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Changing Cropping Pattern, Agricultural Diversification and Productivity in Odisha – A District-wise Study

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Abstract

The paper examines the structure and nature of cropping pattern, crop diversification, crop concentration, productivity level and inter-districts disparity in the state of Odisha based on the secondary data collected for the period 1980 – 2005 from different published sources. The study has used Herfindahl index, location quotient, Gini coefficient and panel data regression for analysis. The study has revealed that most of the districts in Odisha are experiencing a lateral movement towards crop specialization and crop diversification is seen only in tribal-dominated / technologically less-developed districts. The study has observed a reduction in inequality during the studied period and has concluded that districts in Odisha are converging as far as agricultural productivity is concerned. The study has identified the major determinants of agricultural productivity in Odisha and has suggested some policy measures for increasing agricultural productivity in the state.

Key words: Cropping pattern, crop diversification, crop concentration, agricultural productivity, Odisha

JEL Classification: Q1, Q 15, Q19, Q24

Introduction

Odisha is primarily an agrarian economy and agriculture holds the key to overall development of the state, which remains backward, unstable, rain-fed, traditional and prone to natural calamities like droughts, floods and cyclones. The Odisha's agricultural scenario has become "stagnant" over a long period of time (Pattnaik and Shah, 2010; Swain, 1999). Tripathy and Sarap (1994, p.969) state that an important determinant of growth in agricultural income is the rise in agricultural output, and change in crop pattern. These in turn depend on institutional as well as technological factors.

Agriculture continues to be the mainstay of Odisha economy with contribution of about 25.6 per cent to the state gross domestic product during 2000-2005. The performance of agriculture in the state of Odisha since 1980-81 shows that the overall pattern of structural changes is associated with the process of economic development (Table 1). During the past three decades, the contribution of agriculture and allied sector to the net state domestic product (NSDP) declined consistently and continuously from 56.6 per cent during 1980-1985 to 29.7 per cent during 2000-2005 and further to 19.4 per cent in 2009-10. On the other hand, the contribution of industry and services sectors increased respectively from around 15.4 per cent and 28.0 per cent in the 1980-1985 to around 20.7 per cent and 49.6 per cent in 2000-2005 and reached 26.3 per cent and 54.4 per cent, respectively in 2009-10.

Despite decline in its share of NSDP of Odisha, agriculture continues to be a major source of livelihood to a significant segment of population (around 60%). Therefore, agricultural development holds the key to

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Table 1. Sectoral composition of net state domestic product (NSDP) in Odisha: 1980 to 2010

(per cent)

Sector	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2009-2010
Agriculture and allied	56.58	51.65	41.76	37.20	29.70	19.35
Agriculture	48.89	45.93	36.93	32.67	25.57	16.75
Forestry and logging	6.97	4.82	3.43	2.78	2.65	1.67
Fishing	0.73	0.90	1.41	1.75	1.48	0.93
Industry	15.41	16.59	20.83	19.77	20.67	26.25
Services	28.01	31.75	37.41	43.03	49.63	54.40
Per capita NSDP at 1999-2000 prices (in ₹)	7960	9084	8921	9855	11323	19456

Source: Calculated by author, taking NSDP at factor cost data from http://www.mospi.gov.in/cso_rept_pubn.htm, Accessed: 7 May, 2011

the overall development of the state by way of creating employment, generating income, providing raw materials to the industrial sector and ensuring food security for the poor. Agriculture in Odisha is characterized by low productivity due to dominance of traditional agricultural practices, inadequate capital formation, low investment, inadequate irrigation facilities and uneconomic size of holdings. The recent years have experienced not only low productivity but also declining productivity.

The paper examines the structure and nature of changing cropping pattern and crop diversification, crop concentration, productivity level and inter-districts disparity in the state of Odisha during the past three decades (1980-2005). These have been studied through measuring across districts and state as a whole, temporal percentage changes in area share of agricultural crops, crop diversification, crop concentration index, productivity index and disparity in agricultural productivity. The methods employed for the study included Herfindahl Index for measuring crop diversification, locational quotient measure for crop concentration (Ghosh, 2011), and Sapre and Deshpande index (Sapre and Deshpande, 1964) for measuring ranks of the districts as per their agricultural productivity. To compare inter-districts disparity, various inequality measures were calculated; these included relative mean deviation, coefficient of variation, standard deviation of logs, Gini coefficient and Theil index. The correlation and panel data regression was used for the comparative analysis.

