Statistical Assessment on the Extent of Agricultural Diversification in Different Districts of Karnataka

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Abstract

Crop diversification is observed as a key strategy for accelerating agricultural expansion in India by increasing food and nutritional security, income and employment generation, poverty reduction, use of effective natural resources and proper environmental management. Using the herfindhal index, Simpson index and entropy index, the study was carried out across all districts of Karnataka state in an attempt to determine the level of agricultural diversification of crops. Secondary data on the area and production of principal crops in all districts for the duration of the study period were gathered from the 'Karnataka at a Glance' publication by the Directorate of Economics and Statistics, Government of Karnataka, Bengaluru. For the time periods 1995-2007 and 2008-2019, Chamarajanagar district exhibited strong diversity whereas Yadgir and Bengaluru urban districts showed relatively low diversification.

Karnataka is situated in India's south western region. It is one of India's most prosperous states. Karnataka has achieved significant progress in the fields of education, manufacturing, agriculture, writing and tourism. Karnataka's capital is Bengaluru. In terms of area, Karnataka is India's seventh largest state which is divided into 30 districts.

Crop diversification near high-value vegetation can boost farm profitability, particularly in rural areas like India, where demand for high-value food items is surpassing demand for staple plants. Smallholders dominate Indian agriculture and experts have long speculated on the possibility for a smallholder-dominated subsistence agricultural economic system to diversify into riskier high-priced commodities. As a result, the fate of agriculture is determined by whether or not crop diversity is accepted (Basavaraj *et al*., 2016).

To analyse the degree of agricultural diversification, study considered 13 main crops *viz.,* Paddy, Jowar, Bajra, Ragi, Wheat, Tur, Bengal gram, Groundnut, Sugarcane, Cotton, Brinjal, Mango and Coconut across all the districts of Karnataka. The period considered in this study was from 1995-2019 considering 30 districts.

The majority of earlier research on agricultural activities in Karnataka were evaluated and analysed at the aggregate level. Because the majority of arable land is not covered by rainfall, there have been less in-depth studies on the structure and dynamics of agricultural production and productivity in the state's many districts.

Material and Methods

The present study has used various statistical diversification indices (Aheibam *et al.,* 2017).

1. Herfindhal Index

2. Simpson Index

3. Entropy Index

Herfindhal Index (HI) : It is the sum of square of the proportion of individual activities in a portfolio. With an increase in diversification, the sum of square of the proportion of activities decreases, so also the indices (HI).

$$\text{Herfindhal Index (HI)} = \sum P_i^2 \quad ....(1)$$

Where, $P_i = A_i / \sum A_i$, was the proportion of the ith activity in acreage or income to the total activities.

The Herfindhal index was a measure of concentration and the index which decreases with increase in diversification (Devi and Prasher, 2018). Herfindhal index ranges from 0-1.

Simpson Index (SI) : Simpson Index of diversification (SID) is considered as the most suitable index for measuring dispersion of enterprises in a particular geographical region (Joshi *et al.*, 2006).

$$\text{Simpson Index of Diversification (SID)} = 1- \sum P_i^2 \quad …(2)$$

Where, $Pi = Ai / \sum Ai$ was the proportion of the ith activity in acreage to the total activities.

The SID ranges from zero to one. If the estimated SID is near zero, it indicates that the district is near to the specialized in growing of particular crops. If the SID is close to one, the district is fully diversified in the crops that it has grown (Dembele *et al.*, 2018 and Ibrahim *et al.*, 2009).

Entropy Index (EI)

Entropy indices discussed below constitute a positive measure of diversification. The Entropy index is feasible direct measure of diversification having a logarithmic character.

$$\text{Entropy Index (EI)} = \sum i\, Pi * \log (1/Pi) \quad …(3)$$

Where, $Pi = Ai / \sum Ai$ was the proportion of the Ith activity in acreage to the total activities

The Entropy index increases with an increase of diversification. The Entropy index approaches zero when the farm is specialized and takes a maximum value one when there is perfect diversification. The upper limit of the Entropy Index is determined by the base chosen for taking logarithms and the number of crops. The upper value of the index can exceed one, when the number of total crops is higher than the value of the logarithm's base and it is less than one when the number of crops is lower than the base of logarithm. Thus, a major limitation of the Entropy Index is that it does not give a standard scale for assessing the degree of diversification. The EI lies between zero to one (Chand, 1996).

