

Contents

Effects of biological and chemical sources of fertilizers on sunflower yield and its components	63
<i>Maryam Zamanian and Mohammad Yazdandoost</i>	
Targeted yield based integrated nutrient management of cabbage in torripsamment	75
<i>S.R. Yadav, B.S. Meena, Anirudh Choudhari and Sunil Kumar</i>	
Boron management in green gram (<i>Vigna radiata</i> L. Wilczek) under custard apple (<i>Annona squamosa</i> L.) based agri-horti system in semi-arid region	79
<i>Raj Kumar, J.K. Singh, Alok Kumar Singh, Srishti Dipriya Minz and Nasam Midhun Kumar</i>	
Conjunctive application of organic and inorganic fertilizers to improve soil fertility and wheat (<i>Triticum aestivum</i> L.) productivity in semi-arid region	85
<i>Narendar Kumar Meena, A.M. Latore, M.K. Singh, Prashant Sharma and Kamlesh Verma</i>	
Effect of different grazing management practices on soil health in <i>Lasiurus indicus</i> grasslands of arid western plain	93
<i>Nav Raten Panwar, Sharmila Roy, Mahesh Kumar and C.B. Pandey</i>	
Techno-economic analysis of inclined solar dryer for carrot (<i>Daucus carota</i> L.) drying	99
<i>Surendra Poonia, A.K. Singh and Dilip Jain</i>	
Genetic diversity of groundnut (<i>Arachis hypogaea</i> L.) revealed by RAPD and ISSR markers	109
<i>Papi Reddy, Pritesh Sabara, Shital M. Padhiyar, Kulkarni, G.U., J.V. Kheni and Rukam S. Tomar</i>	
Effect of hormonal application on physio-biochemical characters to improve seed yield of Sewan grass (<i>Lasiurus indicus</i> Henrard)	117
<i>Maharaj Singh, K. Venkatesan and N.K. Sinha</i>	
Pollen biology of <i>Grewia optiva</i> drummond genotypes: An important agroforestry tree of north western Himalayas	123
<i>Saresh N.V., Archana Verma, Asu Singh Godara, Dharmendera Meena and Arjun Lal Bijarnia</i>	
Genetic variability studies in fennel (<i>Foeniculum vulgare</i>) in arid western Rajasthan	135
<i>Mahipal Jat and Santosh Choudhary</i>	
Assessment of pattern and sustainability of livestock diversification in Odisha	141
<i>Urmi Pattanayak and Kalu Naik</i>	
Short Communication	
Should we be concerned about climate change?	149
<i>Bachir Khezzani</i>	
Modification of traditional tractor-drawn seed drill for arid region crops	151
<i>A.K. Singh, Dinesh Mishra, Prem Veer Gautam, Surendra Poonia and Dilip Jain</i>	



Assessment of Pattern and Sustainability of Livestock Diversification in Odisha

Urmi Pattanayak^{1*} and Kalu Naik²

¹Rama Devi Women's University, Bhubaneswar 751 007, India

²ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi 110 012, India

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Abstract: The present paper described the pattern and sustainability of livestock diversification in 30 districts of Odisha. Secondary data of livestock census were used in computing Simpson diversification index and composite index. The study reveals that during the censal period 1992 to 2012, the individual pattern of crossbred cattle and goat has been declined in the state. Similarly, the pattern of fowls was also decreased by -58.20% for the same period. However, duck and other birds have shown increase. The Khordha, Nuapada, Rayagada, Subarnapur are the least diversified districts during the censal period 2007. While the analysis on inter-composite index comparison showed that all the 30 districts have less agricultural index but with more infrastructural and social indicators put together implying that the study region is more livestock and poultry pattern. The few suggestions towards more diversification in the state is to increase marketing outreach, enhancement of income of farmers through artificial insemination for genetic improvement of indigenous cattle and buffalo, to increase the animals health care centres to achieves the long term goals and diversify the livestock sectors in the state.

