in future. The exponential function was employed to arrive at the growth rates Area, production and productivity of basmati rice and non-basmati rice during period I (1995-96 to 2009-10), period II (2010-11 to 2017-18), and overall period (1995-96 to 2017-18).

The compound growth rates in Area, production and productivity of basmati and Non-basmati rice from India clearly indicated that there was a significant increase during period I, period II and overall period except area and production of II.

It could be seen from the Table 6 that during period I, the area and production of basmati rice export recorded a positive and significant compound growth rate of 6.67 and 15.86 respectively. In period II to negative growth rate for area and production yield. While considering overall period in basmati area (6.01%) production (10.55%) and yield (4.28%) shows positive growth rate with 1 per cent level of significance. While non-basmati area Period 1(0.38 %) and Overall (0.19%) shows Negative growth rate with

10 and 5 per cent level of significance respectively. In contrary, the Production and yield registered a positive growth rate for all the period. The higher positive growth rate was in period II production (1.97%) and yield (1.63%). The coefficients of Production and yield of non-basmati rice were statistically significant at 1 per cent level of probability.

4.7 Instability of Basmati and Non-Basmati Rice in India

The instability indices were employed for area, production and yield of basmati and Non – basmati rice and the result are presented in the table 7. It could be seen from the table that the stability of area for basmati has been increased from 36.29 to 12.36 in Period II. In overall period the instability index is high (27.13). While the stability of area for non-basmati has been increased from 3.25 to 1.03 in Period II. In overall period the area of non-basmati rice is highly stable (2.81).

It could be seen from the table that the stability of Production for basmati has been increased from 39.56 to 15.16 in Period II. In overall period the instability index for the production of basmati rice is high (33.45). While the stability of production for non-basmati has been increased from 7.08 to 3.04 in Period II. In overall period the production of non-basmati rice is stable (6.24).

It could be seen from the table that the stability of yield for basmati has been increased from 10.39 to 3.46 in Period II. In overall period the instability index for the yield of basmati rice is high (15.59). While the stability of yield for non-basmati has been increased from 4.46 to 2.68 in Period II. In overall period the yield of non-basmati rice is stable (4.26).

4.8 Categorization Based on State Performance in Each Year

In this study, the production performance of the 12 states were analyzed using a 39-year area, production, and yield information. The sates were categorized into Low, Medium, and High performance based on area and production share to total area and production of the country. However, the sate Productivity performance is grouped in comparison with county average productivity.

Table 5. Triennium Ending (TE) in area, production and yield of Non-Basmati rice producing states in India

States	Area ('000' ha)		Production ('000' tones)		Yield (tones)	
	TE 1998	TE2018	TE 1998	TE2018	TE 1998	TE2018
Haryana	537	718	1837	1884	3.42	2.62
Punjab	2166	2426	7421	10116	3.43	4.17
UP	5602	5875	11650	13006	2.08	2.21
Others	34202	33394	58283	82415	1.70	2.47
India	42507	42413	79191	107420	1.86	2.53

Source: Directorate of economics and statistics 2018-19

Table 6. Compound growth rates of Area, production and Yield of Basmati rice & non -basmati rice (percentage)

Periods	Basmati rice			Non -Basmati rice		
	Area	Production	Yield	Area	Production	Yield
I (1995-96 to 2009-10)	6.67**	15.86***	8.62***	-0.38*	0.52*	0.91**
	(2.79)	(2.40)	(0.93)	(0.27)	(0.60)	(0.38)
II (2010-11 to 2018-19)	-1.08*	-1.41**	2.38***	0.33**	1.97***	1.63***
	(2.12)	(2.61)	(0.63)	(0.18)	(0.55)	(0.48)
Overall	6.01***	10.55***	4.28***	-0.19**	1.23***	1.43***
(1995-96 to 2018-19)	(1.15)	(1.34)	(0.70)	(0.11)	(0.25)	(0.17)

*Note: Figures within the parentheses indicate standard error in respective values ***, ** and * denote significance at 1 per cent, 5 per cent, and 10 per cent levels, respectively.*

Table 7. Instability (%) in area ('000 Ha), production ('000 tones) and yield (tones/ha) of Basmati and Non-Basmati rice in India; 1995-96 to 2018-19

