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A COMPARATIVE STUDY OF GROWTH AND INSTABILITY OF RICE PRODUCTION IN BALASORE AND MAYURBHANJ DISTRICTS OF ODISHA

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ABSTRACT

The objective of this paper is to compare and analyze the growth and instability of rice production and its related inputs of irrigated Balasore district with that of rainfed Mayurbhanj district. Therefore two-sample mean comparison test (t-test) is conducted to compare the means area under rice production, rice production, productivity of rice, percentage of area under rice to gross cropped area, rainfall, irrigation potential created, fertilizer consumption credit supply, cropping intensity, seed distribution and irrigated area under rice between Balasore and Mayurbhanj district. In order to measure the instability in rice production in these two districts, coefficient of variation, stationary of time series production data are analyzed. The instability in area, production and productivity of rice are extensively analyzed. Simple growth rate is also calculated to know the overall performance of rice production in these districts.

KEYWORDS: *Agriculture, Gross Cropped Area, Irrigation, Production, Rain-fed*

INTRODUCTION

Agriculture, as the largest private enterprise in India has been continued to be the lifeline of the Indian economy (Handbook of Agriculture, 2013). Since the inception of the first five year plan agriculture and rural development has been given the first priority. Rice is life, for most people living in Asia. Rice has shaped the cultures, diets and economies of thousands of millions of people. Considering its important position, the United Nations designated year 2004 as the International year of rice. Rice can play in providing food security and eradicating poverty . In India, it is cultivated in about 150 million hectares, producing 132,013,000 metric tons, which covers about 26 percent of the global rice production .But yet the rice farm productivity in India is less than half the rice farm productivity in China. India's total factor productivity growth remains less than 2 percent as against 6 percent per annum factor productivity growth of China, even though China has small holding farmers. Besides this although India has shown remarkable progress in recent years and has attendant self sufficiency in food staples the crop productivity of Indian farm is very less as compared to Brazil, The United States, France and other countries of the world. India is the second largest rice producer and consumer in the world.

LITERATURE REVIEW

Joshi D. and Singh H.P (2015) examined trend in growth and instability of major spices in India for the last 39 years from 1974-75 to 2012-13. The growth rates were worked out by fitting the exponential growth function and instability analysis was carried out by generating Cuddy Della instability index. The study has observed that almost all the spices have recorded a positive and significant growth rate in all the sub-periods. Variations in weather and price fluctuations were observed as the main factors affecting growth and instability in spices in India. Ankur Jain (2018) in his paper explained that agricultural growth with stability has been a matter of concern in India. This paper analyses 41 years data (1970-71 to 2011-12) on area, production and yield under paddy to understand the question of instability in rice production in India. The analysis shows that at all India level compound annual growth rate of area, production and yield of rice were positive but it had been declining gradually over the periods.

J. Siva Sankaramma and K. Satyanarayana Reddy (2015) highlighted that the agriculture sector is the largest sector of the nation's economy and offered employment above fifty percent of the total population, the demand for agricultural products is increasing day-to-day in India due to enormous

growth of population. Andhra Pradesh is not exempted from this. The growth of agricultural sector (area, production and yield) had not been uniform or steady. An increased in cropped area may not raise the output of the crop. To find out growth and instability simple linear regression model and co-efficient of variation used and tested by F-test statistics and to examine the supply response of crop hectareage Nerlovian partial adjustment adaptive expectation model was used.

Harshita Tewari, H.P. Singh and Usha Tripathi (2017) analyzed that the growth and instability in terms of area, production and productivity of wheat in Uttar Pradesh. The growth was examined by compound annual growth rate and contribution of area and productivity towards output growth by decomposition analysis. After instability analysis it was observed that there is high instability in production and productivity as compared to area under wheat. Further, the growth in wheat production is decomposed into three components viz. area effect, yield effect and interaction effect.

