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RESEARCH NOTES

Diversification of Agriculture in Gujarat: A Spatio-Temporal Analysis

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INTRODUCTION

Indian rural economy is basically considered to be crop economy. The level of diversification of crop enterprises reflects the extent of economic development in the rural sector. The omnipresent problem facing the farmers lies in the decision-making about the profitable levels of diversification of crop farming. For the rural economy, in general and, small and marginal farmers in particular, the crop diversification has been largely considered as a ray of hope for their economic uplift. The diversification in agriculture is also practised with a view to avoiding risk and uncertainty due to climatic and biological vagaries. In the early stage of development, the farmers generally grow subsistence crops. With the increase in human population, they try to produce more to maximise total farm output. In the third stage, they again diversify their agriculture to strengthen the existing level of development (Chand and Singh, 1985).

The introduction of high-yielding varieties (HYVs) and new technology not only leads to intensification of farming but also results in the growth of diversified farming leading to spill-over benefits to the whole farming community. The levels of crop diversification vary for different regions because of varied agro-climatic conditions and resource endowments of the farmers. The present study is, therefore, aimed at examining the levels of crop diversification in different agro-climatic zones of Gujarat over a period of time.

METHODOLOGY

Gujarat Plains and Hills Region (zone 13) encompasses the state of Gujarat. There are large variations in topography and rainfall across the state leading to climatic situations ranging from dry sub-humid to arid. Nearly 25 per cent of the area in the western part is arid and 20 per cent of the area in all the nineteen districts of the state is considered to the drought prone (Basu and Guha, 1996). The cropping pattern in the zone provides a wide base for development of the agro-processing sector. The zone is subdivided into seven sub-zones on the basis of cropping pattern, soil types, climate and average rainfall (Wadia, 1996). The details of all these sub-zones are given in Appendix 1. The districtwise time-series data on crop acreages were collected from the Directorate of Agriculture, Gujarat State, Ahmedabad for the period from 1960-61 to 1995-96. The sub-zonewise compilation

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of the collected data was made for further analysis. To examine the trends in acreage under different crops, the compound growth rates were calculated separately for all the sub-zones of Gujarat.

MEASURES OF CROP DIVERSIFICATION LEVEL

The approach used in this study is to utilise a variety of measures of crop diversification, which connote the extent of dispersion and concentration of activities in a given time and space by a single quantitative indicator. Following five measures of crop diversification are used in the empirical analysis (Chand, 1995).

(a) Herfindahl Index (H.I.)
(b) Ogive Index (O.I.)
(c) Entropy Index (E.I.)
(d) Modified Entropy Index (M.E.I.)
(e) Composite Entropy Index (C.E.I.)

(a) *Herfindahl Index (H.I.)*

Herfindahl Index given below is computed by taking sum of squares of acreage proportion of each crop in the total cropped area:

$$H.I. = \sum_{i=1}^{N} P_i^2$$

where N is total number of crops and P_i represents acreage proportion of the i-th crop in total cropped area. With the increase in diversification, the Herfindahl Index would decrease. This index takes a value one when there is a complete specialisation and approaches zero as N gets large, that is, if diversification is 'perfect'. Thus the Herfindahl Index is bounded by zero and one. However, the major limitation of the index is that it cannot assume the theoretical minimum, i.e., zero for smaller values of N (number of activities). Since the Herfindahl Index is a measure of concentration, it was transformed by subtracting it from one, i.e., 1-H.I. The transformed value of H.I. will avoid confusion to compare it with other indices.

(b) *Ogive Index (O.I.)*

This index was first used by Tress (1938) to measure industrial diversity. It measures deviations from benchmark given by equal proportion of each crop. For example, if there are N crops, the norm used for measuring deviations is 1/N. The formula of computing Ogive Index is as follows:

$$O.I. = \frac{\sum_{i=1}^{N} \{P_i - (1/N)\}^2}{(1/N)}.$$

Like H.I. the Ogive Index is also a measure of concentration. Hence, it was transformed as 1-O.I. The transformed values of H.I. and O.I. are presented in Table 2 along with other indices. The major limitation of this index is that the upper bound tends to approach zero

in case of perfect concentration, i.e., $N \rightarrow 1$, since $P_i \rightarrow 1$ and $(1/N) \rightarrow 1$. Thus it implies that the index approaches zero in extreme cases of perfect concentration as well as perfect diversification.

