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Relationship between Crop Diversification and Farm Income in Odisha — An Empirical Analysis§

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Abstract

This paper has examined the extent and pattern of crop diversification and its impact on farm income across all the districts of Odisha. The determinants of crop diversification have been identified. Using the NSSO data, the study has found three districts, namely Anugul, Jharsuguda, and Balangir, to be highly diversified districts and the average farm income in these districts is significantly higher than in both moderately and least diversified districts. The medium farmers are the most diversified category of farmers in two out of the three highly diversified districts. The marginal farmers are the most diversified category of farmers in one highly diversified district. On the basis of regression analysis, the study has found that SC households in Odisha are less diversified in comparison to other households and higher the extent of irrigated land, lower is the extent of crop diversification.

Key words: Crop diversification, farm income, irrigation

JEL Classification: Q100, Q12, Q15

Introduction

The Government of India, in its annual budget 2016-17, announced to double farmer's income by 2022. The shift of focus from agricultural output and food security to farm income is a welcome step given the low level of absolute as well as growth in farm income (Ranganathan, 2015; Chand *et al*., 2015). Now the question is how to double farmer's income? The answer to the question fundamentally lies on improved performance of agriculture in the country. Many studies have found a direct impact of improved agricultural performance (in terms of high growth rate of agriculture sector) on rural incomes (DFID, 2004; Bresciani and Valdes, 2007). We can expect such a relationship in India given that agriculture contributes significantly to rural income for all farm households in general (with a contribution of 41.4 % to total income) and for the bottom 20 per cent of farm households (nearly 50 %) in particular (Birthal *et al*., 2014). There are also evidences in literature which show that increased farm income results from high growth rate in agriculture and it eventually leads to higher poverty reduction (Ligon and Sadoulet, 2008; Montalvo and Ravallion, 2009; Ravallion and Chen, 2007; Kumar *et al*., 2011; Sharma and Kumar, 2011).

If high growth in agriculture increases farm income, then the next question is how to increase its growth rate? The sources of agricultural growth may stem from within and/or outside the agricultural sector (Chand *et al*., 2015). Factors such as increase in productivity, lower cost of production with efficient use of resources, increase in cropping intensity, diversification towards high-value crops, and

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diversification towards other allied enterprises like livestock, fishery, sericulture, etc. contribute towards higher agricultural growth from within. Shift towards non-farm enterprises and increase in real prices received by the farmers (better known as favourable terms of trade for agriculture) help in increasing agricultural growth rate from outside. Out of these strategies to increase farm income via higher agricultural growth, the present study focuses on the role of diversification towards high-value crops in increasing farm income.

The relationship between crop diversification and farm income has been analysed for Odisha where agriculture sector provides livelihood to 60 per cent of its population. The contribution of agriculture, forestry, and fisheries to the gross state domestic product (GSDP) has declined to 15.3 per cent in 2016. The percentage of cultivators to total workers in Odisha stood at 23.4 per cent, the percentage of agricultural labourer to total workers was 38.4 per cent, and 61.8 per cent workers are engaged in agricultural activities (Census, 2011). The state of Odisha is an agrarian state and it was only second, with 32.59 per cent incidence of poverty, to Jharkhand in the list of 14 poorest states in India in 2011-12 (GoO, 2013-14). To add to it, 32.1 per cent of its farm households were poor in 2011, which is just lower than Jharkhand where 45.3 per cent of farm households were poor (Chand, 2017). Crop cultivation in Odihsa is dominated by paddy. The percentage area under paddy to gross cropped area, total area under foodgrains, and total area under cereals stood at 46.23 per cent, 80.64 per cent, and 96 per cent, respectively in 2014-15 (GoO, 2016). However, the net returns from paddy are not remunerative even in states where its productivity is higher than Odisha. For example, farmers in Andhra Pradesh (AP), during 1975-76 to 2006-07, had suffered losses from paddy cultivation (Narayanamoorthy, 2013). So the economy of Odisha is facing the problem of overburdened agriculture which is worsening day by day with falling contribution of its agriculture to GSDP. And the predominant crop paddy is not that remunerative which opens up the scope for crop diversification in the state. Hence, the present study has investigated the impact of crop diversification on farm income across 30 districts in Odisha. The main hypothesis of the study is that 'highly diversified districts have higher farm income than least diversified districts have'.

Data and Methodology

The study has used the data collected by the National Sample Survey Office (NSSO) in its 70th round on 'Situation Assessment Survey of Agricultural Households'. The 70th round of NSSO conducted surveys on land and livestock holdings, debt and investment, and situation assessment of agricultural households. It also provides information on the value of output and cost of cultivation. To calculate net reruns from various crops across districts in Odisha, the average cost of cultivation was subtracted from the average gross returns. The average net returns from cultivation in different categories of districts in terms of crop diversification were compared using t-test. The crop diversification was measured using Herfindahl Index (HI) which is given by formula (1).

$$HI = \Sigma_1^n P_i^2 \quad \ldots(1)$$

where, P_i is the proportion of area under the i^{th} crop. And $P_i = \frac{A_i}{\sum_1^n A_i}$. And A_i is the actual area under i^{th} crop, and $\Sigma_1^n A_i$ is the summation of area under all 'i' crops and $i = 1,2,3,\ldots,n$.

When the value of HI declines, crop diversification takes place and when value of HI increases, crop concentration takes place. The determinants of diversification in Odisha were investigated through a regression equation, having household diversification index as dependent variable and various explanatory variables, calculated by ordinary least square method (the details of the regression equation are given in Annexure 1).

