

Crop Diversification in Odisha: An analysis of area dynamics with gender perspective

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Received: March 2021; Revised accepted: June 2021

ABSTRACT

Crop diversification is considered as a pathway for holistic agricultural development. Odisha with a rural sex ratio of 989 bears a tradition of dynamic involvement of women in agriculture across the operations. The present paper examines the intricacies of crop diversification in Odisha in women perspective. The decadal data analysis (2010–19) indicated sluggishness and inconsistency in crop diversification in the state. A regional divide in spread of crop diversification as well as women cultivators was observed in southern districts *vis-à-vis* coastal districts of Odisha. Significant correlation was observed among female cultivators, female agricultural work participation rate, mechanization, and livestock with crop diversification. Based on the panel data analysis, the study concluded that in Odisha; districts with higher female cultivators and maximum Agricultural work participation rate contributed more to crop diversification.

Key words: Crop diversification, Entropy index, Farm women, Work participation rate

Odisha located in the Eastern coast of India and covers over 1.56 million ha of land, accounting 4.7% of total land mass of the country. It is divided into 4 geographical regions, *viz.* the Northern plateau, Central river basins, Eastern hills and Coastal plains. These regions further divided into 10 agro-climatic zones (CES, 2012). With diverse agroclimatic zones, crop diversification in Odisha is a general phenomenon. Odisha economy has 20% share of agriculture and allied activities (Economic survey, GoO, 2019–20), contributing 18.9% to the state's Gross Value Added (GVA). As per Census of India (Census, 2011), more than 83% of Odisha's population reside in rural areas. Agricultural Census (2015–16) indicated that the average size of operational land holding in the state has contracted from 1.04 ha in 2010–11 to 0.95 ha in 2018–19. About 93% of operational holdings represent marginal and small holdings (0.00–2.00 ha). Although the share of these farmers in land possessed is less compared to their numbers, but they contribute more to the agriculture output. About 65% of the state's work force is engaged in agriculture which provide them food and livelihood directly or indirectly. However among them 32.1% of the family are below poverty line which seems their livelihood is insecure and they are in challenging and stressed situation. As per the

Livestock Census (2019), Odisha has 4.05% share of India's total livestock and 2.73% of the total poultry in India. Cattle form the largest share (60%) of livestock population.

India has achieved record foodgrain production (290 million tonnes) in 2019–20 (Economic survey, GoI, 2019). However, this is primarily restricted to cereals. Since Green Revolution there is a substantial increase in cereal production but pulses and oilseeds are still behind targets. As a result, there is a constant shortage *vis-a-vis* import of edible oils and pulses. Over the years, there is a change in consumer preferences from cereals to nutrient-rich diet which includes protein, fruits and vegetables (Joshi *et al.*, 2006). Crop diversification in India is generally viewed as a shift from the traditionally grown less-remunerative crops to more-remunerative crops. The focal point of crop diversification is the addition of more crops based on their comparative advantage to the existing cropping system, also referred as horizontal diversification (Joshi *et al.*, 2003) and considered as important pathway for agricultural development (Aheibam *et al.*, 2017, Birthala *et al.*, 2020). The crop diversification holistically covers food security, nutrition, income and employment to a wider section of the society as well as holds a significant effect on GDP. Diversification of agriculture for more competitive and high-value enterprises is considered as an important approach for augmenting farm income, employment generation, pov-

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erty alleviation and biodiversity conservation (Choudhary, 2016; Birthal and Hazrana, 2019). Women's involvement in agriculture is complex and diverse. Unlike their male counterpart, women are involved in a wide range of activities in agriculture. Women are traditional caretakers of crop genetic diversity in agriculture. Their knowledge of the plant growing conditions and nutritional characteristics of various species gives them an edge of experience from seed selection to its processing. However, women's contribution in resource management has not been recognized and the lack of documentation bars access their multi-dimensional role in agriculture. As per Census (2011), in India the share of agriculture, based workers in total women workers was 71.8% in 2001 came down to about 65%. Furthermore the share of women in total agricultural workers has also reduced to about 37% in 2011. In the context of crop diversification and farm women agriculture participation, the present study primarily analyses the crop-diversification dynamics of Odisha and explores its gender aspect as well as other influencing factors using modern statistical tools.