S P Samal, R N Patra, B B Nanda and M K Das (2017) aimed at analyzing the growth and instability of foodgrain production over a 20 years' time period from 1995-96 to 2014-15 across the districts. The 1st decadal period 1995-96 to 2004-05 was a gloomy period with total food grains experiencing nil growth. Paddy had only 0.5% growth while other cereals and pulses experienced negative growth. Rakesh Sihmar (2014) highlighted that agriculture reforms such as land reforms, green revolution, minimum support price, and new economic reforms have directly affected the agriculture sector in overall India. Even these reforms are favorable in terms of productivity and production of all the crops but they have inadequately affected in terms of crop stability. Only a few crops such as rice and wheat are going to more stable but the coarse cereals and pulses are going to highest instable in area and production in Haryana.

R. Ganesan (2018) said that in the agricultural economy of India, the share of rice and wheat is larger among the foodgrains. These two foodgrains cover about 80 percent of the food requirement and about 60 percent of the nutritional requirement of the country's population. Rice is cultivated in more than 40 agro-economic sub-regions covering an area of 44 million hectares. In terms of production of rice, India ranks second to China among rice producing countries of the world.

VARIATION IN AREA, PRODUCTION AND PRODUCTIVITY OF RICE

Both Balasore and Mayurbhanj are the major rice producing districts in the state of Odisha. Since the rice production in Kharif season mainly depends on rainfall, it is expected that there is year to year variation in rice production. The variations in area, production and productivity of rice in Balasore and Mayurbhanj district are presented in the table 1.

Table-1 : Total Rice Area, Production and Productivity of Balasore and Mayurbhanj District (Area : 000' hect., Yield : kg./hect., Production : 000' MT)

Year	Area		Production		Yield		% to Gross Cropped	
	Balasore	Mayurbhanj	Balasore	Mayurbhanj	Balasore	Mayurbhanj	Balasore	Mayurbhanj
2003-04	235.5	340.90	367.6	496.80	1561	1457.00	73.87	70.36
2004-05	240.4	325.10	424	489.70	1764	1507.00	73.79	67.41
2005-06	246.8	316.30	380.2	472.20	1541	1493.00	74.36	65.70
2006-07	251.28	317.47	364.15	501.43	1449	1579.00	74.32	64.94
2007-08	241.13	344.80	395.00	574.85	1638	1667.00	72.85	66.82
2008-09	245.54	345.19	351.58	542.59	1432	1572.00	73.74	66.51
2009-10	240.86	328.62	387.08	458.72	1607	1396.00	71.90	65.59
2010-11	239.61	284.63	443.75	265.38	1852	932.00	71.95	62.97
2011-12	235.50	299.21	506.03	563.67	2149	1884.00	69.47	62.47
2012-13	206.64	287.33	364.72	495.92	1765	1726.00	68.42	62.06
Mean	238.33	318.96	398.41	486.13	1675.80	1521.30		-
SD	12.16	22.48	47.39	86.41	215.79	251.37		-
CV	5.10	7.05	11.90	17.78	12.88	16.52		-
SROG	-12.25	-15.71	-0.78	-0.18	13.07	18.46		-

Source: Directorate of Agriculture and Food Production, Odisha, and Authors own calculation.

The average area under rice production of Balasore and Mayurbhanj district from 2003-04 to 2012-13 are 238.33 and 318.96 thousand hact. respectively. But the coefficient of variation and standard deviation of area under rice for Mayurbhanj is 7.05 and 22.48 respectively which are higher than that of Balasore 5.10 and 12.16 respectively. This implies that area under rice has greater instability in Mayurbhanj than Balasore district. The growth rate of area under rice in Balasore is -12.25, whereas it is -15.71 in Mayurbhanj. The growth rate refers that area under rice in both the district have continuously declining over the time period. The average rice production of Balasore and Mayurbhanj district from 2003-2012 are 398.41 and 486.13 thousand MT respectively. Coefficient of variation and standard deviations of rice production of Balasore is 11.90 and 47.39 which is less than the coefficient of variation and standard deviation of Mayurbhanj i.e. 17.78 and 86.41. In other words, there is greater instability in the rice production of Mayurbhanj than Balasore. The simple growth rate of rice production of Balasore is -0.78 but it is -0.18 for Mayurbhanj. Hence the growth rate of rice production in both districts has been declining but the growth rate is higher in Mayurbhanj than Balasore. The average rice productivity of Balasore and Mayurbhanj district from 2003-2012 is 1675.80 and 1521.30 kg/hectare respectively. Coefficient of variation and standard deviations of rice productivity of Balasore is 12.88 and 215.79 which is less