Results and Discussion

Extent of Diversification and Farm Income across Districts in Odisha

Area under foodgrains and non-foodgrains, crop diversification, and net returns across districts of Odisha are presented in Table 1. The district that stands out is Jharsuguda with the lowest HI value of 0.17 implying that its extent of crop diversification is highest. District Jharsuguda makes a significant contribution (8.38 %) to the total value of Odisha agriculture. The percentage of area under non-foodgrains with 54.34 per cent is the highest in Odisha. The agricultural households of this district have the

Table 1. District-wise aggregate picture of agriculture in Odisha in reference to diversification and returns

District	Proportion of area under (%)		Share in total value of agriculture (%)	Diversification index (₹ /ha)	Gross returns (₹ /ha)	Cost of cultivation (₹ /ha)	Net returns
	Foodgrains	Non - foodgrains					
Bargarh	84.31	15.69	11.08	0.53	48816	22736	26080
Jharsuguda	45.66	54.34	8.38	0.17	50671	3862	46809
Sambalpur	78.43	21.57	2.71	0.62	40423	10229	30194
Debagarh	55.38	44.62	0.95	0.35	18038	2909	15129
Sundargarh	88.26	11.74	3.30	0.74	31868	5217	26651
Kendujhar	95.84	4.16	2.56	0.89	31263	8332	22931
Mayurbhanj	92.17	7.83	2.51	0.85	24888	8315	16573
Baleshwar	94.21	5.79	1.53	0.89	32859	14275	18584
Bhadrak	91.76	8.24	1.76	0.84	35835	10539	25296
Kendrapara	97.01	2.99	2.26	0.90	27460	14168	13292
Jagatsinghapur	87.21	12.79	3.54	0.77	42815	13390	29424
Cuttack	89.65	10.35	2.45	0.81	35870	11572	24298
Jajapur	98.19	1.81	3.67	0.95	44045	11658	32387
Dhenkanal	85.06	14.94	3.88	0.70	42558	10327	32230
Anugul	81.83	18.17	2.29	0.27	25796	2900	22896
Nayagarh	100.00	0.00	1.26	1.00	32996	8106	24890
Khordha	97.28	2.72	1.37	0.82	24574	9688	14886
Puri	74.03	25.97	2.18	0.57	33095	12404	20691
Ganjam	56.22	43.78	12.36	0.40	37849	10381	27467
Gajapati	98.91	1.09	2.08	0.38	23580	7754	15826
Kandhamal	100.00	0.00	0.99	0.59	20876	5502	15374
Baudh	100.00	0.00	0.88	0.70	26799	5568	21231
Sonapur	84.19	15.81	1.60	0.71	32410	8889	23521
Balangir	74.19	25.81	6.25	0.26	24317	4216	20101
Nuapada	100.00	0.00	0.87	0.88	18031	4567	13464
Kalahandi	64.71	35.29	8.44	0.41	40399	12378	28021
Rayagada	99.85	0.15	1.48	0.73	23911	9911	14000
Nabarangapur	94.35	5.65	4.51	0.45	25081	6937	18145
Koraput	96.16	3.84	1.08	0.55	19033	3541	15492
Malkangiri	100.00	0.00	1.76	1.00	22326	10681	11646

Source: Calculated by the authors from the unit level data of NSSO's 70th Round Survey on the 'Situation Assessment Survey of Agricultural Households'

highest net returns (₹ 46809/ha) among all the districts. This district has a significant presence of OBC agricultural households. More than 50 per cent of its agricultural households have BPL cards and the majority have below primary education level. The average age of respondent farmers of this district is also on a higher side at 53 years. The net returns of this district are higher because of low cost of cultivation. The average net returns of farm households in India are ₹ 77,888/ha (Ranganathan, 2015). So compared to this figure, the net returns from cultivation in Jharsuguda are lower.

The next highly diversified district is Balangir with HI value of 0.26 and its average net returns are ₹ 20101/ ha. Its percentage area under non-foodgrains is at 25.81 per cent and share in total value of Odisha agriculture

is 6.25 per cent. The third highly diversified district is Anugul with HI value of 0.27 and its average net return is ₹ 22896/ha which is higher than Balangir but lower than Jharsuguda. Its percentage of area under non-foodgrains is 18.17 per cent but it is contributes only 2.29 per cent to the total value of Odisha agriculture. There are three districts, namely, Sambalpur, Jajapur, and Dhenkanal whose average net returns are above ₹ 30000/ha. However, these are not diversified districts and also their area percentages under foodgrains are high.

There are again three districts in which percentage of area under non-foodgrains is significantly higher; these are Debagarh, Ganjam, and Kalahandi with 44.62 per cent, 43.78 per cent, and 35.29 per cent, respectively. But in these districts, the extent of diversification is relatively high with Debagarh, Ganjam, and Kalahandi having HI values of 0.35, 0.40, and 0.41, respectively. The average net returns per hectare in Debagarh, Ganjam, and Kalahandi are ₹ 15129, ₹ 27467, and ₹ 28021. So only in the case of Debagarh, the average net returns are very low, despite having 44.62 per cent of its area under non-foodgrains. Interestingly some districts (such as Kendrapada, Khordha, Nuapada, Rayagada, and Malkangiri) having lowest average net returns also have a significant area under foodgrains and based on their HI values can be termed as districts where there is crop concentration not diversification. Some of the districts where there is high crop concentration are Kendujhar, Mayurbhanj, Baleshwar, Bhadrak, Kendrapada, Cuttack, Jajapur, Nayagarh, Nuapada, and Malakangiri. In all these concentrated districts, HI value is above 0.8 and percentages of foodgrain area are also significantly higher.