Standard classification of selected statistical indices (Halagundegowda *et al.,* 2015)

Index	Range Value		
	0 - 0.3	0.3 - 0.6	0.6 - 1.0
Herfindhal Index	Complete Diversification	Medium Diversification	Crop Specialization
Simpson Index	Crop Specialization	Medium Diversification	Complete Diversification
Entropy Index	Crop Specialization	Medium Diversification	Complete Diversification

RESULTS AND DISCUSSION

Agricultural diversification was calculated using the statistical diversification index. Three indices were utilised in this study. The computed indices have a range value of 'zero' to 'one'. The research looked at 13 selected different crops to determine the degree of agricultural diversity. In all of Karnataka's districts, Paddy, Jowar, Bajra, Ragi, Wheat, Tur, Bengal gram, Groundnut, Cotton, Sugar cane, Brinjal, Mango, and Coconut were picked and considered under agriculture. The study period frame was discovered to be 1995-2019, divided into two periods: 1995-2007 and 2008-2019 (Singha and Chakravorty, 2013). The time period is divided to study the diversification as a 2 equal split and as a whole, to understand the change in crop diversification over the considered period of time based on the availability of data from the source.

Herfindhal Index (HI)

It is observed that HI value obtained had complete diversification for 26 districts *viz.,* Bagalkote, Bengaluru rural, Belagavi, Ballari, Bidar, Vijayapura, Chamarajanagar, Chikkamagaluru, Chitradurga, Dakshina Kannada, Davanagere, Dharwad, Gadag,

TABLE 1

Distribution of selected principal crops for area, production and productivity in Karnataka

Study period	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
		Paddy	
1995-2007	1442331	5901655	4.17
2008-2019	1373077	5314247	4.47
Overall	1407704	5607951	4.32
		Jowar Crop	
1995-2007	1381274	1376106	1.01
2008-2019	1101920	1059276	0.98
Overall	1241597	1217691	1.00
		Bajra Crop	
1995-2007	321614.5	200492.2	0.57
2008-2019	237648.2	240326.6	1.01
Overall	279631.3	220409.4	0.79
		Ragi Crop	
1995-2007	796607.2	1281705	1.32
2008-2019	684205.9	1024797	1.49
Overall	740406.5	1153251	1.40
		Tur (Redgram)	
1995-2007	267449.7	256176.4	1.20
2008-2019	193684.2	199471.1	1.05
Overall	230567	227823.7	1.12
		Groundnut Crop	
1995-2007	692270.6	378415.5	0.71
2008-2019	954435.3	703406.6	0.74
Overall	823352.9	540911.1	0.72
		Sugarcane Crop	
1995-2007	750434.4	412250.3	0.53
2008-2019	1126808	666434.5	0.58
Overall	938621.1	539342.4	0.55
		Coconut Crop	
1995-2007	862749.1	512680.2	0.60
2008-2019	620800.4	469324.4	0.77
Overall	741774.8	491002.3	0.69
		Wheat Crop	
1995-2007	464092.8	834469.9	1.80
2008-2019	650746.9	1511494	2.37
Overall	557419.9	1172982	2.09

Study period	Area (ha)	Production (tonnes)	Productivity (tonnes/ha)
		Bengal gram	
1995-2007	372776.1	26966949	87.8
2008-2019	461756.7	34427445	67.1
Overall	417266.4	30697197	77.4
		Cotton Crop	
1995-2007	13495.85	144699.6	10.92
2008-2019	14728.07	184719.8	13.07
Overall	14111.96	164709.7	11.99
		Brinjal Crop	
1995-2007	125465	525547.9	4.56
2008-2019	148160.7	675053.3	4.66
Overall	136812.9	600300.6	4.61
		Mango Crop	
1995-2007	429373.5	2901966	5.17
2008-2019	474245.3	3721357	5.08
Overall	451809.4	3311661	5.13