Key words: Composite index, livestock, simpson diversification index, sustainability.

In Odisha about 60% of the population depends on agriculture and the performance of this sector is highly susceptible to adverse impact of natural shocks in the form of cyclones, droughts and floods. Like agriculture, livestock production system is an integral part of the sustenance of small and marginal farmers of the rural Odisha (Kurup, 2003). More than 80% of the rural households own livestock of one species or other or a combination of them to get milk, meat, egg, skin, bone, manure and draught power and open condition throughout the year and are regular breeders. The growth in livestock sector is helpful in many ways such as alleviate poverty and lessen interpersonal income disparities. Additionally, increase in outputs of livestock would direct to increased consumption of livestock products and contributing towards lessening of nutrition insecurity. Acceleration in growth of livestock products would promote ease of significance in confidence as well as assist in selling products overseas. Above all, being an integral part of agricultural economy, livestock would improve sustainability of the crop sector through provision of organic manure and draught power as inputs. The present study focuses on the pattern, diversification and sustainability

of livestock and poultry sector in Odisha as a districts level analysis.

Materials and Methods

Odisha state (30 districts) was purposefully selected with an aim to find out the pattern and diversification of livestock and poultry of three different censuses along with to assess the district level composite index for sustainability of social, infrastructural and agricultural indicators. This study is based on secondary data which are collected from 15th, 16th, 17th, 18th and 19th livestock census for the state.

Livestock and poultry pattern

A change in the livestock pattern is measured through the variation in the value under different categories of livestock/poultry in the total number of livestock/poultry.

Livestock and poultry diversification index

Simpson Index (SI) was used for calculating livestock/poultry diversification in districts. The different categories of livestock of Odisha such as Crossbred cattle, indigenous cattle, buffaloes, sheep, goats, pigs whereas poultry includes fowls, ducks, turkeys and were considered to calculate the index. The index

*E-mail: urmi14989@gmail.com

value lies between 0 to 1, when SI value towards 0 it indicates high diversification and value towards 1 presents low diversification.

$$SI = 1 - \sum_{i=1}^n p_i^i$$

where, p_i represents value under i^{th} category of livestock/poultry in the total number of livestock/poultry. On the basis of index values, the areas are classified into three categories such as, a) highly diversification (0.00 to 0.30 index value), b) Moderately diversification (>0.30 to 0.60) and c) Least diversification/highly concentration (> 0.60 to 1 index value). This estimation covers 30 districts of Odisha for livestock and poultry.

Normalisation of data

Before using the composite index, data were normalised for all 22 indicators following appropriate methodologies (Vincent, 2004; Varadan and Kumar, 2015; Kale *et al.*, 2016; Kumar *et al.*, 2016; Ponnusamy *et al.*, 2016). For positive functional relationship following equation was used for normalization.

On the other hand, if negative functional relationship occurs, then the following equation was used,

$$\text{Normalisation} = \frac{(\text{Maximum value} - \text{Active value})}{(\text{Maximum value} - \text{Minimum value})}$$

$$\text{Normalisation} = \frac{(\text{Actual value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})}$$

Table 1. Census wise percentage change of livestock and poultry pattern

Livestock categories	15 th to 16 th Census (1992-1997)	16 th to 17 th Census (1997-2003)	17 th to 18 th Census (2003-2007)	18 th to 19 th Census (2007-2012)	15 th to 19 th Census (1992-2012)
Crossbred cattle	52.00	16.60	60.23	-23.34	117.70
Indigenous cattle	-2.59	-0.45	-17.39	-2.74	-22.09
Total cattle	-0.22	0.67	-11.46	-5.59	-16.04
Buffalos	-9.64	0.43	-14.65	-38.95	-52.71
Sheep	-3.97	-8.22	12.24	-13.04	-13.98
Goats	16.77	0.54	22.82	-8.61	31.80
Pigs	3.08	9.97	-7.61	-54.17	-52.00
Totals	2.62	0.23	-1.42	-10.08	-8.83
Poultry categories					
Fowls	43.03	-3.85	15.41	-0.33	58.20
Ducks etc.	11.24	-16.9	53.57	-57.95	-40.30
Totals	41.13	-4.47	16.97	-3.44	52.30