MATERIALS AND METHODS

Data sources

This study is based on a set of panel (secondary) data on all the 30 districts of Odisha for the period from 2011–12 to 2018–19. The data were collected from the various issues of Agriculture Statistics of Odisha published by the Directorate of Agriculture and Food Production (Five decades databook, 2020), Livestock Census (2019) and Final Report, Mechanization (2019). Analysis is extended to disaggregate level using the district level data for the state, were analysed using SAS package. There are several indices to measure crops diversification (Adjimoti *et al.*, 2018) and the most important ones are Table 1.

RESULTS AND DISCUSSION

Crop-area dynamics

The change in cropping area of Odisha can be evaluated through different area dynamics presented in Fig. 1 a and

b respectively. The gross cropped area (GCA) continued to decline from 9.08 m ha in 2010–11 to 8.34 m ha in 2018–19. Around 55% of GCA was used for foodgrain production as a result, there is growing pressure on productivity of land. During 2018–19, net sown area (NSA) was 5.36 m ha, which is a further reduction compared to 2010–11 (5.42 m ha). Over the years, there is an average difference of 3.28 m ha (Avg.) between GCA and NSA. The reason attributed for decreasing NSA can be increase in fallow land. The area under fallow land continued to increase from 0.78 m ha in 2007–08 to 1.07 m ha in 2018–19. Natural calamities are the major factors for the fluctuating trend of NSA, other factors such as lack of irrigation, rainfall, increased land use to non-agricultural activities and ease of marketing also decides NSA. The declining NSA and increase of fallow land points to a worrying scenario, but can be overcome through policies and higher incentives to farmers for optimum use of land (Economic Survey, GoO 2019). With negative drift in NSA, fragmentation of land is a common concern for policy-makers across India. As families break into smaller units, the common piece of land continues to be fragmented, leading to rise in the number of marginal land holdings. Cropping intensity of the state increased marginally during first 3 years (2010–13) of the decade and thereafter showed decline, the sharpest drop was seen in 2015–16. The decline trend does not appear to be temporary, despite an increase in 2017–18 it reversed in the following year. The drop from the peak of 167 to 156% (2018–19) is substantial enough to cause concern. These negative trends challenges the efforts of Government and policy-makers to promote multiple sowing, provision of better irrigation facilities, and measures to reduce risks attached with natural disasters.

A preliminary impression of crop diversification was revealed from the area dynamics of different crops (Fig. 1 b). Shares of different crops showed that Odisha agriculture is dominated by rice. Pulses are the next important crops, followed by oilseeds and vegetables. In the last decade, the area share of rice and pulses has not been changing the area shares of fruits and fibres have been expand-

Table 1. Measures of crop diversification

Measure	Description
Herfindahl index (HI) $HI = \sum_{i=1}^N P_i^2$	It is a concentration index which is used to determine the concentration of a crop/commodity. It decreases as the level of diversification increases. It takes the value 1 when there is total monocropping or specialization and tends to zero as the level of diversification increases (Swades and Shyamal, 2012). P_i is the proportion area of the i th crop and N is the total number of crops.
Theil entropy Index $= \frac{\sum_{i=1}^n P_i \log \frac{1}{P_i}}{\log n}$	This index is a weighted sum of proportions [Weights being $\log(P_i)$]. It attains 0 with complete specialization and $\log(N)$ with perfect diversification. For assessing the 'diversity' aspect of diversification it shows how diversified is a distribution as N varies. Entropy Index evaluates the shares of farm activity in logarithm term with the inverse measure of the shares (Shiyani and Pandya, 1998). With P_i the proportion of cultivated land for the i th crop. TEI is supposed to increase, as the level of diversification increases and <i>vice versa</i> .

