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AGRICULTURAL DEVELOPMENT IN ODISHA: ARE THE DISPARITIES GROWING?

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Abstract

In the recent years India's agricultural sector has experienced significant changes in institutional and policy interventions and productivity at the national and sub-national levels. But although overall production has increased growth has slowed down, inter-state and intra-state disparities continue to remain very high and even widened in some cases. Using Principal Component Analysis technique and constructing district-wise agricultural development indices, this paper analyses the spatio-temporal variations in agricultural development in Odisha , India for 3 years over the period 2001-02 to 2011-12, identifies the underlying factors, examines inter-relationships and draws policy implications for improving the agricultural situation. Increasing public investment in agricultural infrastructure including irrigation, establishing appropriate farming systems , developing suitable and affordable technology and crop varieties, augmenting credit delivery and designing region and crop-specific plans and strategies are suggested for moderating spatial inequalities and achieving a less unbalanced regional development in agriculture.

Key words: *Agriculture, Regional Disparity, Productivity, Inter District Variations*

1. Introduction

Agriculture is a vital sector of the economy of Odisha and a good deal has been achieved in this sector during the plan period. Farm production has increased manifold and yields of major crops such as paddy, pulses, oilseeds and vegetables have more than trebled in the last four and half decades. The impressive long term growth in agriculture has helped in taking the state out of famines and serious food shortages into one of the food surplus states in the country and ensuring food, nutrition and livelihood security. But although the need of making available an adequate food supply of reasonable quality for the population has been accomplished, the corresponding need of sustainable and equitable agricultural growth still remains a problem in the state. In fact, agriculture in Odisha is characterized by wide diversity and considerable spatio-temporal variations in growth and productivity. Such disparities are a cause of concern for obvious reasons. In such view of the facts, a study on spatio-temporal variations in agricultural development of Odisha is worth pursuing.

1.1 Review of Literature

Scholarly works on spatio-temporal disparities in agricultural development concerning less developed countries like India are relatively scarce and more so in respect of small poor states like Odisha. Although systematic evidence is still limited, a growing body of empirical work documents the existence of such inequalities in India and some of the states. A brief review of the important studies is presented here to assess their contribution to knowledge, identify gaps and indicate scope for research.

1.1.1 Studies at the State Level

Most of the studies in India focus on disparities in agricultural performance at the state level. However, their findings do not reveal a clear trend over time and lack a definite pattern across states. The studies by Nayak (1998), Birthal et al. (2011) and Chand and Parappurathu (2012) reveal the existence of wide variations in productivity and overall agricultural performance among the states. Somasekharan et al. (2011) studied the regional development in agriculture in 15 major states of India for the period 1971-2007. Their findings indicate that regional disparities in agricultural performance, which increased during 1971-88, moderated during 1988-2007 suggesting a kind of convergence.

1.1.2 Studies at Regional , District, Block and Tehsil Levels

Bhalla and Alagh's seminal work (1979) laid the foundation of district level studies on spatio-temporal variations in levels of agricultural development in India. It reveals vast variations in yields across crops and districts. The study by Bhalla and Singh (2001) is a milestone in contemporary research in this area which also indicates wide inter-district and inter-crop inequalities. However, the findings point to declining disparities over the years and convergence. Singh's latest study (2007) shows considerable inter-district variations in productivity and extreme disparities in Indian agriculture. Chand et al. (2009) observed wide variations in agricultural productivity across districts. Intensive regional and district level studies for Maharashtra (Mohanty, 2009), West Bengal (Khan et al., 2011) and Andhra Pradesh (Dev, 2007; Reddy,2011) also point to acute spatial inequalities in agricultural performance.

A study by Kumar et al. (2012) concerning Haryana over three periods – up to 1990, during 1990-2002 and 2002-09 – shows marked inter-district disparities in agricultural performance. However, the disparities were found to have widened up to 1990, then moderated during 1990-2002 but aggravated again during 2002-09. Raman and Kumari (2012) studied agricultural development at the regional and district levels in Uttar Pradesh for two years – 1990-91 and 2008-09 – and found evidence of remarkable and persistent disparities. However, the disparities were observed to have narrowed in 2008-09.

At a more disaggregate level, the study by Ajagekar and Masal (2011) on agricultural development in Kolhapur district of Maharasthra for the year 2003-04 reveals glaring disparities across the tehsils and still greater inequalities across the villages at the grass roots level. From their study relating to South 24 Parganas district of West Bengal for the year 2001, Mandal and Dhara (2012) found a wide range of variations with higher productivity in Blocks under the south-western and north-central parts of the district than others.