Composite sustainability index

Social, infrastructural and agricultural indicators were calculated separately by using their respective indicators along with their respective calculated weights in the following equation (Sendhil *et al.*, 2018).

$$\text{Index}_{\text{District}} = \frac{\sum_{i=1}^n X_i W_i}{\sum_{i=1}^n W_i}$$

where, X_i represents the normalized value of i^{th} variable and W_i is the weight of i^{th} variable

Categorisation of the districts: Based on the computed composite index of the districts, Odisha state was categorised as high, moderate and low using mean and standard deviation following Ayyoob *et al.* (2013), Rana *et al.* (2015), Kale *et al.* (2016); Sendhil *et al.* (2018). The three categorization formulas are as follows,

High=Index > (Mean+0.5 SD), Moderate = (Mean-0.5SD) < Index < (Mean+0.5 SD) and Low=Index < (Mean-0.5 SD)

Results and Discussion

Livestock and poultry pattern

The analyzed census wise change of livestock and poultry pattern of Odisha state are presented in Table 1. During the 15th to 16th census, the crossbred cattle increased by 52% but the indigenous cattle decreased marginally by -2.59% and showing an overall decrease of -0.22% in total cattle pattern during the inter-censal period. The buffalos and sheep were decreased by -9.64 and -3.97% respectively during 1992 to 1997 census. The goats and pigs

showed an increase of around 16.77% and 3.08% respectively. However, the total livestock in the state increased between these two censuses showing an increase of 2.6%. There is a sharp increase in the fowls, ducks and other birds in the state during the period. The fowls increased by around 43% and ducks and other birds also shown an increase of 11.2% during the period. Thus, the total poultry in the state recorded an increase of 41.1%. During 16th to 17th census, the crossbred cattle decrease by 16.60% but the decrease in indigenous cattle was only -0.45%. The buffalo, goats and pigs have shown an increase 0.43, 0.54 and 9.97% respectively. The pattern of sheep has recorded decrease by -8.22%. Fowls, ducks and other birds decreased by -3.85% and -16.9% respectively. However, the pattern of livestock and poultry has been decreased during the censal period 1997 to 2003 which are 0.23% and -4.47% respectively. During the period from 2003 to 2007, crossbred cattle, sheep and goats have increased by 60.23%, 12.24% and 22.82% respectively. Other livestock such as indigenous cattle, buffalos and pigs are declined. In total cattle pattern has also been decreased during the censal period of the state. Therefore, the state pattern of livestock have been decline that is -1.42%. The poultry shown opposite pattern in Odisha. The state has recorded an increase of 16.97% during the same period as well fowls, ducks and other birds of poultry have increased by 15.41% and 53.57% in that order. During 18th to 19th census, the pattern of livestock and poultry was decline. During the period between the

Table 2. Categories of Districts Wise Diversification (Livestock)