(c) *Entropy Index (E.I.)*

Entropy Index is regarded as an inverse measure of concentration having logarithmic character. This index has been widely used by many research workers to measure diversification (e.g., Hackbart and Anderson, 1975; Singh *et al.*, 1985; Gupta and Tewari, 1985). Entropy Index is specified as:

$$E.I. = -\sum_{i=1}^{N} P_i \cdot \log P_i$$

or

$$E.I. = \sum_{i=1}^{N} P_i \cdot \log(1/P_i).$$

The index would increase with the increase in diversification and it approaches zero when there is perfect concentration, i.e., when P_i equals one. The upper bound of the index is log N. However, the upper limit of 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 can be less than one when the number of crops is lower than the base of logarithm. Thus the major limitation of Entropy Index is that it does not give standard scale for assessing the degree of diversification.

(d) *Modified Entropy Index (M.E.I.)*

Modified Entropy Index is used to overcome the limitation of Entropy Index by using variable base of logarithm instead of fixed base of logarithm. It can be computed as:

$$M.E.I. = -\sum_{i=1}^{N} (P_i \cdot \log_N P_i).$$

The M.E.I., however, is equal to EI/log N. It is worth mentioning that the base of logarithm is shifted to 'N' number of crops. This index has a lower limit equal to zero when there is complete concentration, and it assumes upper limit of one in case of perfect dispersion, i.e., it is bounded by zero and one.

Maximum M.E.I. (when P_i approaches 1/N)

$$= \sum 1/N \cdot \log_N N = \sum 1/N = 1.$$

The Modified Entropy Index imparts uniformity and fixity to the scale used as norm to examine the extent of diversification. This index is, therefore, quite useful as compared to the Entropy Index which does not have a fixed upper value. However, its limitation is that it measures the deviations from equal distribution among existing activities, i.e., number of crops only, and does not incorporate the number of activities in it. This index measures diversification given the number of crops, and the index is not sensitive to the change in the number of crops.

(e) *Composite Entropy Index (C.E.I.)*

This index possesses all desirable properties of Modified Entropy Index, and is used to compare diversification across situations having different and large number of activities since it gives due weight to the number of activities. The formula of calculating C.E.I. is given by:

$$C.E.I. = -\left(\sum_{i=1}^{N} P_i . \log_N P_i\right) * \{1 - (1/N)\}.$$

or

C.E.I. = (Modified Entropy Index)*{1 - (1/N)}.

The C.E.I. has two components, viz., distribution and number of crops, or diversity. The value of Composite Entropy Index increases with the decrease in concentration and rises with the number of crops/activities. Both the components of index are bounded by zero and one and thus the value of C.E.I. ranges between zero and one. Since the index uses - $\log_N P$ as weights, it assigns more weight to lower quantity and less weight to higher quantity.

RESULTS AND DISCUSSION

Trend in Acreage under Different Crops

The sub-zonewise compound growth rates of acreage under different crops were computed for the period from 1960-61 to 1995-96. The results presented in Table 1 indicated that the

TABLE 1. SUB-ZONEWISE COMPOUND GROWTH RATES OF AREA UNDER DIFFERENT CROPS IN GUJARAT, 1960-61 to 1995-96

(per cent)

