

**PERFORMANCE OF AGRICULTURE IN THE CHANGING  
STRUCTURE OF THE ORISSA ECONOMY:  
ISSUES REVISITED**

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# PERFORMANCE OF AGRICULTURE IN THE CHANGING STRUCTURE OF THE ORISSA ECONOMY: ISSUES REVISITED

*This paper discusses the nature of structural change in the economy of Orissa. The trends in the changing share of the different sectors to Gross State Domestic Product has been analyzed in brief. As the major focus of the study is agriculture, district wise agricultural productivity has been measured. An attempt has been made to explain the inter districts differences in productivity in terms of input use. The variation in input use and productivity over the periods and across the districts has been found out. Using an empirical model, the importance of several inputs has been examined.*

*Key Words:* Structural Change, Agricultural Productivity, Orissa Economy  
*JEL Classification:* O13; Q10

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## **I. Introduction**

In any less developed region, agriculture is the prime sector of economic activity. It provides not only food and raw materials but also employment to a very bulky proportion of the population. Agricultural development is essential, if poverty and hunger are to be removed. In *Principles of Political Economy and Taxation*, Ricardo(1817) viewed the predicament of diminishing returns to agriculture as fundamental. He held that a check on the growth of agricultural output sets the upper limit to the growth of the nonagricultural sector and to capital formation for economic expansion.

Contribution of agriculture to the economy is analyzed in various perspectives. Kuznets<sup>1</sup> discussed the contribution of agricultural sector as the “market contribution” and the “factor contribution”. Mellor (1973)<sup>2</sup> claimed, “Both in concept and in practice it is possible for the agricultural sector to make larger net transfer of resources. If these transfers are used productively, the rate of economic growth can be accelerated.” In addition, a marketable surplus from agriculture required not only to supply the wage goods to industry, but also to enlarge the home market for industrial goods.<sup>3</sup> As stated by Meier (1995) “ the emphasis on agricultural development now is not only for its instrumental value in sustaining expansion elsewhere in the nonagricultural sectors, but also for its own absorption of labour and its own increase of real income among the rural poverty target groups of the small farmers and the landless laborers.” Moreover, the widely debated structural transformation process is itself dependent on agricultural progress.

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<sup>1</sup> Simon Kuznets, *Economic Growth and Structure* (1965), pp. 244-45.

<sup>2</sup> John W. Mellor “Accelerated Growth in Agricultural Production and the Intersectoral Transfer of Resources,” *Economic Development and Cultural Change* (October 1973):5.

<sup>3</sup> Gerald Meier, *Leading Issues in Economic Development*, (Delhi: Oxford University Press,1995)

This paper examines the nature of structural transformation in Orissa economy and performance of agricultural sector. The paper is organized as follows. The next section presents a brief background of the Orissa agrarian economy. The section 3 provides the data sources and methodology for the various indicators used. Section 4 examines the nature of the structural transformation. Section 5 sheds some light on the issues of measurement of agricultural productivity. Agricultural productivity, inter district disparity and possible causes discussed in section 6. Section 7 presents an empirical model to explain the determinants of agricultural productivity and concludes.

## **II. Background**

The economy of Orissa is characterized by the dominance of agricultural sector. Nearly, eighty-five percent of its population live in rural area and depend on agriculture for their livelihood. Despite being endowed with vast natural, human resources, the state continues to be one of the less developed states with a very high incidence of poverty.<sup>4</sup> Agriculture continues to be the mainstay of the state's economy with contribution about 28.13 percent to net state domestic product during 2001-2002. The agriculture alone provides direct and indirect employment to around 65 percent of the total workforce of the state as per 2001 provisional census. Nevertheless, the sector is continued to be characterized by low productivity. Nearly 62 percent of the cultivable land is rain-fed and exposed to the vagaries of the monsoon. The per capita availability of cultivated land, which was 0.39 ha. in 1950-51 has declined to 0.17 ha. in 2001-02. Out of the total number of operational holdings of 39.66 lakhs, small and marginal farmers as per agricultural census 1995-96 hold 81.98 percent. Most of the small and marginal farmers do not have the means to make adequate investment in agriculture due to poverty. Although the contribution of agriculture to GSDP has significantly declined, the percentage of work force engaged in agriculture has remained somewhat unchanged. This implies that there has been an overcrowding in agriculture without any perceptible increase in production. As the pace of industrialization in the state is slow and has not taken off, agriculture continues to provide sources of livelihood to a significant segment of population. Therefore, agricultural growth holds the key to the overall development of a state by way of creating employment, generating income, providing raw materials to the industrial sector and last but not the least ensuring self-reliance in food production and food security to the deprived sections.

## **III. Data, Scope and Methodology**

The study is based on secondary data. The major source of the data for this study is "*Orissa Agricultural Statistics*" published by Directorate of Agriculture and Food production, Orissa, Bhubaneswar. The labour data has been taken from "*Orissa statistical Abstract*" which reproduced the census of India report. The price of the crops has been taken from "*Quarterly bulletin on Price statistics*" published by Directorate of Economics and Statistics, Orissa, Bhubaneswar. The state domestic product data has been

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<sup>4</sup> In 1999-2000, 47.15 percent of population is under the poverty line, whereas the national average is 26.10 percent.

taken from *Estimates of State Domestic Product*, Published by Directorate of Statistics and Economics, Bhubaneswar, Orissa. The study covered the period from 1985-86 to 1999-2000 for which the latest data are available. We have taken into consideration the 13 old undivided districts as the unit of study because the year of study starts from 1985-86 at which point of time the number of districts in Orissa were 13. The 13 districts are Balasore, Bolangir, Cuttack, Dhenkanal, Ganjam, Kalahandi, Keonjhar, Koraput, Mayurbhanj, Phulbani, Puri, Sambalpur and Sundargarh. The coastal districts, which are referred, in this study are Cuttack, Balasore, Ganjam and Puri. We have made the 15 years into 3 periods- 1985-90, 1990-95, 1995-00. The agricultural productivity is measured by employing Sapre and Deshpande index. The inequality in productivity is measured by seven indicators such as Relative mean deviation, Coefficient of variation, Standard deviation of logs, Gini coefficients, Mehran measure, Piesch measure, Kakwani measure and Theil index. The empirical model has been estimated by generalized least square estimators, which discussed in detail later in the paper.