Categorization of Districts on the basis of Diversification Index

On the basis of value of diversification index (same as Herfindahl Index), the districts in Odisha can be categorized under three heads, namely, highly diversified, moderately diversified, and least diversified. The districts with HI values below 0.3 are highly diversified, with HI between 0.3 and 0.6 are moderately diversified, and with HI values above 0.6 are least diversified. We can see from Table 2 that highly diversified districts have a cost advantage (with lower average cost of cultivation) and its average gross as well as net returns are also higher in comparison to other two categories. The highly diversified districts contribute 17 per cent to the total value of Odisha agriculture. Similarly, moderately-diversified and least-diversified districts contribute 44 per cent and 39 per cent to the total value, respectively. The average gross returns as well as average net returns of least diversified districts are higher than those of the moderately diversified districts, but the average cost of cultivation of later is slightly lower than that of the former.

When we attempted to locate the highly and moderately diversified districts in terms of agro-climatic zones, we found that they fall in 7 out of total 10 zones. There are no districts from 3 zones which are either highly or moderately diversified. These agro-climatic zones are North Central Plateau, North Eastern Coastal Plain and South Eastern Ghat. All the rest agro-climatic zones (North Western Plateau, East & South Eastern Coastal Plain, North Eastern Ghat, Eastern Ghat High Land, Western Undulating Zone, Western Central Table Land, and Mid Central Table Land) have at least one district which is either highly or moderately diversified.

The average net returns per hectare of highly diversified, moderately diversified, and least diversified districts are ₹ 29935, ₹ 20247, and ₹ 21972, respectively (Table 2). To know whether or not the differences in the average net returns in these three districts are significant, pair-wise comparison with equal variance test was done and the results are presented in Table 3.

The difference in the mean values of average net returns of moderately diversified and highly diversified is negative ₹ 9688 and it is statistically significant at 5 per cent level. That means net returns of highly diversified districts are significantly higher than those of moderately diversified districts. Similarly, difference in the mean values of average net returns of least diversified districts and highly diversified districts is negative ₹ 7963 and it is statistically significant at 5 per cent level. It establishes the fact that highly diversified districts earn higher net returns from crop cultivation than least diversified districts. The difference in the average net reruns from crop cultivation between least and moderately diversified districts, although positive, is not statistically significant.

Table 2. Identification of districts and their mean values of select variables in terms of different levels of diversification

Categories of districts	Name of districts	Share in the value of Odisha's agriculture (%)	Average gross returns (₹/ha)	Average cost of cultivation (₹/ha)	Average net returns (₹/ha)
Highly diversified	Jharsuguda, Anugul, and Balangir	17	33595	3659	29935
Moderately diversified	Bargarh, Debagarh, Puri, Ganjam, Gajapti, Kandhamal, Kalahandi, Nabarangpur, and Koraput	44	29641	9394	20247
Least diversified or Highly concentrated	Sambalpur, Sundargarh, Kendujhar, Mayurbhanj, Baleshwar, Bhdrak, Kendrapada, Jagatsinghapur, Cuttack, Jajapur, Dhenkanal, Nayagarh, Khordha, Baudh, Sonapur, Nuapada, Rayagada,and Malkanagiri	39	31718	9746	21972

Source: Authors' own computation based on 70th round NSSO data

Table 3. Pair-wise comparison of mean values of average net returns of different categories of diversified districts with equal variance

Comparison between different categories of diversified districts	Difference in the average net returns (₹)
Moderately diversified versus highly diversified	-9688** (-1.97)
Least diversified versus highly diversified	-7963** (-1.73)
Least diversified versus moderately diversified	1725 (0.57)

Note: The figures within the parentheses are t-values and ** implies statistically significant at 5 per cent level of significance
Source: Authors' computation

Drivers of High Crop Diversification in Anugul, Jharsuguda, and Balangir Districts

The extent of diversification in three highly diversified districts can be linked to the level of development of these districts proxied by per capita income and the low yield of paddy. First, we will take up the factor Per Capita Net district domestic product (NDDP). Based on the data from *Odisha Economic Survey, 2014-15* (Annex-2/37), per capita Net Domestic Product (NDP) of Odisha in 2004-05 and 2010-11 stood at ₹ 17650 and ₹ 23968, respectively. In district Anugul, the same for these two years was ₹ 37689 and ₹ 37569 which is significantly higher than the Odisha average. The case of Jharsuguda is highly revealing. Its per capita NDDP was highest in Odisha in 2010-11 and currently also. Its per capita NDDP for 2004-05 and 2010-11 was recorded as ₹ 34463 and ₹ 49021, respectively. We can see the stark positive divergence of its per capita NDDP from that of all Odisha figure. In the district Balangir, this relationship between diversification and high per capita NDDP is not so strong. Its per capita NDDP for 2004-05 and 2010-11 was ₹ 15319 and ₹ 23340. Compared to the year 2004-05, the divergence between per capita NDDP of Balangir and NDP of Odisha is much smaller. So, overall we can say that high per capita NDDP (or economic development) is one of the factors responsible for crop diversification.

Second, we will turn to the productivity of paddy and rice. Paddy is the dominant crop in Odisha and its low productivity distracts farmers from its cultivation as it will not be remunerative for the farmers. And the farmers of developed district take this factor into consideration at the time of crop cultivation. Most recent data with regard to productivity of rice and paddy corroborate this point in so far as highly diversified

districts are concerned. The yield rate (q/ha) for high yielding variety paddy (HYV) for the year 2015-16 in Odisha was 23.46 and same for rice was 15.48 (GoO, 2016-17). When we compared this figure with the figure of highly diversified districts, we found the yield rate for HYV paddy and rice in all the three highly diversified districts was significantly lower. This is evident from the fact that yield rates (q/ha) for paddy and rice in Anugul are 12.0 and 7.92, in Balangir are 14.29 and 9.43, and in Jharsuguda are 14.25 and 9.96. Hence these two factors, viz. per capita NDDP and low yield of paddy and rice, throw some light on the extent of crop diversification in Anugul, Jharsuguda, and Balangir districts.

