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RICE PRODUCTION IN INDIA : DECOMPOSITION AND TREND ANALYSIS

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Abstract

The present study assess the contribution of area, yield and their interaction to growth in production of rice as well as the compound annual growth rate in area, production and yield of rice in India. Time series data on area, production and yield of rice for the period 1980-2014 were collected from different secondary sources like Agricultural Statistics at a Glance, FAO Statistical Yearbook. Decomposition model proposed by Sharma (1977) was used to examine the contribution of area, average yield and their interaction towards rice production. The compound annual growth rates of area, production and yield were worked out using the formula recommended by Dandekar (1980). The study revealed that over the year from 1980-2014, yield effect has the highest contribution to the change in the production of rice in India. In India both production and yield of rice increased at the compound annual growth rate of nearly 5 per cent and 4 percent per annum, respectively. However, a marginal increase of 0.48 per cent per annum was recorded in case of area under the crop over the time period of 34 years (1980-2014).

Key words : Decomposition, rice, area, yield, India.

Introduction

Rice is the primary staple food for more than half the world's population, with Asia representing the largest producing and consuming region. Global rice production was estimated to be 470.49 million metric tons in 2015-16, registering a decrease by about 1.72 per cent from the previous year. Of the total world production and area under rice, Asia accounted for 89.40 per cent and 87.40 per cent respectively in 2015. India (75 mha) ranked first in area under rice in 2015 followed by, China (30.21 mha), Bangladesh (11.77 mha), Indonesia (11.66 mha), Thailand (9.44 mha). Regarding the production of rice in the world, India (103.00 mt) ranked second, after China (145.77 mt), followed by Indonesia (35.30 mt), Bangladesh (34.50 mt), Vietnam (28.10 mt). Although, India ranked first in the world in area under rice and second in production, its productivity is very low. The yield of rice in India is 3.61 t/ha in 2015 (USDA, 2016).

In area under rice in India, during the period 2013-14, Uttar Pradesh ranked first, followed by, West Bengal and Andhra Pradesh. In production of rice, West Bengal ranked first, followed by Uttar Pradesh and Andhra Pradesh. The yield of rice is highest in Punjab, followed by Haryana and Tamil Nadu (GoI, 2014).

The productivity of rice in India increased from an average of 1.5 t/ha in the 1980's to 2.42 t/ha in 2014 (USDA, 2016). But according to the CRRI 2011, India needs to produce 120 million tonnes by 2030 to feed its one and a half billion plus population by then for which, it needs to increase the productivity to about 3 t/ha. According to FAO estimates, India's rice productivity in 2010 was higher than Thailand and Cambodia among the top ten producing countries and was much lower than the world average. The main reason for low productivity of rice in India is that rice is grown in the country under various production ecologies mainly grouped as irrigated and rainfed systems. Productivity in these systems vary widely, while former is considered more favourable. Based on available figures, the states of Andhra Pradesh, Karnataka, Tamil Nadu, Punjab and Haryana have predominantly irrigated rice and average productivity of

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these states for 2009-10 is 3.136 t/ha (Rani *et al*., 2010). Likewise states of Uttar Pradesh, Bihar, West Bengal, Orissa and Assam represent predominantly rainfed system and have registered an average productivity of 1.658 t/ ha in 2010.

Apart from being used as a source of food, the by-products of rice milling are used for a variety of purposes, rice bran being the most valuable by-products. The de-oiled bran, which is a rich source of protein (about 17%) and vitamins (vitamins A and E), is used as cattle feed and poultry feed. Rice hulls can be used in manufacture of insulation materials, cement and cardboard. Rice straw is used as cattle feed and also as litter during winter season. Rice also contributes a significant share in the national economy through foreign exchange from its export. India exports both basmati and non-basmati rice, with basmati rice having high international demand. In 2009-10, rice export had a 1.33% share in the total national export and about 12.6% in the agricultural export by value, while it was 4.5% and 24.6% respectively in 1998-99. The decrease in the share of export is because of the food crisis in 2008 due to which India imposed a ban on the export of non-basmati rice.

Availability of modern biotechnological tools, trained manpower and the requisite infrastructural facilities for the rice breeders is a great opportunity to enhance the breeding efficiency and thereby the rice production in the country. The national hybrid rice network coordinated by Directorate of Rice Research (DRR) helped in release of over 46 hybrids both from public sector and private sector. Area under hybrids is now about 1.25 million ha and with a minimum of 1 tonne yield advantage, hybrids alone are contributing to production of an additional 1 million tonnes per year. With this backdrop, the present study is to assess the contribution of area, yield and their interaction to growth in production of rice and to work out the compound annual growth rate in area, production and yield of rice.

Methodology

The time series data on area under rice, production and yield of rice were collected from various issues of Agricultural statistics at a glance, FAO Statistical yearbook and other secondary sources of data. The data pertained to the period 1980-2014 *i.e.,* 34 years. Biennial averages were used in order to minimise the fluctuations.