1.1.3 Studies on Odisha Agriculture

Of late some studies on agricultural development in Odisha have appeared in reputed journals and publications of research institutions. One such study is by Swain (2002) and another by Swain et al. (2009 covering three benchmark years i.e. 1980-81, 1990-91 and 1998-99. A notable finding of the studies is that regional disparities have moderated in the post-reform period 1991-1999 because of implementation of backward area development programmes by the government. The results of the study by Tripathy et al. (2011) covering the period 1980-81 to 1992-93 also point to uneven performance across districts with the coastal districts and Sambalpur district of western region exhibiting better performance than others. Pattanayak and Nayak (2004) have studied the regional disparity in agricultural development in different districts and zones of Odisha during the benchmark years 1980 and 2000. The findings indicate high inter-district variations in agricultural productivity with

higher productivity in the coastal and plain land areas than others .In a recent study concerning Odisha agriculture covering the pre-liberalisation (1971-90) and post-liberalisation (1991-2008) periods, Reddy (2013) observed perceptible regional disparities in agricultural growth with Coastal Plains and Central Table Land zones showing commendable performance compared to Eastern Ghat and Northern Plateau zones in both the periods. In contrast the study by Chand et al. (2009) did not show large variations in productivity levels across various districts in Odisha.

1.2 The Research Problem and Need for the Study

The foregoing survey of literature points to a number of deficiencies of existing research works on the subject. First, the findings appear to be mixed and diverse. Second, with agricultural performance of an area influenced significantly by its natural – institutional-technological characteristics (which differ widely among and within states), existing research focusing largely at the state level and the evolution of bottom up and micro-level planning emphasizing the importance of district level approach to agricultural development, the need for studies at the lower level becomes apparent. Third, there is a paucity of studies on agricultural performance at the disaggregate level in Odisha. Whatever little studies do exist are confined to the 13-district set up and are based on a very limited number of variables covering periods up to the early 2000s. Meanwhile 17 new districts have been carved out by reorganizing most of the existing districts raising their number to 30. Besides a lot of changes in cropping pattern, irrigation coverage, cropping intensity, fertilizer consumption, average size of operational holdings and percentage of agricultural workers have taken place in Odisha's agriculture during the recent years. These changes might have affected the agricultural performance of districts differently and needless to say they could not have been grasped in the existing studies. There is thus a need for overcoming these research gaps and enriching the existing literature. The present study is a humble attempt in this direction.

1.3 Objectives, Database, Methodology and Plan of the Study

The broad objectives of the study are to present an overview of agricultural scenario of Odisha, analyse the productivity of paddy and total food grains across the districts, examine the inter-district differences in agricultural performance with reference to the determinants of productivity and draw some policy implications. The study is based on secondary data for three benchmark years viz. 2001-2002, 2006-07 and 2011-12 collected from Odisha Agriculture Statistics and Economic Survey of Odisha for various years and Census of India -2011 Primary Census Abstract Data Highlights Odisha Series 22. Simple statistical tools such as averages, percentages, regression and panel data technique have been used in the study.The study are arranged in four sections. In the following section we present an overview of agriculture in Odisha vis-à-vis the national economy. Inter-district variations in agricultural productivity, dependency relationships and overall agricultural performance are discussed in section - III. In section - IV we conclude with some policy implications.

2. Agriculture in Odisha – An Overview

Odisha is basically an agrarian state. More than 83 per cent of its total population lives in rural areas and depends primarily on agriculture for livelihood. The performance of agriculture determines food and nutrition security of the population and is important for reducing poverty and achieving inclusive growth. Recent trends in sectoral and overall growth in Odisha and India are given inTable-1.

Table 1. Place of Agriculture in the Economy – Odisha *vis-à-vis* India

Indicators / Sectors		2000–01to2004 – 05 (Old Base:1999-2000)		2005 – 06 to 2009 – 10		2010 – 11	
		Odisha	India	Odisha	India	Odisha	India
1		2	3	4	5	6	7
Growth Rates (%)	Agriculture and Allied Activities	3.5	1.3	3.9	2.9	0.1	6.5
	Industries	12.6	4.2	6.3	8.1	-10.8	6.4
	Services	6.3	6.8	10.3	10.2	6.6	9.3
	Combined	6.1	5.1	7.9	8.5	2.2	8.4
Share in NSDP / NDP (Annual Average %)	Agriculture and Allied Activities	29.7	21.8	22.4	17.3	20.6	15.0
	Industries	15.0	17.4	18.9	16.9	15.1	16.3
	Services	55.3	60.8	58.7	65.8	64.3	68.7
	Combined	100.0	100.0	100.0	100.0	100.0	100.0

Source: Khan (2012)

It can be seen from the table that during the last decade (2000-01 to 2009-10) the growth rate in net state domestic product (NSDP) has shown an upward trend registering an increase from 6.1 per cent per annum during 2000-01 – 2004-05 to 7.9 per cent per annum during 2005-06 to 2009-10 but it fell to 2.2 per cent in 2010-11. The average annual rates of growth in agriculture and allied activities in these periods have been 3.5 per cent, 3.9 per cent and 0.1 per cent respectively. This suggests a direct relationship between agricultural and overall growth rates in the state economy and that agricultural growth is an important support for NSDP growth. A comparison with the national scenario reveals that excepting 2010-11,the growth rate in agriculture and allied activities has been higher in Odisha than India . Secondly, though the share of agriculture and allied activities in NSDP- Odisha and all-India NDP has been falling, the rate of decline is higher at the national level than in Odisha indicating the predominance of agriculture in the state.