('Karnataka at a Glance' publication by the DOE & S, Govt. of Karnataka, Bangalore)

Kalburgi, Hassan, Haveri, Kolar, Koppal, Mandya, Mysuru, Raichur, Ramanagar, Shivamogga, Tumkuru, Udupi and Uttar Kannada for both the study periods. There is little increase or decrease in the diversification which is varying between zero to 0.3. However, the extent of cropping diversification was more in the period 1995-2007, compared to the period 2008-2019. Because these districts have higher index values during the first period (nearer to zero) when compared to the index values during the second period.

The Chamarajanagar districts obtained lowest value (0.168) among all districts during first period. The calculated index value, for both the period found nearer to zero, suggesting crop diversification for both period of study. The Yadgir district shown moderate diversification (0.562) in first period, followed by Bengaluru urban district, slightly moderate diversification of (0.324) was observed in first period (Halagundegowda *et al.,* 2015).

Simpson Index

It was calculated for all the districts separately for periods 1995-2007 and 2008-2019. It is observed that

Simpson Index value obtained had complete diversification for 16 districts the districts *viz.,* Bagalkote, Belagavi, Ballari, Bidar, Chamarajanagar, Chikkamagaluru, Chitradurga, Dakshina Kannada, Davanagere, Kalburgi, Hassan, Haveri, Kolar, Mysuru, Shivamogga and Tumkur for study periods 1995-2007.

The Chamarajanagar districts obtained highest value (0.832) among all districts for first period. The calculated index value, for both the period found nearer to one, suggesting crop diversification for both period of study. The Yadgir districts obtained lowest value (0.438) among all districts for first period. The calculated index value, for both the period found nearer to zero, suggesting crop specialization for both period of study (Behera *et al.,* 2007)

Entropy Index

It was calculated to analyse agricultural diversification in different regions of Karnataka, the above index was used. The Entropy Index calculates all regions in the periods of 1995-2007. It is observed that EI value obtained had complete diversification for 26 districts

TABLE 2

Herfindhal index (HI), Simpson index (SI) and Entropy index (EI) for the time period from 1995 to 2007

Districts	Herfindhal index		Simpson Index		Entropy Index	
	1995-2007		1995-2007		1995-2007	
Bagalkote	0.194	#	0.806	#	0.832	#
Bengaluru urban	0.324	**	0.676	**	0.613	**
Bengaluru rural	0.235	*	0.765	*	0.846	#
Belagavi	0.172	#	0.828	#	0.729	*
Ballari	0.183		0.817	#	0.708	*
Bidar	0.191	#	0.809	#	0.796	*
Vijayapura	0.224	*	0.776	*	0.768	*
Chamarajanagar	0.168	#	0.832	#	0.865	#
Chikkaballapura	0.354	**	0.646	**	0.819	#
Chikkamagaluru	0.193	#	0.807	#	0.778	*
Chitradurga	0.237	*	0.763	*	0.754	*
Dakshina Kannada	0.277	*	0.723	*	0.800	-
Davanagere	0.176	#	0.824	#	0.632	**
Dharwad	0.210	*	0.791	*	0.858	#
Gadag	0.225	*	0.775	*	0.863	#
Kalburgi	0.186	#	0.814	#	0.842	#
Hassan	0.182	#	0.818	#	0.717	*
Haveri	0.222	*	0.778	*	0.801	#
Kodagu	0.299	*	0.701	*	0.826	#
Kolar	0.259	*	0.741	*	0.700	*
Koppal	0.184	#	0.816	#	0.751	*
Mandya	0.249	*	0.751	*	0.787	*
Mysuru	0.198	#	0.802	#	0.776	*
Raichur	0.256	*	0.744	*	0.751	*
Ramanagar	0.253	*	0.747	*	0.831	#
Shivamogga	0.185	#	0.815	#	0.858	#
Tumkur	0.181	#	0.820	#	0.817	#
Udupi	0.236	*	0.764	*	0.844	#
Uttar Kannada	0.215	*	0.785	*	0.763	*
Yadgir	0.562	**	0.438	**	0.512	**