#### **IV. Structural Change and Place of Agriculture**

There has been a marked structural transformation in the Orissa economy in the nineties vis-à-vis eighties. The inter-sectoral and intra-sectoral composition of GSDP underwent a significant change. The service sector has come to occupy a place of prominence in terms of its relative contribution to GSDP. Primary sector whose share was more than half of GSDP in 1980-81 (Table-1) has come down to 37.12 percent of GSDP in 1999-2000. During 1980's the contribution of Primary sector to GSDP varied between 52.58 percent to 47.24 percent. However, since 1990-91, it has fallen sharply and in 1990's the contribution of primary sector varied between 42.13 percent to 37.12 percent. Secondary sector in Orissa is yet at its primal stage and rising at a sluggish pace. It accounts for about 15 to 22 percent of GSDP in all these years. In 1980-81, the share of Secondary sector was 17.14 percent and it reached ever highest of 22.07 percent in 1990-91. Its contribution to GSDP is decreasing since then and was 17.33 percent in 1999-2000. The share of service sector has increased significantly from 30.28 percent in 1980-81 to 45.55 percent in 1999-2000. This is the only sector in Orissa economy that registered a spectacular growth in these twenty years in terms of its share in GSDP. The pace of growth of this sector is higher in 1990's than the previous decade. Agriculture i.e. sub-sector of Primary sector, sole major contributor to the GSDP, is losing its dominance in terms of its share in GSDP of the state. The share of Agriculture in GSDP has declined significantly from 44.20 percent in 1980-81 to 26.06 percent in 1999-2000. Apart from this, the share of agriculture in the primary sector has also registered a uniform decline in these years. It has declined from 84.08 percent in 1980-81 to 70.21 percent in 1999-2000.

**Table- 1: Contribution of Sectors to GSDP (1980-81 Prices) In Orissa**

Year	Primary (percentage to GSDP)	Secondary (percentage to GSDP)	Service (percentage to GSDP)	Agriculture (percentage to GSDP)	Agriculture (percentage to Primary Sector)
1980-81	52.58	17.14	30.28	44.20	84.08
1981-82	53.72	15.17	31.12	45.24	84.22
1982-83	50.13	16.86	33.01	41.30	82.39
1983-84	54.13	16.24	29.63	46.26	85.47
1984-85	49.09	18.54	32.38	41.40	84.33
1985-86	51.42	16.61	31.98	44.03	85.64
1986-87	48.75	17.44	33.81	41.23	84.57
1987-88	45.86	18.49	35.65	37.98	82.84
1988-89	44.95	20.99	34.07	37.49	83.40
1989-90	47.24	19.02	33.74	39.44	83.48
1990-91	40.43	22.07	37.50	31.16	77.08
1991-92	40.86	21.10	38.05	32.81	80.29
1992-93	38.98	21.41	39.60	29.48	75.62
1993-94	42.13	19.43	38.43	32.33	76.73
1994-95	40.43	20.72	38.85	30.09	74.44
1995-96	39.84	20.27	39.89	29.25	73.42
1996-97	37.82	18.81	43.36	25.97	68.66
1997-98	39.70	17.79	42.51	28.10	70.52
1998-99	38.73	16.74	44.54	27.59	71.24
1999-00	37.12	17.33	45.55	26.06	70.21

Source: Estimates of State Domestic Product, Directorate of Economics and Statistics, Orissa.

To study the pattern of GSDP and the relative share of primary sector as a whole and agriculture over the period, we have fitted the following linear regression equation. Here, we have taken year as the independent variable and shown the movement of primary sector share and agriculture (as a subgroup of primary sector) share in GSDP. From equation 1, it is found that the share of primary sector is going down over the periods. There is a decline in share of primary sector by 0.91 percent as one unit change in time occurs. The model is highly significant with high-adjusted R square value. In equation 2, dummy has been taken for pre-reform (1980-81 to 1989-90) and post-reform (1990-91 to 1999-2000) period. The equation says that, holding all other factors constant, the share of primary sector was higher in GSDP during pre-reform period in comparison to post reform period. It goes in tandem with Indian economy and supports the structural change hypothesis.

**Table-2: The OLS Result of Changing Share of Sectors with Respect to Years**

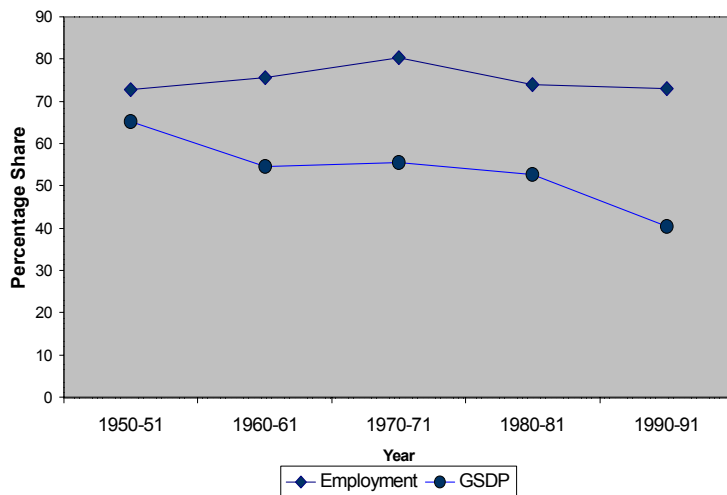
Equation		1	2	3	4	5	6
Dependent variable*		PRI	PRI	AG GSDP	AG GSDP	AG PRI	AG PRI
Coefficient of independent Variable	Constant	54.31	53.11	47.36	45.79	88.47	87.14
	X (Year)	-0.91	-0.60	-1.12	-0.71	-0.91	-0.56
	Dummy		-4.14		-5.43		-4.58
t-statistics	Constant	58.11	57.30	46.65	50.48	78.73	75.81
	X (Year)	-11.73	-4.45	-13.26	-5.39	-6.68	-3.35
	Dummy		-2.65		-3.55		-2.36
Adjusted R Square		0.88	0.91	0.90	0.94	0.83	0.86
F Statistics		137.68	95.43	175.74	150.83	93.80	61.64
D-W Statistics		1.94	2.15	2.22	2.81	1.13	1.09

\*PRI= Share of primary sector in GSDP, AG GSDP= Share of Agriculture in GSDP, AG PRI= Share of agriculture in primary sector, dummy =1 for post reform period.

In equation 3, dependent variable is share of agriculture in GSDP. The share of agriculture is going down over the periods in gross state domestic product. In equation 4, the dummy is significant at 1 percent level. There is a fall in share of agriculture in GSDP during post reform period in comparison with pre-reform period. The equation-5 implies that the share of agriculture in primary sector falls by 0.91 percent with one unit change in time. The dummy is significant in equation 6 and hence implies a fall in share of agriculture in

primary sector in the post reform period.