3. Spatio-Temporal Variations in Agricultural Performance

3.1 Variables and Methods

The level of agricultural development of an area is determined by a complex set of natural, institutional, technological and demographic forces. Hence spatial variations in these forces need to be considered to distinguish areas that exhibit high and successful performance and those that do not. We have constructed CADIs for each of the 30 districts of Odisha for three benchmark years - 2001-02, 2006-07 and 2011-12. In constructing the CADI for measuring the level of agricultural development and mapping it to regional disparities, our concerns are two-fold viz. what indicators /variables enter the index and how they need to be standardised / weighted to arrive at the final index. We have used the following 12 indicators for the purpose: (1)Yield of food grains (Kg/Ha), (2) Yield of Paddy (Kg/Ha) ,(3) Annual rainfall (mm), (4) Gross irrigated area (GIA) as percentage of gross cropped area (GCA), (5) Cultivated area as percentage of cultivable area, (6) Area under non-food grains as percentage of GCA, (7) Cropping intensity (%), (8) Area under high yielding varieties (HYV) of paddy as percentage of GCA under paddy, (9) Average size of operational holdings (Ha), (10)Consumption of fertilizer (Kg/Ha), (11) Percentage of total workers engaged in agriculture and (12) Rural literacy rate.

Our choice of indicators is based on both what previous researchers used and our own judgment. Yield is proxied for the productivity of land - the scarcest factor in agriculture. Since the cropping pattern across the districts is dominated by food grains and paddy in particular, we have taken yield of both food grains and paddy as indicators of agricultural development. Water being vital to agricultural operations, we have included annual rainfall and area under irrigation in the index. The extent of cultivated area, cropping intensity and average size of holdings have been taken to focus on the importance of land factor in agricultural development. Area under non-food grains is a good indicator of diversification within agriculture and hence is included in the index. We have considered area under HYV paddy and consumption of fertilizer as indicators of technology spread in agriculture. Finally, agriculture being a largely labour-intensive activity, the size and quality of work force in agriculture matter much to highlight which we have taken percentage of total workers engaged in agriculture and rural literacy rate in the index.

In making the index we have standardized these indicators. This has been done using the minimum and maximum values to ensure that no indicator has a disproportionate importance in the overall index. The normalized values are obtained by applying the simple formula:

$$Y_{ij} = \frac{a_{ij} - \min a_{ij}}{\max a_{ij} - \min a_{ij}} \qquad (1)$$

where Y_{ij} is the index for the j^{th} district in respect of the i^{th} variable, a_{ij} is the actual value of the variable for the district and max a_{ij} and min a_{ij} are the maximum and minimum values of the variable in the state. The normalized values of all the variables are then aggregated and averaged to yield the CADI for the district and the formula adopted is given by:

$$Cj = \frac{\sum_{i=0}^{n} Y_{ij}}{\sum_{i=0}^{n} i} \qquad (2)$$

where C_j is the CADI for the j^{th} district. The districts are ranked in descending order of their CADI score.

A better alternative to equal weights is the squared factor loadings from principal component analysis (PCA) which sum up to 1. Each indicator is normalized between 0 and 1 such that 0 indicates the lowest score and 1, the highest. Needless to say, the closer the weight lies to 1, the greater is the importance of the indicator on agricultural development and vice versa. The weights so derived are given in the appendix.

3.2 Inter-District Variations in Agricultural Productivity

Average productivity of agri-inputs is a summary measure of agricultural performance of an area/district. Since land and labour are the two principal factor inputs in agriculture, information relating to output per unit of both land and labour can be used to assess the level of agricultural development. But measuring labour productivity is a difficult task and whatever assessment can be made in this regard is bound to be inadequate and unreliable for obvious reasons. Further, in poor agrarian states like Odisha characterized by overcrowding in agriculture, land is the scarcest factor and it is relatively easy to compute output per unit of land. Besides, such data is published annually by Government of Odisha. We have, therefore,

chosen land productivity as a key indicator of agricultural development in our study and such productivity is measured in terms of yields of food grains and paddy per hectare of cropped area. Food grains and paddy have been selected because they constitute 74 % and 45.5% respectively of GCA. District-wise data in respect of per hectare yield of food grains and paddy for the three benchmark years are given in Table-2.