Note : ** Moderately Low Diversification, * Moderately High Diversification, # High Diversification

the districts *viz.,* Bagalkote, Bengaluru rural, Belagavi, Ballari, Bidar, Vijayapura, Chamarajanagar, Chikkamagaluru, Chitradurga, Dakshina Kannada, Davanagere, Dharwad, Gadag, Kalburgi, Hassan, Haveri, Kolar, Koppal, Mandya, Mysuru, Raichur, Ramanagar, Shivamogga, Tumkuru, Udupi and Uttar Kannada for both the study period. There is little increase or decrease in the diversification varying between zero to 0.3. However, the extent of cropping diversification was more in the period 1995-2007, compared to the period 2008-2019. Because these districts have higher index values during the first period (nearer to zero) when compared to the index values during the second period.

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The Chamarajanagar districts obtained highest value (0.865) among all districts for first period. The calculated index value, for both the period found nearer to one, suggesting crop diversification for both period of study. The Yadgir district shown moderate diversification (0.512) in first period, followed by Bengaluru urban district, slightly moderate diversification of (0.613) was observed in first period (Singha *et al.,* 2014).

Comparison of indices was done based on the results obtained. It was observed that most of the districts of Karnataka showed high diversification.

Herfindhal Index

It is observed that HI value obtained had complete diversification for 26 districts *viz.,* Bagalkote, Bengaluru rural, Belagavi, Ballari, Bidar, Vijayapura, Chamarajanagar, Chikkamagaluru, Chitradurga, Dakshina Kannada, Davanagere, Dharwad, Gadag, Kalburgi, Hassan, Haveri, Kolar, Koppal, Mandya, Mysuru, Raichur, Ramanagar, Shivamogga, Tumkuru, Udupi and Uttar Kannada for both the study periods. There is little increase or decrease in the diversification which is varying between zero to 0.3. However, the extent of cropping diversification was more in the period 1995-2007, compared to the period 2008-2019. Because these districts have higher index values during the first period (nearer to zero) when compared to the index values during the second period.

Davangere and Koppal obtained lowest value (0.170) during the second period. The calculated index value, for both the period found nearer to zero, suggesting crop diversification for both period of study. The Yadgir district shown moderate diversification (0.473) in second period of the study, followed by Bengaluru urban district, slightly moderate diversification of (0.339) was observed in second period (Halagundegowda *et al.,* 2015).

Simpson Index

It was calculated for all the districts separately for periods 1995-2007 and 2008-2019. It is observed that Simpson Index value obtained had complete

diversification for the study period 2008-2019 for the districts of Bagalkot, Belagavi, Ballari, Bidar, Vijayapura, Chamarajanagar, Chitradurga, Davangere, Dharwad, Gadag, Kalburgi, Koppal and Raichur. However, the extent of cropping diversification was more in the second period 2008-2019. Because these districts have higher index values during the second period (nearer to zero) when compared to the index values.

The Chamarajanagar districts obtained highest value (0.831) among all districts for the second period. The calculated index value, for both the period found nearer to one, suggesting crop diversification for both period of study. The Yadgir districts obtained lowest value (0.527) among all districts for second period. The calculated index value, for both the period found nearer to zero, suggesting crop specialization for both period of study (Behera *et al.,* 2007).

Entropy Index

It was calculated to analyse agricultural diversification in different regions of Karnataka, the above index was used. The Entropy Index calculates all regions in the periods of 2008-2019. It is observed that EI value obtained had complete diversification for 26 districts the districts *viz.,* Bagalkote, Bengaluru rural, Belagavi, Ballari, Bidar, Vijayapura, Chamarajanagar, Chikkamagaluru, Chitradurga, Dakshina Kannada, Davanagere, Dharwad, Gadag, Kalburgi, Hassan, Haveri, Kolar, Koppal, Mandya, Mysuru, Raichur, Ramanagar, Shivamogga, Tumakuru, Udupi and Uttar Kannada for both the study period. There is little increase or decrease in the diversification varying between zero to 0.3.