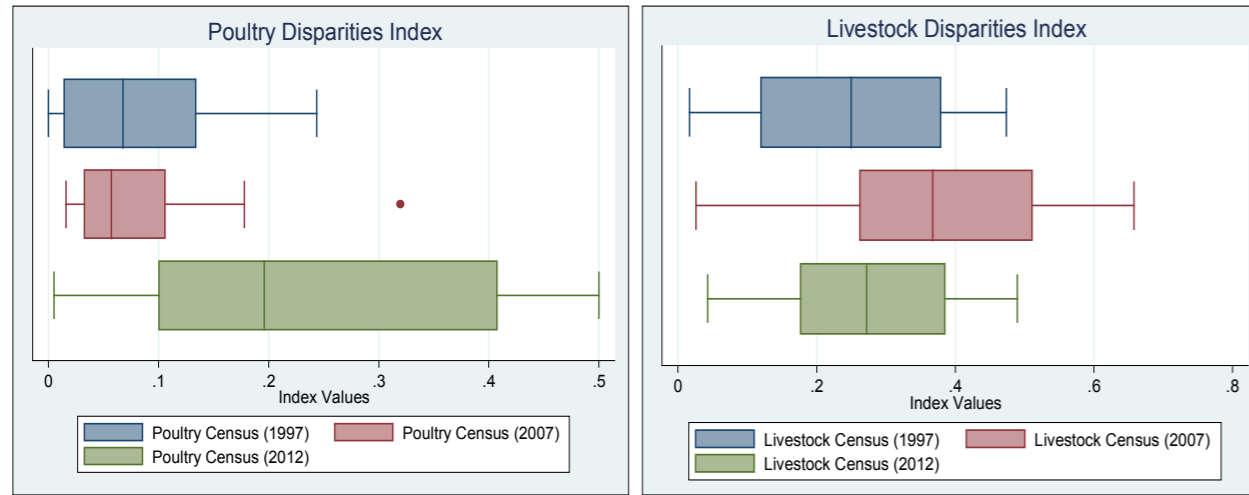
Categories	1997	2007	2012
Highly diversified	Angul, Balasore, Bargarh, Boudh, Cuttack, Deogarh, Dhenkanal, Gajapati, Ganjam, Jagatsinghapur, Jajpur, Jharsuguda, Keonjhar, Koraput, Mayurbhanj, Nayagarh, Puri, Sambalpur, Subarnapur.	Angul, Balasore, Bhadrak, Dhenkanal, Jajpur, Jharsuguda, Kendrapada, Nabarangpur, Puri, Sundargarh.	Angul, Balasore, Bhadrak, Deogarh, Dhenkanal, Gajapati, Jagatsinghapur, Jajpur, Jharsuguda, Kendrapada, Khordha, Malkangiri, Nabarangpur, Nayagarh, Nuapada, Puri.
Moderately diversified	Bolangir, Bhadrak, Kalahandi, Kandhamal, Kendrapada, Khordha, Malkangiri, Nabarangpur, Nuapada, Rayagada, Sundargarh.	Bolangir, Bargarh, Boudh, Cuttack, Deogarh, Gajapati, Ganjam, Jagatsinghapur, Kalahandi, Kandhamal, Keonjhar, Koraput, Malkangiri, Mayurbhanj, Nayagarh, Sambalpur	Bolangir, Bargarh, Boudh, Cuttack, Ganjam, Kalahandi, Kandhamal, Keonjhar, Koraput, Mayurbhanj, Rayagada, Sambalpur.
Least diversified or highly concentrated	-	Khordha, Nuapada, Rayagada, Subarnapur	-

five censuses, the decrease in the crossbred cattle is -118% and a decrease of -31.80% has been observed in goats. Whereas buffalos and indigenous cattle have increase by 52.71% and 22.09% during the inter censal period. The increase in buffaloes is more than indigenous cattle. There is a sharp increase in the pig's population in the state during the period. The sheep population increased by 13.98% and the total livestock by 8.83% in the state. The total poultry declined during the five censuses is -52.30% whereas fowls populations deceased by -58.20% for the same period but duck and other birds have shown increase.

Simpson diversification index analysis: Livestock and poultry

The Table 2 depicts the categories wise and district wise diversification index. It was found that out of 30 districts, Khordha, Nuapada, Rayagada, Subarnapur are least diversified districts during the censal period 2007. Rest of the districts are highly diversified and moderately diversified whereas, all the 30 districts are highly diversified during the censal period 1997. While during 2012, 12 districts have moderately diversified index value. None of the districts belong to least diversified in case of poultry.