than the coefficient of variation and standard deviation of Mayurbhanj i.e. 16.52 and 251.37. The simple growth rate of rice productivity of Balasore is 13.07 but it is 18.46 for Mayurbhanj. Hence the growth rate of rice productivity in both districts has been increasing but the growth rate is higher in Mayurbhanj than Balasore. The percentage of area under rice to gross cropped area in both the district have declined from 2003-2013. The percentage of area under rice to gross cropped area in Balasore and Mayurbhanj was 73.87 and 70.36 percent respectively during 2003-04, which has continuously declined to 68.42 and 62.06 percent respectively during 2012-13. But still the percentage of area under rice to gross cropped area in Balasore is higher than Mayurbhanj district.

COMPARISON OF AREA, PRODUCTION AND YIELD OF RICE

It is necessary to compare the yield rate in two districts, which are different in rainfall. Balasore is a coastal district with substantial canal irrigation where production and productivity are expected to be higher than Mayurbhanj. The average of area, production and productivity can be better compared through t test with equal variance and without equal variance. In table-2, t-tests is conducted to compare the means of rice production between Balasore and Mayurbhanj district. Both the districts have of 10 years of samples.

Table-2 : t test for Rice Production in Balasore and Mayurbhanj District

Two-sample t test with equal variances						
Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
Balasore production	10	398.411	14.98714	47.3935	364.5077	432.3143
Mayurbhanj production	10	486.126	27.32599	86.41236	424.3103	547.9417
combined	20	442.2685	18.20127	81.39855	404.1728	480.3642
diff		-87.715	31.16607	-153.1925	-22.23 752	
diff = mean(Balasore production) - mean(Mayurbhanj production) t = -2.8144						
Ho: diff = 0 degrees of freedom = 18						
Ha: diff < 0	Ha: diff != 0		Ha: diff > 0			
Pr(T < t) = 0.0057	Pr(|T| > |t|) = 0.0115		Pr(T > t) = 0.9943			

Source: Computed by the Author using STATA

For two tailed test, the critical value at 5 percent level of significance is ±1.73. There is no significant difference in average rice production in Balasore and Mayurbhanj district The difference between means between the rice productions of two districts is -87.72. The 95 percent confidence level interval of the difference is (-153.19, -22.23). The t-statistic calculated is -2.8144 with 18 degrees of freedom. The corresponding two-tailed p-value is 0.0115, which is less than 0.05. It is concluded that the difference of means in rice production between Balasore and Mayurbhanj is statistically significantly different from zero. The calculated value of 't' (-2.8144) is greater than the critical value of 't' (2.10), is significant. Hence we reject the null hypothesis. In order to compare the means of rice productivity between Balasore and Mayurbhanj district t-test is conducted

Table-3 : t test for Rice Productivity in Balasore and Mayurbhanj District

Two-sample t test with equal variances						
Variable	**Obs**	**Mean**	**Std. Err.**	**Std. Dev.**	**[95% Conf. Interval]**	
Balasore yield	10	1675.8	68.23893	215.7904	1521.433	1830.167
Mayurbhanj yield	10	1521.3	79.49117	251.3731	1341.478	1701.122
Combined	20	1598.55	53.97702	241.3926	1485.575	1711.525
Diff		154.5	104.7635	-65.6	374.6	
diff = mean(Balasore yield) - mean(Mayurbhanj yield) t = 1.4747						
Ho: diff = 0 degrees of freedom = 18						
Ha: diff < 0	Ha: diff != 0		Ha: diff > 0			
Pr(T < t) = 0.9212	Pr(|T| > |t|) = 0.1576		Pr(T > t) = 0.0788			

Source: Computed by the Author using STATA

There is no significant difference in average rice productivity in Balasore and Mayurbhanj district .The difference between means between the rice productivity of two districts is 154.5. The 95 percent confidence level interval of the difference is -65.6 and 374.6. Value of t-statistic is 6.7532 with 18 degrees of freedom. The corresponding two-tailed p-value is 0.1576, which is greater than 0.05.