Gadag obtained highest value (0.894) among all the districts for the second period. The calculated index value, for both the period found nearer to one, suggesting crop diversification for both period of study. The Yadgir district shown moderate diversification (0.568) in second period of study, followed by Davangere (0.631) in second period with slightly moderate diversification (Singha *et al.,* 2014).

The total period of the reference is divided into a split with 50 per cent of the duration. The split in the

TABLE 3

Herfindhal index (HI), Simpson index (SI) and Entropy index (EI) for the time period from 2008 to 2019.

Districts	Herfindhal index		Simpson Index		Entropy Index	
	2008-2019		2008-2019		2008-2019	
Bagalkote	0.177	#	0.823	#	0.768	*
Bengaluru urban	0.339	**	0.661	**	0.681	**
Bengaluru rural	0.285	*	0.715	*	0.854	#
Belagavi	0.172	#	0.828	#	0.871	#
Ballari	0.183	#	0.817	#	0.792	*
Bidar	0.197	#	0.803	#	0.720	*
Vijayapura	0.174	#	0.82	#	0.732	*
Chamarajanagar	0.169	#	0.831	#	0.834	#
Chikkaballapura	0.209	*	0.791	*	0.813	#
Chikkamagaluru	0.225	*	0.789	*	0.762	*
Chitradurga	0.197	#	0.803	#	0.726	*
Dakshina Kannada	0.250	*	0.750	*	0.717	*
Davanagere	0.170	#	0.830	#	0.631	**
Dharwad	0.193	#	0.807	#	0.794	*
Gadag	0.192	#	0.808	#	0.894	#
Kalburgi	0.178	#	0.822	#	0.872	#
Hassan	0.214	*	0.786	*	0.690	**
Haveri	0.205	*	0.795	*	0.793	*
Kodagu	0.316	**	0.684	**	0.802	#
Kolar	0.224	*	0.776	*	0.769	*
Koppal	0.170	#	0.830	#	0.748	*
Mandya	0.250	*	0.750	*	0.767	*
Mysuru	0.226	*	0.774	*	0.732	*
Raichur	0.195	#	0.805	#	0.733	*
Ramanagar	0.242	*	0.758	*	0.859	#
Shivamogga	0.220	*	0.780	*	0.801	#
Tumkur	0.215	*	0.785	*	0.835	#
Udupi	0.214	*	0.786	*	0.854	#
Uttar Kannada	0.250	*	0.750	*	0.794	*
Yadgir	0.473	**	0.527	**	0.568	**

Note: ** Moderately Low Diversification, * Moderately High Diversification, # High Diversification

variation, trend, differentials in the variation are varied and inspected. For any normal or moderate, drastic changes over the period under reference. Technically variation for a longevity is not generally excepted on a statistical frame work for an authenticity except it needs to be split with a duration and test for its diversification for a clarity of statistical output within the considered duration.

The implicit of non-significant output statistically reveals that the variation found within the structure of the study on the characteristic indicate the difference found to be non-significant specifying the

TABLE 4

Herfindhal index (HI), Simpson index (SI) and Entropy index (EI) for the overall period of 1995 to 2019