Sr. No.	Crops	Sub-zone I	Sub-zone II	Sub-zone III	Sub-zone IV	Sub-zone V	Sub-zone VI	Sub-zone VII	Overall
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Paddy	2.86	-0.58	0.24	0.57	-	-8.94	-11.55	0.20
2.	Jowar	-4.21	-1.72	-2.94	-2.96	-5.94	-5.23	-5.80	-3.51
3.	Pearl millet	-	-1.89	-1.42	-2.30	-4.56	-4.00	-4.60	-1.21
4.	Maize	1.35	5.74	1.27	1.21	1.25	5.01	2.09	1.35
5.	Wheat	-1.20	-1.27	1.50	0.31	1.56	0.21	1.68	0.71
6.	*Tur*	2.32	7.64	5.32	4.16	-	-	-	5.71
7.	Gram	1.77	1.53	-0.38	2.46	-0.86	5.30	3.24	1.40
8.	Total pulses	-0.31	3.58	2.78	2.09	-1.03	4.25	3.03	2.17
9.	Groundnut	0.60	-2.52	-3.76	-5.41	2.48	0.28	0.42	-0.25
10.	Castor	-	-1.06	6.84	6.18	7.69	8.26	2.71	5.97
11.	Rapeseed and Mustard	-	2.04	16.12	8.41	18.40	18.06	8.26	8.76
12.	Oilseeds	-4.81	-2.25	-1.96	2.42	3.30	0.48	0.50	7.93
13.	Cotton	-17.10	-5.69	-2.56	-2.20	-1.69	0.86	-2.98	-1.57
14.	Tobacco	-	-2.99	0.75	0.45	-	-	-	0.78
15.	Sugarcane	10.25	11.09	5.26	-2.75	-	-1.62	2.63	5.40
16.	Chillies	-0.71	-2.76	-2.65	0.83	-	-1.96	-4.56	-1.19

annual compound growth rate of acreage under sugarcane was the highest (10.25 per cent) in sub zone I (i.e., Valsad and Dangs districts), followed by paddy (2.86 per cent), *tur* (2.32 per cent), etc. On the other hand, the area under cotton and oilseeds cultivation has declined at the annual rate of 17.10 per cent and 4.81 per cent respectively. These results are also supported by the data presented in Appendix 2. It may be seen from Appendix 2 that the average area under cultivation of sugarcane crop considerably increased from 400 hectares in 1960-63 (triennium) to 32,800 hectares in 1993-96 (triennium) in the South Gujarat Heavy Rainfall Zone. Similarly, the corresponding figures for paddy crop were 33,600 and 1,03,400 hectares. It is interesting to note that the farmers of this zone have shifted from crops like cotton and oilseeds to paddy, sugarcane and *tur* crops. A large number of recommendations on crop improvement, cultural practices and plant protection made by the Gujarat Agricultural University for paddy and sugarcane, particularly for this zone have positively influenced the acreage under these crops. Well established co-operative marketing facilities for sugarcane in this region also tempted the farmers for realisation of higher price.

In sub-zone II, i.e., South Gujarat, which consists of Surat and Bharuch districts, a remarkable increase in acreage under sugarcane and *tur* was noticed, whereas there was a drastic decline in the area under cotton and oilseeds (Table 1 and Appendix 2). The farmers of Middle Gujarat Zone (sub-zone III) that includes Kheda, Panchmahals and Vadodara districts, have shifted their cultivation from cotton, groundnut, bajra and jowar to crops like *tur*, maize, wheat and castor. The results presented in Table 3 also revealed that the farmers of agro-climatic sub-zones II and III adopted more diversification as compared to the farmers of other zones.

The North Gujarat Zone (sub-zone IV) comprises five districts, viz., Ahmedabad, Banaskantha, Gandhinagar, Mehsana and Sabarkantha. It may be observed from the results that there was remarkable change in the cropping pattern of the farmers in this zone over a period of 36 years. The farmers have diverted acreage towards rapeseed-mustard, castor, wheat and pulse crops from the traditionally grown bajra, jowar, groundnut and cotton. The Gujarat Agricultural University has released four promising varieties of castor and two varieties of rapeseed-mustard for this zone. Moreover, nearly one-third of the total recommendations and about 89 per cent of the recommendations on the cultural practices of the state as a whole for castor crop were made only for this zone. This shows the positive impact of research and extension wings of the Gujarat Agricultural University and the State Government. The North-West Arid Zone (sub-zone V) includes only Kutch district. The climatic condition of the zone is arid to semi-arid and the annual average rainfall is only 340 mm. Bajra, jowar and cotton were the dominant crops of the zone in the early years of study. But the farmers have now shifted acreage towards more remunerative crops, viz., rapeseed-mustard, castor and groundnut.