STATIONARITY TEST OF TIME SERIES DATA OF RICE PRODUCTION

Since the purpose of the study is to analyze the instability of rice production in Balasore and Mayurbhanj district, Dickey fuller test was used to analyze the instability in rice production in these two districts.

Table-4 : Result of Dickey-Fuller test of rice production in Balasore District

Dickey-Fuller test for unit root		Number of obs =	9
---------- Interpolated Dickey-Fuller ---------			
Test	1% Critical	5% Critical	10% Critical
Statistic	Value	Value	Value
Z(t) -2.522	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.1101			

Source: Computed by the Author using STATA

Table-4 shows that MacKinnon p-value is found to be 0.1101, which is not significant at any significance level. Hence the time series of rice production in Balasore district has unit root and it is non-stationary. So the rice production in the district over the years has instability.

Table-5 : Result of Dickey-Fuller test of rice production in Mayurbhanj District

Dickey-Fuller test for unit root		Number of obs =	9
---------- Interpolated Dickey-Fuller ---------			
Test	1% Critical	5% Critical	10% Critical
Statistic	Value	Value	Value
Z(t) -2.882	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0474			

Source: Computed by the Author using STATA

Table-5 shows that MacKinnon p-value is found to be 0.0474, which is significant at 5 percent level of significance level. Hence the time series of rice production in Mayurbhanj district has no unit root and it is stationary. So the rice production in the district over the years has lesser fluctuations.

VARIATION IN IRRIGATED AREA OF RICE

Irrigation is the most important resources of rice production and also main factor which increases the cropping intensity of a district. An increase in the percentage of cropping intensity increases the rice production or agricultural production of a district. The variation in the irrigation area under rice leads to instability in rice production. As the irrigated area under rice in Balasore district is larger than Mayurbhanj district, the cropping intensity is also higher than the Mayurbhanj district

Table-6 : Irrigated Area under Rice/ Paddy in Balasore and Mayurbhanj District

Year	Balasore Irrigated Area (000' ha.)	Mayurbhanj Irrigated Area (000' ha.)
2003-04	89.75	93.64
2004-05	102.51	93.95
2005-06	109.11	95.65
2006-07	106.97	100.65
2007-08	114.27	104.75
2008-09	118.4	103.05
2009-10	103.81	101.85
2010-11	120.81	101.45
2011-12	134.24	106.17
2012-13	146.17	106.74
Mean	114.60	100.79
SD	16.34	4.84
CV	14.26	4.80
Min	89.75	93.64
Max	146.17	106.74
SROG	62.86	13.99

Source: Directorate of Agriculture and Food Production, Odisha, and Authors own calculation.

The average irrigated area under rice production of Balasore and Mayurbhanj district from 2003 to 2013 are 114.60 and 100.79 respectively. But the coefficient of variation and standard deviation of irrigated area under rice for Mayurbhanj district is 4.80 and 4.84 respectively which are less than that of Balasore 14.26 and 16.34 respectively. This implies that irrigated area under rice has greater instability in Balasore district than Mayurbhanj district. The growth rate of irrigated area under rice in Balasore district is 62.86 where as it is 13.99 in Mayurbhanj district. The growth rate refers

that irrigated area under rice in both the district have continuously increasing over the years and growth rate of Balasore district is more than Mayurbhanj district. The maximum irrigated area under rice in Balasore district is 146.17 thousand hectares in 2012-13 and minimum is 89.75 thousand hectares in 2003-04. The maximum area under rice in Mayurbhanj district is 106.74 thousand hectares in 2012-13 and minimum is 93.64 thousand hectares in 2003-04.