Districts	1995-2019		
	Herfindhal index	Simpson Index	Entropy Index
Bagalkote	0.170 #	0.830 #	0.812 #
Bengaluru urban	0.263 *	0.737 *	0.694 **
Bengaluru rural	0.277 *	0.723 *	0.781 *
Belagavi	0.188 #	0.812 #	0.774 *
Ballari	0.193 #	0.807 #	0.788 *
Bidar	0.181 #	0.819 #	0.789 *
Vijayapura	0.189 #	0.811 #	0.783 *
Chamarajanagar	0.119 #	0.881 #	0.849 #
Chikkaballapura	0.259 *	0.741 *	0.762 *
Chikkamagaluru	0.148 #	0.852 #	0.798 *
Chitradurga	0.161 #	0.839 #	0.777 *
Dakshina Kannada	0.327 **	0.673 **	0.733 *
Davanagere	0.189 #	0.811 #	0.746 *
Dharwad	0.134 #	0.866 #	0.823 #
Gadag	0.123 #	0.877 #	0.844 #
Kalburgi	0.166 #	0.834 #	0.838 #
Hassan	0.191 #	0.809 #	0.764 *
Haveri	0.115 #	0.885 #	0.810 #
Kodagu	0.310 **	0.690 **	0.740 *
Kolar	0.231 *	0.769 *	0.751 *
Koppal	0.160 #	0.840 #	0.797 *
Mandya	0.220 *	0.780 *	0.767 *
Mysuru	0.218 *	0.782 *	0.773 *
Raichur	0.221 *	0.779 *	0.762 *
Ramanagar	0.288 *	0.712 *	0.791 *
Shivamogga	0.192 #	0.808 #	0.812 #
Tumkur	0.133 #	0.867 #	0.836 #
Udupi	0.315 **	0.685 **	0.786 *
Uttar Kannada	0.193 #	0.807 #	0.779 *
Yadgir	0.408 **	0.592 **	0.527 **

Note: ** Moderately Low Diversification, * Moderately High Diversification, # High Diversification

variation observed showed very marginal or lesser variation in magnitude difference in the crop area.

Table 5 depicts the overall comparison of indices value for the study period among districts. It is evident from the finding that 83.3 per cent of districts during 1997 - 2007 and 86.7 per cent during 2008-2019 observed with Herfindhal index range between 0.16 - 0.25.

Regarding Simpson index it is noticed that 73.3 per cent of districts during 1995 - 2007 and 86.7 per cent during 2008 - 2019 with index value as 0.75 - 0.84, Further Entropy index established that 63.4 per cent of districts during 1995 - 2007 and 43.3 per cent during 2008 - 2019 with index value range between 0.75 - 0.84.

TABLE 5

Overall comparison of Indices value for the study period among Districts

Indices	Extent of Diversification	Study Period				χ^2
		1995-2007		2008-2019		
		N	%	N	%	
HerfindhalIndex	(0 – 0.15)	00	0.0	00	0	0.13 [NS]
	(0.16 – 0.25)	25	83.3	26	86.7	
	(0.26 – 0.56)	05	16.7	04	13.3	
SimpsonIndex	(0.85 – 1.0)	00	0.0	00	0.0	1.67 [NS]
	(0.75 – 0.84)	22	73.3	26	86.7	
	(0.44 – 0.74)	08	26.7	04	13.3	
EntropyIndex	(0.85 – 1.0)	04	13.3	06	20.0	2.41 [NS]
	(0.75 – 0.84)	19	63.4	13	43.3	
	(0.51 – 0.74)	07	23.3	11	36.7	

NS: Non-Significant
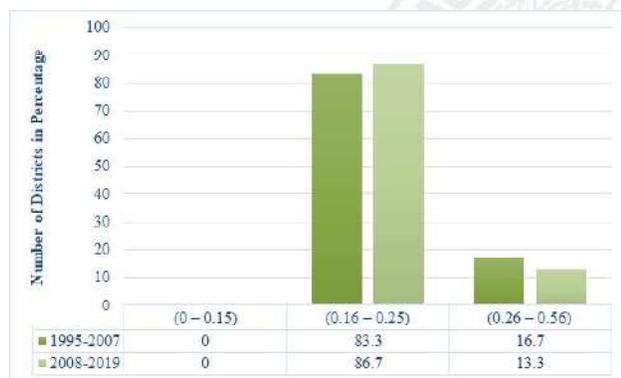
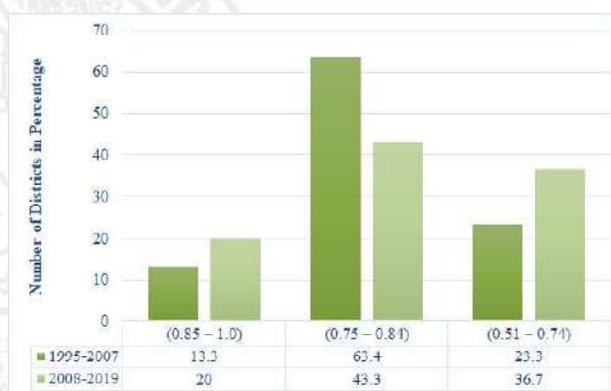Fig. 1: Overall comparison of herfindhal indices value for the study period among districts

