CROP DIVERSIFICATION IN ORISSA:

A SPATIO-TEMPORAL ANALYSIS

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ABSTRACT

The objective of this paper is to analyze the crop diversification and crop concentration in Orissa in the last one and half decade. It is pursued through measuring crop diversification and crop concentration index. We have used Herphindal and Entropy measure for crop diversification and locational quotient measure has been used to measure crop concentration. The result shows that in all most all districts, crop specialization is taking place and more so in the last phase of our study. Then employing an ordinary least square we have figured out the major determinants of crop diversification.

JEL Classification: N55, Q10
Key Words: Crop diversification, Crop Concentration, Orissa Agriculture

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INTRODUCTION:

Agriculture continues to be the mainstay of Orissa's economy with contribution of about 28.54 percent of the state domestic product during 2000-01. The agriculture also provides direct and indirect employment to around 73 percent of the total workforce of the state as per 1991 census. Though the share of agriculture in SDP of Orissa has declined over the years, agriculture still continues to provide source of livelihood to a significant segment of population. Orissa is one of the economically backward states of India with 47.2 percent of its population living below the poverty line (1999-2000). Agricultural development holds the key to the over all development of the state by way of creating employment, generating income, providing raw materials to industrial sector and ensuring food security to the poor. Agriculture in Orissa is characterized by low productivity due to traditional agricultural practices, inadequate capital formation, low investment, inadequate irrigation facility and uneconomic size of the holding. Recent years have experienced not only low productivity but also declining productivity. The disparity among the districts in agricultural productivity has also gone up (NCDS, 2001, Pattanayak and Nayak, 2004). Cropping pattern has shown a changing trend in the state in recent years. The area under paddy has increased from 46.06 percent of the gross cropped area of the state in 1985-90 to 51.87 percent during 1995-2000. There is a marginal increase in the area under cash crops. At district level one major significant change is the increased concentration of paddy cultivation. This paper is an attempt to study the issue of crop diversification in the state of

Orissa during 1985 to 2000. This study is first of its kind which has considered 18 crops. It covers 96% to 98% of gross cropped area and all the districts.

The broad objective of this study is to examine whether there is any kind of crop diversification at district level and to find out the main determinants of crop diversification. The selected crops are: Paddy, Wheat, Maize, Jawar, Ragi (cereals), Biri, Mung, Kulthi, Arhar, Gram (pulses), Til, Mustard, Groundnut (oil seeds), Onion, Potato, Sugarcane, Jute and Cotton (cash crops). The study period 1985 to 2000 is divided into three periods and quinenial averages are worked out. The data is obtained from published sources of Directorate of Agriculture and Food Production, Government of Orissa.

CROP DIVERSIFICATION IN ORISSA:

Crop diversification is a widely advocated means for agricultural and rural development. Crop diversification is a concept, which is opposite to crop specialization. It implies shift from single crop farming to multiple crop farming, from subsistence farming to commercial farming or from low value food crops to high value food or non-food crops. The level of crop diversification largely depends upon the agro climatic/socio-economic condition and technological development in the region. In general, it is presumed that higher the level of agricultural technology, lesser the degrees of diversification. As agriculture in less developed region is more dependent upon nature, the risk of crop loss is very high. In the areas where the variability of rainfall is high and adequate sources of irrigation are not available, farmers grow several crops in a season to get some thing from their fields in case of extreme weather. Further, diversification is also considered essential to reap scale economies arising out of complementary and supplementary enterprises. The diversification of crops also generate more employment as the farmers and agricultural workers remain busy in the sowing, weeding, harvesting and marketing of different crops throughout the year.

To study the extent of diversification, various methods are available in the literature. The most commonly used methods are Herphindal index and Theil's entropy index -:

Herphindal index is defined as:

$$H = \sum_{i=1}^{n} p_i^{\,2}$$

pi =Proportion of area under i th crop

$= \dfrac{A_i}{\sum_{i=1}^{n} A_i}$ In which A_i=Area under i th crop and $\sum_{i=1}^{n} Ai$ = Total cropped area

The value of H-index varies between zero to one. It is one in case of perfect specialization and zero in case of perfect diversification.

The Entropy index is defined as:

$$Entropy(E) = \sum_{i=1}^{n} p_i \log(1/p_i)$$

pi =Proportion of area under i th crop

The value of entropy index varies from zero to log n. When there is perfect specialization *'E'* takes the value of zero and when there is perfect diversification *'E'* takes the value of log n.