**Figure-1: Percentage Share of Primary Sector in GSDP and Employment**



Therefore, from the above discussions it is clear that over the years, primary sector's share in GSDP is decreasing fast and service sector's share has registered a significant increase. The share of agriculture in GSDP and in primary sector is declining over the years.

This structural transformation is regarded as a long run tendency of an economy and a step forward for economic prosperity when it is accompanied with a relative shift in workforce from primary sector to other sectors of the economy. However, this is not the case in Orissa economy. The labor force has not moved out from primary sector though its share in GSDP has declined. From the above graph no. 1, it is apparent that in 1950-51, the gap between the share of primary sector in contribution to GSDP and employment

was 7.69 unit that had gone up to 24.80 unit in 1970-71. During 1990-91, the gap has widened more to 32.47 unit. While the share of primary sector in GSDP has gone down from 65.17 percent in 1951 to 40.43 percent in 1991, the employment share has remained static i.e. 72.86 percent in 1950-51 and 72.90 percent in 1991.

## V. Agricultural Productivity

Agricultural productivity may be defined as the ratio of the index of total agricultural output to the index of total input used in farm production. It is therefore a measure of the efficiency with which inputs are utilized in production, other things being equal. According to Dewett, “productivity expresses the varying relationship between agricultural output and one of the major inputs, like land or labour or capital, other complementary factors remaining the same...”<sup>5</sup> The connotation of agricultural productivity engaged the attention of many economist at the 23<sup>rd</sup> Annual Conference of the Indian Society of Agricultural Economics. Some economist suggested that the yield per acre should be considered to indicate agricultural productivity. Nevertheless, it was criticized on the ground that it measures only the productivity of land. It was suggested for instance, that productivity could also be measured in terms of per unit of labor and different regions compared on that basis. It was further suggested that, the marginal returns per unit of scarce resource should be considered. *After a thorough discussion, it was generally agreed that the yield per acre may be considered to represent the agricultural productivity in a particular region, and that other factor of production be considered as the possible causes for the variation while comparing it with other regions.*<sup>6</sup>

Thompson while measuring the relative productivity of British expressed it in terms of gross output of crops and livestock.<sup>7</sup> Ganguli first took into account the area under any crop “X” in a particular unit area belonging to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. Secondly, Ganguli tried to obtain the index number of the yield. This is calculated by dividing the yield per ha. of region “A” of crop “X” by the yield per ha. of crop “X” in the entire region. Thirdly, the proportion of the area under “A” and the corresponding index number of the yields were multiplied.<sup>8</sup> Kendall used a system of four-coefficient (a) productivity coefficient (b) ranking coefficient (c) money value coefficient (d) starch equivalent or energy coefficient<sup>9</sup> Hirsch has suggested, ‘*crop yield index*’ as the basis of productivity measurement. It expressed the average of the yields of various crops on a farm or in a locality relative to the yields of the same crops on another farm in a second locality.<sup>10</sup> Zobel has attempted to determine the labour productivity. He considered productivity of

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<sup>5</sup> K.K Dewett & G.Singh, “*Indian Economics*”, ( Delhi: 1966), pp 66.

<sup>6</sup> See for detail “Regional variations in Agricultural Development and productivity”, *Indian journal of Agricultural Economics*, Vol –19,number 1, 1964, pp. 168-266.

<sup>7</sup> R.J Thompson, (1926) “The productivity of British and Danish Farming” *Journal of the Royal Statistical society*, Vol 89, 1926, pp 218 cited in M. Shaffi, no.3.

<sup>8</sup> Shaffi, no.3.

<sup>9</sup> M.G Kendall, “The Geographical distribution of Crop Productivity in England” *Journal of Royal Statistical society*, 1939, pp 162 cited in Shaffi, no.3.

<sup>10</sup> H.G Hirsch “Crop Yield Index” *Journal of Farm Economics*, Vol 25, no. 3, pp 583 cited in Shaffi, no. 3.

labour as the ratio of total output to the total man-hours consumed in the production of that output resulting in output per man-hour.<sup>11</sup> Enyedi while describing geographical type of agriculture in Hungary refers to a formula for determining agricultural productivity as follows:<sup>12</sup>  $Y/Y_n : T/T_n$  Where, Y= total yield of the respective crops in the unit area,  $Y_n$ =total yield of the crop at the national level, T=total cropped area of the unit,  $T_n$ =Total cropped area at the national level. Sapre and Deshpande refined further the Kendall's ranking coefficient method. For this, they used 'weighted average of ranks' instead of the simple average ranks. Thus, it incorporates the proportion of the crops (area) to the total area of the district. In order to assess the weighted ranks, the ranking position of a crop is multiplied by the magnitude of it to the total cropped area.<sup>13</sup>

Khusro has linked assessment of productivity with the output per unit of a single input and output per unit of cost of all inputs in the agricultural production.<sup>14</sup> Tambad has adopted crop yield index as the basis for measuring agricultural productivity. He has expressed the average yield of various crops on a farm or in a region relative to the yield of same crops on a farm or in a second region. It can be expressed as:<sup>15</sup>

$$\text{Crop yield index} = \frac{\sum_{i=1}^n \frac{y_i}{y_{i0}} A_i}{\sum_{i=1}^n A_i}$$

Where i =1, 2, 3...n are the number of crops considered in

a unit Area or year.  $Y_i$  =is the yield per acre of crops i, in a farm area or year,  $A_i$ =is the weightages of crop i, denoted by the area under the crop as a percentage of total cropped area, and  $y_{i0}$ =is the average yield per acre of crop i, at the group of farms or entire region or the base year. Shafi has expressed the productivity on the basis of labour population engaged in agriculture. According to him, gross production in any unit area /number of man-hours (or the total number of workers) gives agricultural productivity. Bhatia while assessing the productivity in UP during 1953-63 adopted Ganguli's method of productivity measurement and his equation is as follows:<sup>16</sup>  $I_{ya} = y_c / y_r * 100$  Where,

$I_{ya}$  =is the yield index of crop a,

$y_c$  =is the average acre yield crop 'a' in the component unit and

$y_r$  = is the average acre yield crop 'a' in the entire study area.

<sup>11</sup> Shaffi, no.3.

<sup>12</sup> Ibid.

<sup>13</sup> S. C. Sapre and C. D. Deshpande, "Inter-District Variation in Agricultural Efficiency in Maharashtra State", *Indian Journal of Agricultural Economics*, Vol. 19, no. 1, 1964, pp. 242-252.

<sup>14</sup> A.M Khusro, "Measurement of Productivity at Micro and Macro Levels", *Journal of the Indian Society Of Agricultural Statistics*, Vol 27, no. 2, 1965, pp. 278.