Table 2. Inter-District Variations in Agricultural Productivity in Odisha

Districts	Productivity of Food Grains (Kg/Ha)			Productivity of Paddy (Kg/Ha)		
	2001-02	2006-07	2011-12	2001-02	2006-07	2011-12
1	2	3	4	5	6	7
Sundargarh	880	1073	1482	1481	1841	2678
Debagarh	1095	998	1157	1976	1895	2449
Mayurbhanj	1403	1396	1651	2326	2357	2812
Kendujhar	1064	1087	1363	2015	2060	2557
Balasore	1624	1376	1999	2661	2163	3207
Bhadrak	1754	1628	1555	2919	2648	2487
Jajpur	1150	1051	862	2416	2037	1667
Cuttack	1163	1063	1239	2529	2256	2860
Jagatsinghpur	1203	1110	1627	2583	2231	3633
Kendrapara	1086	890	1106	2170	1677	2279
Puri	1283	1103	1124	2525	2046	2258
Khordha	1132	1275	1298	2258	2443	2339
Nayagarh	1060	981	520	2454	2241	967
Ganjam	1375	1322	616	3270	3148	887
Gajapati	1293	1193	957	2934	2673	1539
Rayagada	1032	1182	1176	2294	2567	1876
Kandhamal	1181	1105	943	2288	2089	1709
Koraput	1056	1217	1211	2266	2537	2196
Nabarangpur	1172	1488	1249	1925	1987	1051
Malkanagiri	906	1098	729	1643	2101	852
Kalahandi	1085	930	894	2085	1670	1442
Nuapada	836	795	649	1912	1650	1182
Bolangir	1101	1049	486	2314	2228	642
Subarnapur	1621	1768	1772	2855	3132	3287
Boudh	993	1226	951	1875	2391	1782
Sambalpur	1508	1588	1458	2763	3036	2710
Bargarh	1713	1718	1787	2971	3055	3219
Jharsuguda	1295	1512	987	2277	2789	1822
Dhenkanal	1309	1051	1392	2810	2161	3139
Angul	1048	918	725	2484	2042	1476
C.V.	19.68	20.93	33.91	17.47	18.47	39.34

Source : Author's compilation and calculation from Odisha Agriculture Statistics (Various Years)

A cursory look at the table reveals wide spatio-temporal variations in yield of both food grains and paddy. The temporal variations show the vulnerability of agriculture to the vagaries of monsoon and to fluctuations in rainfall in particular. Inter-district differences in yield are very large and widening over the years as measured by both range and coefficient of variation. The yield rate of food grains in the top most district are 2.10 times, 2.22 times

and 4.11 times higher than those at the bottom and of paddy in the highest yield district are 2.21,1.91 and 5.66 times greater than those of the lowest yield district for the selected years 2001-02, 2006-07 and 2011-12 respectively. In the case of food grains the coefficients of variation of yield have been 19.68, 20.93 and 33.91 in the respective years and those for paddy have been 17.47, 18.47 and 39.34 in the successive benchmark years. It may be noted that the increase in inter-district yield disparities has been much greater between 2006-07 and 2011-12 than between 2001-02 and 2006-07 for both food grains and paddy and the said increase during 2006-07 to 2011-12 has been far higher for paddy than for food grains.

3.3 Determinants of Productivity –Panel Data Analysis

Agricultural Productivity is influenced by a number of factors. In this section we have laid down the empirical framework for indentifying the determinants and estimating their influence on productivity in respect of food grains and paddy. Panel data technique and pool regression method have been used for the purpose. To control the problem of heteroscedasticity robust fixed and random effect models have been applied and the coefficient values remain unchanged with robustness check. Furthermore, Hausman test suggests the appropriateness of random effect model over the fixed effect model in our case and the former yields better results.

Equation-3 describes the specification of the model in respect of food grains.

$$F_{it} = \propto +\beta_1 PA + \beta_2 RA + \beta_3 IR + \beta_4 CU + \beta_5 FG + \beta_6 CI + \beta_7 AH + \beta_8 HY + \beta_9 FC + \beta_{10} WA + \beta_{11} RL + \in_{it} \quad (3)$$

where, F = Yield of food grains, PA=Yield of paddy, RA=Annual rainfall, IR=GIA as per cent of GCA, CU=Cultivated area as per cent of cultivable area, FG=Area under food grains as per cent of GCA, CI=Cropping Intensity, AH=Average size of operational holdings, HY=Area under HYV paddy as per cent of GCA under paddy, FC=Fertilizer consumption, WA=Percentage of total workers engaged in agriculture, RL=Rural literacy, $\in$=Error term, α = Constant term and the βs are the coefficients of the parameters.

The estimated results are shown in Table-3. As can be seen from the table, yield of paddy, cropping intensity, average size of operational holdings and fertilizer consumption are the significant factors influencing the productivity of food grains. Yield of paddy and consumption of fertilizer are very powerful forces with a one per cent increase in yield of paddy raising the yield of food grains by 0.678 per cent. Similarly, a one per cent increase in consumption of fertilizer is found to raise the yield rate of food grains by 0.318 per cent. This is because paddy is the single largest component of food grains accounting for 61.77 percent of area under food grains and the prevailing farm practices have become highly fertiliser sensitive. The per hectare yield of food grains is impacted negatively by average size of agricultural holdings reaffirming the inverse farm size-productivity relationship. The negative impact of cropping intensity may be due to loss of soil nutrients and quality caused by recurrent and multi crop use of lands which fertilizer application has failed to address adequately.