The districts of Amreli, Bhavnagar, Jamnagar, Rajkot and Surendranagar are included in North Saurashtra Zone (sub-zone VI). The zone has medium black soil and dry sub-humid climate with the annual average rainfall of 537 mm. A significant decline in the acreage under bajra and jowar was noticed during the period of study. On the other hand, the area under cotton, wheat, groundnut, castor and gram increased to a considerable extent. The farmers of the zone have also started to increase the area under sesamum, rapeseed-mustard and *tur* in certain pockets. The increase in acreage under castor could be attributed mainly to the recommendation of the Gujarat Agricultural University for taking GAUCH-1 variety

of castor as an intercrop with groundnut, with a view to reduce the risk in groundnut production in this dryland region.

The sub-zone VII known as South Saurashtra comprises only Junagadh district. It can be observed from the results that the farmers have changed their preference from bajra, jowar and cotton to groundnut, wheat, castor, etc. During last two decades, as many as 12 varieties of wheat and 10 varieties of groundnut, i.e., maximum among all the zones of Gujarat, were released/recommended by the Gujarat Agricultural University for the farmers of South Saurashtra Zone. Similarly, total recommendations for wheat and groundnut, which include crop improvement, cultural practices and plant protection, made for this zone, were also highest among all the sub-zones of Gujarat State. Moreover, it has also been recommended for the sugarcane growers of South Saurashtra Zone to grow wheat as an intercrop either in two or three rows of sugarcane. All these can be considered as probable reasons for increasing the area under cultivation of groundnut and wheat in this zone.

Spatio-Temporal Crop Diversification Indices

The approach adopted in this study is to utilise a variety of measures of crop diversification. Five measures of crop diversification are used in the present study, and the results are given in Table 2. It may be observed that the transformed values of Herfindahl and Ogive Indices were, in general, higher in the initial years of study in all the sub-zones of Gujarat, except in sub-zone II for all the years and in sub-zones IV and V for the year 1960-61. In general, the trend of Entropy Index, Modified Entropy Index and Composite Entropy Index was almost the same within the respective zones. Considering the values of these indices, relatively more diversification in the initial years of study compared to the recent years was observed in the case of sub-zones I, III, VI and VII, whereas a reverse trend was noticed in the rest of the sub-zones. Relatively less diversification in recent years of study in the case of sub-zones I, III, VI and VII could be attributed mainly to the farmers' preferences for growing few specific crops, e.g., the farmers of sub-zones I, III, VI and VII preferred paddy; paddy and wheat; groundnut, cotton and wheat; and groundnut and wheat respectively. On the other hand, no single crop dominated in the rest of the zones, which in turn, resulted in more diversification in recent years. The diversification in cropping pattern mainly towards *tur* and sugarcane in the case of sub-zone II, *tur*, castor and rapeseed-mustard in the case of sub-zone IV, groundnut and castor in the case of sub-zone V, and castor and cotton in respect of sub-zone VI was noticed during recent years. The diversification in these zones could be utilised in a positive manner through the emphasis on processing of these commodities for their value addition. This would create more jobs in the non-agricultural sectors and strengthen the linkages of the secondary activities with the agricultural stratum. The diversification of cropping pattern towards specific crops also suggests that the zonewise intensive research efforts should be made by the research institutions on the crops most suited to each zone.