<sup>15</sup> S.B Tambad, (1965): "Spatial and temporal Variations in Agricultural Productivity in Mysore" *Indian Journal Of Agricultural Economics*, Vol 20, 1965 and Tambad S.B &K.V Patel "crop yield index as a measure of productivity" *Economic and political Weekly*, 5(25), 1970, pp 878-879.

<sup>16</sup> S.S Bhatia, "Spatial variations, Changes and Trends in agricultural Efficiency in Utter pradesh, 1953-63", *Indian Journal of Agricultural economics*, 22(1), 1967, pp 66-80

And  $E_i = \frac{i_{ya} * c_a + i_{yb} * c_b + \dots + i_{yn} * c_n}{c_a + c_b + \dots + c_n}$  Where,  $E_i$  = is the agricultural efficiency index

$i_{ya}, i_{yb}$ , etc. = are the indexes of various crops, and  $c_a, c_b$ , etc. = represents the proportion of cropland devoted to different crops. Singh has devised a new technique for the measurement of agricultural efficiency, which consists of the measurement of carrying capacity per unit area in terms of population in relation to output per unit area. Shafi has modified the formula of Enyedi in determining productivity index. In the modified formula, the summation of the total yield of all the crops in the district is divided by the total area under the crop considered in the district and the position thus obtained is examined in relation to the total yield of all the crops considered at the national level divided by the total area under those crops.

The formula would be read thus:<sup>17</sup>

$$\left(\frac{y_w}{t} + \frac{y_r}{t} + \frac{y_{mi}}{t} + \dots\right) : \left(\frac{Y_w}{T} + \frac{Y_r}{T} + \frac{Y_{mi}}{T} \dots n\right)$$

Alternatively,  $\frac{\sum_{i=1}^n y}{t} : \frac{\sum_{i=1}^n Y}{T}$  Where  $y_w, y_r$ , etc. = Total yield of the respective crop in the district.  $Y_w, Y_r$ , etc. = Total yield of the respective crop at the national level.  $t$  = area planted under the crop in the district, and  $T$  = area planted under the crop at the national level.

## V. A) Productivity Level and Inter District Disparities

In this study to assess, the agricultural productivity *Sapre and Deshpande* index has been used. Sapre and Deshpande refined the Kendall's ranking Coefficient method. This method is one of the widely used methods because along with crop yield level's rank, it takes into account the proportion of area under the crop. Instead of using simple averaged ranks, they used weighted average of ranks. This can be expressed as:

$$\text{Sapre \& Deshpande - index} = \frac{r_{1i}p_{1i} + r_{2i}p_{2i} + \dots + r_{ni}p_{ni}}{p_{1i} + p_{2i} + \dots + p_{ni}} \quad \text{Where } r_1 \dots r_n \text{ represents}$$

the rank of the crops as per their yield level in district  $i$  in comparison to other district and  $p_1 \dots p_n$  represents the proportion of area devoted to these crops in district  $i$ .

<sup>17</sup> M. Shafi, "Measurement of agricultural productivity of Great Indian plains" *The Geographer*, Vol 19, 1972, pp 7-9

**Table No- 3a: Ranks of Districts As per Productivity Index: 1985-86 to 1999-00**

Districts	1985-90	Districts	1990-95	Districts	1995-00
Cuttack	3.17	Sambalpur	2.98	Sambalpur	1.46
Sambalpur	4.61	Dhenkanala	4.84	Ganjam	2.85
Puri	5.07	Puri	4.96	Balasore	5.08
Dhenkanala	5.80	Cuttack	5.19	Bolangir	5.20
Balasore	5.94	Ganjam	5.37	Puri	5.90
Ganjam	6.17	Balasore	5.87	Koraput	6.56
Sundargarh	7.16	Koraput	6.39	Cuttack	6.85
Bolangir	7.18	Bolangir	6.59	Phulbani	8.01
Koraput	7.41	Mayurbhanj	9.22	Mayurbhanj	9.65
Phulbani	8.54	Keonjhar	9.33	Keonjhar	9.77
Mayurbhanj	8.81	Phulbani	10.01	Sundargarh	10.07
Keonjhar	9.12	Kalahandi	10.22	Dhenkanala	10.33
Kalahandi	9.62	Sundargarh	10.38	Kalahandi	10.78
<b>Mean Productivity level</b>	6.81		7.02		7.11

*Source: Calculated from Orissa Agricultural Statistics, various issues.*

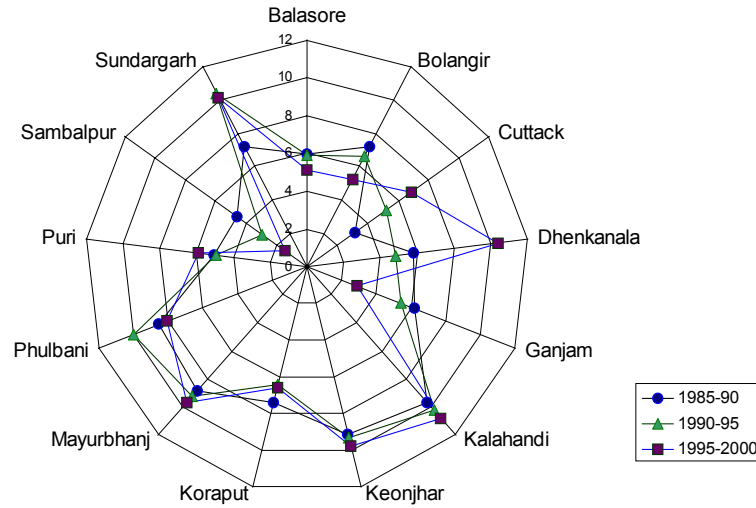
From the Table 3A it is clear that, in first period, Cuttack is the most productive district. The value of Sapre and Deshpande index (henceforth S&D index) is 3.17, followed by Sambalpur, Puri, Dhenkanal, Balasore and Ganjam. All of them have productivity score less than the average productivity score. **As it is evident from Sapre & Deshpande index, lower is the value of index, higher is the productivity level.**<sup>18</sup> Thus, in the upper bound of productivity, there are four coastal districts<sup>19</sup> and two non-coastal districts. In the lower strata of productivity, there are districts like Kalahandi, Keonjhar, Mayurbhanj, Phulbani, Koraput, Bolangir. In the second period, Sambalpur is the most productive district followed by Dhenkanal, Puri, Cuttack, Ganjam & Balasore. At the lower end there are districts like Sundargarh, Kalahandi, Phulbani, Keonjhar and Mayurbhanj. All the hilly and plateau regions are less productive except Sambalpur and Bolangir. In the final period, Sambalpur is at the peak position in the productivity index followed by Ganjam, Balasore, Bolargir and Puri. In the bottom, there are Districts such as Kalahandi, Dhenkanal, Sundargarh, Keonjhar and Mayurbhanj.