Nature and Extents of Crop Diversification across Famers' Categories of Highly Diversified Districts

The questions dealt with in this section are 'Which categories of farmers are more diversified in the highly diversified districts?', and What is the nature of their diversification, i.e. which are the crops towards which they are diversifying? It also presents crop-wise and farmer category-wise analysis of gross returns, total cost, and net returns from crop cultivation. This analysis is focused only on highly diversified districts identified in the previous section (Jharsugudaa, Anugul, and Balangir). Each of these three districts has been studied separately. Farmers (same as agricultural households here) have been divided into five categories on the basis of their operational holding land size, namely sub-marginal (< 0.5 ha), marginal (0.5– 1.0 ha), small (1-2 ha), medium (2-4 ha) and large (> 4 ha) farmers. The cases of district Jharsuguda, Anugul, and Balangir are presented in Tables 4, 5, and 6, respectively.

It is evident from Table 4 that in the district Jharsuguda, sub-marginal farmers operate only on 2.8 per cent of total operational area. So this category of farmers is small in size in terms of their total operational area compared to all other farmers' categories. The share of marginal farmers, small farmers, medium farmers, and large farmers in the total operational area is 21.0 per cent, 23.9 per cent, 23.7 per cent, and 28.7 per cent, respectively. Although the share of large farmers is the largest, those of marginal, small, and medium farmers are also significant. From the values of HI, the medium farmers (with HI of 0.176) are highly diversified, followed by small farmers (HI of 0.181). The least diversified category is of marginal farmers with HI of 0.38. The medium farmers allocate 32.3 per cent of their operational area for paddy and the rest 67.7 per cent to vegetables and oilseeds cultivation. In other words, these farmers are diversifying towards pulses, vegetables and oilseeds. Among vegetables the prominent crops are tomato, radish, brinjal, and onion. The net returns from tomato, radish, brinjal, and onion are ₹ 44676, ₹ 47188, ₹ 41488, and ₹ 41929, respectively. The returns from these crops are higher than from paddy. Similarly, one pulse preferred by these farmers is moong which gives them a net return of ₹ 36681. The main oilseed that is cultivated by these farmers is groundnut which gives them a return of ₹ 46402.

The second highly diversified category is of small farmers and they allocate 27.3 per cent of their total operational area to paddy. In this case, diversification is taking place in favour of only vegetables and pulses. The vegetables preferred for cultivation are tomato, other leafy vegetables, cabbage and brinjal. In terms of net returns, among these vegetables, tomato and particularly cabbage yield a high return. Moong is the only pulse that is cultivated by the small farmers.

The medium farmers of Jharsuguda are diversifying towards pulses, vegetables and oilseeds; but its small farmers are diversifying towards vegetables and pulses. The sub-marginal farmers are choosing paddy, tomato, other leafy vegetables, radish and lemon/Acid lime for cultivation. The large farmers cultivate paddy, moong, potato, and onion. And the least diversified category of Jharsuguda allocate 50 per cent of their total operating area for paddy and rest 50 per cent is divided equally between tomato and groundnut. To sum up, the medium and small farmers are more diversified than sub-marginal, marginal, and large farmers in Jharsuguda. Medium farmers are diversifying towards tomato, radish, brinjal, onion, moong, and groundnut. And Small farmers are diversifying towards tomato, other leafy vegetables, cabbage, brinjal, and moong.

Table 5 presents the case of district Anugul. The marginal farmers dominate the farmers' category in this district with a share of 70.3 per cent in the total operating area. The next substantial category is of small farmers with a 12.3 per cent share in the total operating area. The shares in total operating area of sub-marginal, medium, and large farmers are 7.4 per cent, 5.2 per cent, and 4.7 per cent, respectively. From the

Table 4. Extent and nature of diversification across farmer categories in district 'Jharsuguda'

Crops	Cropping share (%)	Gross returns (₹ /ha)	Total cost (₹ /ha)	Net returns (₹ /ha)	Diversification index	Share in total operational area (%)
Sub-marginal farmers (<0.5 ha)						
Paddy	34.7	37196	6494	30702	0.23	2.8
Tomato	14.1	32930	6520	26411		
Other leafy vegetables	17.1	36094	5556	30538		
Radish	17.1	36094	5556	30538		
Lemon/Acid lime	17.1	36094	5556	30538		
Marginal famers (0.5-1.0 ha)						
Paddy	50.0	45805	6539	39267	0.38	21.0
Tomato	25.0	76318	6550	69767		
Groundnut	25.0	76318	6527	69791		
Small farmers (1.0-2.0 ha)						
Paddy	27.3	59597	2926	56672	0.181	23.9
Tomato	22.8	64396	2969	61426		
Other leafy vegetables	10.3	37561	2859	34702		
Groundnut	1.6	30848	2706	28142		
Moong	7.8	101188	2990	98198		
Potato	1.6	30848	2706	28142		
Cabbage	12.4	86594	3045	83549		
Brinjal	14.7	45049	2945	42104		
Cauliflower	0.1	49170	2852	46318		
Colocasia/Arum	1.6	30848	2706	28142		
Medium farmers (2.0-4.0 ha)						
Paddy	32.3	42727	4146	38581	0.176	23.7
Tomato	9.5	48384	3708	44676		
Other leafy vegetables	1.9	60839	4330	56508		
Radish	11.7	51214	4026	47188		
Groundnut	9.2	50726	4324	46402		
Moong	15.6	40381	3701	36681		
Brinjal	9.4	45927	4439	41488		
Rapeseed & mustard	1.0	34101	3706	30396		
Onion	8.1	46171	4241	41929		
Spinach	1.3	43773	5709	38064		
Large farmers (>4.0 ha)						
Paddy	25.8	40595	2328	38268	0.25	28.7
Moong	24.7	39562	2278	37283		
Potato	24.7	39562	2278	37283		
Onion	24.7	39562	2278	37283		