Box plot-1 represents the Simpson index for diversification of livestock and poultry of 30 districts in Odisha. The box plot shows that during the 2007 census, the livestock production having least diversified as compared to the other two censuses. In case of poultry,



Box-plot 1. Simpson index for diversification of livestock and poultry.

during 2012 census having diversification index is moderate. Box plot-2 represents the categories wise Simpson diversification index. Here, crossbred cattle, buffalo, sheep and pig, the index value are least diversified or highly concentrated as compared to the other livestock and poultry categories.

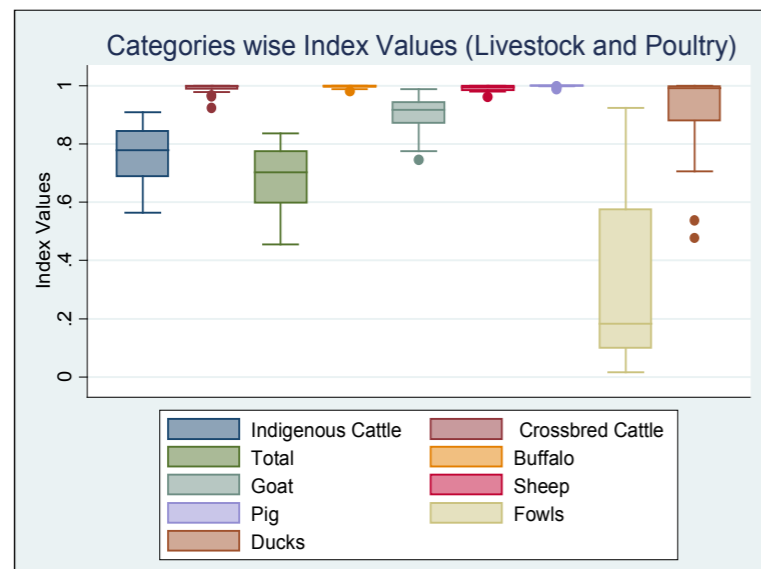
Composite index of 30 districts in Odisha

The composite index was computed using three indicators such as social, infrastructural and agricultural for the sustainable development of 30 districts in Odisha. A social indicator includes six sub indicators such as total population, urban population, rural population, SC population, ST population and literacy rate while a infrastructural indicator include

seven sub indicators namely sex ratio in dairy animals, wet dry ratio in dairy animals, livestock density, milk production density, per capita milk availability, veterinary institution and artificial insemination centres. The agricultural indicators include nine sub indicators such as exact geographical areas, forest areas, average annual rainfall, fallow lands, net sown areas, irrigation intensity, irrigation potential created, farm mechanizations and cropping intensity.

Social indicators

In a diverse structural society social indicator is the main pillar of sustainable development. Social indicator index for 30 districts of Odisha is presented in Table 3 using six indicators. It reveals that highest social indicator index is



Box-plot 2. Categories wise Simpson index for diversification of livestock and poultry.