Table 3. Panel Data Analysis of Yield of Food grains

Variables	Fixed effect estimation with robustness			Random effect estimation with robustness		
Dependent variable : Yield of Food grains	Coefficients	Standard Error	P Values	Coefficients	Standard Error	P Values
1	2	3	4	5	6	7
Independent variables:						
Yield of Paddy (Kg./Ha.)	0.627***	0.052	0.000	0.678***	0.055	0.000
Rainfall (mm)	0.009	0.032	0.790	0.036	0.038	0.349
Gross irrigated area as % of GCA	0.004	0.074	0.961	0.026	0.069	0.710
Cultivated area as % of cultivable area	-0.017	0.043	0.685	-0.038	0.027	0.161
Area under food grains as % of GCA	0.032	0.078	0.690	0.020	0.071	0.776
Cropping intensity (%)	-0.005	0.138	0.973	-0.206***	0.068	0.002
Average size of operational holdings (Ha)	-0.142*	0.071	0.056	-0.156***	0.051	0.002
Area under HYV paddy as % of GCA under paddy	0.033	0.0.37	0.373	0.023	0.040	0.571
Fertilizer consumption (Kg./Ha.)	0.199**	0.085	0.027	0.318***	0.058	0.000
% of total workers engaged in agriculture	-0.201	0.345	0.565	0.112	0.094	0.235
Rural literacy (%)	0.103	0.255	0.689	-0.014	0.089	0.874
Constant	0.133	0.257	0.609	0.059	0.123	0.630
	R-Sq. : Within =0.8235			R-Sq. : Within =0.8002		
	Between = 0.5179			Between = 0.9026		
	Overall = 0.5776			Overall = 0.8736		
	Sigma_u = 0.1671			Sigma_u = 0.0623		
	Sigma_e = 0.0683			Sigma_e = 0.0683		
	Rho =0.8569			Rho =0.4542		

Source: Author's own estimates

Note: *** ≤ 0.01 = Significant at 1 % level, 0.01 < ** ≤ 0.05 = Significant at 5% level, 0.05 < * ≤ 0.1 = Significant at 10 % level

Table 4. Panel Data Analysis of Yield of Paddy

Variables	Fixed Effect Estimation with Robustness			Random Effect Estimation with Robustness		
Dependent variable : Yield of Paddy	Coefficients	Standard Error	P Values	Coefficients	Standard Error	P Values
1	2	3	4	5	6	7
Independent variables:						
Rainfall (mm)	0.260**	0.11	0.025	0.16	0.118	0.175
Irrigated area under paddy as % of GCA Paddy	0.451*	0.225	0.054	0.557***	0.165	0.001
Cultivated area as % of cultivable area	0.183	0.137	0.191	0.039	0.084	0.643
GCA under paddy as % of overall GCA	-0.673	0.64	0.302	0.108	0.242	0.656
Cropping intensity (%)	0.466	0.327	0.165	-0.073	0.128	0.568
Average size of operational holdings (Ha)	-0.107	0.177	0.55	0.067	0.126	0.595
Area under HYV paddy as % of GCA under paddy	-0.17	0.104	0.113	-0.028	0.113	0.801
Fertilizer consumption (Kg./Ha.)	-0.107	0.218	0.628	0.156	0.166	0.349
% of total workers engaged in agriculture	-0.502	0.873	0.57	-0.272*	0.143	0.057
Rural literacy (%)	-0.456	0.656	0.493	-0.09	0.157	0.565
Constant	0.907	0.526	0.095	0.258	0.210	0.218
	R-Sq. : Within =0.3077			R-Sq. : Within =0.1570		
	Between = 0.0102			Between = 0.4978		
	Overall = 0.0010			Overall = 0.3533		
	Sigma_u = 0.3923			Sigma_u = 0.0960		
	Sigma_e = 0.1906			Sigma_e = 0.1906		
	Rho =0.8090			Rho =0.2025		

Source: Author's own estimates

Note: *** ≤ 0.01 = Significant at 1 % level, 0.01 < ** ≤ 0.05 = Significant at 5% level,0.05 < * ≤ 0.1 = Significant at 10 % level

In conformity with common perception rainfall, irrigation coverage, area under food grains and HYV paddy, and the share of agriculture in total workers have a direct bearing on the yield of food grains. However, the impact of these factors is not statistically significant. Rural literacy has a negative effect probably because of brain drain from agriculture. The share of cultivated area in cultivable area also has a negative impact. This may be due to problems in cultivating land posed by inadequate input supply, inappropriate and limited mechanization and shortage of labour.