Rating of all the sub-zones was done based on the Modified Entropy Index and Composite Entropy Index to measure the diversification across the regions (Table 3). It is interesting to note that the sub-zone II ranked first and the sub-zone III remained second in the higher level of crop diversification continuously after 1970-71, among all the sub-zones of Gujarat. Both these sub-zones comprise the districts of Surat, Bharuch, Kheda, Baroda and Panchmahals which are relatively more industrialised districts in the state. It could, therefore, be

TABLE 2. CROP DIVERSIFICATION INDICES FOR DIFFERENT AGRO-CLIMATIC SUB-ZONES OF GUJARAT

Sub-zone (1)	Index (2)	1960-61 (3)	1965-66 (4)	1970-71 (5)	1975-76 (6)	1980-81 (7)	1985-86 (8)	1990-91 (9)
I	H.I.	0.7315	0.7533	0.7211	0.7730	0.3136	0.6406	0.6619
	O.I.	-0.4165	-1.3541	-1.7003	-1.0379	-1.6592	-2.5962	-1.6347
	E.I.	1.4699	1.5059	1.4667	1.5855	1.6097	1.4580	1.4904
	M.E.I.	0.5302	0.5431	0.5290	0.5718	0.5806	0.5259	0.5375
	C.E.I	0.4971	0.5092	0.4959	0.5361	0.5443	0.4930	0.5039
II	H.I.	0.8178	0.8103	0.8216	0.8453	0.8728	0.8646	0.8591
	O.I.	-0.7334	-0.8315	-0.6681	-0.3348	-0.0243	-0.1560	-0.2206
	E.I.	1.9731	1.8627	1.8618	1.9620	2.0999	2.0819	2.0852
	M.E.I	0.7116	0.6718	0.6715	0.7076	0.7574	0.7509	0.7521
	C.E.I	0.6671	0.6298	0.6295	0.6634	0.7101	0.7040	0.7051
III	H.I.	0.8856	0.9142	0.9050	0.8989	0.9071	0.9016	0.8729
	O.I.	0.2845	0.2610	0.0998	0.9602	0.1373	0.0374	-0.1990
	E.I.	2.3077	1.8779	1.8359	1.7430	1.8302	1.8036	2.0109
	M.E.I	0.8323	0.6773	0.6622	0.6287	0.6601	0.6505	0.7253
	C.E.I	0.7803	0.6350	0.6208	0.5894	0.6188	0.6098	0.6800
IV	H.I.	0.7696	0.9065	0.9046	0.8892	0.9003	0.9082	0.8314
	O.I.	-1.6860	-0.2412	-0.3082	-0.5244	-0.3074	-0.0915	-0.9492
	E.I.	1.6390	1.3585	1.3062	1.3023	1.4208	1.5598	1.7343
	M.E.I.	0.5882	0.4900	0.4711	0.4697	0.5124	0.5626	0.6255
	C.E.I.	0.5514	0.4594	0.4417	0.4403	0.4804	0.5274	0.5864
V	H.I.	0.7366	0.9559	0.9510	0.9561	0.9381	0.9281	0.9191
	O.I.	-1.1607	0.5686	0.4782	0.5192	0.0434	0.5570	0.4909
	E.I.	1.6089	1.2679	1.2651	1.2099	1.3905	1.5435	1.6475
	M.E.I.	0.5803	0.4573	0.4563	0.4364	0.5015	0.5567	0.5942
	C.E.I.	0.5440	0.4287	0.4278	0.4091	0.4702	0.5219	0.5571
VI	H.I.	0.8130	0.8789	0.9024	0.9044	0.8518	0.8721	0.7764
	O.I.	-0.6183	-0.1653	0.0496	0.0874	-0.4066	-0.4154	-1.2883
	E.I.	1.7899	1.4005	1.3691	1.3903	1.4588	1.3740	1.7057
	M.E.I.	0.6456	0.5051	0.4938	0.5014	0.5262	0.4956	0.6152
	C.E.I.	0.6052	0.4735	0.4629	0.4701	0.4933	0.4646	0.5767
VII	H.I.	0.7876	0.8087	0.8165	0.7727	0.7668	0.7242	0.7006
	O.I.	-0.7612	-0.7298	-0.6537	-1.1927	-1.1798	-1.9976	-2.1233
	E.I.	1.7180	1.4064	1.4002	1.2883	1.3302	1.2230	1.3899
	M.E.I.	0.6196	0.5073	0.5050	0.4667	0.4798	0.4411	0.5013
	C.E.I.	0.5809	0.4756	0.4734	0.4357	0.4498	0.4135	0.4700

(Contd.)