The sources of production growth was examined by using the decomposition model proposed by Sharma (1977) and relative contribution of area, productivity and their interaction effect to the total output change in rice was worked out as follows:

$$P_n - P_0 = (Y_n - Y_0)A_0 + (A_n - A_0)Y_0 + (Y_n - Y_0)(A_n - A_0)$$

$$\Delta P = (\Delta Y)A_0 \quad + \quad (\Delta A)Y_0 \quad + \quad (\Delta Y)\,(\Delta A)$$

Yield effect Area effect Interaction effect

Where, P_n, Y_n and A_n are the production, yield and area under rice in the current periods respectively and P_0, Y_0 and A_0 are the productivity, yield and area under rice in the base periods, respectively.

However, this method has a flaw in that it only considers the discrete data and does not take all the years into consideration. So, another method for decomposition analysis suggested by Palanisami, Paramisivam and Ranganathan (2002) was tried:

$$P_t - P_0 = A_0(Y_t - Y_0) + Y_0(A_t - A_0) + (A_t - A_0)(Y_t - Y_0)$$

$$\Delta P \;=\; A_0 \Delta Y_t \;+\; Y_0 \Delta A_t \;+\; \Delta A \,\Delta Y$$

Yield effect Area effect Interaction effect

Where, P, A and Y represents production, area and yield. '0' and 't' represents time periods such that 't'> '0' by an accounting period, which is usually a single year. The result obtained from this method is more reliable as the analysis is done for the continuous data.

The average annual compound growth rates of area, production and yield were worked out using the formula recommended by Dandekar (1980). The estimation of compound growth rate seems to be more appreciable to analyse the movement of agricultural output rather than linear rate of growth (Dandekar, 1980). The following exponential formula was used:

$$Y = ab_t$$

$$Log\ Y = \log a + \log b$$

$$CGR = (b - 1)100$$

Where, Y is the dependent variable (area, productivity, production) and 't' is the time period in years.

Results and Discussion

Decomposition analysis

The source of production growth was partitioned to area, yield and interaction effects, examined individually for two sub-periods (sub-period I and sub-period II) and the overall study period (1980-2014). The results as shown in table 1 revealed that out of the total production in rice production in 1980-2014, the area effect, yield effect and interaction effect were 7.15 per cent, 86.79 per cent and 6.05 per cent, respectively. Thus, it was established that increase in production was led due to breakthrough in productivity.

Table 1 : Decomposition of growth in rice production (1980-2014).

State/ period	Percent contribution		
	Area	Yield	Inter-action
Andhra Pradesh			
1980-82 to 1994-96 (Sub-period I)	-1.64	102.10	-0.46
1996-98 to 2012-14 (Sub-period II)	-53.71	143.26	10.45
1980-82 to 2012-14 (Over all)	65.42	32.37	2.20
Assam			
1980-82 to 1994-96 (Sub-period I)	23.83	70.20	5.97
1996-98 to 2012-14 (Sub-period II)	-1234.23	1361.83	-27.60
1980-82 to 2012-14 (Over all)	17.56	77.55	4.89
Bihar			
1980-82 to 1994-96 (Sub-period I)	-43.37	159.98	-16.61
1996-98 to 2012-14 (Sub-period II)	118.98	-28.85	9.87
1980-82 to 2012-14 (Over all)	350.77	-425.36	174.59
Haryana			
1980-82 to 1994-96 (Sub-period I)	94.50	3.28	2.22
1996-98 to 2012-14 (Sub-period II)	201.35	-67.10	-34.24
1980-82 to 2012-14 (Over all)	133.15	-13.10	-20.05
Karnataka			
1980-82 to 1994-96 (Sub-period I)	38.02	53.97	8.01
1996-98 to 2012-14 (Sub-period II)	-2.01	101.49	0.52
1980-82 to 2012-14 (Over all)	458.77	-310.81	-47.96
Orissa			
1980-82 to 1994-96 (Sub-period I)	13.63	80.52	5.84
1996-98 to 2012-14 (Sub-period II)	40.29	65.72	-6.01
1980-82 to 2012-14 (Over all)	-13.84	116.82	-2.98
Punjab			
1980-82 to 1994-96 (Sub-period I)	72.54	14.83	12.63
1996-98 to 2012-14 (Sub-period II)	1178.08	-847.34	-230.75
1980-82 to 2012-14 (Over all)	110.76	-4.57	-6.19
Tamil Nadu			
1980-82 to 1994-96 (Sub-period I)	-16.10	125.51	-9.42
1996-98 to 2012-14 (Sub-period II)	46.14	72.38	-18.52
1980-82 to 2012-14 (Over all)	89.87	14.71	-4.59
Uttar Pradesh			
1980-82 to 1994-96 (Sub-period I)	5.96	90.08	4.23
1996-98 to 2012-14 (Sub-period II)	-86.04	175.74	10.30
1980-82 to 2012-14 (Over all)	15.45	76.29	8.26
West Bengal			
1980-82 to 1994-96 (Sub-period I)	16.39	74.43	9.18
1996-98 to 2012-14 (Sub-period II)	37.56	66.67	-4.23
1980-82 to 2012-14 (Over all)	11.40	84.22	4.38
All India			
1980-82 to 1994-96 (Sub-period I)	12.34	82.58	5.08
1996-98 to 2012-14 (Sub-period II)	2.43	96.83	0.75
1980-82 to 2012-14 (Over all)	7.15	86.79	6.05

Table 2 : Decomposition of change in rice production in major states (1980-2014).