We have estimated the impact of some relevant factors on productivity of paddy with the help of the following specification of the model.

$$P_{it} = k + \gamma_1 RA + \gamma_2 IP + \gamma_3 CP + \gamma_4 AP + \gamma_5 CI + \gamma_6 AH + \gamma_7 HY + \gamma_8 FC + \gamma_9 WA + \gamma_{10} RL + \in^{*} \quad (4)$$

where P= Yield of paddy, IP=Irrigated area under paddy as per cent of GCA under paddy, AP=GCA under paddy as per cent of overall GCA, $\in^{*}$=Error term, k =constant term, RA,CU,CI, AH, HY, FC, WA and RL are the parameters as defined in equation-3 and the γs are the coefficients of the parameters. The results of the estimated equation have been presented in Table-4 which make interesting reading.

Yield of paddy is found to be influenced most by irrigation. Estimated results indicate that a one per cent increase in irrigated area under cultivation of paddy leads to a 0.557 per cent increase in the yield of paddy per hectare. The other important factors exerting a positive influence on yield of paddy are rainfall, consumption of fertilizer, average size of operational holdings and share of cultivated area in cultivable area and of area under paddy in GCA. Of course the impact of these factors is not statistically significant. These results reestablish the dependence of agriculture on rainfall, fertilizer consumption and such other factors.

The factors negatively impacting yield of paddy are share of agricultural workers followed by rural literacy, cropping intensity and area under HYV paddy in that order. Among these factors the negative impact of the share of agriculture workers is statistically significant while those of the other three are not so.

3.4 Disparities across Districts and Agro-Climatic Zones

Odisha has 30 administrative districts and 10 agro-climatic zones. The details of the constitution of the zones are given in Table-5. Since administrative division is given credence for policy making and planning purposes we have analyzed the spatial variations in agricultural development at the district level with some focus on the agro-climatic zones. The CADI scores for the districts in terms of the PCA model are presented in the tableto highlight the regional disparities. The districts have been ranked in the descending order of their CADI scores. Instead of adopting arbitrary cut-off score points we have attempted to differentiate the districts by their levels of agricultural performance through division into three equal groups. Accordingly, the top 10 districts have been categorized as the most developed, followed by the middle ranking 10 developed districts and the 10 bottom ranking less developed districts.

The table indicates wide district level inequalities in levels of agricultural development in Odisha as measured in terms of coefficient of variation in their CADI scores. The coefficient of variation remains very high for the reference years 2001-02, 2006-07 and 2011-12. The values are 52.56, 56.55 and 56.02 in the successive years, indicating the fact that, inequalities have increased during 2001-02 to 2006-07. It is heartening to note that the disparities have slightly moderated during 2006-07 to 2011-12 may be due to the differentiated policy measures adopted by the Government for the backward areas.

It can be seen from the table that three districts in the WCTL zone (Bargarh, Sambalpur and Subarnapur) and one district in the NECP zone (Bhadrak) are among the ten agriculturally most developed districts with consistently very high CADI scores in the three reference years. Interestingly, they have exchanged ranks within the top 10 category in the three years. The two districts in the WUZ (Kalahandi and Nuapada) which constitute the most backward among the proverbial KBK districts are among the agriculturally least developed with abysmally low CADI scores in all the three reference years. Kandhamal of

NEG zone is the lone district in the state with a consistently moderate CADI score for which it remained in the category of middle ranking / developed districts in all the years under reference. Barring these seven, the rest 23 districts have different CADI scores for which their ranks and positions have changed across the reference years.

Table -5. CADI Scores of Districts in Agro-Climatic Zones of Odisha

Agro-Climatic Zones	Districts	CADI 2001-02	Ranks	CADI 2006-07	Ranks	CADI 2011-12	Ranks
1	2	9	10	11	12	13	14
North-Western Plateau	Sundargarh	0	30	0.13882	28	0.73202	9
	Debagarh	0.30030	24	0.14746	27	0.60264	12
North -Central Plateau	Mayurbhanj	0.56674	12	0.49922	10	0.80600	6
	Kendujhar	0.27444	26	0.24469	24	0.69758	11
North-Eastern Coastal Plain	Balasore	0.82095	6	0.48562	11	0.98139	2
	Bhadrak	0.99963	2	0.72122	5	0.71256	10
	Jajpur	0.51339	13	0.30037	20	0.36589	21
East and South-Eastern Coastal Plain	Cuttack	0.61391	11	0.44873	15	0.73753	8
	Jagatsinghpur	0.62576	10	0.42424	16	1.00000	1
	Kendrapara	0.38709	21	0.10418	29	0.56288	14
	Puri	0.65928	9	0.47097	14	0.54115	15
	Khordha	0.46807	17	0.52079	7	0.59535	13
	Nayagarh	0.49824	14	0.27739	22	0.09191	28
North-Eastern Ghat	Ganjam	0.98380	3	0.75848	4	0.07613	29
	Gajapati	0.76516	7	0.51107	9	0.32812	22
	Rayagada	0.38554	22	0.47908	12	0.44458	17
	Kandhamal	0.45910	18	0.30838	19	0.36745	20
Eastern Ghat High Land	Koraput	0.40616	20	0.51522	8	0.53663	16
	Nabarangpur	0.29052	25	0.38823	17	0.27452	24
South-Eastern Ghat	Malkanagiri	0.04736	29	0.32937	18	0.09954	27
Western Undulating Zone	Kalahandi	0.37691	23	0.19090	25	0.28397	23
	Nuapada	0.12546	28	0.00000	30	0.16348	26
Western Central Table Land	Bolangir	0.42894	19	0.28042	21	0.00000	30
	Subarnapur	0.94579	4	1.00000	1	0.91830	4
	Boudh	0.20075	27	0.47487	13	0.38659	19
	Sambalpur	0.82791	5	0.80832	3	0.74823	7
	Bargarh	1.00000	1	0.89149	2	0.92427	3
	Jharsuguda	0.48747	16	0.58597	6	0.40889	18
Mid -Central Table Land	Dhenkanal	0.73513	8	0.26311	23	0.82962	5
	Angul	0.48870	15	0.16160	26	0.26772	25
Coefficient of Variation		52.56		56.55		56.02	