Data and Methodology

This study has conducted analysis at disaggregated level by districts and has analyzed 30 crops grown in Odisha covering 96-98 per cent of gross cropped area. The crops selected for the study were (i) Cereals: rice, wheat, maize, jawar, ragi, bajra, small millets; all *kharif* and *rabi* pulses: biri, mung, kulthi, arhar, gram; (ii) Oilseeds: til, mustard, groundnut, castor, linseed, niger, sun flower, safflower; (iii) Vegetables: onion, potato, sweet potato; sugarcane; mesta; fibre crops: sunhemp, jute and cotton; and (iv) Cash crops: chilies, corriender, garlic, ginger, turmeric. The study period, 1980 to 2005 was divided into five sub-periods and quinquennial averages were worked out. The data were obtained from published sources of Directorate of Agriculture and Food Production, Government of Odisha, Bhubaneswar.

Crop Diversification

To study crop diversification, Herfindahl index was used. It is defined as: $HI = \sum_{i=1}^{n} p_i^2$, where, p_i is the proportion of area under i^{th} crop, $p_i = A_i \Big/ \sum_{i=1}^{n} A_i$, in which A_i is the area under i^{th} crop and $\sum_{i=1}^{n} A_i$ denotes the total cropped area. The value of Herfindahl index varies between 0 and 1; the value 1 depicts perfect specialization and 0, shows perfect diversification.

Crop Concentration

Crop concentration means the "*variation in the density of crops in an area or region at a given point/*

period of time" (Ghosh, 2011). The concentration of a crop in an area largely depends on its terrain, temperature, moisture, price and income, social factors, government policy, type of soils and many others. The most commonly method to study crop concentration is the Location Quotient (LQ) method.

$$LQ = \frac{A_{ij}}{A_j} \Bigg/ \frac{\sum_{i=1}^{n} A_{ij}}{\sum_j A_j}$$

where, A_{ij} is the gross cropped area under the i^{th} crop in j^{th} district, A_j is the gross cropped area in the j^{th} district, and ΣjAj is the gross cropped area in the state which is the summation of GCA of each district. Using this Location Quotient method, Crop Concentration Index (CCI) was calculated. If CCI value is higher than unity, the component areal unit accounts for a share greater than it would have had if the distribution was uniform in the entire region and therefore, the areal unit has a concentration of great agricultural significance.

Agricultural Productivity

To assess agricultural productivity, *Sapre and Deshpande* index was used. This method is widely used because, along with crop yield level's rank, it takes into account the proportion of area under crop. Instead of using simple average ranks, weighted average of ranks is used. The lower is the value of index, the higher is the productivity level. Because, if a district has yield level in rice which is highest in the state, its weightage is 1; whereas if a district's yield level in rice is ranked 10th in the state, it will get weightage 10. The formula for calculating this index can be expressed as:

$$\text{Spare and Deshpande index} = \frac{r_{1i}p_{1i} + r_{2i}p_{2i} + \ldots\ldots + r_{ni}p_{ni}}{p_{1i} + p_{2i} + \ldots\ldots + p_{ni}}$$

where, $r_1,\ldots,r_n$ represent the rank of crops as per their yield level in the district '*i*' in comparison to other district and $p_1,\ldots,p_n$ represent the proportion of area devoted to these crops in the district '*i*'.

Results and Discussions

Cropping Patterns in Odisha

The cropping pattern has shown a changing trend in Odisha in recent years (Table 2). The area under rice has increased from 48.1 per cent of the gross cropped area of the state in 1980-1985 to 55.6 per cent during 2000-2005. There is a marginal increase in the area under cash crops.

The temporal changes in cropping pattern in Odisha reveal crop diversification in the state. During the period 1980-2005, the area under some cereals (wheat, ragi, jowar, bajra and small millets); rabi pulses; oilseeds (castor, linseed, and safflower); and cash crops (jute, mesta, tobacco) declined by varying degrees, and increased under selected cereals (rice and maize); oilseed crop sunflower; cash crop cotton; and condiment and spice crop ginger. The vegetable crops like potato, sweet potato and onion have not revealed any clear pattern of changes during the period studied. Based on a similar periodical trend change, the cropping pattern across the selected 30 crops revealed three major groups. One, where area under crops increased from 50 per cent to around 60 per cent; Two, crops in which area decreased from around 25 per cent to 16 per cent, and Three, crops group sharing between 12 and 15 per cent area, did not reveal any clear trend of increasing or decreasing area.

It can be observed from Table 2 that even if there is diversification as reflected through the periodical changes in the cropping pattern of around ten crops (wheat, ragi, jowar, bajra, small millets, castor, linseed, safflower, jute, mesta and tobacco), it is outweighed by the specialized and concentrated crops. Although the number of these specialized crops is small (viz., rice, maize, sunflower, cotton and ginger), the total share of their area is high. Among individual crops, rice has the highest share in area, and this has increased over time in the two and half decades under consideration. An important implication of this observation is that contrary to the association of crop diversification with agricultural development, specialization is associated with higher commercialization and agricultural development in Odisha.