Particulars	Mean		Instability index	
	Basmati rice	Non-Basmati rice	Basmati rice	Non-Basmati rice
Area				
I (1995-96 to 2009-10)	1005	42653	36.29	3.25
II (2010-11 to 2017-18)	1773	41871	12.36	1.03
Overall (1995-96 to 2018-19)	1297	42355	27.13	2.81
Production				
I (1995-96 to 2009-10)	3016	85461	39.56	7.08
II (2010-11 to 2017-18)	6775	98932	15.16	3.04
Overall (1995-96 to 2018-19)	4448	90593	33.45	6.24
Productivity				
I (1995-96 to 2009-10)	2.81	2.01	10.39	4.46
II (2010-11 to 2017-18)	3.80	2.37	3.46	2.68
Overall (1995-96 to 2018-19)	3.19	2.14	15.59	4.26

Table 8. Categorization table

Category	Area (share to total rice area in India)	Production (share to total rice production in India)	Yield
Low	0 to 5%	0 to 5%	Sate yield in the t^{th} year 0.75 times lesser than National Average yield
Medium	5 to 10%	5 to 10%	Sate yield in the t^{th} year 0.75 times of national average to 1.5 times of national Average yield
High	More than 10 %	More than 10 %	Sate yield in the t^{th} year 1.5 times Higher than National Average yield

It could be seen from the table that in Andhra Pradesh, area and yield resulted in medium category as 31 and 38 years are contributing around 5 to 10 % of Indian share, which resulted in high production as 39 years gives more than 10% of the share. While for UP and West Bengal, area is in high category as 39 years are contributing more than 10 % of Indian share and yieldin medium category as 37 years are contributing around 5 to 10 % of Indian share, which resulted in high yield as 39 years gives more than 10% of the share given in appendix.

In Bihar, MP and Odisha, the area is in high category as 32 years, 39 year and 30 year gives more than 10% of the Indian share respectively but production vested in medium category as 31 years, 37 year and 38 year gives around 5 to 10% of the Indian share respectively which resulted in low yield shown in Fig.4. In Haryana, Karnataka and Maharashtra production is in low category as 39 years, 36 year and 39 year gives less than 5% of the Indian share respectively as the area is in low category as 39 years, 39 year and 39 year gives less than 5% of the Indian share respectively. In Tamil Nadu, both area and yield fluctuate between low and medium and medium and high respectively, but the production is at medium category is shown in Fig 5. While in Punjab the area is in low and medium category and production is in medium and high category this is because the yield is in high category for all 39 years. Andhra Pradesh and Assam area contributed in moderate category 31 and 39 years respectively whereas yield is in moderate and low category shown in Fig. 6.