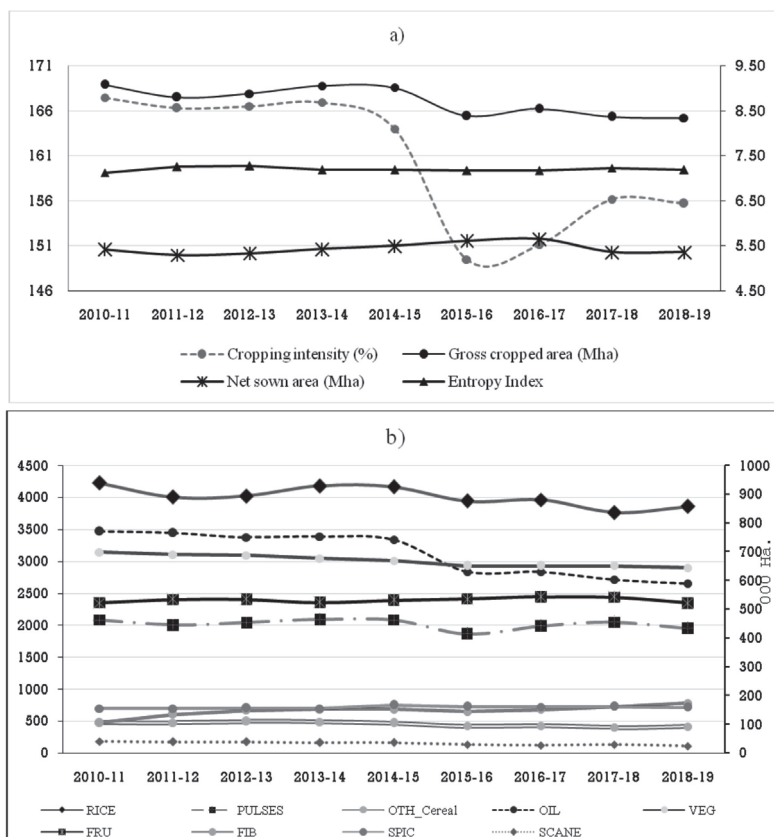


Fig. 1. Graph depicting area dynamics (a) Overall scenario and (b) Crop-wise

ing. However, cereals still occupied the major share of the cropped area, indicating the farmers' awareness about their value in food security besides livelihood security. The share of area under-cereals remained constant around 50–51% during the last decade. Odisha is slowly moving towards production of high-value crops, as the share of cropped area under vegetables, fruits, oilseeds and pulses has increased from 44.86% in 2010–11 to 43.79% in 2018–19. Government has been continuously taking initiatives for diversification of crops with emphasis on high-value crops like pulses, oilseeds, vegetables, and fruits through various developmental schemes like *Rashtriya Krishi Vikas Yojana* (RKVY), National Food Security Mission (NFSM), *Mission for Integrated Development of Horticulture* (MIDH), *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY) and management of soil health. For pulse crops, the area share increased from 22.91% (2010–11) to 26.89%. It may be owing to the awareness among the farmers about protein requirement (nutritional security) and its availability from pulses. In case of fruits and vegetables, the share increased significantly from 0.10% and 4.66% to 0.25% and 7.80% respectively. This reflects the role of high-value horticultural crops and emphasis laid on its promotion through schemes like National Horticulture Mission (Choudhary, 2016).