The disparity in productivity is distinctly visible in the radar diagram. This diagram is plotted on the basis of productivity index in three different periods. The points closer to the center of the diagram are more productive. The distance from the centre of the graph to the radius is Twelve. Here if the districts lies between zero to six is defined as districts with higher productivity and the districts which lie between six to twelve is defined as less productive districts.

<sup>18</sup> The reason is that, if a district has yield level in paddy which is highest in the state, its weightage is 1 whereas if a district's yield level in paddy is ranked 10<sup>th</sup> in the state, it will get weightage 10. Thus yield level and weightage is inversely related.

<sup>19</sup> Coastal districts are Cuttack, Balasore, Ganjam and Puri.

**Figure-2:Disparity in Productivity among Districts of Orissa**



It is visible in the figure that Sundargarh, Kalahandi, Keonjhar, Mayurbhanj and Phulbani have less agricultural productivity. However, the districts like Sambalpur, Balasore, Ganjam and Cuttack and Puri have higher agricultural productivity. More observations can be made on the graph over temporal behavior of the districts.

**Table3b: Spatio-Temporal Disparity In Agricultural Productivity In Orissa**

INEQUALITY MEASURES	I 1985:1990	II 1990:1995	III 1995-2000
Relative mean deviation	0.11	0.15	0.17
Coefficient of variation	0.28	0.35	0.41
Standard deviation of logs	0.31	0.37	0.58
Gini coefficient	0.15	0.18	0.22
Mehran measure	0.23	0.27	0.35
Piesch measure	0.11	0.14	0.16
Kakwani measure	0.02	0.03	0.05
Theil index	0.03	0.05	0.09

As far inequality score is (Table 3B) concerned, it is clear that, in first period, the score of Theil index is 0.03, coefficient of variation is 0.28 and Ginni coefficient is 0.15. In the second period, Theil index has increased by 0.02, C.V. has gone up by 0.07 and Ginni coefficient has gone up by 0.03 in comparison to first period. Therefore, in second period the inter district differences in productivity is larger. In the third period, the inequality is more severe. The Theil index score is 0.09, coefficient of variation is 0.41 and the value of Gini coefficient is 0.22. Hence, one can say that, the districts are diverging as far agricultural productivity is concerned.

**V. B)** Agricultural output is a function of input. Thus, it can be hypothesized that, more is the input application more will be the output, given other things. Index of input use has

been constructed in this study by range equalization method. Three inputs has been taken i.e. (1) percentage of the GCA irrigated (2) percentage of GCA under HYV (3) Fertilizer consumption (kgs/ha). Though agriculture is dependent upon many factors or inputs, due to paucity of data, only three inputs have been considered. By Range equalization method, we have construed the index.  $R = \frac{actualX_{ij} - minimumX_{ij}}{maximumX_{ij} - minimumX_{ij}}$  Where  $i=1, 2, 3$  (inputs) &  $j=1, 2, 3...13$  (Districts). After getting the individual score of three inputs for each districts, the average of three inputs have been taken as districts input score.

**Table No- 4: Index of Input Use of Districts—1985-86 to 1999-00**

<b>DISTRICTS</b>	<b>1985-90</b>	<b>1990-95</b>	<b>1995-00</b>
Balasore	0.89	0.81	0.90
Bolangir	0.64	0.62	0.62
Cuttack	0.75	0.79	0.78
Dhenkanala	0.50	0.44	0.36
Ganjam	0.79	0.68	0.69
Kalahandi	0.07	0.06	0.13
Keonjhar	0.27	0.27	0.25
Koraput	0.30	0.33	0.39
Mayurbhanj	0.49	0.54	0.43
Phulbani	0.16	0.09	0.02
Puri	0.54	0.55	0.59
Sambalpur	0.72	0.66	0.69
Sundargarh	0.25	0.27	0.26
<b>Mean Value of input use index</b>	0.48	0.47	0.47
Theil Index	0.14	0.15	0.17
C.V ( percent)	0.53	0.53	0.56

*Source: Calculated from Orissa Agricultural Statistics, various issues*

From the Table 4 It is evident that, in first period, Balasore, Ganjam, Cuttack, Sambalpur, Bolangir and Puri are the districts where input application/use is more. Each of the mentioned districts have input use level more than the average value which is 0.48..However in Kalahandi, Sundargarh, Keonjhar, Koraput and Phulbani the input use level is less than the state average value. In the second and third period, the relative rank of the districts as far input use is concerned is same. Thus, from the above, it can be easily concluded that all the coastal districts along with Sambalpur and Bolangir have higher input use index than non-coastal hilly district. Besides that, inter district differences in input use is also increasing. In first period, coefficient of variation is 0.53, which has gone up to 0.56 in the final period. In addition, the score of the Theil index has gone up in the three periods.

### V. C) Relationship between Input Use and Productivity

To study the relationship between input use and productivity, we have used three methods. First, we have studied the *correlation* between *input use and productivity* of 13 districts in each period. Secondly, we have calculated *spearman's rank* correlation coefficient of *input use and productivity* of each 13 districts. Thirdly, we have tried to find out how much variation in productivity index is being explained by the index of these inputs by a linear regression model.

**Table No 5: Relationship between Input Use Index and Productivity Index**

Periods	Coeffi. Pearson's coefficient	Spearman's coefficient
FIRST PERIOD	-0.74* (.003) P-Value	-0.72* (.005)
SECOND PERIOD	-0.75* (.002)	-0.69* (.009)
THIRD PERIOD	-0.72* (.005)	-0.76* (.002)

From Table 5, it is evident that during first period, the correlation coefficient of input use index and productivity index is -0.74, which is significant at 1 percent level. This says that, input use index and productivity index is negatively correlated. **It is known that incase of Sapre and Deshpande index, lower is the value of index, higher**

**is the productivity level.** Thus, it is expected that, input use and productivity index should be *negatively correlated*. In addition, during first period, the Spearman's rank correlation coefficient between input use index and productivity index is -0.72 and it is significant at 1 percent level. The high value of rank correlation coefficient indicates that there is a close relationship between rank of index of input use and rank of productivity. From above table, also similar pattern has been observed for the other two periods.