Source: Author's compilation and calculation from Odisha Agriculture Statistics (various years) and Census of India 2011 Primary Census Abstract Data Highlights ODISHA Series 22

Table-6: Inter-District Disparities in Indicators of Agricultural Development

Indicators	Coefficient of Variation		
	2001-02	2006-07	2011-12
1	2	3	4
Yield of Foodgrains	19.68	20.93	33.91
Yield of Paddy	17.47	18.47	39.34
Annual Rainfall	17.47	18.17	17.02
Gross Irrigated Area as % of Gross Cropped Area	46.04	39.64	39.89
Cultivated Area as % of Cultivable Area	6.38	2.96	2.96
Area under Non-Food Grains as % of Gross Cropped Area	29.94	35.31	30.59
Cropping Intensity	12.34	12.66	14.61
Average Size of Operational Holdings	21.61	21.65	23.81
Area under HYV Paddy as % of Gross Cropped Area under Paddy	17.87	12.46	19.91
Fertilizer Consumption	61.70	53.58	63.85
Percentage of Total Workers Engaged in Agriculture	12.93	13.78	14.83
Rural Literacy Rate	27.21	22.96	19.64
CADI Score	52.56	56.55	56.02

Source : Author's own calculation

Mayurbhanj, Kendujhar and Sundargarh districts have achieved continuous improvements while Bhadrak, Jajpur, Puri, Nayagarh, Ganjam, Gajapati, Kandhamal, Bolangir and Bargarh have suffered persistent deterioration in their ranks over the three benchmark years. The six districts which improved their ranks in 2006-07 over 2001-02 but went to lower ranks in 2011-12 while still showing improvement as compared to 2001-02 have been Khordha, Rayagada, Koraput, Nabarangpur, Malkangiri and Boudh. The lone district which improved its rank in 2006-07 with deterioration in 2011-12 but maintained the same rank in 2011-12 as 2001-02 is Subarnapur. Two districts which have shown improvement in 2006-07 and then deterioration in 2011-12 with a lower rank in comparison to 2001-02 and 2006-07 are Sambalpur and Jharsuguda. Seven districts such as Debagarh, Balasore, Cuttack, Jagatsinghpur, Kendrapara, Nuapada and Dhenkanal achieved lower ranks in 2006-07 over 2001-02 but improved their ranks in 2011-12 with higher ranks in relation to both the previous benchmark years. Kalahandi came to a lower rank in 2006-07 over 2001-02 but improved in 2011-12 still having the same rank in 2011-02 as in 2001-02 while Angul which suffered deterioration in 2006-07 but improvement in 2011-12 has a lower rank than in 2001-02.

An important fact may be noted while passing. Most of the districts in the coastal belt (NECP and ESECP zones) and central table land region (WCTL and MCTL zones) are agriculturally more developed than others. Their plain, fertile and alluvial soil; greater irrigation spread and higher fertiliser consumption; and comparatively better rainfall are the enabling factors behind their more advanced agricultural development. On the contrary, a major portion of area sown in rest of the districts and agro-climatic zones are textured land with low organic matter, and warm and humid climate, rain fed and drought prone which may be responsible for their low level of agricultural development.

3.5 Spatial Variations - A New Look through the Key Indicators

Levels of overall development of agriculture have been markedly different across districts and agro-climatic zones. But they do not yield any definite pattern and considerable variations are found over the years under reference. Since we have measured agricultural performance in terms of the composite index technique, it is appropriate to examine the issue in terms of the underlying key indicators. Dynamics of the selected indicators as measured by coefficients of variation show how the disparities have changed since 2001-02.The information in this regard is presented in Table-6.