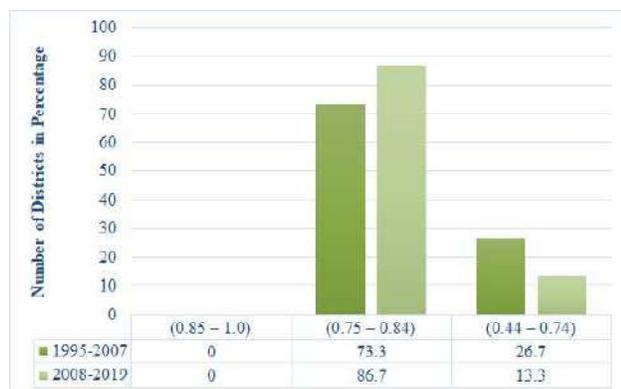Fig. 3 : Overall comparison of entropy index value for the study period among Districts

Fig 2: Overall comparison of simpson index value for the study period among Districts

It can be concluded that the difference in the classification of districts with respect to crop diversification found to be statistically non-significant (p>0.05) revealing more similar trend in both the periods under study. Regarding classification of districts based on three indices revealed that the variation between two study period found statistically non-significant (p>0.05).

In general, the cropping pattern leads to variation over a period of time which in general indicating the terminology has diversification. The study focuses with respect to variation in the present study review on variability observed over the duration with

specificity of regions in the state of Karnataka reviewing the terminology of diversification.

The degree of diversification utilizing *Herfindhal index* was more in the first-time frame 1995-2007, contrasted with the second time frame 2008-2019. Since these regions have higher index during the first-time frame (closer to nothing) when contrasted with the index during the subsequent period. The Chamarajanagar locale acquired least value (0.168) among all districts for first period and Davangere and Koppal got most minimal value (0.170) for the second period. The Yadgir district area shown moderate diversification in first period (0.562) and in second time (0.473) of study, where as in Bengaluru urban locale, somewhat moderate diversification of (0.324) was seen in first period and (0.339) in second period (Satyasai and Vishwanathan, 1996).

Simpsin index was determined for every one of the districts independently for two periods 2005-2012 and 2012-2019. The degree of diversification under Simpson record was more in the period 2013-2019, contrasted with the primary time frame 2005-2013. Since these regions have higher diversification during the second period (closer to one) when contrasted with the principal time frame. The Chamarajanagar locale acquired most diversification worth (0.832) among all regions for first period and Chamarajanagar got most diversified value (0.831) for the subsequent period. The Yadgir locale acquired least value (0.438) and (0.527) among all regions for first period and second time span. The determined index value, for both the period found closer to zero, recommending crop specialization for both time of study. Here moderate diversification is found in the referenced areas (Kumar and Gupta, 2015).

Entropy index was calculated to analyse agricultural diversification in different regions of Karnataka, the above index was used. The Entropy Index calculates all regions in the periods of 1995-2007 and 2008-2019, respectively. The Chamarajanagar districts obtained highest value (0.865) among all districts for first period and Gadag obtained highest value (0.894) for the second period. The calculated index value, for both

the period found nearer to one, suggesting crop diversification for both period of study. The Yadgir district shown moderate diversification (0.512) in first period and (0.568) in second period of study, followed by Bengaluru urban district, slightly moderate diversification of (0.613) was observed in first period and Davangere with (0.631) in second period (Rathod *et al.,* 2012).

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