**Table 6: OLS Result of Productivity and Input Use**

Period	coefficient of Input use Index	P-Value	R Square
First Period	-5.45	0.004	0.55
Second Period	-7.51	0.003	0.56
Third Period	-8.08	0.006	0.51

The theory of production in its simplest form postulates that, there exist a positive relationship between input use and production, *ceteris paribus*. When the level of input use increases, production also increases and vice-versa. We have fitted a linear regression of the form: *Productivity Index = constant + Input use index*. From the simple OLS

regression, it is evident that, there is a significant relationship between productivity index and input use index. In all the periods, the coefficient of input use index is significant at 1 percent level. The sign is negative because in case of Sapre and Deshpande index, lower is the value of index, higher is the productivity level.

## VI. The Model

In most of the empirical study on agricultural productivity, the Cobb-Douglas production function has been extensively employed to measure the nature and contribution of individual factors to output. When variables are entered in logarithmic form estimated coefficients are interpreted as elasticities, the sum of all estimated coefficients provide information about the nature of returns to scale, intercept term is interpreted as disembodied technical change and the marginal productivity of resources can be derived from the estimated coefficients. In this study, also Cobb-Douglas kind of production function has been used. The functions are as follows:

$$Y_{it} = \beta_1 L_{it}^{\beta_2} I_{it}^{\beta_3} H_{it}^{\beta_4} F_{it}^{\beta_5} Rj_{it}^{\beta_6} Ro_{it}^{\beta_7} \text{_____} \quad (1)$$

Where Y is the per hectare agricultural output, L is the number of agricultural workers, I is the proportion of area irrigated (irrigated area/hectare), H is the proportion of area under HYV, F is the fertilizer consumption per hectare (kgs/ha), Rj is the rain fall in the month of June and Ro is the rainfall in the month of October.

Due to high correlation of area under HYV and fertilizer consumption per hectare, the duo has been taken separately in two different equations. Thus, the two equations are as follows:

$$Y_{it} = \beta_1 L_{it}^{\beta_2} I_{it}^{\beta_3} H_{it}^{\beta_4} Rj_{it}^{\beta_6} Ro_{it}^{\beta_7} \text{_____} \quad (2)$$

$$Y_{it} = \beta_1 L_{it}^{\beta_2} I_{it}^{\beta_3} F_{it}^{\beta_5} Rj_{it}^{\beta_6} Ro_{it}^{\beta_7} \text{_____} \quad (3)$$

Taking log the equation 2 and 3 can be expressed as: -

$$\text{Log}(Y_{it}) = \beta_1 + \beta_2 \text{Log}(L_{it}) + \beta_3 \text{Log}(I_{it}) + \beta_4 \text{Log}(H_{it}) + \beta_6 \text{Log}(Rj_{it}) + \beta_7 \text{Log}(Ro_{it}) + U_{it} \text{_____} \quad (\text{Eqn 2*})$$

$$\text{Log}(Y_{it}) = \beta_1 + \beta_2 \text{Log}(L_{it}) + \beta_3 \text{Log}(I_{it}) + \beta_5 \text{Log}(F_{it}) + \beta_6 \text{Log}(Rj_{it}) + \beta_7 \text{Log}(Ro_{it}) + U_{it} \text{_____} \quad (\text{Eqn 3*})$$

The basic equation from which the model is developed is given by:  $y_{it} = x_{it} + u_{it}$  Where  $i=1 \dots m$  is the number of units (or panels) and  $t = 1 \dots n$  is the number of observations for panel  $i$ . In case of Ordinary least squares, the coefficients have been estimated by:

$$\hat{\beta}(ols) = (x'x)^{-1} x'y$$

Moreover, the GLS results which is used in this study are given by:

$$\hat{\beta}(gls) = (x'\hat{\Omega}x)^{-1} x'\hat{\Omega}^{-1}y$$

Where the  $\Omega$  is the estimated variance-covariance matrix. In many cross-sectional data sets, the variance for each of the panels generally differs. And in this study, this is

confirmed by cook-weisberg test, the presence of heteroscedasticity across panels. Thus, cross-sectional weighted regression is appropriate when the residuals are cross section heteroscedastic. That is the reason for which in this study generalized least squares estimator has been adopted instead of ordinary least squares estimators.

### ***Determinants of Agricultural Productivity:***

In this study, five major inputs have been taken as the determinants of Agricultural productivity. They are as follows (a) Agricultural laborer (b) Irrigated Area (c) Area under high yield variety (HYV) (d) Fertilizer Consumption and (e) Rainfall. However, there are many important variables, which could explain the agricultural productivity in a significant manner. Due to paucity of data, this study is limited with the above-mentioned factors.

*Agricultural laborer:* District wise time series labour data is not available for Orissa. In the "census of India report", it is given at a point of time in a decadal interval. Therefore, labour data has been interpolated and extrapolated for the rest of the years. Here we have taken total number of laborer as the labour input. *Irrigated Area:* The data for irrigated area has been taken from the "Orissa agricultural Statistics". In this study, we have taken the total irrigated area of the districts. In addition, to get proportion of area irrigated, the total irrigated area of the districts has been divided by the gross cropped area of the districts. *Area under HYV:* The data for district wise area under HYV has been given in Orissa agricultural statistics. In India, since Mid-sixties, the new high yielding variety seeds were introduced. But, in Orissa, till 80's, the use of High Yielding varieties was very limited which. To get the proportion of area under HYV, the area under HYV was divided by the gross cropped area of each district. *Fertilizer Consumption* - Fertilizer Consumption is one of the important variables of this study. The data for fertilizer has been collected from Orissa Agricultural statistics. We have taken the sum of Chemical fertilizer such as nitrogen (N), phosphorus ( $P_2O_5$ ) and Potash ( $K_2O$ ) as the total fertilizer consumption in agricultural sector. *Rainfall:* Orissa agriculture depends upon southwest monsoon, as the irrigation facilities are inadequate. We have taken the rainfall data for the month of June and October. The reason is that, rainfall during the month of June and October related with two main sowing seasons of Khariff and Rabi. During the Khariff crop, adequate rainfall is required; otherwise, production level will go down. However, the Rabi crops as such do not require much rainfall. The year wise data, for the district wise rainfall has been taken from the Orissa agricultural statistics.

*Dummy Variables:* In this study, 3 dummy variables have been taken. In the absence of irrigation infrastructure, agricultural activities are the gamble of monsoon. In the season, when the amount of rainfall is normal and timely, then it has good effect on agricultural output. But, if there is no rainfall or rainfall much higher than requirement, then it will negatively affect the production level of the crops. It is reported in the Orissa agricultural statistics yearbook that average Normal rainfall during the month of June is 219.0 mm and in October is 170.6 mm. In this study, we have classified normal rainfall as: Normal rainfall  $\pm$  50 percent deviation from normal. If it goes beyond that 50 percent deviation we have considered that as abnormal. That may be flood, if it is normal + more than 50 percent of normal rainfall. And drought if it is less than normal rainfall - 50 percent of normal rainfall. The dummy 1 stands for normal rainfall in the month of June (khariff

season) and dummy 2stands for the normal rainfall in the month of October. Dummy variables are qualitative variables. Thus, in our model to take care of the climatic effect we have incorporated dummy for climate.

