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GROWTH AND INSTABILITY IN RICE PRODUCTION IN ODISHA

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ABSTRACT

The objective of this paper is to analyze the growth and instability in rice production in Odisha. The study is based on secondary data from 2003 to 2012 collected from Economic survey, Govt. of Odisha, Agricultural Statistics of Odisha and District Statistical Handbook . The average area under rice cultivation in Odisha is 44 hect from 1995-2013. Area under rice is also shows fluctuating trends over the years. Rice area is also less fluctuated than area under food grain as its standard deviation is 1.65. Fertilizer consumption in Odisha is highly fluctuated over the years from 1995-2013, since its standard deviation and coefficient of variation is very high i.e. 99.81 and 25.98 respectively. It is also refers that the fertilizer consumption in the state is increasing over the time but it is instable. The correlation coefficient between seed and rice production is found to be positive that is 0.4953. As higher the quality of seed, higher is the rice production. Since the correlation is close to 0.5. The correlation coefficient between agricultural credit supplied and rice production is found to be positive i.e. 0.6032. There exist high correlation between credit availability and rice production.

KEY WORDS: *Agriculture, Fertilizer, Instability, Production, Rice.*

INTRODUCTION

Odisha is endowed with maximum natural resources in India. The development of agriculture in the state has lagged behind due to constraints like practising of traditional methods of cultivation, lack of access to modern technology, low productivity, inadequate capital formation and low investment, inadequate irrigation facilities, uneconomic size of holdings, widespread illiteracy among farmers, helpless victims of natural calamities like flood, draught and cyclone, inefficient management of resources, poor performance of extension education and inadequate agricultural marketing facilities. Odisha was purposively selected for the study because it faces wide inequality, improper management and over-exploitation of natural resources and explosion of population. These have created a threat to ecological balance and economic as well as social status of households in different districts of the state. The persistently increasing inequality has become a big threat to the successful development of sustainable agricultural in the state. Success in promoting sustainable agriculture can be achieved on seven fronts, viz. Crop diversification, Genetic diversity, Integrated nutrient management (INM), Integrated pest management (IPM), Sustainable water management, Post-harvest technology and Sound extension programmes.

The state economy is directly linked with the increase in productivity of Rice as it is the staple food in the state. Orissa agriculture is highly concentrated in low productive and high water consuming paddy cultivation. The yield rate of rice which is the staple cereal crop of Orissa, the picture is, also, not encouraging. The average per hectare yield rate of rice in Orissa is only 2361kg, whereas the all-India average is 2462 kg. In Orissa trends in area, production is fluctuating for both food grains and rice from 1995-2013. In eastern India, Orissa had more than 3% growth but other states continued to have low growth. Rice Production in Odisha is presented in the table-1.