Crop Diversification in Odisha

The computed values of Herfindahl index are presented in Table 3 district-wise for the state of Odisha. A perusal of Table 3 reveals that during the first period (1980-1985), except Cuttack, Dhenkanal, Koraput, Phulbani, all other districts were relatively specialized

Table 2. Changes in cropping pattern in Odisha: 1980 to 2005

Crop groups	Crops	Share in total cropped area (%)				
		1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Cereals	Rice	48.12	48.06	47.31	53.97	55.58
	Wheat	0.83	0.50	0.27	0.21	0.21
	Ragi	3.55	2.91	2.51	2.41	2.39
	Maize	1.81	1.83	2.02	1.91	2.21
	Jowar	0.39	0.36	0.22	0.19	0.14
	Bajra	0.11	0.09	0.07	0.05	0.04
	Small millets	2.42	1.24	0.72	0.58	0.41
	Total cereals	57.25	54.98	53.13	59.32	61.00
Pulses	*Kharif* pulses	5.92	6.96	7.24	6.64	6.89
	Rabi pulses	15.19	15.13	14.91	13.49	12.41
	Total pulses	21.11	22.09	22.15	20.13	19.30
	Total food grains	78.35	77.08	75.27	79.45	80.30
Oilseeds	Groundnut	2.79	4.02	3.59	3.34	2.73
	Til	2.74	3.29	4.35	3.42	3.09
	Castor	0.51	0.39	0.29	0.29	0.21
	Mustard	1.45	1.54	1.72	1.49	1.32
	Linseed	0.39	0.36	0.34	0.35	0.25
	Niger	1.97	2.05	2.08	1.83	1.70
	Sunflower	0.01	0.04	0.05	0.07	0.07
	Safflower	0.05	0.04	0.03	0.03	0.02
	Total oilseeds	9.92	11.72	12.44	10.82	9.40
Vegetables	Potato	0.10	0.11	0.11	0.11	0.10
	Sweet potato	0.63	0.63	0.54	0.60	0.54
	Onion	0.46	0.49	0.48	0.59	0.29
	Total vegetables	8.09	7.72	9.01	6.16	7.08
Cash crops	Sugarcane	0.57	0.51	0.44	0.53	0.29
	Jute	0.54	0.39	0.35	0.22	0.15
	Mesta	0.48	0.43	0.34	0.36	0.32
	Sunhemp	0.13	0.15	0.14	0.14	0.13
	Cotton	0.04	0.05	0.06	0.30	0.53
Condiments and spices	Chilies	0.95	0.98	1.01	1.01	0.92
	Coriander	0.19	0.21	0.23	0.26	0.21
	Garlic	0.19	0.23	0.20	0.19	0.13
	Ginger	0.07	0.08	0.11	0.15	0.18
	Turmeric	0.28	0.27	0.26	0.30	0.31
	Total condiments and spices	1.67	1.78	1.81	1.91	1.74
	Tobacco	0.21	0.17	0.13	0.10	0.06

Source: Calculated from area data obtained from published sources of Directorate of Agriculture and Food Production, Government of Odisha

Note: List of crops taken here cover 96-98 per cent of GCA in the districts of Odisha.

Table 3. District-wise crop diversification index in Odisha, 1980-2005

District	HI index value				
	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Balasore	0.69	0.66	0.62	0.74	0.73
Bolangir	0.68	0.61	0.60	0.66	0.69
Cuttack	0.61	0.60	0.58	0.64	0.67
Dhenkanal	0.61	0.54	0.50	0.57	0.55
Ganjam	0.69	0.64	0.65	0.70	0.67
Kalahandi	0.65	0.63	0.67	0.64	0.68
Keonjhar	0.65	0.62	0.58	0.63	0.59
Koraput	0.58	0.57	0.57	0.58	0.60
Mayurbhanj	0.68	0.65	0.62	0.69	0.72
Phulbani	0.48	0.50	0.48	0.54	0.53
Puri	0.68	0.70	0.72	0.76	0.75
Sambalpur	0.69	0.64	0.60	0.64	0.69
Sundergarh	0.69	0.64	0.61	0.69	0.74
Odisha	0.65	0.61	0.60	0.65	0.66

Source: Author's calculations based on 'area' data for crops taken from Directorate of Agriculture & Food Production, Odisha, Bhubaneswar

districts with HI-index value higher than the state's average value. In the second period (1985-1990), except four districts, viz. Cuttack, Dhenkanal, Koraput, and Phulbani, all other districts have depicted HI-index value higher than 0.6 (i.e. relatively more specialized); the district Phulbani has been found to be the least specialized district. In the third period (1990-1995), Puri, Ganjam, Balasore, Kalahandi, Mayurbhanj and Sundergarh have been found highly specialized districts, while Phulbani, Koraput, Keonjhar, Dhenkanal and Cuttack were the least specialized districts. In the fourth period (1995-2000), there is only one district, viz. Kalahandi where HI value has declined. In the fifth period (2000-2005), the HI values increased to the state average value in seven districts, while, HI values declined vis-a-vis previous period in six districts. In this period, all the thirteen districts have depicted HI-index value greater than 0.5. A comparison of HI values for the periods 1980-1985 and 2000-2005 reveal that except Phulbani, all other districts have experienced a significant degree of crop specialization.