State	Per cent contribution		
	Yield	Area	Interaction
Andhra Pradesh	47.78	46.96	5.25
Assam	-13.49	100.80	12.69
Bihar	34.12	79.86	-13.98
Haryana	105.49	9.59	-15.08
Karnataka	26.83	53.67	19.49
Orissa	-3.64	89.20	14.44
Punjab	97.94	11.84	-9.77
Tamil Nadu	-129.63	198.27	31.35
Uttar Pradesh	11.22	84.96	3.82
West Bengal	14.70	82.12	3.18
All India	3.43	92.43	4.15

It was observed that the highest contribution of yield in the total production growth was recorded during sub-period II (96.83%). Overall, the contribution of area, yield and interaction effect to the production growth of the country was found to have a positive impact during all the three periods. The reason may be due to the concerted effort by the rice farmers to increase the production of this crop owing to the increasing demand.

The analysis across the states showed that during sub-period I, the yield effect contributing to the increase in rice production is highest in Bihar (159.98%), but during sub-period II, the contribution was highest in Assam (1361.83 %). The contribution of area effect was highest in Haryana (94.59%) and Punjab (1178.08%) during sub-period I and sub-period II, respectively. During sub-period I, the interaction effect was highest I Punjab (12.63%) but it was highest in Andhra Pradesh (10.45%) in sub-period II.

Over all in India, during (1980-2014), the highest contribution of area, yield and interaction effect was highest in Karnataka (458.77%), Orissa (116.82%) and Bihar (174.59%), respectively.

The decomposition analysis based on continuous data done for the whole study period *i.e.*, 1980-2014 (table 2) revealed that, of the total increase in rice production in India yield effect was 92.43 per cent, area effect 3.43 per cent and interaction effect was 4.15 per cent. Analyses across the states revealed that Haryana (105.49%) had the highest yield effect, Tamil Nadu had the highest area effect (198.27%) interaction effect (31.35%).

Compound annual growth rates

The annual average Compound Growth Rate (CGR)

Table 3 : Average annual compound growth rates in area, production and yield of rice (1980- 2010).

State	(1980-81 to 1996-97) (Sub-period I)			(1997-98 to 2013-14) (Sub-period- II)			Overall (1980-81 to 2013-14)		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Andhra Pradesh	0.26	2.07	1.85	0.46	0.81	0.30	0.36	1.44	1.08
Assam	0.71	2.41	1.70	-0.31	1.04	1.20	0.20	1.73	1.45
Bihar	-0.40	-2.36	2.55	-2.50	-1.18	1.35	-1.45	-1.77	1.95
Haryana	3.53	4.06	0.51	1.66	2.50	0.83	2.60	3.28	0.67
Karnataka	1.20	2.80	1.58	0.09	-0.13	-0.21	0.65	1.34	0.69
Orissa	0.53	2.90	2.35	-0.50	2.12	2.61	0.02	2.51	2.48
Punjab	3.89	4.85	0.93	0.86	1.40	0.53	2.38	3.13	0.73
Tamil Nadu	-0.42	2.66	3.09	-1.83	-2.44	-0.62	-1.13	0.11	1.24
Uttar Pradesh	0.30	4.56	4.24	-0.05	0.16	0.11	0.13	2.36	2.18
West Bengal	1.05	5.03	3.94	-0.59	-0.10	0.49	0.23	2.47	2.22
All India	1.21	7.45	6.16	-0.26	3.50	3.78	0.48	5.48	4.97

of area, production and productivity of rice across major rice growing states are provided in table 3. Over the period 1980-2010, the growth rate in area was only 0.48 per cent per annum. Also, the growth rate in production and yield were 5.48 per cent and 4.97 per cent per annum, respectively. The annual growth rates of production and yield during the sub-period I were 7.45 per cent and 6.16 per cent, respectively. On the other hand, production grew at a lower rate of 3.50 per cent during the post-globalisation period because of lower yield growth rate (3.78%) and a negative growth rate in area (-0.26%).

The analysis across the states showed that Punjab, West Bengal and Uttar Pradesh had the highest growth rate in area (3.89% p.a), production (5.03% p.a.) and yield (4.24% p.a.) during sub-period I. During sub-period II and in overall (1980-81 to 2013-14), Haryana was registered the highest growth rate in area under rice and production of rice while, Orissa was registered the highest growth rate in yield of rice. However, negative growth rates in area under rice was observed in Bihar and Tamil Nadu, during the overall study period of 1980-2010.

Conclusion

The decomposition analysis indicated that yield effect has the highest percentage contribution to the growth in the production of rice. In India, over the period from 1980-2014, there was marginal increase in the growth rate of area under rice. Across states, Haryana was registered the highest growth rate in area under rice and production of rice while Orissa was registered the highest growth rate in the yield of rice. There was increasing trend in area under rice, production and yield of rice over the period from 1980-2014.

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