Source: Authors' computation from the data from 70th round of NSSO

Table 5. Extent and nature of diversification across farmer categories in district Anugul

Crops	Cropping share (%)	Gross returns (₹ /ha)	Total cost (₹ /ha)	Net returns (₹ /ha)	Diversification index	Share in total operational area (%)
Sub-marginal farmers (<0.5 ha)						
Paddy	99.7	29073	5687.4	23385	0.99	7.4
Other vegetables	0.1	849123	5687.4	843435		
Brinjal	0.1	849123	5687.4	843435		
Onion	0.1	849123	5687.4	843435		
Marginal famers (0.5-1.0 ha)						
Paddy	33.3	22068	2494	19574	0.18	70.3
Brinjal	4.4	34945	2011	32934		
Urad	15.3	18221	2786	15435		
Potato	4.4	34945	2011	32934		
Cabbage	7.8	26200	2756	23443		
Horsegram	15.3	18221	2786	15435		
Cauliflower	4.4	34945	2011	32934		
Maize	6.6	19103	1748	17355		
Tur (Arhar)	8.7	17440	1748	15692		
Small farmers (1.0-2.0 ha)						
Paddy	80.5	32316	3005	29310	0.65	12.3
Other vegetables	4.9	29555	3862	25693		
Brinjal	1.5	119392	2829	116563		
Urad	3.4	219746	5514	214232		
Potato	3.4	219746	5514	214232		
Horsegram	3.4	219746	5514	214232		
Banana	1.5	119392	2829	116563		
Tomato	1.5	119392	2829	116563		
Medium farmers (2.0-4.0 ha)						
Paddy	39.3	29055	4051	25005	0.22	5.2
Brinjal	8.3	47947	2011	45937		
Urad	11.9	17065	5003	12061		
Potato	11.9	17065	5003	12061		
Horsegram	11.9	17065	5003	12061		
Cauliflower	8.3	47947	3005	44942		
Tomato	8.3	47947	3582	44365		
Large famers (>4.0 ha)						
Paddy	100.0	7278.1	1698.2	5579.9	1.00	4.7

Source: Authors' computation from the 70th round of NSSO data

Table 6. Extent and Nnature of diversification across farmer categories in district Balangir

Crops	Cropping share (%)	Gross returns (₹ /ha)	Total cost (₹ /ha)	Net returns (₹ /ha)	Diversification index	Share in total operational area (%)
Sub-marginal farmers (<0.5 ha)						
Paddy	78.9	29307	6907	22400	0.66	7.9
Cotton	17.9	31303	7576	23726		
Urad	1.0	23143	7395	15748		
Other vVegetables	1.8	30337	7296	23041		
Gram	0.3	19130	7610	11520		
Marginal farmers (0.5-1.0 ha)						
Paddy	43.4	25704	4777	20927	0.26	40.7
Urad	4.1	34525	6405	28120		
Other vegetables	18.5	29543	4593	24950		
Moong	11.3	19053	6357	12695		
Horsegram	11.3	19053	4645	14408		
Lady's finger	11.3	19053	4645	14408		
Small farmers (1.0-2.0 ha)						
Paddy	54.3	23718	3421	20297	0.33	22.7
Cotton	11.3	31705	3726	27979		
Urad	9.5	18564	3381	15183		
Other vegetables	0.2	33251	3492	29758		
Horsegram	2.3	10501	3803	6698		
Other cereals	1.5	18784	3345	15439		
Tur (Arhar)	7.2	21088	3248	17840		
Other pulses	2.5	36122	2903	33219		
Sugarcane	0.2	82641	4737	77905		
Tomato	1.5	29528	3184	26344		
Brinjal	0.2	36275	2997	33278		
Beans (green)	0.9	14036	2903	11133		
Pumpkin	1.4	30139	2962	27177		
Groundnut	7.2	21088	3248	17840		
Medium farmers (2.0-4.0 ha)						
Paddy	39.3	21887	3565	18322	0.25	19.8
Cotton	23.7	17199	4028	13171		
Urad	9.2	20978	2955	18023		
Moong	15.1	27667	2895	24772		
Horsegram	0.6	18363	3786	14577		
Other cereals	0.4	34133	2948	31185		
Tur (Arhar)	5.7	34863	2801	32062		
Other pulses	3.5	40079	2801	37278		
Brinjal	0.7	27021	2801	24220		
Groundnut	1.3	42538	2801	39737		
Maize	0.5	26387	4092	22295		
Large farmers (>4.0 ha)						
Paddy	40.1	18546	3005	15541	0.26	8.8
Cotton	20.4	27806	3403	24403		
Urad	18.4	24153	3222	20931		
Moong	15.6	25850	3336	22513		
Maize	2.8	14719	2585	12133		
Ragi	2.8	14719	2585	12133		

Source: Authors' computation from the 70th round of NSSO data

diversification index, it is also evident that marginal farmers are most diversified among all the categories of farmers in Anugul, followed by medium farmers with a HI 0.22. The remaining categories of farmers, namely, sub-marginal, small, and large farmers are not diversifying their crop production. The highly concentrated farmer category is large farmers who cultivate only paddy.