Table-1 Rice Production and inputs in Odisha

Year	Rice Area (Lakh hc)	Rice Production (LakhMT)	Rainfall (mms.)	Seed (Paddy) (in qtls.)	Irrigation (Utilized) (th ha.)	Fertilizer (in 000 MT)	Credit (in Crore Rupees)	Power (in million Unit)
1995-96	45.29	62.26	1588	113274	26.29	237.53	252.00	7532
1996-97	44.67	44.37	990.1	120717	22.63	250.76	275.00	5418
1997-98	44.97	62.05	1493	199976	23.18	290.8	326.00	5571
1998-99	44.47	53.9	1277.5	231636	23.58	299.14	463.00	5431
1999-2000	46.02	51.87	1435.7	230251	25.12	359.94	595.00	5603
2000-01	44.34	46.17	1035.1	220135	21.26	319.21	611.00	6090
2001-02	45	71.49	1616.2	254886	25.46	344.66	754.00	5792
2002-03	42.74	32.44	1007.8	138096	17.12	290.56	869.00	6745
2003-04	45.01	67.33	1663.5	145085	25.18	326.21	1107.00	7208
2004-05	44.92	65.37	1256.7	127427	26.91	355.3	1481.00	7598
2005-06	44.79	69.63	1497.7	160223	29.66	394.88	2111.00	8144
2006-07	44.5	69.28	1682.8	169464	31.49	402.88	2494.00	9288
2007-08	44.52	76.55	1583.2	291850	33.08	462.32	2665.00	10761
2008-09	44.55	69.15	1523.6	360044	31.77	534.87	2614.00	11747
2009-10	43.65	70.22	1362.6	499350.04	30.38	519.34	3944.91	12228
2010-11	42.25	69.31	1293.0	523298.27	31.05	521.8	5448.78	13099
2011-12	40.04	58.95	1338.1	521374.78	30.87	514.68	6852.00	13054
2012-13	40.22	94.96	1384.1	535128.59	33.65	490.20	8457.02	13342
Mean	44.00	63.07	1390.48	269012.00	27.15	384.17	2295.54	8591.72
SD	1.65	13.94	217.69	151816.10	4.60	99.81	2418.22	2980.47
CV	3.76	22.10	15.66	56.43	16.93	25.98	105.34	34.69
Min	40.04	32.44	990.10	113274.00	17.12	237.53	252.00	5418.00
Max	46.02	94.96	1682.80	535128.60	33.65	534.87	8457.02	13342.00
SROG	-11.19	52.52	-12.84	372.42	-8.81	43.86	-11.19	52.52
CAGR	-0.01	0.03	-0.01	0.10	-0.01	0.02	-0.01	0.03

Source : Agricultural Statistics, Odisha, Status of Agriculture, Odisha (Various Years), Statistical Abstract of Odisha 2012, Odisha.

The average area under rice cultivation in Odisha is 44 hect from 1995-2013. Area under rice is also shows fluctuating trends over the years. Rice area is also less fluctuated than area under food grain as its standard deviation is 1.65. The simple growth rate of rice area is -11.19. It shows that area under rice is slowly decreasing over the years. The compound growth rate calculated for area under rice is also negative. The average rice production in Odisha from 1995-2013 is found to be 63.07mt. There is large variation in rice production over the time period from 1995-2013. Since the standard deviation is 13.94. Coefficient of variation of rice production is 22.10 which is higher than coefficient of variations of food grain production. Standard deviation and coefficient of variation of rice in Odisha from 1995-2013 is 217.69 and 15.66. It implies that rainfall in Odisha is highly unstable and erratic. Average seed distribution in the state from 1995-2013 is 269012.The simple rate of growth of seed distribution is 372.42 and its compound growth rate is 0.10. The simple growth rate of seed distribution is very high and positive where as compound growth rate is very low. It refers to seed distribution is increasing over the years. Its standard deviation and coefficient of variation is also very high i.e. 151816.10 and56.43 respectively. There is high instability in Seed distribution over the time. The maximum seed distribution is 535128.60 in 2012-134 and minimum is 113274 in 1995-96.Average irrigated area utilized in the state from 1995-2013 is 27.15 thousand hectare. But there are oscillations in its trend. Irrigated area utilized is less fluctuated as its standard deviation is very low i.e.4.60. But its coefficient of variation is 16.93.

The simple growth rate of fertilizer consumption in the state is 43.86 and its compound growth rate is 0.02. It means that the simple growth rate of fertilizer consumption is high where as compound growth rate calculated for it is low. Fertilizer consumption in Odisha is highly fluctuated over the years from 1995-2013, since its