TABLE 2. *(Concld.)*

Sub-zone	Index	1991-92	1992-93	1993-94	1994-95	1995-96	Per cent change in col. (14) over col. (3)
(1)	(2)	(10)	(11)	12)	13)	(14)	(15)
I	H.I.	0.6007	0.6060	0.6288	0.6235	0.6380	-12.78
	O.I.	-2.7097	-2.6452	-2.3725	-1.6664	-1.5208	-265.14
	E.I.	1.3726	1.3694	1.4082	1.3049	1.3290	-9.58
	M.E.I.	0.4951	0.4939	0.5079	0.4706	0.4793	-9.60
	C.E.I	0.4642	0.4630	0.4762	0.4412	0.4493	-9.61
II	H.I.	0.8680	0.8705	0.8671	0.8626	0.8582	4.94
	O.I.	-0.0818	-0.0483	-0.0993	-0.1844	-0.2260	69.18
	E.I.	2.1220	2.1211	2.1024	2.0624	2.0762	5.22
	M.E.I	0.7653	0.7650	0.7583	0.7439	0.7488	5.23
	C.E.I	0.7175	0.7172	0.7109	0.6974	0.7020	5.23
III	H.I.	0.8955	0.8951	0.8979	0.8587	0.8550	-3.45
	O.I.	0.1053	0.1086	0.1703	-0.4663	-0.4088	-243.69
	E.I.	2.0243	2.0259	2.0544	1.8723	1.9852	-13.97
	M.E.I	0.7301	0.7307	0.7410	0.6753	0.7160	-13.97
	C.E.I	0.6845	0.6850	0.6947	0.6331	0.6713	-13.97
IV	H.I.	0.8753	0.8696	0.8574	0.8250	0.8220	6.81
	O.I.	-0.3546	-0.4342	-0.6316	-1.1815	-1.1365	32.59
	E.I.	1.7412	1.7391	1.6921	1.5882	1.6848	3.30
	M.E.I.	0.6280	0.6272	0.6103	0.5728	0.6077	3.31
	C.E.I.	0.5882	0.5880	0.5722	0.5370	0.5697	3.32
V	H.I.	0.9015	0.9056	0.9174	0.8955	0.8483	15.16
	O.I.	0.6173	0.4701	0.5899	0.2993	0.1625	114.00
	E.I.	1.6297	1.5416	1.4340	1.5285	1.6393	1.89
	M.E.I.	0.5878	0.5560	0.5172	0.5513	0.5913	1.89
	C.E.I.	0.5517	0.5212	0.4849	0.5168	0.5543	1.89
VI	H.I.	0.8122	0.8315	0.8119	0.8200	0.7928	-2.48
	O.I.	-1.0965	-0.7904	-1.0895	-0.9018	-1.2952	-109.48
	E.I.	1.4071	1.4809	1.4120	1.5016	1.4313	-20.03
	M.E.I.	0.5075	0.5341	0.5093	0.5416	0.5162	-20.04
	C.E.I.	0.4758	0.5007	0.4775	0.5077	0.4839	-20.04
VII	H.I.	0.7089	0.7530	0.7212	0.7424	0.7343	-6.77
	O.I.	-2.1630	-1.8040	-2.2837	-1.9190	-1.9927	-161.78
	E.I.	1.2426	1.3539	1.3015	1.3683	1.4121	-17.80
	M.E.I.	0.4482	0.4883	0.4694	0.4935	0.5093	-17.80
	C.E.I.	0.4202	0.4578	0.4401	0.4627	0.4775	-17.80

inferred that the higher level of crop diversification might have resulted in faster growth of the industrial sector too. No specific trend of diversification was noticed in other sub-zones. Appropriate policy measures, viz., establishment of agro-processing industries and infrastructural facilities, arrangement for crop protection, construction, maintenance and management of irrigation works, research prioritisation, distribution of quality seeds and seed materials of the specific crops in the respective zones, etc., may be initiated on the basis of cropping pattern and need of the people in the region.