Table 3. Classification of composite index of 30 districts in Odisha

Districts	SII	Category	III	Category	AII	Category	Three indicators	Categories
Angul	0.54	M	0.22	L	0.40	M	0.37	L
Bolangir	0.56	M	0.32	M	0.48	H	0.44	H
Balasore	0.47	L	0.51	H	0.34	L	0.43	M
Bargarh	0.54	M	0.36	M	0.21	L	0.34	L
Boudh	0.60	H	0.29	M	0.48	H	0.44	H
Bhadrak	0.56	M	0.48	H	0.26	L	0.41	M
Cuttack	0.50	M	0.49	H	0.33	L	0.42	M
Deogarh	0.61	H	0.35	M	0.49	H	0.47	H
Dhenkanal	0.54	M	0.31	M	0.45	H	0.42	M
Gajapati	0.54	M	0.31	M	0.54	H	0.46	H
Ganjam	0.46	L	0.35	M	0.35	L	0.38	L
Jagatsinghapur	0.39	L	0.91	H	0.36	M	0.56	H
Jajpur	0.46	L	0.53	H	0.39	M	0.46	H
Jharsuguda	0.47	L	0.40	M	0.58	H	0.49	H
Kalahandi	0.52	M	0.31	M	0.33	L	0.37	L
Kandhamal	0.48	L	0.12	L	0.45	H	0.34	L
Kendrapada	0.36	L	0.43	H	0.41	M	0.40	M
Keonjhar	0.40	L	0.23	L	0.33	L	0.31	L
Khordha	0.73	H	0.42	M	0.38	M	0.48	H
Koraput	0.53	M	0.17	L	0.40	M	0.35	L
Malkangiri	0.65	H	0.32	M	0.36	L	0.42	M
Mayurbhanj	0.53	M	0.28	L	0.35	L	0.37	L
Nabarangpur	0.66	H	0.25	L	0.36	M	0.40	M
Nayagarh	0.50	M	0.29	M	0.39	M	0.38	L
Nuapada	0.54	M	0.29	M	0.38	M	0.39	L
Puri	0.67	H	0.48	H	0.40	M	0.50	H
Rayagada	0.61	H	0.24	L	0.43	M	0.41	M
Sambalpur	0.56	M	0.28	L	0.47	H	0.42	M
Subarnapur	0.58	H	0.40	M	0.36	M	0.43	M
Sundargarh	0.53	M	0.26	L	0.40	M	0.39	L
Mean	0.5391		0.3565		0.3981		0.4188	
SD	0.0828		0.1451		0.0765		0.0532	

Note: H: High Index Value, M: Moderate Index Value, L: Low Index Value; SII: Social Indicator Index; III: Infrastructural Indicators Index; AII: Agricultural Indicator Index.

observed in Khordha (0.73) while lowest is found in Kendrapara (0.36) with the mean index of 0.53 and SD of 0.08. The less divergence which means difference between maximum index value and minimum index value of 0.37 has been observed among districts which showed that almost all the districts has similar social status under social structure. Eight districts are belongs to moderate index value while another eight districts are under low index value. This reveals that the least populated districts such as Puri followed by Kendrapada

and Jagatsinghapur having ST of 0.35%, 0.62% and 0.70% respectively while highest ST population was observed in Mayurbhanj (59%) followed by Malkangiri (57%) and Rayagada and Nabarangpur having same percentage which is 55. Besides, highest SC population was observed in Subarnapur (25.57%) while least in Gajapati (6.74%), Mayurbhanj (7.34%) and Sundargarh (9.17%). The highest urban population is found in Khordha district followed by Jharsuguda, Sundargarh, Sambalpur and Cuttack whereas these five districts having least