The districts Balasore and Puri, known as rice bowl of Odisha, have depicted higher values of HI, close to 0.7 in the first period. Five other districts have also experienced a similar kind of trend and this signifies crop specialization in the area. From first to second period, there is a clear trend of decline in HI values for all the districts, except Phulbani and Puri. In the next phase of second to third period, except Ganjam, Kalahandi, and Puri, the rest 10 districts continued the declining trend in their HI values. From third to fourth period, the HI values for all districts have shown a significant change towards crop specialization, with the exception in Kalahandi district. The last phase has shown a mix of decline and increase in the number of districts in terms of their HI values. The average value of HI index for all the districts was computed as 0.65 in the first period, and it went down to 0.61 in second period and further to 0.60 in the third period, but in the later two periods, it again scored 0.65 and 0.66 values.

Hence, we may conclude that in Odisha most of the districts are experiencing a lateral movement toward crop specialization and the crop diversification is not happening. This finding needs to be seen in the context of the fact that most tribal-dominated/less-developed districts (such as Phulbani) have depicted a higher level of diversification. The agricultural development has mostly taken the form of shift toward rice production in most districts (such as Sambalpur and Bargarh) of the state.

Table 4. Correlates of crop diversification in Odisha

Correlate	HI value
Herfindahl index	1.000
Cropping intensity	0.421**
Crop yield	-0.011
Net irrigated area	0.305*
Number of landholdings	0.292*
Area operated	0.123
Chemical fertilizer consumption	0.339**
Share of total foodgrain in GCA (%)	0.972**
Share of total oilseeds in GCA (%)	-0.847**
Share of total vegetables in GCA (%)	-0.154
Share of total condiments and spices in GCA (%)	-0.624**
Share of other total crops in GCA (%)	-0.061

Source: Computed data.
Note: * and ** show significance at 0.05 per cent and 0.01 per cent levels, respectively.

Determinants of Crop Diversification

Among the host of factors, crop yield and cropping intensity are the most important determinants of crop choice. If yield level of crop increases, then these crops attract a major chunk of area in a cropping season. But, if cropping intensity increases, then crop diversification takes place. Hence, we hypothesized that crop yield will be negatively and cropping intensity will be positively correlated with crop specialization index.

Table 4 shows the correlation between HI values and factors affecting crop diversification in Odisha. It shows that correlation coefficient for share of total oilseeds is highest (0.972), followed by the share of condiments and spices, vegetables, other total crops and crop yield and these are correlated positively for making diversification in crop cultivation. On the other hand, crop specialization observed in Odisha, is supported positively by the share of total foodgrains, cropping intensity, chemical fertilizer consumption, net irrigated area, number of landholdings, and area operated.

The regression estimates for crop diversification are given in Table 5, where the dependent variable HI indicates that higher is the value less will be the crop diversification and vice versa. The independent variables are cropping intensity, irrigation, fertilizer, share of area under fertilizer and area share under condiments and spices, and foodgrains. The problem of multicollinearity has been taken care of and hence, the mean value of variance inflationary factor (VIF) has been estimated as 2.18, showing no multicollinearity.

The overall significance of F value is quite satisfactory and R-squared value showing 95 per cent variation has been determined by these independent variables. Fertilizer consumption has not emerged significant for crop diversification. Although marginal, irrigation and area under condiments and spices crops

Table 5. Regression estimates for crop diversification in Odisha

Dependent variable: Herfindahl index

Independent variable	Coefficients	P > | t |	Variance inflationary factor	Prob>F	R-squared value
Cropping intensity	0.000 (0.000)	0.009**	2.06		
Irrigation	-0.000 (0.000)	0.018**	3.17		
Fertilizer	0.000 (0.000)	0.648	2.23	0.000***	0.95
Share of area under foodgrains	0.012 (0.001)	0.000***	1.86		
Share of area under condiments & spices	-0.003 (0.001)	0.081**	1.59		
Constant	-0.371 (0.042)	0.000	-		

Source: Author's calculations.
Note: *** and ** Indicate significance at the 1 per cent and 5 per cent levels, respectively; Standard errors are reported in parentheses of coefficients;
Mean VIF = 2.18
Number of observations = 65.