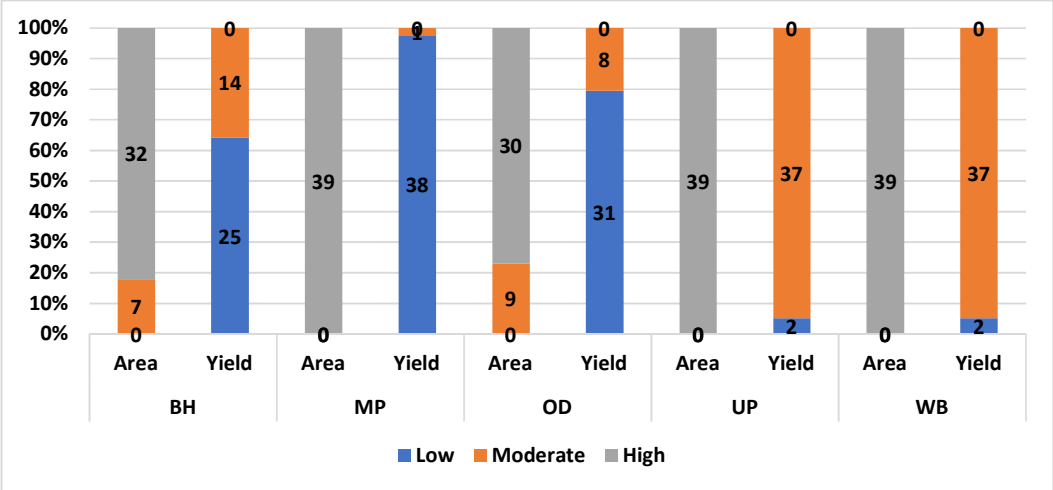

Fig. 4. State wise categorization based on high area contribution

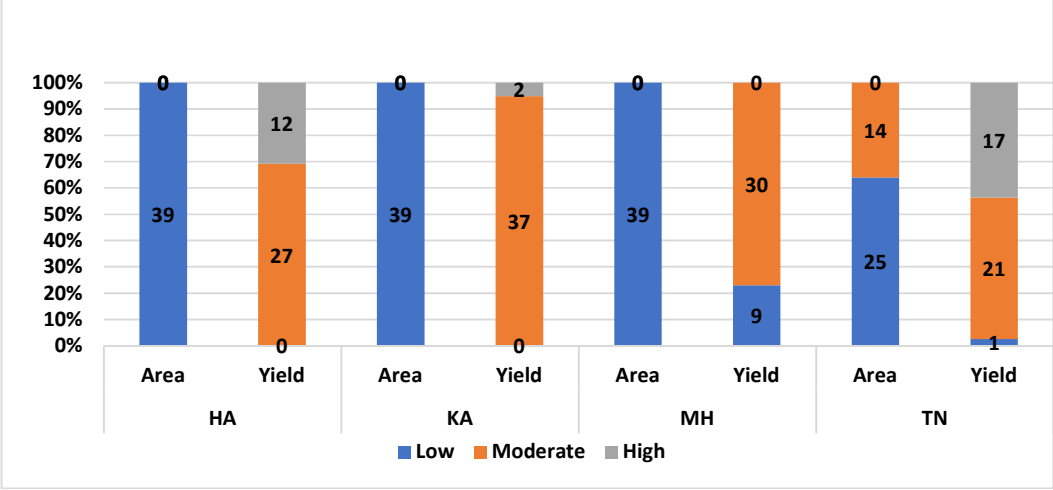

Fig. 5. State wise categorization based on moderate Area contribution

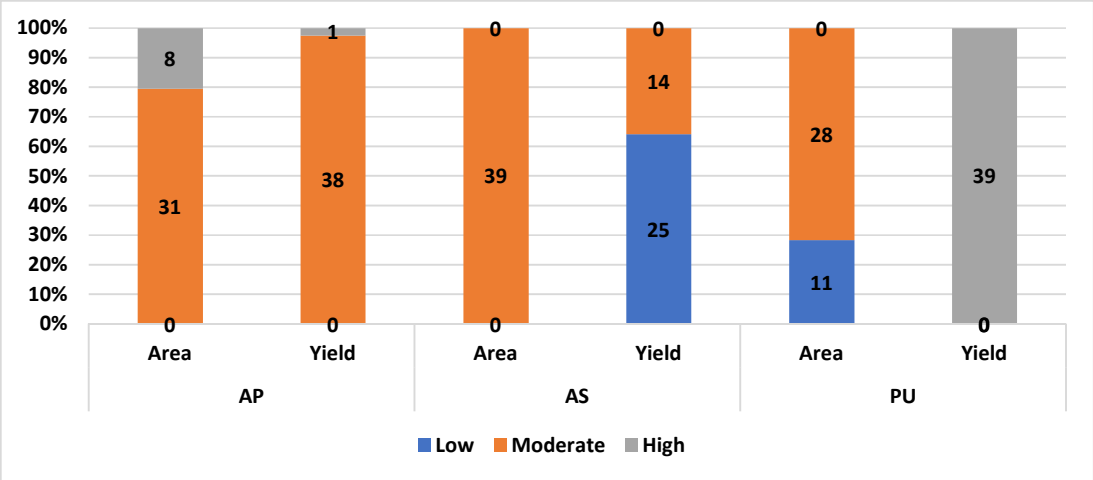

Fig. 6. State wise categorization based on Low Area contribution

5. CONCLUSION

Rice may be a lifeline for India's food and nutritional security, and source of the agricultural livelihood for half billion people. With the introduction of revolution led high yielding varieties including input uses and government's policy support, rice production has increased by 250% and yield by 230% between 1971 and 2018. The irrigated regions of north and south Indian performed better in rice sector during the 1970 and 80s while the rainfed areas in eastern, north-eastern and central Indian states have picked up to extend rice yields after mid-1980s. As a result, about 10 to 12 million tonnes of exportable surplus-both Basmati (4 million tons) and non-basmati (8.5 million tons) rice- was generated after meeting domestic consumption requirements. India became leading rice exporter within the world today worth folks $ 9 Billion- and increase in export of three folds in 2018 over 2005. Basmati rice by four time and non- basmati rice by 3 folds in 2018 over 2005 [12].

While considering overall period in area and Production Haryana and Punjab shows highest positive growth rate with 1 per cent level of significance. While Tamil Nadu and Odisha shows Negative growth rate. Productivity shows positive growth rate in all major rice producing states in which West Bengal and Bihar shows highest growth rate with 1 per cent level of significance. Allover India shows positive growth rate like area (0.24%), production (1.95%) and Productivity (1.70%) with 1 per cent level of significance. In production and yield states like West Bengal, Punjab and Haryana shows high stability whereas Tamil Nadu, Madhya Pradesh and Bihar shows low stability. For India, in overall period it is more stable as Area (2.89), Production (6.07) and yield (4.5) give low instability percent.

While considering overall period in basmati area (6.01%) production (10.55%) and yield (4.28%) shows positive growth rate with 1 per cent level of significance. The higher positive growth rate was in period II production (1.97%) and yield (1.63%). The coefficients of Production and yield of non-basmati rice were statistically significant at 1 per cent level of probability. It could be seen from the table that the stability of yield for basmati has been increased from 10.39 to 3.46 in Period II. In overall period the instability index for the yield of basmati rice is high (15.59). While the stability of yield for non-basmati has been increased from 4.46 to 2.68 in Period II. In overall period the yield of non-basmati rice is stable (4.26).