Crop diversification

The current status (2018–19) of crop diversification in different districts of Odisha is presented through Entropy index (EI) in Fig. 2. A wide variation in crop diversification across the districts observed (0.88, Kandhamal to 0.13, Bhadrak) located in different agro-climatic zones (10 nos.) of Odisha. Coastal region and high rice-productivity districts like Bhadrak (0.43), Balasore (0.47) and Puri (0.53) have shown low values of EI. This is also echoed in western region which are rice in concentrated zone like Bargarh (0.43), Jharsuguda (0.62) and Subarnpur (0.56). This can be explained as these districts takes double crop of paddy and possess high-cropping intensity (188%). Hence, the small value of diversifications are observed. Southern and central west region, Rayagada (0.88), Kandhamal (0.88), Gajapati (0.83) and Koraput (0.79) shows maximum values on crop diversification (Nayak, 2015). Interestingly, agriculture in Kandhamal, a tribal-dominated district, has remained more diversified than others. For remaining districts, there is no noticeable trend in crop diversification. It may be noted here that, the southern and west central regions are relatively less developed than coastal and northern Odisha (Kumar *et al.*, 2020). Most of the southern districts in infamous KBK (Kalahandi, Bolangir and Koraput) region, one of the most backward regions of India. This

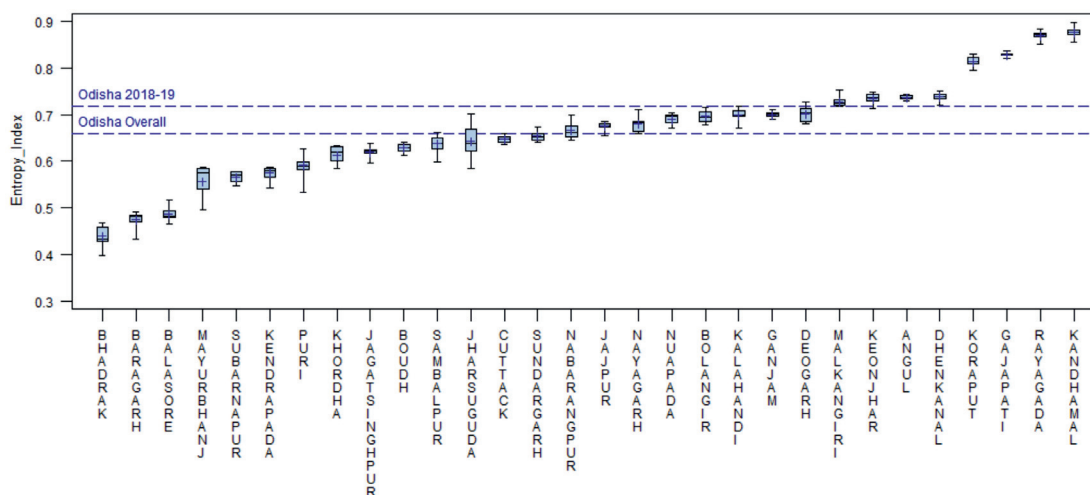


Fig. 2. Crop diversification in different districts of Odisha (based on 2010–19 data)

signifies that economic development is not a precursor of crop diversification. Nayak and Kumar (2018) in their study indicates towards higher level of association between diversification with backwardness of agriculture. Mohanty *et al.*, 2013 and Nayak (2016) also revealed that, most of the districts in coastal Odisha are undergoing crop specialization, whereas the tribal-dominated and technologically less-developed districts are experiencing crop diversification. Basantaray and Nancharaiiah (2017) also reported diversification higher among marginal farmers (0.5 to 1.0 ha.).

In order to study the diversification succession along the decades and across districts paired t-test was done (Table 2.). The analysis showed significant decrease between 1993 and 2003 and in next decade (2002–2012) a significant improvement in crop diversification was observed. Thereafter till 2018–19 no significant succession in crop diversification was noticed. Further, the significance was also tested for change in EI values explained with the help of correlation matrix. The correlation coefficients are significant at 1% level, indicating that respective district with higher EI values are maintaining higher diversification over the years. Kumar (2020) also indicated towards similar diversification succession in Odisha.