We have taken another dummy for periods. From 1985 to 1995, the value of dummy is 1 and for 1995-00, the value of dummy is zero. The reason for taking this dummy is that, we have seen that, in most of the districts the crop yield level was gone down during last quinquennial. The yield levels of most of the crops were high during first and second period in comparison to third period. To confirm this in our econometric study we have taken that dummy.

***Result (Panel Evidence Of Agricultural Productivity i.e. Land Productivity In Orissa 1985-86 To 1999 - 2000)***

The results of the estimation of the Cobb-Douglas production function for all the 13 districts for the period 1985-96 to 1999-00 is summarized in Table 7A and 7B. All the included variables show expected behavior as the estimated value of coefficients bear expected positive signs. The only exception is the coefficient for “rainfall-October” variable. The variable has negative sign with insignificant coefficient. But, this is not surprising because the Rabi crops do not require much rainfall. The underlying hypothesis in this production relationship is that the increased use of land (irrigated and HYV sown area), labour, fertilizer and timely and adequate rainfall during the months of June and October leads to higher productivity.

The labour coefficient i.e. the elasticity of labour input with respect to output per hectare is 0.15. This says that, if the labour input will increase by 1 percent, the output per hectare will go up by 0.15 percent. From the table, it is clear that, labour is an important variable with higher coefficient value. The coefficient is also significant at 1 percent level. As explained earlier since in Orissa, the level of modern input use is not very high & infrastructural facilities is not well developed, labour is one of the few important variables, which could explain the changing productivity in agriculture in a significant manner. The coefficient of proportion of area irrigated is 0.06. The coefficient shows the elasticity of proportion of area irrigated with respect to output per hectare. If there will be 1 percentage increase in irrigated area per hectare, output will go up by 0.06 percent. The value of the coefficient is very low in comparison to all other variables. This says that, though irrigation facilities affect positively to the production level but in comparison to other variables, its contribution is less. The reason behind this could be attributed to the less and insufficient irrigation facilities. It is observed in our study that, during 1985-90, only 32.91 percent of GCA was irrigated at Balasore district, which increased to 35.07 percent during 1995-00. In case of Cuttack districts, during 1985-90, 34.39 percent of GCA was irrigated, which increased marginally to 34.74 percent during 1995-00. Ganjam another coastal district has 30.18 percent of GCA under irrigation during 1985-90. During 1995-00, it has gone up to 33.47 percent. The situation is very shaky in case of

non-coastal hilly districts. In case of Kalahandi, during 1985-90, only 9.14 percent of GCA was irrigated which has gone up to

**Table No 7A**  
(Determinants of Land productivity in Orissa, A panel data Result)

Coefficients: generalized least squares						
Estimated covariances	=	13	Number of obs	=	195	
Estimated coefficients	=	9	Number of groups	=	13	
Log likelihood	=	260.9614	No. of time periods	=	15	
			Wald chi2(8)	=	217.94	
			Pr > chi2	=	0.0000	
-----						
outha		Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
-----						
labour		.1513003	.0241939	6.254	0.000	.1038811 .1987195
irha		.0614259	.0234678	2.617	0.009	.0154299 .1074219
hyvha		.178673	.0409167	4.367	0.000	.0984777 .2588683
rj		.0742968	.0181149	4.101	0.000	.0387923 .1098013
ro		-.0041004	.0107863	-0.380	0.704	-.0252413 .0170404
dm3		.0611113	.0111899	5.461	0.000	.0391812 .0830448
dm1		.0203725	.0099551	2.046	0.041	.0008609 .0398842
dm2		.0171585	.0091428	1.877	0.061	-.000761 .0350781
_cons		3.008266	.1423243	21.137	0.000	2.729315 3.287217
-----						
N.B outha= output per hectare, irha= irrigated area per hectare, hyvha= area under hvv per hectare, rj= Rainfall in the month of June, ro= rainfall in the month of October, dm3= for 1985-1995 the value of dummy is 1, dm1 and dm2 is dummy for normal climate in the month of June and October respectively.						

**Table No 7B.**

Coefficients: generalized least squares						
Estimated covariances	=	13	Number of obs	=	195	
Estimated coefficients	=	9	Number of groups	=	13	
Log likelihood	=	264.4012	No. of time periods	=	15	
			Wald chi2(8)	=	205.71	
			Pr > chi2	=	0.0000	
-----						
outha		Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
-----						
labour		.1418194	.0240521	5.896	0.000	.0946781 .1889607
irha		.0376992	.020564	1.833	0.067	-.0026054 .0780039
ferha		.1048998	.0169349	6.194	0.000	.0717079 .1380916
rj		.07025	.0178093	3.945	0.000	.0353443 .1051556
ro		-.002468	.0109932	-0.225	0.822	-.0240144 .0190783
dm3		.0654404	.0105385	6.210	0.000	.0447852 .0860955
dm1		.0203058	.009853	2.061	0.039	.0009942 .0396174
dm2		.0223193	.009036	2.470	0.014	.0046091 .0400295
_cons		2.828447	.1317545	21.468	0.000	2.570213 3.086681
-----						
N.B ferha= fertilizer consumption per hectare.						

17.15 percent during 1995-00. In case of Keonjhar, another non-coastal district, during 1985-90, only 8.76 percent of GCA was irrigated which has gone up to 20.79 percent during 1995-00. In case of Mayurbhanj, during 1985-90, only 17.11 percent of GCA was irrigated, which has gone up to 20.56 percent during 1995-00.