It may be read off the table that the behavior of the indicators have not been uniform over the years. For some indicators, the inter-district disparities have widened while for some others they have moderated and there are still others which do not exhibit any consistent pattern. In the case of rural literacy rate, the disparity has substantially moderated i.e. coefficient of variation has lowered with time. For a number of indicators such as yield rates of food grains and paddy, cropping intensity, size of holdings and share of agriculture in total workers, the disparity across the districts has widened in the successive reference years i.e. coefficients of variation have increased consistently. In respect of these indicators the developed districts are marching ahead while the backward ones are lagging behind. In terms of the share of area under cultivation in cultivable area the disparity has considerably lowered in 2006-07 over 2001-02 and then persisted at the same level. When we look at irrigation coverage, area under HYV paddy and consumption of fertilizer, disparities are found to have decreased in 2006-07 over 2001-02 but increased in 2011-12 over 2006-07. Inter- district disparities in annual rainfall and percentage of area under non-food crops are observed to have increased in 2006-07 over 2001-02 but decreased in 2011-12 over 2006-07.The disparities in CADI score, as explained earlier, have increased in 2006-07 and moderated only slightly in 2011-12 but stand higher than those in 2001-02.The moderation in disparities is, indeed, a welcome sign.

4. Conclusions and Policy Implications

Agriculture is a prime sector of the economy of Odisha where industrial expansion has been limited due to various constraints. But the trend and pattern of agricultural development has been grossly uneven across time and space. Productivity of land, the most important measure of agricultural development, exhibit large disparities and worse still, the disparities are widening over the years. The CADI, constructed for the districts on the basis of some selected indicators at the three points of time chosen in the study, indicate that the leading and lagging districts have, by and large, maintained their agricultural development status over the period of ten years (2001-02 to 2011-12). With few exceptions, normally most of the districts in the coastal belt (NECP and ESECP zones) and central table land region(WCTL and MCTL zones) have occupied ranks in the class of 10 developed districts while most of the districts in the eastern ghat area (NEG,EGHL,SEG and WU zones)have remained in the bottom 10 less developed category. Of course, some of the districts have been seen changing their ranks over the years under reference. Available evidence suggests that the high and yawning disparity is due to differences in location, topography, natural endowments, technology adoption, irrigation spread, crop diversification and commercialization in agriculture.

Disparity anywhere is a threat to growth and development. If allowed to persist and accentuate, it will put the largest chunk of population and a vital sector of the economy under duress. And given the emphasis on balanced and inclusive development, the imperatives of addressing disparity are well apparent. The following policy implications drawn from our study may be suggested to put the agricultural sector of the state in right gear.

We need to establish farming systems which are appropriate for and tolerant towards sustainable agriculture. The existing practice of using more external inputs helps to tighten the control of external agencies on agriculture and disempower farmers. Large scale use of chemical fertilizer has reduced soil quality and done colossal damage to land. Hence there is an urgent need of strengthening indigenous innovation for developing, disseminating and adopting affordable, suitable and effective technology and crop varieties. Development of less water-intensive and women labour friendly technology assumes importance in this regard. Agricultural extension and training need to be oriented to educate the farmers and expedite the process.

Non availability of easy, affordable and dependable finance is a perennial problem in Odisha agriculture. Given the limitations of micro credit, the RBI and NABARD need to develop an appropriate mechanism of greater financial inclusion to ensure the flow of credit and subsidy to the really needy farmers. Plugging leakages in the delivery system will be the key in this context.

Modern agriculture is water-intensive but irrigation coverage is very limited. Pani Panchayats are not doing as per expectations and the government is withdrawing and avoiding responsibility. In the process the farmer are getting little pani and less of panchayat. There is need of effective government intervention to streamline the working of the irrigation system, and increase public investment in agricultural infrastructure including irrigation.

Agricultural development is polarized and exclusive. The lagging districts and agro-climatic zones have specific and differentiated problems. Designing region and crop-specific strategies is very important to bridging the disparity and resurrecting agriculture in the state. The government should formulate, adopt and implement area-specific plans and a long term policy to give a new direction to the state's agriculture.

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Appendix

Weights on Indicators of Agricultural Development

Indicators	Weights		
	2001-02	2006-07	2011-12
1	2	3	4
Yield of Food grains (Kg/Ha)	0.1156	0.04	0.1521
Yield of Paddy (Kg/Ha)	0.1156	0.04	0.1849
Rainfall (mm)	0.0144	0.0121	0.04
Gross irrigated area as % of GCA	0.1156	0.1764	0.2209
Cultivated area as % of cultivable area	0.0049	0.0049	0.0049
Cropping intensity (%)	0.0256	0.0324	0.0196
Average size of operational holdings (Ha)	0.0784	0.0841	0.04
Area under non food grains as % of GCA	0.0784	0.0289	0.09
Area under HYV paddy as % of GCA under paddy	0.0729	0.1936	0.0016
Fertilizer consumption (Kg/Ha)	0.1296	0.0729	0.0361
% of total workers engaged in agriculture	0.09	0.1156	0.0729
Rural literacy (%)	0.1521	0.1936	0.1369
Total	**0.9931**	**0.9945**	**0.9999**