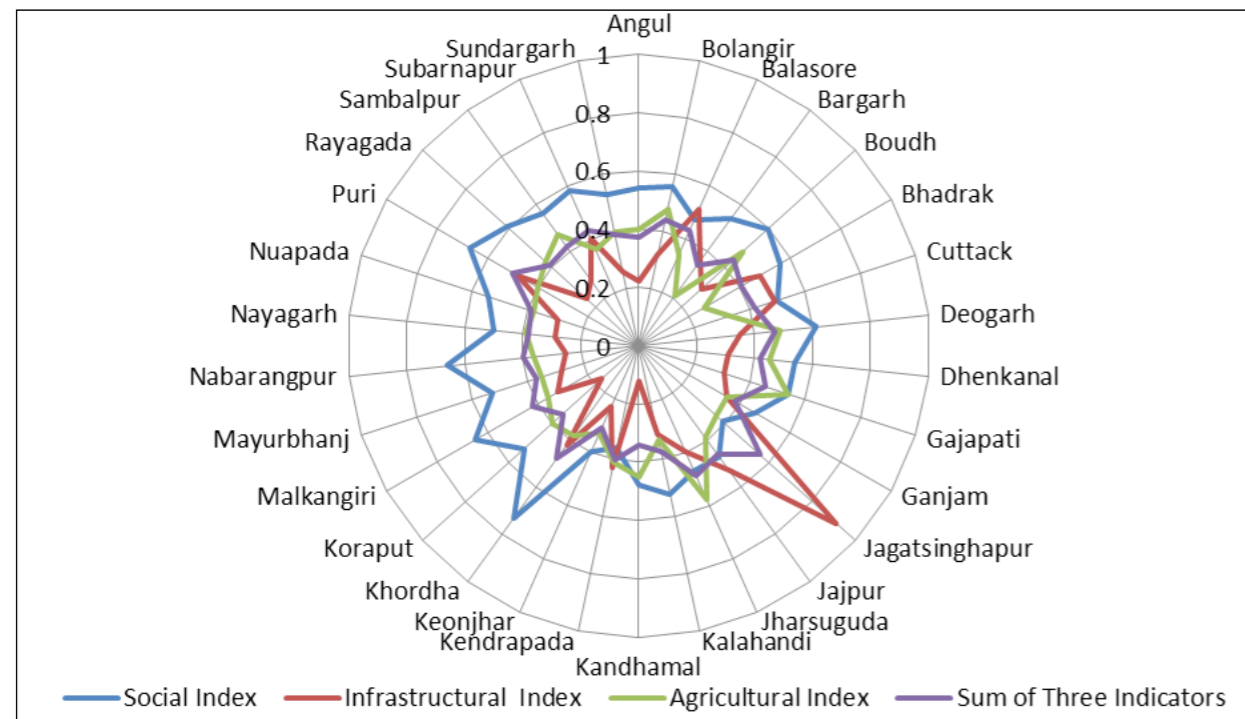


Fig. 1. Radar Pictorial of Social, Infrastructural and Agricultural Indices.

rural population. These indicators indicate that Khordha district having high social index value as compare to the rest of the 29 districts and Kendrapada district is least one.

Infrastructural indicators

Infrastructure services are the mainstay phase associated towards sustainable development. The infrastructure index status reveals that it is highest in Jagatsinghapur (0.91) and lowest in Kandhamal (0.12) with a mean index of 0.35 and SD of 0.14. A high divergence of 0.79 has been found in infrastructure due to its wider range among all the districts. About seven districts are categorised as high infrastructural index value, fourteen districts as moderate index value and nine districts as low index value. The districts that comes under high index value is attributed to highly developed regarding infrastructure. Same is the case in districts that comes under moderate index value the increase in dairy animals and livestock centres. However, the least access district is Kandhamal followed by Koraput where the index values are 0.12 and 0.17 respectively. The least access of milk production density per day is only 1.62 and 5.56% respectively. Moreover, only 13% and 9% are veterinary institutions and AI centres. Thus, these indicators are influencing

the lowest infrastructure sustainability in these nine districts.

Agricultural indicators

Agricultural indicator index for 30 districts of Odisha depicted in table 3. The highest agricultural index is found in Jharsuguda (0.58) while lowest is observed in Bargarh (0.21) with a mean index of 0.39 and SD of 0.07. A divergence of 0.37 has been observed in agricultural indicators. About eight districts are classified as highly agricultural index, thirteen districts as moderately agricultural index and nine districts possess low agricultural index. Most of the districts are belongs to moderate agricultural index. The plausible reason is because of high value of cropping intensity, irrigation intensity, irrigation potential created and rainfall. However, the districts that are in between high to low index value despite higher value in crop diversification coupled with more or less equal in share of net cultivated area, are mainly due to poor farm mechanization, area under pasture and grazing land, less share of agriculture and allied sector income.