Table No: 1 - Crop Diversification Index---1985-86 to 1999-00

Districts	1985-90	1990-95	1995-00	1985-90	1990-95	1995-00
	E.I	E.I	E.I	H.I	H.I	H.I
Balasore	0.47	0.46	0.32	0.56	0.56	0.72
Bolangir	0.72	0.71	0.66	0.36	0.36	0.4
Cuttack	0.7	0.68	0.61	0.33	0.34	0.41
Dhenkanal	0.81	0.81	0.78	0.24	0.23	0.25
Ganjam	0.81	0.79	0.76	0.23	0.24	0.27
Kalahandi	0.82	0.81	0.79	0.28	0.27	0.28
Keonjhar	0.66	0.62	0.58	0.42	0.44	0.49
Koraput	0.78	0.78	0.77	0.29	0.29	0.3
Mayurbhanj	0.48	0.46	0.37	0.58	0.6	0.68
Phulbani	0.85	0.8	0.74	0.22	0.25	0.32
Puri	0.64	0.58	0.56	0.38	0.43	0.45
Sambalpur	0.55	0.56	0.51	0.5	0.47	0.52
Sundargarh	0.6	0.6	0.57	0.48	0.47	0.49
Orissa	0.68	0.67	0.62	0.37	0.38	0.43

N.B: E.I is Entropy Index and H.I is Herphindal Index

Source: Calculated from Orissa Agricultural Statistics, various issues.

From the table 1, it is evident, that in first period, Balasore and Sambalpur are highly specialized districts with value of H-Index greater than 0.5. In the same

period Dhenkanal, Ganjam and Phulbani are highly diversified districts with value of H-Index less than 0.25. In the second period, only Balasore have H-index greater than 0.5 (i.e. highly specialized) whereas Dhenkanal, Ganjam and Phulbani are least specialized (i.e. more crop diversification) district. In the final period, Balasore, Sambalpur are the highly specialized districts (H Index > 0.5). And Koraput, Ganjam, Kalahandi, Dhenkanal are least specialized districts. In this period, there are 9 districts whose H-index value is greater than 0.4. Thus, it is evident that in Orissa, crop specialization is taking place. All districts except Mayurbhanj are experiencing increased specialization. Balasore is the lead district with an increase of HI from 0.56 in first period to 0.72 in final period. Balasore is also known as rice bowl of Orissa. The districts like Bolangir, Cuttack, Keonjhar, Phulbani and Puri experienced significant increase in crop specialization. Dhenkanal, Ganjam, Kalahandi, Koraput, Sambalpur and Sundargarh are the districts that have not experienced any such significant change during the study period. Among these districts Sambalpur and Sundergarh are specialized districts with HI values 52 and 49 respectively. The average value of H-Index for all districts was 0.37 in first period, and it has gone up to 0.43 in the final period. So a larger number of districts are experiencing crop specialization.

From the crop concentration table (discussed later), it is clear that in those districts where specialization is taking place, mostly the area share of paddy (along with pulses) is going up at the cost of other crops. In the first period, the area share under paddy of 2 highly specialized districts are 61.52% and 58.41% respectively, higher than all other districts. In second period, the highly specialized district i.e. Balasore area share under Paddy was 72.77%. Thus, when specialization is taking place, the area is going to be concentrated under few crops (i.e. this will be clear from crop concentration analysis).

Determinants of Crop Diversification

Among the host of factors, crop yield and cropping intensity are the most important one. It is expected that as yield level of crop increases, then those crops are going to take major chunk of area in a cropping season. But, if cropping intensity increases i.e. if the same plot of land is cultivated more than once in an agricultural year then crop diversification will take place. The reason being that, to

maintain the natural nutritional cycle of the land, farmers have to do rotation cropping. That is they do different crops in a year in different crop season. **Hence we hypothesize that the crop yield will be positively and cropping intensity negatively correlated with crop specialization index.** The ordinary least square equation is as follows:

Third period :(1995-2000)

Log (H.I) = -3.50 + 1.14(log Y) -1.84 (log ci)

(-0.91) (1.88) (-2.31) R2=0.38 n=13

Second period :(1990-1995)

Log (H.I) = -1.40 +0.71(log Y) -1.42(log ci)

(-0.59) (1.99) (-6.80) R^2=0.44 n=13

First period: (1985-1990)

Log (H.I) = 0.37 +0.55(logY) -1.77(log ci)

(0.11) (0.85) (-2.36) R^2=0.30 n=13

Where, Y= yield level (Rs/ha.), ci= cropping intensity which is defined as the ratio of gross cropped area to net sown area and H= Herphindal index. n= no. of observation. Values in parenthesis are t values.