The coefficient of proportion of area under HYV (i.e. high yielding varieties) is 0.17. This says that input (i.e. HYV per hectare) elasticity with respect to per hectare output is 0.17. If the proportion of area under HYV goes up by 1 percent per hectare output will go up by 0.17 percent. Since mid-sixties, HYV cultivation has started in India. But, its spread to Orissa is of very recent past. HYV seeds require, high irrigation facilities along with increased fertilizer consumption. Since, both irrigation facilities as well fertilizer consumption is very low in Orissa, the spread of HYV is very limited. If we will look at the district wise scenario, the picture will be very clear. It is found that at Balasore district, during 1985-90, only 31.48 percent of GCA was under HYV, which has gone upto 50.50 percent during 1995-00. In case of Cuttack, during 1985-90, only 24.19 percent of GCA was irrigated which has gone upto 43.85 percent during 1995-00. In case of Ganjam district 32.87 percent of GCA was under HYV during 1985-90, which has gone upto 36.53 percent during 1995-00. Among, the non-coastal districts, in case of Kalahandi, only 10.86 percent of GCA was under HYV during 1985-90, which has gone upto 25.43 percent during 1995-00. In case of Keonjhar district, only 16.17 percent of GCA was under HYV during 1985-90, which has gone upto 28.88 percent during 1995-90. In case of Mauyrbhanj, during 1985-90, only 20.84 percent of GCA was under HYV, which is increased to 33.44 percent during 1995-00. Thus, from the above analysis, it is apparent that, there is a wide disparity between coastal and non-coastal districts as far the area under HYV is concerned. But it is also observed that, the area under HYV is increasing in a significant manner in almost all districts. Modern day agriculture is more responsive to scientific cultivation with high quality input use. Also, our estimation results confirm this. Among, the co-efficient of all variables, the co-efficient of per hectare area under HYV is very high. This is also significant at 1 percent level.

The coefficient of rainfall during the month of June is 0.07. It is discussed above that, irrigation facilities in Orissa is very poor. And in almost all districts less than 50 percent of GCA was irrigated during the last period (1995-00). Thus, in true sense agriculture of Orissa is a gamble of monsoon. Rainfall in the month of June affects the summer crops. The Khariff season begins generally on the onset of southwest monsoon in mid-June in Orissa. The food crops grown in Khariff season are: rice, jawar, Bajra, Maize, Pigeon pea, green gram, black gram, groundnut and sugarcane. These crops require high temperature and plentiful supply of water. Thus, we have earlier hypothesized that adequate and timely rainfall has positive impact on agricultural productivity. Also, it is found that the coefficient of rain-June is positive (i.e. 0.07) and it is significant at 1 percent level. The coefficient of rainfall in the month of October is negative and insignificant. The Rabi season starts at the beginning of cold weather season i.e. at the end of October or early November, when the monsoon has receded. The food crops of

Rabi season are: wheat, lentils, barley, Bengal gram, peas and potatoes. These crops require cool weather and less supply of water. Thus, the coefficient turns out to be insignificant which could be interpreted, as rainfall during the month of October does not have any impact on the productivity level of agriculture.

The  $DM_1$  stands for the dummy variables for the defined normal rainfall during the month of June. The dummy acts as a proxy for the natural calamities. It is known that, if there is more rainfall it turns out to be 'flood' and if there is less rainfall, it is equivalent to 'drought'. Also, the cyclone, Hailstorm, whirlwind and Tornado, generally accompanied by rainfall. Thus, rainfall is the best proxy for 'erratic-climate' behaviour. The coefficient of dummy for the month of June is 0.02 and it is significant at 5 percent level. This says that, if there is no natural calamity in the month of June, or if the nature is normal, then there will be increased level of output and productivity. The  $DM_2$  stands for dummy for the defined normal rainfall during the month of October. This says that, if there is no natural calamity, there will be more production and higher productivity level.

$DM_3$  stands for the year dummy (i.e.  $DM_3 = 1$  for 1985-86 to 1994-95 and  $DM_3 = 0$  for 1995-96 to 1999-00). From our tabular analysis in chapter 3, we have found that in most of the districts, the yield level of crops have gone down during the last period. To confirm this in our econometrics study, we have taken that dummy. The coefficient of dummy is positive and significant at 1 percent level. Thus, it says that productivity level during the first and second period (1985-90) was higher than the productivity level during the last period. Though input use level has gone up during the last period, the fall in productivity level may be due to flood during 1994-95 and 1995-96, drought during 1996-97 and super cyclone and flood during 1999-2000.

The model is highly significant as the Wald chi-square is significant at 1 percent level. From the above analysis, one can conclude that, in Orissa (taking 13 districts and 15 years i.e. 1985-96 to 1999-00) land productivity is highly influenced by HYV, followed by labourer, rainfall and irrigated area.

As explained earlier due to multi-collinearity problem, we could not take fertilizer consumption per hectare in our second equation. Thus, in the third equation (Table 7B) we have excluded proportion of Area under HYV and included fertilizer consumption per hectare. All other variables remain the same. The model is also highly significant. The coefficient of fertilizer consumption per hectare is 0.10. This is the value of input (Fertilizer consumption per hectare) elasticity with respect to per hectare output. This says that if fertilizer consumption per hectare goes up by 1 percent, the per hectare output level will go up by 0.10 percent. Fertilizer is an important input in modern day agriculture. The green revolution in India had started with seed (HYV) – Fertilizer-irrigation technology. Thus, the "Trio" goes together. The deficiency of any of these could hamper the productivity level. Like equation 2, in equation 3, also all other variables are highly significant and the relative contribution is same as in equation 2, though the value of coefficient has changed due to the inclusion of one new variable and exclusion of proportion of Area under HYV.

Thus from the above analysis, it is established that proportion of area under hyv is significantly affecting the agricultural productivity. The reason is that high yielding varieties are scientifically made and some times genetically modified seeds. And those

seeds have higher productive capacity than the traditional seeds. Besides HYV, labour, rainfall and irrigated area are the other variables, which affect land productivity significantly. Role of fertilizer in increasing productivity of land cannot be undermined and it's also evident from our study. The rainfall in the month of June is also affecting agricultural productivity positively.

## **Conclusion**

Fifty years of developmental effort of the state has not made any significant impact on poverty. Still, nearly fifty percent of the population of the state is living in abject poverty. Industrial development is at its infancy and viable alternative sources of employment are illusive in the state. Agriculture is the only sector, which is so far the livelihood providing sector for most of the people. Unfortunately, agriculture in Orissa is characterized by low productivity. As well as, there is high inter district variation in agricultural productivity. The answer is partially found in terms of high inter district variation in input use as well as natural calamities. In the last decade and half no other states faced such devastating kind of natural calamities like Orissa. Besides that, the agrarian structure of the state is hurdled with umpteen bottlenecks. The skewed distribution of land, small size of operational holding, high incidence of share tenancy and rural poverty are the other institutional factors affecting negatively agricultural productivity. Social discontentment is the outcome of economic deprivation. This is in its most naked form present in Orissa. The share of service sector is going up in Gross State Domestic Product. However, the employment share is not showing any trend of increment. The proportion of workforce remained unchanged across the sectors. Thus, while the benefit of reform or structural transformation is unequally distributed. It has large negative consequences on the social fabric as well as economic standard of the people. The long-term sustainable solution for such kind of problem can be found in terms of improved agricultural productivity and conscious policy decisions to reduce inter district disparity.

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