The crop production of sub-marginal farmers is also highly concentrated in paddy, whose cropping share is 99.7 per cent. The small farmers are also not diversified with area under paddy occupying a very high share (80.5 %) of their total cropping area. In the case of most diversified category (that is marginal farmers), the share of area under non-paddy crops is 66.7 per cent. The marginal farmers are diversifying towards vegetables such as brinjal, potato, cabbage, and cauliflower; coarse cereals such as horsegram and maize; and pulses such as urad and tur. In terms of net returns, the vegetables, namely, brinjal, potato, and cauliflower, are most profitable for these marginal farmers. The medium farmers, who are the next most diversified category, allocate 60.7 per cent of their total cropping area to non-paddy crops. These farmers are diversifying their cultivation in favour of vegetables like brinjal, potato, cauliflower, and tomato; and urad and horsegram. Brinjal, cauliflower, and tomato are the most profitable crops for the medium farmers.

To sum up, the marginal and medium farmers are the most diversified crop cultivators in district Anugul. Both these categories of farmers allocate a high share of cropping area to non-paddy crops. The marginal farmers are diversifying their cultivation towards vegetables (brinjal, potato, cabbage, and cauliflower), coarse cereals (horsegram and maize), and pulses (urad and tur). And medium farmers are diversifying towards vegetables (brinjal, potato, cauliflower, and tomato), pulses (urad), and coarse cereal (horsegram).

The extent and nature of crop diversification for the district Balangir is presented in Table 6. The share in total operational area of the district is largest of marginal farmers (40.7%), followed by small farmers (22.7%), medium farmers (19.8%), large farmers (8.8%), and sub-marginal farmers (7.9%).The most diversified category is medium farmers (with a HI of 0.25), closely followed by marginal and large farmers with each recording a HI of 0.26. The small farmers are moderately diversified with HI of 0.33. Among all categories, sub-marginal farmers are the least diversified in Balangir or to put it more correctly they concentrate their crop cultivation in paddy and cotton. The medium farmers grow paddy in 39.3 per cent of their total cropping area and allocate the rest (60.7%) to other crops. The most prominent among those crops are cotton, urad, moong, tur, other pulses, and groundnut. So unlike other two districts, the medium farmers in Balangir are diversifying towards pulses (urad, moong, tur, other pulses), oilseed (groungnut) and fibre crop (cotton). But, the net returns from these crops are not that significantly high. The marginal farmers allocate 43.5 per cent of their total cropping area for paddy. They are diversifying their cultivation, unlike medium farmers, towards other vegetables and lady finger. They also grow pulses like urad and moong and coarse cereals like horsegram. Among all three highly diversified districts, thelarge farmers of Balangir are more diversified and they are diversifying into fibre crop like cotton; pulses like urad and moong; and cereals like maize and ragi. The moderately diversified small farmers allocate 54.3 per cent of total cropping area to paddy.

Econometric Results

After trying various regression equations, only the results of best equation are presented in Table 7. The results bring out the determinants of Hefindahl Index (or crop diversification) at all Odisha level. Here, HI of all sample agricultural households was calculated and then regressed on various explanatory variables. Among the social categories, only dummy Scheduled Caste is statistically significant at 5 per cent level. That means in comparison to 'others', the value of HI of schedule caste agricultural households is higher by 0.026223. A higher value of HI of SC households in comparison to others indicates that SC households are less diversified than households who fall in 'Others' category. The other two dummies for ST and OBC were statistically not significant.

The coefficient of irrigated land (IL) was found positive and was statistically significant at 5 per cent level. This shows that there is a positive relationship between irrigated land and HI value. When irrigated land area increases, HI value rises or diversification falls. To be precise for one unit increase (decrease) in the area under irrigation, there is increase (decrease) in HI value by 0.026223. When there is an increase in

Table 7. Regression results

Independent variables	Model-1 Coefficients	Model-2 Coefficients
Dummy SC	0.026223** (2.09)	0.025592** (2.03)
Dummy ST	-0.024729 (-2.02)	-0.024720** (-2.02)
Dummy OBC	0.003279 (0.34)	0.001723 (0.18)
IL	0.005543** (2.44)	—
TL	—	-0.003786 (-1.18)
Dummy LK	-0.004837 (-0.58)	-0.003722 (-0.44)
Dummy OA	-0.001943 (-0.17)	-0.002992 (-0.26)
Dummy SE	0.005334 (0.57)	0.003354 (0.36)
Dummy SPIS	0.02595* (2.63)	0.023698** (2.38)
Dummy NEPIS	0.020031 (1.06)	0.010773 (0.57)
Dummy MGNREGA	-0.016174** (-1.97)	-0.017358** (-2.12)
Dummy ABPL	0.000366 (0.04)	-0.001277 (-0.15)
Dummy PEDU	0.023126** (2.32)	0.024171** (2.42)
Dummy HSEDU	0.022413** (2.09)	0.021995** (2.05)
Dummy DIPEDU	0.012020 (0.68)	0.011456 (0.65)
Dummy AT	-0.070628** (-2)	-0.069955** (-1.98)
Dummy LEMP	0.045418* (2.91)	0.042504* (2.66)
Dummy LML	-0.002042 (-0.11)	-0.000424 (-0.02)
Dummy LSHT	-0.042113 (-1.33)	-0.044462 (-1.4)
Dummy MSP	0.011984 (1.5)	0.014105** (1.77)
Dummy AEA	-0.049204* (-3.29)	-0.047223* (-3.16)
Dummy AKVK	-0.003989 (-0.18)	-0.003979 (-0.17)
Age	0.000108 (0.34)	0.000114 (0.35)
NR	-0.000001 (-1.17)	-0.0000007 (-0.81)
OL	-0.0000001 (-1.35)	0.00000002 (0.3)
Constant	0.929386* (39.1)	0.936051* (39.16)
No. of observations	1557	1557
R-squared	0.0521	0.0511

Note: *Significant at 1 per cent level, **Significant at 5 per cent level, ***Significant at 10 per cent level. Figures within the parentheses are t-values. Full forms of the abbreviations are given in annexure-1.
Source: Computed by authors based on 70th round NSSO data

the area under irrigation, crop concentration takes place. We can expect this concentration to be guided by paddy as it is the dominating crop in Odisha and it is water-intensive. This means that farmers use irrigation more for cultivation of paddy. They do not use the scarce resource for a crop that can increase their income as the net returns from paddy in almost all the districts are not that high. So here lies an opportunity for the government to persuade farmers to use irrigation for more high-value crops.