Table 6. Percentage share of GCA under total foodgrains in Odisha across districts against other crops

(per cent)

District	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Balasore	82.15	80.05	77.19	85.36	84.66
Bolangir	81.32	76.70	75.85	80.10	82.54
Cuttack	77.25	76.00	74.04	78.78	80.86
Dhenkanal	77.47	70.71	66.81	71.89	71.85
Ganjam	82.18	78.45	81.06	83.02	80.80
Kalahandi	78.25	77.94	73.61	78.76	81.70
Keonjhar	76.81	76.96	74.34	76.70	74.71
Koraput	74.08	73.79	74.23	75.10	75.77
Mayurbhanj	81.91	80.21	77.67	82.61	84.46
Phulbani	68.37	66.76	64.97	70.96	70.66
Puri	79.32	83.28	84.26	87.28	85.75
Sambalpur	81.89	78.76	75.59	78.71	82.32
Sundergarh	82.20	79.26	76.30	82.10	85.29
Odisha	78.35	77.08	75.27	79.45	80.30

Source: Calculated from area data obtained from published sources of Directorate of Agriculture and Food Production, Government of Odisha

influence crop diversification (at 5 % level). Area share under foodgrains (at 1 % significance level) and cropping intensity (at 5 % significance level) exercise crop specialization.

The extent of crop diversification varies across districts, depending upon agro-climatic conditions and also equally important factors are crop yield and cropping intensity. In this context, Table 6 shows that there has been a significant share of total foodgrains in gross cropped area, which shows the occurrence of reverse of diversification, i.e. crop specialization. It is seen that not a single district has less than 65 per cent gross cropped area under total foodgrain crops. It implies that this is the sole reason of crop specialization in the state. It was therefore decided to see which crops are getting concentrated across the districts in comparison to the state as a whole.

Crop Concentration

- The crop concentration index (Table 7) shows that out of 30 crops grown in Odisha, the focus is only on following 7 crops: Rice, Maize, Ragi, Niger, Mustard, Til, Groundnut and Turmeric.
- In all the 13 districts, the value of concentration index for rice is higher than for rest of the crops grown in Odisha in all the five sub-periods from 1980 to 2005.
- The CCI value for maize has been found greater than unity in only two districts — Phulbani and Keonjhar — for all the five sub-periods.
- As per CCI value, ragi has depicted concentration only once in the first period (1980-1985) and only in two districts, Phulbani (1.53) and Ganjam (1.05).
- Niger crop has shown concentration in only two districts, Phulbani and Keonjhar, although it has shown presence in all the sub-periods.
- The concentration of mustard crop has been observed only in one district, Phulbani, in all the five sub-periods, while groundnut has depicted concentration in only one period (1985-1990) and one district, Dhenkanal.
- Til and turmeric crops have shown concentration in Dhenkanal and Phulbani districts, respectively.

Productivity Level and Inter-district Disparities

Table 8 presents the ranking of the districts in Odisha as per Sapre and Deshpande index. It shows a declining trend in agricultural productivity in Odisha for the period 1980 to 1995 and increasing trend for the period 1995 to 2005. The results remain somewhat inconclusive as the overall productivity has decreased between 1980 and 2005 and the value of index has

Table 7. Crop concentration index (CCI) of major crops in Odisha 1980-2005

	1980-1985		1985-1990		1990-1995		1995-2000		2000-2005	
Crop	Districts	CCI	Districts	CCI	Districts	CCI	Districts	CCI	Districts	CCI
Rice	Sundergarh	14.52	Sundergarh	12.74	Sundergarh	12.56	Sundergarh	13.20	Sundergarh	14.75
	Keonjhar	12.90	Keonjhar	11.89	Keonjhar	12.27	Phulbani	12.90	Phulbani	13.14
	Mayurbhanj	11.08	Mayurbhanj	10.59	Mayurbhanj	10.42	Keonjhar	12.33	Mayurbhanj	12.56
	Balasore	9.83	Balasore	9.01	Phulbani	9.06	Mayurbhanj	11.75	Balasore	11.67
	Bolangir	8.11	Phulbani	8.02	Balasore	8.35	Balasore	11.29	Keonjhar	10.36
	Phulbani	7.36	Bolangir	7.20	Puri	7.40	Bolangir	8.01	Bolangir	8.07
	Dhenkanal	7.10	Sambalpur	6.39	Bolangir	7.23	Puri	7.51	Puri	7.69
	Sambalpur	7.00	Puri	6.38	Sambalpur	5.91	Sambalpur	6.38	Dhenkanal	6.56
	Puri	5.62	Dhenkanal	5.55	Dhenkanal	5.03	Dhenkanal	5.08	Sambalpur	6.37
	Ganjam	4.48	Kalahandi	4.44	Kalahandi	4.22	Ganjam	5.00	Kalahandi	5.83
	Kalahandi	4.38	Ganjam	4.08	Ganjam	4.07	Kalahandi	4.91	Ganjam	4.82
	Cuttack	3.63	Cuttack	3.64	Cuttack	3.85	Cuttack	4.58	Cuttack	4.55
	Koraput	2.92	Koraput	3.17	Koraput	2.99	Koraput	3.30	Koraput	3.49
Maize	Phulbani	1.49	Phulbani	1.56	Phulbani	1.68	Phulbani	1.81	Phulbani	1.69
	Keonjhar	1.13	Keonjhar	1.20	Keonjhar	1.22	Keonjhar	1.23	Keonjhar	1.13
Ragi	Phulbani	1.53	–	–	–	–	–	–	–	–
	Ganjam	1.05	–	–	–	–	–	–	–	–
Niger	Phulbani	2.06	Phulbani	2.33	Phulbani	2.76	Phulbani	2.17	Phulbani	1.20
	–	–	Keonjhar	1.12	Keonjhar	1.51	Keonjhar	1.48	Keonjhar	1.13
Mustard	Phulbani	1.52	Phulbani	1.50	Phulbani	2.00	Phulbani	1.80	Phulbani	1.42
Til	Dhenkanal	1.11	Dhenkanal	1.05	Kalahandi	1.54	Dhenkanal	1.36	Dhenkanal	1.42
					Dhenkanal	1.49				
Groundnut	–	–	Dhenkanal	1.29	–	–	–	–	–	–
Turmeric	Phulbani	1.31	Phulbani	1.13	Phulbani	1.13	Phulbani	1.49	Phulbani	1.14