Bihar, Uttar Pradesh, Madhya Pradesh, Odisha and West Bengal are states contributing major area in rice cultivation of India. However, sates expect West Bengal and Uttar Pradesh, all others are in low productivity category in most of the year, which indicates that an improvement in productivity of these states from low productivity to high productivity categories which in turn increase the production of the country. Hence yield enhancing technology has to be concentered on these sates to enhance the productivity to increase the production of the country. Haryana, Karnataka, Maharashtra and Tamil Nadu (25 years) are the major sates

having lesser area in the rice cultivation. However, Haryana and Karnataka has the productivity of medium category whereas in the states of Maharashtra and Tamil Nadu is also under the medium category as further increasing in area cannot be achieved these by sates. This is also due to the dominance of diversified cropping system; hence, they have options to further increase the productivity towards high productivity category. Hence the policy has to be framed to enhance the productivity of these four states. Punjab is a top producer as in two third of the period (21/39 stands first in the production and productivity) further it has been maintaining the productivity to their contribution. Whereas Assam stands medium contribution in terms of area however the production is in low category because of low productivity. Special attention program is need to enhance the production of rice in Assam and Orissa were two states are in lowest category in terms of productivity, so effects may be taken to increase the productivity in Assam and further increase from medium to high productivity states in case of Andhra Pradesh.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Table 1. State wise categorization based on share of area, production and yield in each year

States	Area			Production			Yield		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Andhra Pradesh	0	31	8	0	0	39	0	38	1
Assam	0	39	0	32	7	0	25	14	0
Bihar	0	7	32	1	31	7	25	14	0
Haryana	39	0	0	39	0	0	0	27	12
Karnataka	39	0	0	36	3	0	0	37	2
Madhya Pradesh	0	0	39	1	37	1	38	1	0
Maharashtra	39	0	0	39	0	0	9	30	0
Odisha	0	9	30	1	38	0	31	8	0
Punjab	11	28	0	0	18	21	0	0	39
Tamil Nadu	25	14	0	3	34	2	1	21	17
Uttar Pradesh	0	0	39	0	0	39	2	37	0
West Bengal	0	0	39	0	0	39	2	37	0

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