The dependant variable is the Herphindal index. Yield level and cropping intensity are the independent variable. During the latest period of the study i.e. 1985-1990, it is found from the equation that, yield level is significant at 10 % level and cropping intensity is significant at 5 % level. The model says that if yield level will increase, crop specialization will also increase. This is as per our hypothesis, because higher is the yield level; more is the incentive to cultivate the crop. There is no incentive to diversify when the output from the crop is increasing. Cropping intensity has a negative sign. This says that when cropping intensity increases, the value of Herphindal index will go down means crop diversification will take place.

During the second period also the result is as per expectation with positive sign of yield level and negative sign of cropping intensity. Both are highly significant. But, during first period though sign of crop yield and cropping intensity is as per our hypothesis but coefficient of yield level is not significant. This gives substantial empirical evidence of cropping diversification and its determinants.

From the above discussion it is clear that in Orissa, crop specialization is taking place. The necessary concomitant of the above discussion is to see which crops are getting concentrated across the districts in comparison to state as a whole.

Crop Concentration

Crop concentration means the "*variation in the density of crops in an area or region at a given point/period of time*". The concentration of a crop in an area largely depends on its terrain, temperature, moisture, price and income, social factors, govt. policy, type of soils and many others. The most commonly method to study crop concentration is the location quotient method.

We can write location quotient method of crop concentration algebraically as:

$$L.Q = \frac{\frac{A_{ij}}{A_j}}{\frac{\sum_{i=1}^{n} A_{ij}}{\sum_{j} A_j}} .$$

A_{ij} = Gross cropped area under ith crop in jth district, A_j = Gross cropped area in jth district. $\sum_j A_j$ = Gross cropped area in the state, we have found out this by summing the GCA of each district.

By using this location Quotient method Crop Concentration Index is estimated. When the index value is greater than unity, the component areal unit accounts for a share greater than it would have had if the distribution were uniform in the entire region and therefore, the areal unit has a concentration of great agricultural significance.

In the table 2, the crop concentration index of 5 major crops has been given.

Table No- 2: Crop Concentration Index of 5 Major Crops-1985-86 to 1999-00

Balasore	1980-85		1990-95		1995-2000
Paddy	1.29	*Paddy*	1.28	*Paddy*	1.57
Mung	0.15	*Mung*	0.15	*Biri*	0.09
Biri	0.12	*Biri*	0.13	*Mung*	0.08
Mustard	0.04	*Mustard*	0.05	*Mustard*	0.03
Ground nut	0.04	*Ground nut*	0.04	*Ground nut*	0.03
Bolangir	1980-85		1990-95		1995-2000
Paddy	1.03	*Paddy*	1.04	*Paddy*	1.13
Mung	0.15	*Mung*	0.16	*Mung*	0.17
Til	0.11	*Til*	0.13	*Til*	0.11
Biri	0.11	*Biri*	0.10	*Kulthi*	0.10
Kulthi	0.09	*Kulthi*	0.09	*Biri*	0.09
Cuttack	1980-85		1990-95		1995-2000
Paddy	0.94	*Paddy*	0.98	*Paddy*	1.14
Biri	0.22	*Biri*	0.22	*Biri*	0.21
Mung	0.22	*Mung*	0.20	*Mung*	0.17
Ground nut	0.14	*Ground nut*	0.17	*Ground nut*	0.14
Kulthi	0.09	*Kulthi*	0.07	*Kulthi*	0.06
Dhenkanala	1980-85		1990-95		1995-2000
Paddy	0.78	*Paddy*	0.74	*Paddy*	0.83
Mung	0.20	*Til*	0.22	*Til*	0.23
Ground nut	0.18	*Mung*	0.20	*Mung*	0.20
Contd….					
Biri	0.17	*Biri*	0.19	*Biri*	0.20
Til	0.15	*Ground nut*	0.14	*Ground nut*	0.12
Ganjam	1980-85		1990-95		1995-2000
Paddy	0.75	*Paddy*	0.76	*Paddy*	0.85
Mung	0.34	*Mung*	0.36	*Mung*	0.34
Ragi	0.16	*Biri*	0.15	*Ragi*	0.16
Biri	0.13	*Ragi*	0.14	*Biri*	0.14
Ground nut	0.13	*Ground nut*	0.10	*Til*	0.09
Kalahandi	1980-85		1990-95		1995-2000
Paddy	0.80	*Paddy*	0.81	*Paddy*	0.90
Mung	0.14	*Mung*	0.20	*Mung*	0.21
Biri	0.11	*Biri*	0.15	*Biri*	0.15
Kulthi	0.11	*Kulthi*	0.12	*Kulthi*	0.13
Til	0.09	*Til*	0.09	*Til*	0.09
Keonjhar	1980-85		1990-95		1995-2000
Paddy	1.08	*Paddy*	1.08	*Paddy*	1.13
Maize	0.11	*Maize*	0.11	*Kulthi*	0.10
Biri	0.10	*Biri*	0.09	*Biri*	0.08
Kulthi	0.10	*Kulthi*	0.08	*Maize*	0.07
Mung	0.06	*Mung*	0.06	*Arhar*	0.05