Source: Author's calculations.

Note: Though here calculation of crop concentration index is made for 30 crops, in the above table only the major crops' concentration index has been shown.

Table 8. Ranking of districts as per productivity index, 1980-2005

Rank-ing	1980-1985		1985-1990		1990-1995		1995-2000		2000-2005	
1	Cuttack	1.44	Cuttack	1.85	Cuttack	2.04	Cuttack	1.82	Balasore	3.50
2	Sambalpur	3.83	Puri	4.83	Sambalpur	4.22	Sambalpur	3.64	Cuttack	3.69
3	Koraput	5.09	Sambalpur	5.19	Ganjam	5.72	Ganjam	5.43	Sambalpur	4.56
4	Ganjam	5.60	Koraput	5.78	Dhenkanal	6.09	Koraput	6.04	Koraput	5.65
5	Puri	6.16	Dhenkanal	6.25	Koraput	6.15	Balasore	6.86	Mayurbhanj	6.10
6	Mayurbhanj	6.69	Balasore	6.57	Puri	6.51	Puri	7.00	Phulbani	7.01
7	Dhenkanal	6.73	Mayurbhanj	6.92	Balasore	7.14	Bolangir	7.58	Ganjam	7.03
8	Phulbani	7.07	Phulbani	7.59	Bolangir	7.68	Phulbani	7.88	Kalahandi	8.16
9	Bolangir	7.49	Ganjam	7.84	Mayurbhanj	7.74	Sundergarh	8.28	Keonjhar	8.20
10	Balasore	7.57	Bolangir	7.89	Keonjhar	8.71	Mayurbhanj	8.44	Bolangir	8.44
11	Kalahandi	9.63	Keonjhar	8.83	Phulbani	9.09	Keonjhar	8.66	Puri	8.61
12	Keonjhar	10.53	Kalahandi	9.50	Kalahandi	9.29	Dhenkanal	9.06	Dhenkanal	8.84
13	Sundergarh	10.69	Sundergarh	10.00	Sundergarh	9.54	Kalahandi	9.20	Sundergarh	9.72
	Odisha	6.81	Odisha	6.85	Odisha	6.92	Odisha	6.91	Odisha	6.89

Source: Calculated form the data Directorate of Agriculture and Food Production, Odisha, Bhubaneswar.

Note: Lower the index value higher is the productivity level. Hence, author has presumed here that taking the productivity index values of Odisha as bench-mark the districts having productivity index value between 0 and 6 are considered more productive, while those having productivity index value higher than 6 are regarded low productive. .