standard deviation and coefficient of variation is very high i.e. 99.81 and 25.98 respectively. It is also refers that the fertilizer consumption in the state is increasing over the time but it is instable. Average fertilizer consumption in the state from 1995-2013 is 384.17. The minimum fertilizer consumption in the state is 237.53 thousand MT in 1995-96 and maximum is 534.87 thousand MT in 2008-09.Average credit distribution in the state is 2295.54 crore rupees. But it has instability over the years, since its standard deviation band coefficient of variation is very high i.e. 2418.22 and 105.34 respectively. The simple growth rate of credit distribution is -11.19 that mean that credit distribution is decreasing over the years. The compound growth rate is also computed to be negative i.e. -0.01. The maximum credit distribution in the state is 8457.02 crore rupees in 2012-13 and minimum is 252.00 crore rupees in1995-96. Average power consumption in the state from 1995-2013 for agriculture sector is 8591.72 Million Unit. Coefficient of variations of power consumption is also very high 34.69 from 1995-2013. Power consumption shows highly fluctuating trends because standard deviation calculated for it is very high i.e. 2980.47.The simple growth rate of power consumption is 52.52. It implies that power consumption in the state is increasing over the years. The compound growth rate is also found to be positive i.e. 0.03.The table summarizes that food grain and rice production in the state is mainly depends upon rainfall, area under cultivation, seed, and irrigation, credit and power consumption.

CORRELATION BETWEEN RICE PRODUCTION AND INPUTS

Correlation is a statistical method to know the degree and extent of relation between two or more variables. An attempt is made in this section to find out Karl Pearson's coefficients of correlation between production of rice and related inputs. The results are shown in table-2

Table-2 Correlation matrix of Rice Production with Inputs

	Production	area	rainfall	seed	irrigation	fertilizer	credit	power
Production	1.0000							
Area	-0.2368	1.0000						
Rainfall	0.6468	0.2744	1.0000					
Seed padd	0.4953	-0.7469	0.0054	1.0000				
Irrigation	0.8437	-0.3443	0.5395	0.6278	1.0000			
Fertilizer	0.5879	-0.5526	0.2124	0.8549	0.8177	1.0000		
Credit	0.6032	-0.8759	0.0486	0.8734	0.7237	0.8116	1.0000	
Power	0.6086	-0.7100	0.1706	0.8429	0.8230	0.9112	0.9048	1.0000

Source- Computed by the Author using STATA

Land is one of the most important natural resources of the state as the agricultural sector is more predominant than the industrial sector. Proper utilization of land according to its use potential is important for enhancing productivity of any crop. Coefficient of co-relation between Rice Production and Rainfall is found to be -0.2368. It implies that there is negative correlation between them. Increase in land area does not lead to increase in rice production and vice-versa. Since area under rice production decreases farmers uses more fertilizer and quality seeds to move up the rice production

Distribution of rainfall during crop growing season plays a very important role in increasing the kharif rice. Rainfed agriculture is complex, diverse and risk-prone and is characterized by low level of productivity and low input usage. Variability in rainfall results in wide variations and instability in yields. The correlation coefficient between rainfall and rice production is found to be positive that is 0.6468. As higher the amount of rainfall, higher is the rice production and vice versa. Since the correlation is more than 0.5 there is high correlation between them. Since value of the correlation coefficient is high. The rainfall is found to be an important factor for rice production. Better the availability of water better will be the production of rice.

Seed plays an important role in rice production. The correlation coefficient between seed and rice production is found to be positive that is 0.4953. As higher the quality of seed, higher is the rice production. Since the correlation is close to 0.5 there is medium correlation between them. During green revolution more variety of seeds are developed in wheat.

Irrigation is the artificial application of water to partially meet the crop evapo-transpiration requirements. It is essential for sustaining crop productivity in many regions of the state mainly because the rainfall is inadequate and unevenly distributed to meet crop-water demand. The correlation coefficient between irrigation potential utilized and rice production is found to be 0.8437.It implies that there exists positive and high

correlation between the irrigation potential utilized and rice production. In other words more the area put under irrigation more will be the rice productivity and vice versa. Since the correlation between these two is found to be very high, irrigation is an important input for rice production. Undoubtedly, irrigation has been one of the pillars of green revolution and key factor for increasing rice productivity. There is a wide difference in geographical distribution of irrigation facility in the state. Some blocks have more than 50% irrigation facility whereas other blocks have less than 5% facility Government have, therefore, decided that a Master Plan for each district should be drawn up so as to provide at least 35 % irrigation in every block i.e. from 2005-06 to 2009-10 198 blocks were identified having less than 35% irrigation facility. By the end of March 2014, out of 198 deficit blocks, 73 blocks have achieved 35% irrigation coverage.