COMPARISON OF FERTILIZER UNDER RICE

The use of fertilizers differs widely across districts of Odisha. Though there has been considerable improvement in the use of fertilizers and other inputs, the rate of fertilizer use in both Balasore and Mayurbhanj district still remains far behind the state average. Since the per capita income and literacy rate of Balasore district is more than the Mayurbhanj district, the per hectare fertilizer consumption of Balasore district is higher than the Mayurbhanj district.

Table-7 Fertilizer Consumption (Kg./Ha.) in Balasore and Mayurbhanj District

Year	Balasore	Mayurbhanj
2003-04	80	28
2004-05	106	35
2005-06	105	35
2006-07	101	38
2007-08	126	40
2008-09	133	44
2009-10	129.09	46.49
2010-11	141.98	49.25
2011-12	117.4	50.29
2012-13	96.03	36.37
Mean	113.55	40.24
SD	19.2	7.15
CV	16.91	17.77
Min	80	28
Max	141.98	50.29
SROG	20.04	29.89

Source: Directorate of Agriculture and Food Production, Odisha, and Authors own calculation.

The average per hectare fertilizer consumption of Balasore and Mayurbhanj district from 2003 to 2013 are 113.55 and 40.24 kg per hectare respectively. The per hectare fertilizer consumption in Mayurbhanj district is much less than the Balasore district. But the coefficient of variation of fertilizer consumption in kg per hectare in Mayurbhanj 17.77 is more than that of Balasore 16.91. Fertilizer consumption in Mayurbhanj district has greater instability than Balasore district Standard deviation of fertilizer consumption in kg per hectare is high in Balasore district (19.2) than Mayurbhanj district (7.15). The growth rate of fertilizer consumption in kg per hectare in Balasore is 20.04 where as it is 29.89 in Mayurbhanj. It implies that per hectare fertilizer consumption in both the district has continuously increasing over the years and growth rate of Balasore district is less than Mayurbhanj. The maximum per hectare fertilizer consumption in Balasore district is 141.98 kg in 2010-11and minimum is 80 kg. in 2003-04. The maximum area under rice in Mayurbhanj is 50.29 kg in 2011-12 and minimum is 28 kg in 2003-04.

VARIANCE ANALYSIS OF FERTILIZER CONSUMPTION, RICE PRODUCTIVITY AND CROPPING INTENSITY

Rice is the staple food of both the district Balasore district has more irrigated area under rice cultivation than Mayurbhanj. The former district also uses more fertilizer than the later. Rice productivity is less in Mayurbhanj district than Balasore district as the former is a rainfed district and uses less fertilizer. F test is conducted for testing the equality of two variances i.e. instability in rice productivity of Balasore and Mayurbhanj district.

Table-8 compares the variability of Fertilizer Consumption in Balasore and Mayurbhanj District.

Table-8 : F test for Fertilizer Consumption (Kg./Ha) in Balasore and Mayurbhanj District

Variable |	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Balasore |	10	113.55	6.071833	19.20082	99.81456	127.2854
Mayurbhanj |	10	40.24	2.261189	7.150506	35.12484	45.35516
Combined |	20	76.895	8.980973	40.16413	58.09761	95.69239
ratio = sd(Balasore) / sd(Mayurbhanj)				f = 7.2105		
Ho: ratio = 1				degrees of freedom = 9, 9		
Ha: ratio < 1			Ha: ratio != 1		Ha: ratio > 1	
Pr(F < f) = 0.9965			2*Pr(F > f) = 0.0071		Pr(F > f) = 0.0035	

Source: Computed by the Author using STATA

The table value of *F* at 5 percent level of significance for v_1=11and v_2=11 is 2.72 and the table value of *F* at 1 percent level of significance for v_1=11and v_2=11 is 4.46.since the calculated value of *F*=7.21which is greater than 2.72 and also greater than 4.46, the *F* ratio is significant at 5 percent as well as at 1 percent level of significance. Therefore the null hypothesis is rejected and alternative hypothesis is accepted. It implies that instability in fertilizer consumption of Balasore district is more than the instability in fertilizer consumption of Mayurbhanj district.