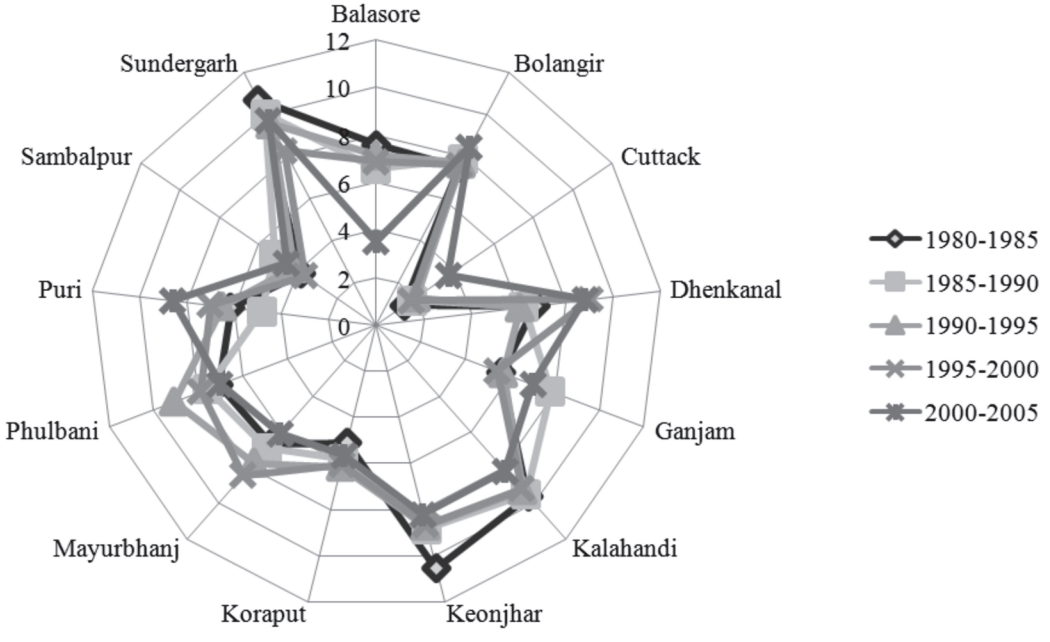

Figure 1. Disparity in agricultural productivity among districts of Odisha, 1980-2005

Source: Based on Table 8.

Note: Lower is the value of index, higher is the agricultural productivity level and vice-versa.

Table 9. Spatio-temporal disparity in agricultural productivity in Odisha

Inequality measures	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005
Relative mean deviation	0.38	0.30	0.28	0.34	0.35
Coefficient of variation	0.44	0.36	0.35	0.41	0.42
log standard deviation	0.57	0.46	0.44	0.53	0.49
Gini coefficient	0.25	0.20	0.19	0.23	0.24
Theil index	0.13	0.09	0.08	0.11	0.11

Sources: Based on Table 8 data.

increased marginally. Nevertheless, the Sapre and Deshpande index values for the districts capture important characteristics of inter-district variations in Odisha's agricultural productivity.

It is visible that the districts of Sundergarh, Bolangir, Dhenkanal, Kalahandi, Keonjhar, Mayurbhanj and Phulbani have less agricultural productivity. On the other hand, the districts like Cuttack, Sambalpur and Koraput have higher agricultural productivity, followed by Puri, Ganjam and Balasore districts. More observations can be made on the graph over temporal behaviour of Odisha by districts. The disparity in productivity is distinctly visible in the radar diagram (Figure 1). The points closer to the centre in the diagram are more productive. The distance from centre to the radius is 12 unit.

Table 9 depicts spatio-temporal disparity in agricultural productivity in Odisha based on various inequality measures. A perusal of Table 9 reveals that the values of Theil index, coefficient of variation, relative mean deviation, Gini coefficient and log standard deviation depict a similar kind of slightly declining trend during the first three periods, and increase in these values in the fourth period, but still lower than in the first period. As a whole, all the inequality measures show a reduction in inequality during the study period 1980 to 2005. Hence, we may say that the districts in Odisha are converging as far as agricultural productivity is concerned.

The agrarian structure and productivity inter-linkage can be described better based on Table 10, which shows correlation among the yield rate of foodgrains, fertilizer consumption, irrigation (percentage NIA to NSA), proportion of share-cropping in total operated area, proportion of leased-in land in total operated area, and proportion of marginal, small and large size landholdings in total operated area. The agrarian structure is based on technological and institutional factors; here the variables fertilizer and irrigation represent technological factors and the other variables, viz. share-cropping, leased-in land, marginal, small and large size landholdings represent institutional factors.

A perusal of Table 10 reveals that the technological factors, fertilizer and irrigation, are correlated positively with the yield rate and show significance at 0.01 level of probability. But, the marginal landholding size is negatively correlated with the yield rate and is significant at 0.05 level of probability. The leased-in land and yield rate are positively (24%) correlated and are significant at 0.10 level of probability.

The correlation of yield rate with other variables of institutional factors have not been found significant. Fertilizer and irrigation, the technological factors are positively (55%) correlated and are significant at 0.01 per cent level of probability. The leasing-in of land has been adopted largely in the technologically-developed regions as the correlation coefficients of fertilizer and irrigation are positive and significant at 0.01 level of probability. The correlation coefficients of marginal size of landholding with fertilizer and irrigation are significant at 0.01 level. It shows that fragmentation of landholding is less in the technologically-developed area and tenancy is associated with the low technology adoption. The correlation coefficient of large landholding size with fertilizer is significant at 0.10 level and with irrigation is significant at 0.01 level of probability. It supports that agricultural technology is being adopted by large farmers. The large farmers have been found involved in share-cropping. The share-cropping has been found quite significant in technologically-developed regions.