TABLE 3. RATING OF SUB-ZONES

Sub-zone	Rank				
	1960-61	1970-71	1980-81	1990-91	1995-96
(1)	(2)	(3)	(4)	(5)	(6)
I	7	3	3	6	7
II	2	1	1	1	1
III	1	2	2	2	2
IV	5	6	4	3	3
V	6	7	6	5	4
VI	3	5	4	4	5
VII	4	4	7	7	6

CONCLUSIONS

It may be concluded from the results presented in this study that there exists wide spatio-temporal disparity in the acreage allocation under different crops. In general, the farmers have shifted their cropping pattern from the subsistence crops to the commercial crops. On an average, relatively higher growth rates of acreage under *tur*, castor, rapeseed-mustard, sugarcane, maize and wheat were found in different agro-climatic sub-zones of Gujarat, whereas negative compound growth rates of acreage under pearl millet, jowar and cotton were noticed in most of the zones. Five different measures of crop diversification were tried in this study. The Composite Entropy Index was found to be better suited, based on the situations. Relatively more diversification was noticed in the initial years of study as compared to the recent years in the case of sub-zones I, III, VI and VII, whereas a reverse trend was observed in the rest of the sub-zones, indicating that no single crop has dominated in these sub-zones. A comparison of crop diversification by sub-zones revealed that the sub-zones II and III ranked first and second respectively in higher level of crop diversification continuously after 1970-71. The diversification in the respective zones could be utilised in a positive manner through the emphasis on processing for enhancing the value addition of commodities.

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APPENDIX I

CHARACTERISTICS OF VARIOUS AGRO-CLIMATIC SUB-ZONES OF GUJARAT

Sr. No.	Sub-zone	Name of districts covered	Annual rainfal (mm)	Climate	Soil type	Major crops
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	South Gujarat Heavy Rainfall Zone	Dangs and Valsad	1793	Semi-arid to dry sub-humid	Deep black, coastal alluvium	Paddy, jowar, sugarcane
2.	South Gujarat	Surat and Bharuch	974	Semi-arid to dry sub-humid	Deep black, coastal alluvium	Jowar, *tur*, cotton, wheat
3.	Middle Gujarat	Panchmahals, Vadodara, Kheda	904	Semi-arid	Medium black	Paddy, maize, bajra, cotton, wheat, *tur*, tobacco
4.	North Gujarat	Ahmedabad, Gandhinagar, Banaskantha, Mehsana, Sabarkantha	735	Arid to semi-arid	Grey brown, coastal alluvium	Bajra, cotton, rapeseed-mustard, wheat, jowar, castor
5.	North-West Arid	Kutch	340	Arid to semi-arid	Grey brown, coastal alluvium	Bajra, cotton, groundnut
6.	North Saurashtra	Surendranagar, Rajkot, Amreli, Bhavnagar, Jamnagar	537	Dry sub-humid	Medium black	Bajra, jowar, wheat, cotton, groundnut
7.	South Saurashtra	Junagadh	844	Dry sub-humid	Coastal alluvium medium black	Groundnut, wheat, bajra, cotton

APPENDIX 2

SUB-ZONEWISE TEMPORAL CHANGE IN ACREAGE UNDER DIFFERENT CROPS IN GUJARAT

(area in '00 ha)