Adequate and balanced use of chemical fertilizer as well as organic manure plays important role in augmenting rice production. The correlation coefficient between fertilizer consumption and rice production is found to be positive that is 0.5879. As more nutrient wise fertilizer applied to plant, more will be the rice production and vice versa. It refers that there exist positive and high correlation between these two variables. Fertilizer is the key determinant of increase in rice production

Credit is an important agricultural development index. The correlation coefficient between agricultural credit supplied and rice production is found to be positive i.e. 0.6032. There exist high correlation between credit availability and rice production. Famer avails credit from the agricultural credit co-operative societies. More the credit supplied for agricultural purpose more will be the rice production and vice versa. Rapid expansion of agricultural credit leads to development of agricultural sector.

Power as the prime mover for growth is the most important infrastructural input for socioeconomic development including agriculture and industry of any country. The trend in the use of human and animal energy are declining over the years, but the use of diesel and electricity has been increasing after rural electrification programme launched by the government in the mid-sixties. In rural electrified areas electrical energy is consumed mainly in irrigation pumps and threshers and to a small extent for agro-processing units such as rice mills, flour mills etc. The correlation coefficient between power consumption and rice production is found to be positive i.e. 0.6086. There exists high correlation between power consumption and rice production as the correlation coefficient is greater than 0.5. Orissa, agriculture accounts for less than 3 per cent of the total electricity consumption, whereas, in some States like AP and Haryana, the percentage is very high.

SIGNIFICANCE OF CORRELATION BETWEEN RICE PRODUCTION AND INPUTS

t test is a statistical technique for testing a hypothesis for significance of correlation coefficient. Test result of Spearman Correlation coefficient between production of rice and area under rice is given in the Table-3.

Table-3 t test results spearman's coefficient of correlation between production of rice and Inputs

Inputs	Spearman's rho	Probability value > |t|
Area	-0.0815	0.7478
Rainfall	0.5769	0.0122
paddy seed	0.5108	0.0303
irrigation potential utilized	0.8019	0.0001
fertilizer consumption	0.6202	0.0060
credit	0.6285	0.0052
power/ electricity consumption	0.6409	0.0042

Source- Computed by the Author using STATA

Spearman correlation between rice production and area under rice is not significant at all, as the probability value is 0.7478. There is highly positive correlation between rice production and area under rice. Spearman correlation between rice production and rainfall is significant at 5 percent level of significance, as the probability value is 0.0122. There is highly positive correlation between rice production and rainfall. Spearman correlation between rice production and paddy seed is significant at 5 percent level of significance, as the probability value is 0.0303. There is highly positive correlation between rice production and paddy seed. Correlation between rice production and irrigation potential utilized is significant at1 percent level of

significance, as the probability value is 0.0001. There is highly positive correlation between rice production and irrigation potential utilized. Correlation between rice production and irrigation potential utilized is significant at1 percent level of significance, as the probability value is 0.0060. There is highly positive correlation between rice production and fertilizer consumption. Spearman correlation between rice production and power consumption is significant at 1 percent level of significance, as the probability value is 0.0042. There is highly positive correlation between rice production and power consumption.

REGRESSION RESULTS

A linear regression was conducted with secondary data from Odisha and the results are shown in the table-4

Table-4: Regression results and parameters

Rice production	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Rice area	6.33539	4.767002	1.33	0.213	-4.286151	16.95693
Rainfall	.0200875	.0117635	1.71	0.119	-.0061231	.0462982
Seed paddy	.0000154	.0000297	0.52	0.615	-.0000507	.0000815
Irrigation	1.000012	1.464467	0.68	0.510	-2.263023	4.263047
Fertilizer	-.0618097	.0551946	-1.12	0.289	-.1847909	.0611714
Credit	.0077529	.00449	1.73	0.115	-.0022514	.0177571
Power	-.0006431	.0021656	-0.30	0.773	-.0054683	.0041821
_cons	-263.4178	190.9115	-1.38	0.198	-688.7952	161.9596