Table 10. Correlates of productivity, technological and institutional factors, 1980-2005

Correlate	Yield rate	Fertilizer	Irrigation	Share-cropping	Leased-in land	Marginal landholding size	Small landholding size	Large landholding size
Yield rate	1.00							
Fertilizer	0.44***	1.00						
Irrigation	0.32***	0.55***	1.00					
Share-cropping	-0.06	0.08	0.35***	1.00				
Leased-in land	0.24*	0.63***	0.42***	0.34***	1.00			
Marginal landholding size	-0.29**	-0.33***	-0.56***	-0.61***	-0.34***	1.00		
Small landholding size	-0.05	-0.09	-0.18	-0.12	-0.22*	0.22*	1.00	
Large landholding size	0.08	0.21*	0.35***	0.37***	0.29**	-0.27**	-0.20	1.00

Source: Calculated from Agricultural Statistics, Statistical Abstract and Agricultural Censuses.
Note: ***, ** and * denote significance at 0.01 per cent, 0.05 per cent and 0.10 per cent levels of probability, respectively.

The next logical step was to probe into the causes for inter-district variations in agricultural performance in Odisha. To identify such factors, we estimated a panel data regression equation by taking yield rate of foodgrains for the five sub-periods in 13 districts of Odisha as a dependent variable and fertilizer use, cropping intensity, irrigation, percentage of leased-in land in total operational area and four dummies, d 1, d 2, d 3 and d 4, for the years 2000-01, 1995-96, 1990-91 and 1985-86, respectively as the explanatory variables. The cropping intensity and irrigation were taken as proxy for infrastructure, percentage of leased-in land for institutional factor, fertilizer-use for technological factor and dummies for the previous years for capturing favourable climatic conditions in Odisha.

In the panel data regression (Table 11), fertilizer consumption (positively), d 1 dummy for the year 2000-01 (negatively) and d 2 dummy (positively) for

Table 11. Determinants of agricultural productivity in Odisha

Dependent variable : Yield rate

Independent variables	Coefficients	P > | t |	Variance inflationary factor	Prob > F value	R-squared
d 1	-166.39 (77.01)	0.035**	2.40		
d 2	151.15 (69.16)	0.033**	1.94		
d 3	59.14 (66.77)	0.380	1.81		
d 4	110.58 (64.03)	0.090	1.66	0.000***	0.468
Fertilizer	5.13 (1.44)	0.001***	2.56		
Cropping intensity	-2.15 (2.30)	0.354	2.92		
Irrigation	2.07 (2.34)	0.381	2.81		
Leased-in land	3.12 (6.54)	0.635	2.33		
Constant	987.87 (242.58)	0.000***	–		

Source: Author's calculation.
Note: *** and ** indicate significance at the 1 per cent and 5 per cent levels, respectively.
Standard errors are reported in parentheses of coefficients;
Mean VIF = 2.30
Number of observations = 65.

the year 1995-96 were the only variables that exercised maximum influence on the yield of foodgrains by affecting it significantly at 1 per cent and 5 per cent levels, respectively. Other factors have not been found statistically significant. Thus, the results indicate fertilizer consumption to be the most important determining factor of agricultural productivity, which again proves that yield in Odisha agriculture is technology-driven and not because of institutional agrarian structure. The negative coefficient for the dummy variable d 1 shows that 2000-01 was a bad year for disaster-prone, flood, and drought affected Odisha. The positive value of coefficient for dummy d 2 shows the year 1995-96 to be good from agricultural point of view. The R-squared value 0.468 indicates that around 47 per cent of inter-district variations in yield could be explained by this regression model.

Concluding Remarks

The study has revealed that Odisha is basically a mono-crop (rice) state. The reasons behind increasing preference for production of rice are irrigation facilities and provision of minimum support price (MSP) by the government for this crop. An assured and increasing price of rice vis-à-vis other crops has resulted in a higher preference for rice cultivation. Thus, there has been a move towards specialization rather than diversification as a result of agricultural development in the state.

Agricultural productivity level across the districts of Odisha is converging as per the Sapre and Deshpande index and the values for various inequality measures have been found out in the analysis. The ranks of districts as per productivity level urge for micro level research across low-productivity districts by adopting the model of high-productive districts (Balasore, Cuttack and Sambalpur).

The inter-district variations in yield rate are mostly related to difference in fertilizer consumption and climatic conditions. Therefore, agricultural productivity can be enhanced by increasing technological factors and promoting crop-diversification. To combat exogenous factors such as disasters like floods and droughts, the Government of Odisha should accord due attention to plantation programmes and related measures. The study has suggested that the government should take proper steps on management of the existing institutional drawbacks.

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