Sr. No.	Crops	Sub-zone I			Sub-zone II			Sub-zone III			Sub-zone IV		
	(1)	1960-61 to 1962-63 (2)	1993-94 to 1995-96 (3)	Per cent change in col. (3) over col. (2) (4)	1960-61 to 1962-63 (5)	1993-94 to 1995-96 (6)	Per cent change in col. (6) over col. (5) (7)	1960-61 to 1962-63 (8)	1993-94 to 1995-96 (9)	Per cent change in col. (9) over col. (8) (10)	1960-61 to 1962-63 (11)	1993-94 to 1995-96 (12)	Per cent change in col. (12) over col. (11) (13)
1.	Paddy	336	1,034	67.50	1,361	902	-33.72	2,763	2,947	6.66	787	1,036	31.64
2.	Jowar	45	59	31.11	1,645	1,083	-34.16	852	450	-47.18	3,540	1,174	-66.63
3.	Pearl millet	0	0	0	263	154	-41.44	3,871	2,559	-33.89	18,754	8,753	-53.32
4.	Maize	2	4	100.00	15	76	406.67	1,492	2,394	60.45	710	1,169	64.44
5.	Wheat	16	60	275.00	1,390	1,716	23.45	3,302	6,008	81.95	10,794	16,008	48.30
6.	*Tur*	42	113	169.05	285	1,502	427.02	405	1,680	314.81	159	541	240.25
7.	Gram	5	16	220.00	52	54	3.85	397	416	-30.32	167	291	74.25
8.	Total pulses	196	253	29.08	994	1,737	74.75	1,367	2,652	94.00	1,375	2,262	65.51
9.	Groundnut	19	37	94.73	637	275	-56.82	1,672	476	-71.53	2,434	420	-82.74
10.	Castor	4	1	-75.00	45	16	-64.44	28	308	1,000.00	497	2,412	385.31
11.	Rapeseed and mustard	0	0	0	0	2	-	0	145	-	353	3,476	884.70
12.	Oilseeds	86	38	-55.81	738	339	-54.06	1,853	1,044	-43.66	3,538	6,569	85.66
13.	Cotton	89	0	-100.00	3,785	891	-76.46	3,258	1,529	-53.07	4,812	2,621	-45.53
14.	Tobacco	0	0	0	9	2	-77.78	821	1,019	24.12	59	85	44.06
15.	Sugarcane	4	328	8,100.00	41	933	2,175.61	3	35	1,066.67	27	17	-37.04
16.	Chillies	2	6	200.00	29	19	-34.48	37	18	-51.35	46	73	58.69

(Contd.)

APPENDIX 2 *(Concld.)*

Sr. No.	Crops	Sub-zone V			Sub-zone VI			Sub-zone VII		
		1960-61 to 1962-63	1993-94 to 1995-96	Per cent change in col. (15) over col. (14)	1960-61 to 1962-63	1993-94 to 1995-96	Per cent change in col. (18) over col. (17)	1960-61 to 1962-63	1993-94 to 1995-96	Per cent change in col. (21) over col. (20)
(1)	(2)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1.	Paddy	0	0	0	127	10	-92.12	95	1	-98.95
2.	Jowar	932	17	-98.18	5,418	522	-90.36	694	179	-74.20
3.	Pearl millet	3,649	1,457	-60.07	12,988	7,714	-40.60	2,322	753	-67.57
4.	Maize	0	0	0	16	78	387.50	5	17	240.00
5.	Wheat	462	632	36.80	5,616	7,522	33.93	1,226	2,822	130.18
6	*Tur*	0	0	0	0	55	-	0	10	-
7.	Gram	3	1	-66.66	69	292	323.19	52	72	38.46
8.	Total pulses	969	834	-13.93	288	968	236.11	87	147	68.95
9.	Groundnut	566	819	44.70	13,413	14,040	4.67	3,197	3,952	24.31
10.	Castor	66	351	431.82	15	420	2,700.00	14	111	692.85
11.	Rapeseed and mustard	2	51	2,450.00	2	94	4,600.00	0	7	-
12.	Oilseeds	725	1,377	89.93	13,980	15,525	11.05	3,233	4,167	28.88
13.	Cotton	857	464	-45.85	4,176	6,713	60.75	442	253	-42.76
14.	Tobacco	0	0	0	0	0	0	0	0	0
15.	Sugarcane	3	3	0	120	91	-24.16	27	78	188.88
16.	Chillies	2	2	0	87	66	-24.14	14	3	-78.57

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