The HI value of the households whose PIS is wage/salaried employment is higher by 0.02595 and is statistically significant at 1 per cent level. This means that the households whose PIS is wage/salaried employment are less diversified than households whose PIS is not wage/salaried employment. Any household whose PIS is wage/salaried employment is likely to devote less time for cultivation and therefore, may choose a crop which is less time-consuming. And the crop thus selected is repeated time and again and hence there is concentration not diversification. Other PIS, namely, non-agricultural activity is not statistically significant.

There is a negative relationship between HI value and MGNREGA card holders. The households having MGNREGA card, have a lower HI value than those households who do not have MGNREGA card. The HI value for the former is lower by 0.161748 than of the latter. MGNREGA card holders are more diversified than the non-holders. This can be explained as the one who has card earns that extra income which is used for diversification of crops. However, due to the small scale of income earned through MGNREGA, the diversification that results will not be cash crop led diversification but distress diversification.

In comparison to illiterates, farmers who are primary educated or educated up to high school have depicted a higher HI value. In the case of primary level educated farmers, HI is higher by 0.231268 and it is statistically significant at 5 per cent level. And in case of up to high school level educated farmers, HI is higher by 0.0224137 and it is statistically significant. So in comparison to illiterate farmers, the above two levels of educated farmers are less diversified and among them primary level educated farmers are least diversified. So education leads to concentration up to primary and up to high school results in concentration of crop cultivation.

The coefficient of agricultural training (dummy AT) is negative and statistically significant. That means those farmers who have agricultural training have a lower HI in comparison to those farmers who do not have any agricultural training. Hence, an agriculturally trained farmer is more diversified than an untrained farmer. So agricultural training leads to crop diversification. To promote diversification in crop sector, government can focus on providing training to farmers.

The only statistically significant variable under loans from different sources is loans from employer (Dummy LEMP). In comparison to loans from the public sources and cooperative societies, the farmers who take loan from their employer, have shown a higher HI value, higher by 0.045418. This means that farmers taking loan from employer are less diversified than the farmers taking loan from government and cooperative societies.

The last variable that is significant is advisory services of extension agents (Dummy AEA). The coefficient of the variable is negative and statistically significant at 1 per cent level. The value of HI of those farmers who got advice from the extension agents, was lower by 0.049204 than of those farmers who did not get advice of extension agents. So advice of extension agents results to crop diversification.

All other explanatory variables of Model-1 are not statistically significant and hence not discussed. The results of Model-1 can be summarized as follows. At all Odisha level, variables like SC, irrigated land, wage/ salaried employment as PIS, primary level education, and up to high school level education are positively related to value of Diversification Index. With the increase (decrease) of these variables, the extent of crop diversification falls (rises). However, variables like MGNREGA card, agricultural training, and advice of extension agents are negatively linked with the value of diversification index. With the increase (decrease) in these variables, the extent of crop diversification rises (falls). From the results of model-2, it is clear that ST households in Odisha are more diversified than the base category 'others'. The coefficient of dummy ST came out to be negative and statistically significant at 5 per cent level. One other revealing result is that the HI value of the households aware about MSP is higher by 0.014105 than those not aware about MSP. The coefficient of dummy MSP is statistically significant at 5 per cent level. This means that the extent of crop diversification is lower in the case of households who are aware about MSP. Other significant variables of model-2 are dummy SC, dummy SPIS, dummy MGNREGA, dummy PEDU, dummy HSEDU, dummy AT, dummy LEMP, and dummy AEA.

Conclusions

The study conducted on different districts of Odisha, has found Jharsuguda, Anugul, and Balangir to be highly diversified districts; Bargarh, Debagarh, Puri, Ganjam, Gajapti, Kandhamal, Kalahandi, Nabarangpur and Koraput to be moderately diversified districts; and Sambalpur, Sundargarh, Kendujhar, Mayurbhanj, Baleshwar, Bhdrak, Kendrapada, Jagatsinghapur, Cuttack, Jajapur, Dhenkanal, Nayagarh, Khordha, Baudh, Sonapur, Nuapada, Rayagada, and Malkanagiri to be least diversified districts. Both average gross and net returns from cultivation in the case of highly diversified districts are significantly higher than those of moderately

diversified and least diversified districts. Moreover, in the district, Jharsuguda, the medium farmers are most diversified, followed by small and sub-marginal farmers. The marginal farmers in Jharsuguda are the least diversified. In the district Anugul, most diversified are marginal farmers, followed by medium farmers and small farmers. The sub-marginal farmers and large farmers are least diversified in Anugul. In district Balangir, medium farmers are most diversified, followed by marginal farmers, large farmers, and small farmers. The sub-marginal farmers in district Balangir are least diversified. The SC households in Odisha are less diversified in comparison to other households. Irrigated lands in Odisha are mostly used for paddy cultivation and hence higher the extent of irrigated land, lower is the extent of crop diversification. The salary as principal source of income, loan from employer, primary education, and secondary education are positively related to the HI value. MGNREGA card holding, agricultural training, and advice of extension agents promote diversification at all-Odisha level.

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References

Birthal, P.S., Negi, D.S., Jha, A.K. and Singh, D. (2014) Income sources of farm households in India: Determinants, distributional consequences and policy implications. *Agricultural Economics Research Review*, **27** (2): 37-48.