Source- Computed by the Author using STATA

A linear regression was conducted of rice production with inputs. The equation is as follows

Y = -263.41 +6.33 A+ 0.02 R + 0.01S + 1.00I – 0.06F + 0.008C – 0.001P

Where Y = Rice Production, R = Rainfall, S= Seed, I=Irrigation potential utilized, F= Fertilizer consumption, C= Credit and P= Power or electricity consumption. Hence the rice Production is positively correlated with Rain Fall, Seed, Irrigation and Credit in study area and it is also found that rice production is not functionally related with fertilizer consumption and power/electricity consumption. It implies that increase in the amount of rainfall, irrigation potential utilized, quality seed, and credit availability leads to increase in the quantity of rice production and vice versa. The probability values for't' test between rice production and area under rice production, rainfall, seed, irrigation potential utilized, fertilizer, credit, and power consumption are calculated to be 0.213, 0.119, 0.615, 0.510, 0.289, 0.115, and 0.773 respectively are insignificant. The adjusted R-squared is found to be 0.7512 or 75 percent.

EFFECT OF CROPPING INTENSITY ON RICE PRODUCTION

Rice production of smallholder and marginal farmers is sensitive to climate change and climate variability. Cropping intensity, the number of crops planted annually, can be used as a indicator of rice production by smallholder and marginal farmers given that it can greatly affect total production of rice. Cropping Intensity and Rice Production in Odisha is given in table-5.

Table-5 Cropping Intensity and Rice Production in Odisha

Year	Rice Production (in '000 M.T)	Cropping Intensity (%)
2000-01	46.17	135
2001-02	71.49	151
2002-03	32.44	138
2003-04	67.33	149
2004-05	65.37	152
2005-06	69.63	157
2006-07	69.28	158
2007-08	76.55	160
2008-09	69.15	162
2009-10	70.22	163
2010-11	69.31	158
2011-12	58.95	166
2012-1 3	94.96	167
Mean	66.22	155.08
SD	14.76	9.89
CV	22.29	0.06
Min	32.44	135
Max	94.96	167

Source : CSO, Govt. of India and Odisha Agricultural Statistics 2012-13.

The average cropping intensity from 1999-2011 in Odisha is 155.08 percent. But there are fluctuations in its trend. Cropping intensity has low fluctuation as its standard deviation is low. Its coefficient of variation is also found to be very low i.e. 0.06. It implies that it has low instability.. The maximum cropping intensity in Odisha is 167 percent in 2012-13 and minimum is 135 percent in 2000-01.Averagerice production from 1999-2011 in Odisha is 66.22Thousand MT. Rice is highly fluctuated as its standard deviation is very high i.e. 14.76 It has also high instability as its coefficient of variation is 22.29. The maximum rice production in Odisha is 94.96 Lakh MT in 2012.13 and minimum is 32.44 Lakh MT in 2002-03. The regression between rice production and cropping intensity is given in table-6.

Table-6 Regression result of rice production and cropping intensity.

Rice production |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Cropping intensity |	1.144254	.2884247	3.97	0.002	.5094359	1.779073
_cons |	-111.2282	44.81198	-2.48	0.030	-209.8587	-12.59772

Source- Computed by the Author using STATA

A linear regression was conducted of rice production with cropping intensity. The equation is as follows

$$Y = -111.2282+1.14CI$$

Where Y = Rice Production and CI= Cropping intensity. Hence the rice Production is positively correlated with cropping intensity, as the regression coefficient is found to be 1.144254. When cropping intensity increases, rice production increases and vice versa. The probability value for 't' test is found to be 0.002 which is significant at 1 percent level of significance.

Table-7 Correlation between Rice Production and Cropping Intensity

|	Rice Production	Cropping Intensity
Rice Production |	1.0000	
Cropping Intensity |	0.7672	1.0000

Source- Computed by the Author using STATA

Cropping Intensity is an important driver of rice production. Coefficient of co-relation between rice production and Cropping Intensity is found to be 0.7672 (Table-7). It implies that there is highly positive correlation between them. Higher the cropping intensity higher will be the rice production and vice versa.