Inter-index analysis

Inter-index values of social, infrastructure and agricultural indicators show a huge

difference (Fig. 1). Social index is higher than infrastructure and agricultural indicators for all the districts except Jagatsinghapur, Jharsuguda, Kendrapada and Balasore. Jagatsinghapur has highest infrastructural index (0.91) than the other two dimensions. The districts such as Jagatsinghapur, Jharsuguda, Khordha and Puri have higher index of three indicators as compare to rest of the districts of the state while three districts has lower index values of all three indicators such as keonjhar, Bargarh and Kandhamal. The analysis on inter-index comparison showed that all the districts have less agricultural index but with more infrastructural and social indicators put together implying the study region is more livestock and poultry pattern.

Conclusion

The study clearly indicates that during the last census that is 19th, both livestock and poultry have low diversification as compared to the 16th and 18th census due to less access to land for crop and livestock production. Another reason behind the low diversity towards livestock is attributed to low share in rural employment as it is considered a subsidiary to crop production. The declining trend in livestock population is an area of concern between 2007 and 2012, livestock population is reduce by 10% to 207.33 lakhs in 2012 from 230.57 lakh in 2007. All livestock species witnessed a decline with the largest dip witnessed for pig population. The number of pigs in the state reduced to less than half in a span of 5 years (Anonymous, 2020). Buffaloes witnessed the second largest population decline. The percentage share of exotic or cross-breed cattle in total cattle population is increasing but for indigenous cattle, it is decreasing compared to previous Census (Anonymous, 2012). This indicates the rising share of higher productive animals and the same is reflected in the rising milk production in the State. The few suggestions towards more diversification in the state is to increase marketing outreach especially in Kandhamal, Puri, Jagatsingpur districts, enhancement of income of farmers through artificial insemination for genetic improvement of indigenous cattle and buffalo in terms of

dung manure, to increase the animals health care centres to achieves the long term goals and diversify the livestock sectors in the state.

References

- Anonymous 2012. 19th Livestock Census-2012 All India Report. Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Krishi Bhawan, New Delhi
- Anonymous 2020. Odisha Economic Survey 2019-2020. Planning and Convergence Department, Directorate of Economics and Statistics, Government of Odisha, Odisha. 250 p.
- Ayyoob, K.C., Krishnadas, M. and Kaeel, C.M.H. 2013. Intra-regional disparities in agricultural development in Kerala. *Agricultural Update* 8: 103-106.
- Kale, R.B., Ponnusamy, K., Chakravarty, A.K., Sendhil, R. and Mohammad, A. 2016. Assessing resource and infrastructure disparities to strengthen Indian Dairy Sector. *Indian Journal Animal Science* 86: 720-725.
- Kumar, S., Raizada, A., Biswas, H., Srinivas, S. and Biswajit, M. 2016. Application of indicators for identifying climate change vulnerable areas in semi-arid regions of India. *Ecological Indicator* 70: 507-517.
- Kurup, M.P.G. 2003. *Livestock in Orissa: The Socio-Economic Perspective*. Manohar Publishers and Distributors, UK. 264p.
- Ponnusamy, K., Sendhil, R. and Krishnan, M. 2016. Socio-economic development of fishers in Andhra Pradesh and Telangana states in India. *Indian Journal of Fish* 63(3): 157-161.
- Rana, V., Ram, S., Sendhil, R., Nehra, K. and Sharma, I. 2015. Physiological, biochemical and morphological study in Wheat (*Triticum aestivum* L.) RILs population for salinity tolerance. *Journal of Agricultural Science* 7: 119-128.
- Sendhil, R., Jha, A., Kumar, A. and Singh, S. 2018. Extent of vulnerability in wheat producing agro-ecologies of India: Tracking from indicators of cross-section and multi-dimension data. *Ecological Indicator* 89: 771-780.
- Varadan, R.J. and Kumar, P. 2015. Mapping agricultural vulnerability of Tamil Nadu, India to climate change: A dynamic approach to take forward the vulnerability assessment methodology. *Climate Change* 129: 159-181.
- Vincent, K. 2004. *Creating an Index of Social Vulnerability for Africa*. Working Paper 56, Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, UK.