Table:2 contd….

Koraput	1980-85		1990-95		1995-2000
Paddy	0.74	*Paddy*	0.75	*Paddy*	0.82
Ragi	0.22	*Ragi*	0.22	*Ragi*	0.22
Maize	0.10	*Kulthi*	0.12	*Maize*	0.11
Kulthi	0.09	*Maize*	0.10	*Kulthi*	0.09
Til	0.07	*Til*	0.07	*Til*	0.07
Mayurbhanj	1980-85		1990-95		1995-2000
Paddy	1.26	*Paddy*	1.53	*Paddy*	1.41
Biri	0.08	*Biri*	0.08	*Kulthi*	0.06
Kulthi	0.07	*Kulthi*	0.08	*Biri*	0.05
Mung	0.05	*Maize*	0.05	*Maize*	0.04
Maize	0.04	*Mung*	0.05	*Arhar*	0.03
Phulbani	1980-85		1990-95		1995-2000
Paddy	0.64	*Paddy*	0.69	*Paddy*	0.85
Kulthi	0.17	*Mustard*	0.15	*Kulthi*	0.14
Maize	0.12	*Kulthi*	0.14	*Maize*	0.13
Mustard	0.12	*Maize*	0.13	*Mustard*	0.12
Mung	0.11	*Mung*	0.09	*Mung*	0.09
Puri	1980-85		1990-95		1995-2000
Paddy	1.04	*Paddy*	1.13	*Paddy*	1.18
Mung	0.24	*Mung*	0.23	*Mung*	0.24
Biri	0.17	*Biri*	0.14	*Biri*	0.14
Kulthi	0.12	*Kulthi*	0.11	*Kulthi*	0.10
Ground nut	0.05	*Ground nut*	0.05	*Ground nut*	0.05
Sambalpur	1980-85		1990-95		1995-2000
Paddy	1.23	*Paddy*	1.21	*Paddy*	1.33
Mung	0.12	*Mung*	0.13	*Mung*	0.12
Ground nut	0.11	*Ground nut*	0.13	*Til*	0.11
Biri	0.09	*Biri*	0.10	*Ground nut*	0.10
Til	0.08	*Til*	0.10	*Biri*	0.10
Sundargarh	1980-85		1990-95		1995-2000
Paddy	1.14	*Paddy*	1.11	*Paddy*	1.21
Biri	0.09	*Biri*	0.10	*Biri*	0.10
Kulthi	0.09	*Kulthi*	0.09	*Kulthi*	0.10
Mung	0.08	*Mung*	0.08	*Mung*	0.08
Til	0.06	*Til*	0.07	*Til*	0.07

Source: Calculated from Orissa agricultural statistics, various issues.

In Balasore districts during first period, the five most concentrated crops are (a) paddy (b) Mung (c) Biri (d) Groundnut and (e) Oil. In second period instead of groundnut, Til's concentration is more and same in third period. In case of Bolangir district, the five mostly concentrated crops are (a) paddy (B) mung (c) Biri (d) Kulthi (e) Til. In third period, the concentration index of groundnut is more than Til.

In Cuttack district, the five most concentrated crops are paddy, mung Biri, Kulthi and groundnut. And it is same for all periods. But, crop concentration index of paddy is less than one during first and second period. In case of Dhenkanala, the five most concentrated crops are (a) Paddy (b) mung (c) Biri (d) Groundnut and (e) Til and this is same for all the other two periods. In case of Ganjam, the five mostly concentrated crops are (a) Paddy (b) mung (c) Biri (d) Ragi and (e) Groundnut and in third period index value of Til is more than groundnut. But index value of paddy is less than one. In Kalahandi district, the five mostly concentrated crops are (a) Paddy (b) mung (c) Biri (d) Kulthi and (e) Til. And this is same for all other period. But, the index value of Paddy is less than 1.