Farm women and crop diversification

Gender bears a long-term emphasis on crop diversifica-

tion and farm women are imperative catalyst of crop diversification directly and indirectly. As per the census data (2011) the per cent female cultivators in Odisha was 15.2. The classification of districts in low, medium and high categories is presented through Fig. 3 (a and b). The highest number of female cultivators (27–30%) were recorded in tribal, remote districts, *viz.* Koraput, Malkangiri (29.6%), Gajpati (29.2%), Kandhamal (28.05%) and Rayagada (26.8%). However, these districts possess low socio-economic ranking with an identity of aspirational districts (Kumar *et al.*, 2020). On other hand, the coastal and progressive districts are with very few female cultivators (5–10%) with Bhadrak and Jajpur showing the minimum female cultivators of 5.7%. It is worth to note that the district with very poor crop diversification is also having minimum number of female cultivators (Bhadrak, Balasore, Jagatsinghpur and Puri) and *vice-versa* (Koraput, Malkangiri, Gajpati, Kandhamal and Rayagada). The decadal data analysis incites to the statement that women plays a key role in crop diversification (Muvla and Mulwafu, 2018).

Work participation rate (WPR) is defined as number of persons working per 100 persons in a population and it is an indicator of employment scenario. Agricultural work participation rate (AWPR) is defined as percentage of working population engaged in agriculture and is an indicator of the dependence of population on agriculture sec-

Table 2. Decadal change in crop diversification (EI)

Year	Mean	SD	SE	t Value	Pr > t	
(EI-1993–94	EI-2002–03)	0.029	0.049	0.009	3.26	0.0029
(EI-2002–03	EI-2012–13)	-0.075	0.057	0.010	-7.21	<0.0001
(EI-2012–13	EI-2015–16)	0.012	0.068	0.012	0.96	0.3463
(EI-2015–16	EI-2018–19)	0.005	0.022	0.004	1.27	0.2137

tor (Kumar *et al.*, 2019). The female AWPR of Odisha is 22.6% with a range of 3.8–41.9. The highest female AWPR was observed in Gajapati (41.9%) followed by Koraput (41.6), Malkangiri (41.5), Nuapada (40.9), and Deogarh (40.6), whereas the lowest AWPR was observed in Jajpur (3.8%), Bhadrak (4.4), Khorda (5.2). Similar to the case of female cultivators, the AWPR was very low in coastal districts having a very poor diversification. The role of female

in crop diversification is more elucidated in Fig. 3(b) which shows maximum EI value for Kandhmal (0.88) and Rayagada (0.88) followed by Gajapati (0.83) and Koraput (0.79). The district with maximum EI values recorded the maximum female AWPR as well as female cultivators (%). This signifies to a very important establishment that female cultivator and work participation is having direct bearing on crop diversification and confirms the findings of De