EFFECT OF PESTICIDE CONSUMPTION ON RICE PRODUCTIVITY

Adoption of HYVs technology particularly after green revolution gave a path to much increase in pesticide demand in agriculture, due to increase in plant diseases. To remove pest problem, pesticides and insecticides demand has been increased, at larger extent, over a period of time.

Table-8 Productivity of rice and Pesticide consumption in Odisha

Year	Productivity (Kg/Ha).	Pesticide Consumption (Gms/Ha.)
2000-01	1041	157.00
2001-02	1589	159.04
2002-03	759	139.67
2003-04	1496	138.09
2004-05	1455	148.68
2005-06	1554	138.53
2006-07	1557	148.94
2007-08	1720	143.28
2008-09	1553	149.1
2009-10	1609	140.06
2010-11	1640	151.5
2011-12	1472	148.00
2012-1 3	2361	158.00
Mean	1523.54	147.62
SD	364.40	7.48
CV	23.92	0.05
Min	759	138
Max	2361	159

Source: CSO, Govt. of India and Odisha Agricultural Statistics 2012-13.

The average pesticide consumption in Odisha from 2000-2013 is 149.1gms/ha. There are slight fluctuations in its trend. The standard deviation and coefficient of variation of pesticide consumption is very low i.e. 7.48 and 0.05 respectively (table-8). It implies that instability in the pesticide consumption very meager.. The maximum value pesticide consumption in Odisha is 159 gms/ ha in 2001-02 and minimum is 138 gms/ ha in 2003-04. Average rice productivity from 200-2013 in Odisha is 1523.54 kg/ ha. Rice productivity is highly fluctuated as its standard deviation is very high i.e. 364.40. It has also high instability as its coefficient of variation is 23.92. The maximum rice productivity in Odisha is 2361 kg/ha in 2012-13 and minimum is 759 kg/ ha in 2002-03.

Table-9 Regression result of rice productivity and pesticide consumption.

Rice productivity	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
pesticide consumption	15.55786	13.9248	1.12	0.288	-15.09042	46.20613
_cons	-773.1482	2058.044	-0.38	0.714	-5302.871	3756.575

Source- Computed by the Author using STATA

A linear regression was conducted of rice productivity with pesticide consumption. The equation is as follows

$$Y = -773.1482+15.56PC$$

Where Y = Rice Productivity and PC= Pesticide consumption. Hence the rice Productivity is positively correlated with cropping intensity, as the regression coefficient is found to be 15.56 (table-9). Higher the pesticide consumption higher will be the rice productivity and vice versa. The probability value for 't' test is found to be 0.288 which is not significant at all.

Table-1 0 Correlation between Productivity of Rice and Pesticide Consumption

	Productivity	Pesticide Consumption
Rice Productivity	1.0000	
Pesticide Consumption	0.3192	1.0000

Source- Computed by the Author using STATA

Pesticide consumption plays lilited role in rice productivity. The coefficient of co-relation between rice productivity and Pesticide Consumption is found to be 0.3192(table-10). It implies that there is very low positive correlation between them. Pesticide consumption has little effect in rice productivity.

CONCLUSION

Instability is an intrinsic element of agriculture universally. Besides the fluctuations in area, the instability in the production and productivity (yield) has increased for all major crop groups including rice across the physiographic zones. The credit of reducing the instability in the rice production should go to the plan policy adopted by the state government. Agricultural growth is indispensable for the aggregate economic development of the economy of the state of Odisha. In Odisha the instability in rice production an be reduced by improving anal irrigation in Odisha. So that rice in Rabi season can be harvested more. There is an urgent need to reformulate the agricultural policy of the state, so that the rice farmers can easily avail more credit before beginning of Kharif crop. The farmers under Below Poverty Line need to be provided subsidized fertilizer to increase rice production.

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