In case of Keonjhar district, the five mostly concentrated crops are (a) Paddy (b) Maize (c) Mung (d) Biri and (e) Kulthi and in third period the index value of Arhar is more than mung. This is the only district where Arhar is highly concentrated. In case of Koraput district, the five concentrated crops are (a) Paddy (b) Ragi (c) Maize (d) Kulthi and (e) Til. In second and third periods, these are the same crops, which are highly concentrated. But the index value of paddy is less than 1.

In case of Mayurbhanj, the five mostly concentrated crops are (a) paddy (b) maize (c) mung (d) Biri and (e) kulthi. And this is same in all periods. In case of Phulbani, the five concentrated crops are paddy, Maize, mung, Biri, Kulthi and mustard. And this is same in all periods. But, the index value of Paddy is less than 1. In case of Puri, the five mostly concentrated crops are Paddy, mung, Biri, Kulthi, groundnut and Til.This is same for all periods. In case of Sambalpur, the five mostly concentrated, crops are paddy, mung Biri, Groundnut, and Til. This is same for all period. In case of Sundargarh district paddy, mung, Biri, Kulthi and Til is mostly concentrated. And this is same for all periods.

OBSERVATIONS

(1) In Cuttack (first and second period), Kalahandi and Phulbani paddy's concentration is less than one. It shows less area in comparison to state average is devoted for Paddy. Also, it says that paddy is highly concentrated in the districts in comparison to other crops.

(2) Keonjhar is the only district where Arhar is also highly concentrated.

(3) In Koraput maize, Ragi is also highly concentrated.

(4) In Mauyrbhanj and Phulbani maize is highly concentrated than other districts.

(5) In almost all district Paddy, Mung, Biri, Kulthi, groundnut, Til and Mustard are highly concentrated.

From our above analysis we have seen that Orissa is basically a mono-crop state where more than 50% of GCA in majority of districts is under paddy. Out of the rest area pulses have gained the maximum followed by oilseeds and cash crops. Millets like Jawar, Bajra, and Maize etc have been found to be grown in larger areas in non–coastal districts. In case of yield level, the coastal districts along with well-irrigated districts such as Sambalpur and a part of Bolangir have dominated the other. And the inter-district variability of yield level is very high. Except paddy, the inter-district variability of yield level in other crops is increasing. In case of Paddy the c.v. has came down from 20.77% in first period to 14.98% in the final period. Not only that the inter district variability of area share under different crops are increasing over the years (except paddy, where it is coming down). From this it is very clear that although the districts are converging w.r.t. Area share and yield level in paddy, they are diverging in all other crops. One of the reasons for this increasing preference for production of paddy could be explained in terms of irrigation facilities. It is known that rice is grown in those areas where sufficient water is available either through rain or irrigation. We have seen that, out of 13 districts 11 districts irrigated area have increased in third period in comparison to second period.

Secondly, food habits of the people in non-coastal part (where larger % of ST people are living) are changing due to modernization. Thus, commensurate with food habits, to increase production of paddy, People are devoting more areas. Thirdly, govt. minimum support price in case of paddy and wheat is increasing at a higher rate than other crops. Thus, it also gives incentive to increase production.

Also, in our above analysis we have seen that, in Orissa crop specialization is taking place. In other words cropping pattern is monotonically biased towards few crops (especially paddy). From the fitted relationship, we have found that as the yield level increases, it positively affects the H-index. That means specialization is directly correlated with high yield. And it is found that in case of paddy 10 districts

yield level of paddy in third period is higher than first period. But, in most of the other crops, the yield level in third period has gone down for every district in comparison to first and second period.

Future Of Cropping Pattern In Orissa

Orissa is a state of small farmers. In future the size of holding will diminish. The state has to produce enough for its people without deterioration the quality of the land and environment. This is a challenge of the future for the farmers. It is suggested that output of all existing crops should be increased so as to meet the diversified consumption needs of the people. And there should be a shift towards high valued crops, which leads to a more efficiency utilization of land. But, when doing this, the state mechanism should look after the poor people who are so far dependent upon coarse cereals.

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