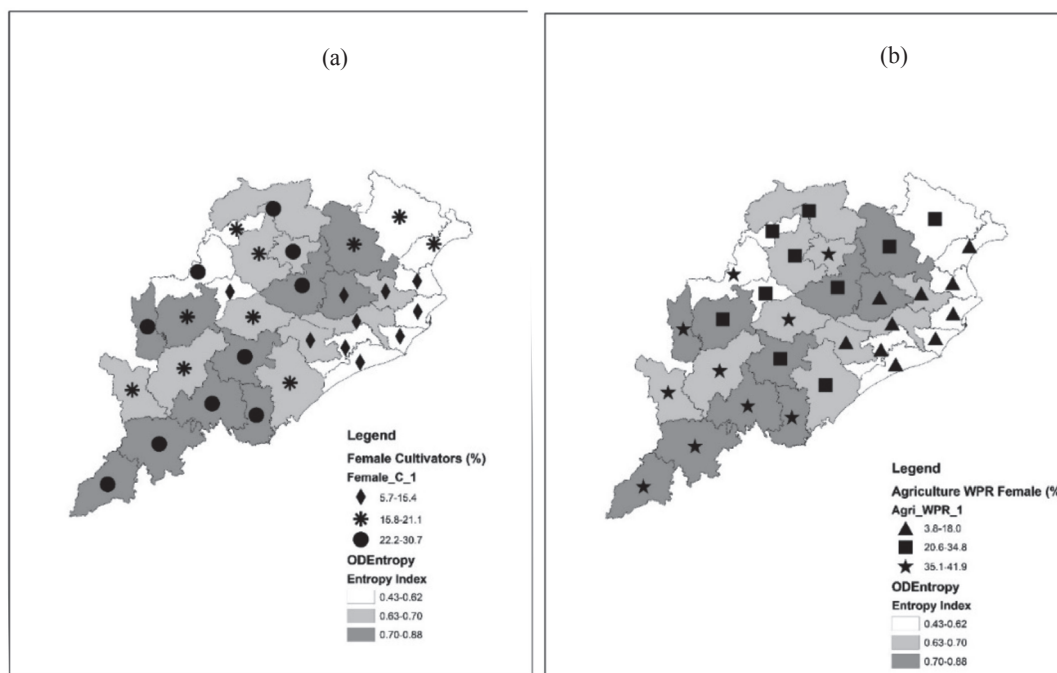


Fig. 3. Odisha district map showing crop diversification (EI) with (a) female cultivators (%) and (b) AWPR-Female (%)

Table 3. Correlation coefficients among different parameters of crop diversification

	HI	EI	CI	II	Fert. C	FPA	ME	FC	AWPR-F	TAW-F	TW	FAL	FHH-AE	FHH-I	TL-HH
HI															
EI	-0.97*														
CI	-0.16	0.02													
II	0.34	-0.45*	0.70*												
Fert. C	0.55*	-0.49*	-0.21	0.08											
FPA	0.19	-0.26	0.40*	0.48*	0.25										
ME	0.50*	-0.53*	0.25	0.48*	0.38*	0.66*									
FC	-0.43*	0.53*	-0.44*	-0.53*	-0.23	-0.48*	-0.51*								
AWPR-F	-0.36*	0.47*	-0.45*	-0.53*	-0.11	-0.56*	-0.51*	0.90*							
TAW-F	-0.28	0.39*	-0.39*	-0.42*	-0.08	-0.60*	-0.37*	0.75*	0.91*						
TW	0.03	0.02	-0.24	-0.01	-0.01	-0.30	-0.22	0.51*	0.33	0.34					
FAL	-0.31	0.41*	-0.31	-0.44*	-0.08	-0.52*	-0.30	0.59*	0.83*	0.93*	-0.03				
FHH-AE	0.32	-0.40*	0.20	0.50*	0.23	0.32	0.51*	-0.38*	-0.38*	-0.34	-0.24	-0.27			
FHH-I	0.30	-0.26	-0.31	0.03	0.08	-0.11	0.31	0.11	0.18	0.20	0.11	0.17	0.52*		
TL-HH	0.34	-0.30	-0.17	0.07	0.13	0.15	0.54*	-0.10	-0.03	0.02	-0.14	0.08	0.55*	0.85*	
BP-HH	0.20	-0.10	-0.48*	-0.32	0.06	-0.20	0.17	0.24	0.33	0.30	0.00	0.32	0.08	0.82*	0.79*

HI, Herfindahl Index 2018–19; EI, Entropy Index 2018–19; CI, Cropping Intensity 2018–19; II, Irrigation Intensity 2017–18, Fert. C, Fertilizer consumption, 2017–18; FPA, Farm Power Availability 2016–17; ME, Motors Engines 2016–17; FC, Female cultivators/total cultivators*100/2011, AWPR-F, Female Agri. Workers/Total female population*100 (2011); TAW-F-Female Ag. Worker/Total Worker*100 2011, Female Cultivator/Total Worker*100/2011, FAL Female Agri Labour/ Total Worker*100 2011; FHH-AE, female headed households owning mechanized 3/4 wheeler agricultural equipment 2011, FHH-I, No. of Female headed Household Households with income source cultivators; TL-HH, Total livestock HH 2011–12; BP-HH, Backyard poultry household 2011–12

Pinto *et al.* (2020).