Table-9 : Rice Productivity (Kg./Ha.) in Balasore and Mayurbhanj District

Year	Balasore	Mayurbhanj
2003-04	1561	1457
2004-05	1764	1507
2005-06	1541	1493
2006-07	1449	1579
2007-08	1638	1667
2008-09	1432	1572
2009-10	1607	1396
2010-11	1852	932
2011-12	2149	1884
2012-13	1765	1726
Mean	1675.8	1521.3
SD	215.79	251.37
CV	12.88	16.52
SROG	13.07	18.46

Source: Directorate of Agriculture and Food Production, Odisha, and Authors own calculation.

The average rice productivity of Balasore and Mayurbhanj district from 2003 to 2013 are 1675.8 and 1521.3 respectively. The rice productivity in Mayurbhanj district is less than the Balasore district. But the coefficient of variation and of rice productivity in kg per hectare in Mayurbhanj 16.52 is more than that of Balasore 12.88. Rice productivity in Mayurbhanj district has greater instability than Balasore district. Standard deviation of rice productivity is less in Balasore district (215.79) than Mayurbhanj district (251.37). The growth rate of rice productivity in Balasore is 13.07 where as it is 18.46 in Mayurbhanj. It implies that rice productivity in both the district has continuously increasing over the years but the growth rate in Balasore district is less than Mayurbhanj. The maximum rice productivity in Balasore district is 2149 kg per hectare in 2011-12 and minimum is 1432 kg in 2008-09. The maximum rice productivity in Mayurbhanj is 1884 kg in 2011-12 and minimum is 932 kg in 2010-11.

Table-10 : F test for Rice Productivity (Kg./Ha.) in Balasore and Mayurbhanj District

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Balasore	10	1675.8	68.23893	215.7904	1521.433	1830.167
Mayurbhanj	10	1521.3	79.49117	251.3731	1341.478	1701.122
Combined	20	1598.55	53.97702	241.3926	1485.575	1711.525
ratio = sd(balasore) / sd(mayurbhanj)				f = 0.7369		
Ho: ratio = 1			degrees of freedom = 9, 9			
Ha: ratio < 1		Ha: ratio != 1		Ha: ratio > 1		
Pr(F < f) = 0.3283		2*Pr(F < f) = 0.6567		Pr(F > f) = 0.6717		

Source: Computed by the Author using STATA

Table-10 represents that the probability value of *F* is 0.6567 which is greater than 0.05.the table it can be conclude that the difference of variance in rice productivity between Balasore and Mayurbhanj is statistically significantly not different from 0. value of *F* at 5 percent level of significance for v_1=11and v_2=11 is 2.72 and the table value of *F* at 1 percent level of significance for v_1=11and v_2=11 is 4.46.since the calculated value of *F*=0.7369which is less than 2.72 and also less than 4.46, the *F* ratio is not significant at 5 percent as well as at 1 percent level of significance. Therefore the null hypothesis is accepted.

CONCLUSION

Introduction of green revolution and formulation of various special programmes and plans move up the use of agricultural inputs such as fertilizer consumption, irrigation facilities, use of quality seed, credit availability and cropping intensity in both Balasore and Mayurbhanj districts of Odisha. Balasore district has increased the rice productivity by increasing the inputs used in it. But Mayurbhanj district lagged behind the Balasore district. Balasore district is socio-economically more developed than the tribal dominated rainfed Mayurbhanj district. Therefore rice productivity is less in

Mayurbhanj district as the farmers are using less agricultural inputs. The rice production in Balasore district has more instability than Mayurbhanj district. The percentage of area under rice to gross cropped area, fertilizer use, credit, cropping intensity and use of seed are the major factors which have increased the production and productivity of rice in Balasore district. Therefore major initiatives should be taken to increase the use of such inputs in order to enhance the production and productivity of rice in rainfed Mayurbhanj district.

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