Bresciani, F. and A. Valdés, A. (2007) *Beyond Food Production: The Role of Agriculture in Poverty Reduction.*, Food and Agriculture Organisation of the United Nations, Rome.

Chand, Ramesh (2017) *Doubling Farmers' Income: Rationale, Strategy, Prospects, and Action Plan*. NITI Policy Paper No.1/2017. National Institute for Transforming India, Government of India, New Delhi.

Chand, Ramesh, Saxena, R. and Rana, S. (2015) estimates and analysis of farm income in India: 1983–84 to 2011–12. *Economic & Political Weekly*, **50** (22): 139-145.

DFID (2004) *Agriculture, Growth and Poverty Reduction*, http://www.dfid.gov.uk/Documents/publications/agri-poverty-reduction.pdf

GoI (Government of India) (2013) Census of India 2011: Executive Summary. Retrieved on August 3, 2017 from online via access: http://www.censusindia.gov.in/2011census/PCA/PCA_Highlights/pca_highlights_file/Odisha/Executive_Summary.pdf

GoO (Government of Odisha) (2014) *Odisha Economic Survey: 2013-14*. Planning and Coordination Department, Directorate of Economics and Statistics, Bhubaneswar.

GoO (Government of Odisha) (2015) *Odisha Economic Survey: 2014-15*. Planning and Coordination Department, Directorate of Economics and Statistics, Bhubaneswar.

GoO (Government of Odisha) (2017) *Odisha Economic Survey: 2016-17*. Planning and Coordination Department, Directorate of Economics and Statistics, Bhubaneswar.

GoO (Government of Odisha) (2016) *Odisha at a Glance-2016*. Directorate of Economics & Statistics, Bhubaneswar.

Kumar, Anjani, Kumar, Praduman, and Sharma, Alakh N. (2011) Rural poverty and agricultural growth in India: Implication for the twelfth five year plan. *Indian Journal of Agricultural Economics*, **66** (3): 269-278.

Kumar, P., Mruthyunjaya, and Birthal, P.S. (2007) Changing consumption pattern in South Asia, In: *Agricultural Diversification and Smallholders in South Asia*, Academic Foundation, New Delhi. pp. 151-194.

Ligon, E. and Sadoulet, E. (2008) *Estimating the Effects of Aggregate Agricultural Growth on the Distribution of Expenditures*. Background paper for the World Development Report 2008, World Bank.

Montalvo, J. and Ravallion, M. (2009) *The Pattern of Growth and Poverty Reduction in China*. Policy Research Working Paper 5069, World Bank.

Narayanamoorthy, A. (2013) Profitability in crops cultivation in India: Some evidence from cost of cultivation data. *Indian Journal of Agricultural Economics*, **68** (1): 104-121.

Ranganathan, Thiagu (2015) *Farmers' Income in India: Evidence from Secondary Data*. Report Submitted to the Ministry of Agriculture, New Delhi.

Ravallion, M. and Chen, S. (2007) China's (Uneven) progress against poverty. *Journal of Development Economics*, **82** (2007): 1-42.

Sharma, Alakh N. and Kumar, Anjani (2011) *The Role of Poverty in Poverty Reduction: The Indian Experience*. https://www.vu.edu.au/sites/default/files/SHARMA_KUMAR_2011_Role_Agric_in_Poverty-Reduction_India.pdf

Annexure 1

Details of Regression Equations

$$HHI_i = \alpha + \beta_1 Dummy\ SC_i + \beta_2 Dummy\ ST_i + \beta_3 Dummy\ OBC_i + \beta_4 IL_i + \beta_5 Dummy\ LK_i + \beta_6 Dummy\ OA_i + \beta_7 Dummy\ SE_i + \beta_8 Dummy\ SPIS_i + \beta_9 Dummy\ NEPIS_i + \beta_{10} Dummy\ MGNREGA_i + \beta_{11} Dummy\ ABPL_i + \beta_{12} Dummy\ PEDU_i + \beta_{13} Dummy\ HSEDU_i + \beta_{14} Dummy\ DIPEDU_i + \beta_{15} Dummy\ AT_i + \beta_{16} Dummy\ LEMP_i + \beta_{17} Dummy\ LML_i + \beta_{18} Dummy\ LSHT_i + \beta_{19} Dummy\ MSP_i + \beta_{20} Dummy\ AEA_i + \beta_{21} Dummy\ AKVK_i + \beta_{22} Dummy\ Age_i + \beta_{23} Dummy\ NR_i + \beta_{24} Dummy\ OL_i + \epsilon_i$$

Here, i represents the number of households and it varies between 1 and 1557, α is the constant. β_j are the coefficients and j varies from 1 to 25. ε_i represents error-term. ST is scheduled caste, St is scheduled tribe, OBC is other backward caste, IL is irrigated land, LK is livestock activity, OA is other agricultural activity, SE is wage/salaried employment, SPIS is salary as principal income source (PIS), NEPIS is non-agricultural enterprise as PIS, MGNREGA is Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) Card Holder, ABPL is Antyodaya card or Below Poverty Line card holder, PEDU is primary and below educational level, HSEDU is up to high school level education, DIPEDU is diploma and above educational level, AT is agriculturally trained, LEMP is loans whose sources are employer, LML is loans whose source are moneylenders, LSHT is loans which are taken from shopkeepers and traders, MSP is awareness on minimum support price, AEA is advice of the extension agents, AKVK is advice of Krishi Vigyan Kendra, NR is net receipts from non-farm business, and OL is outstanding loan amount of the agricultural household.

In model-2, the variable IL is dropped and replaced by variable total land (TL). All other variables are same as in model-1.