Correlation

Significant statistical output in terms of correlation coefficients between different parameters, *viz.* female cultivators (%), female AWPR (%), mechanization and livestock, owing households with crop diversification, is presented in Table 3. The crop diversification index, EI, showed significant negative correlation with total female cultivators (0.43) as well as female AWPR (0.36). This signifies strong association and contribution of women in crop diversification. The findings were confirmed as EI registered significant positive correlation value of 0.53 and 0.47, for these parameters respectively. Female agricultural labourers also showed significant positive correlation (0.41) with EI, indicating the female role in diversification (De Pinto *et al.*, 2020). The results indicate that crop diversification is more prominent in rainfed areas showing maximum EI values for remote districts like Kandhamal, Koraput and Gajapati. Furthermore, it recorded a negative trend with irrigation intensity (0.45), fertiliser consumption (0.49) as well as motor engines (0.53). Since in diversified cropping system in different crops, the demand of water as well as nutrient is met out from resource recycling between different components (Jakhar *et al.*, 2017). These negative correlation values further explains that why remote and tribal districts having poor infrastructure like Kandhamal, Rayagada and Gajapati yielding higher value for crop diversification. Mechanization (farm power availability) is not vital for higher crop diversification. The negative relationship (0.45) of the decadal pooled data among irrigation intensity and EI indicates irrigation facilities as not a precursor of crop diversification. Significant correlation of decadal data of EI with other parameters and farm women signifies to a strong association of gender with crop diversification (Nayak and Kumar, 2019).

Irrigation intensity positive relationship (0.70) with cropping intensity points that with higher irrigation intensity; cropping intensity increases (Nayak, 2014). More area under canal irrigation in the state in comparison to minor (lift and flow) irrigation which leads to concentration rather than crop diversification (Kumar, 2020). The data also signifies that mechanization is very much essential for concertation farming (low EI), as indicated by CI correlation values (0.40). Fertilizer consumption, farm power and mechanization are 3 important aspects to achieve higher cropping intensity. High CI point that in districts (Bhadrak, Balaeswar and Bargarh) having higher production and productivity of rice, availability of farm power as well as mechanization is utmost important. Further, farm mechanization has great significance for enabling farmers to take up timely and quality agricultural

operations, thus reducing the costs of production. Studies revealed that, there was a positive correlation between application of improved technologies and the land productivity (Basavaraja, 2016). The agricultural equipment used by female are small, handy and low-priced; thus are widely used for crop diversification. Female cultivators (%) and female AWPR positive correlation significance with total workers (0.58) and agricultural labour (0.53) indicates the cohesiveness the farm women brings in the agriculture workforce. A highly significant relationship of households having livestock (0.85) and backyard poultry (0.82) with female headed household income shows the significance of livestock in crop diversification.

CONCLUSION

There is regional gap in crop diversification which was apparent between the southern districts and coastal districts. Highest number of female cultivators was recorded in tribal and remote districts, *viz.* Koraput, Malkangiri, Gajapati, Kandhamal and Rayagada. On the other hand, the coastal and progressive districts possessed very few female cultivators (5–10%). The district with very poor crop diversification was also having minimum number of female cultivators (Bhadrak, Balasore and Puri) and *vice-versa* (Gajapati, Kandhamal and Rayagada). Significant correlation coefficients was observed between female cultivators, female AWPR, livestock owing households with crop diversification. We may conclude that districts of Odisha with higher female cultivators and maximum AWPR contributed to more to crop diversification.

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