

SPATIAL ANALYSIS OF CROP DIVERSIFICATION IN INDIAN AGRICULTURE

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Abstract: In order to improve incomes, generating year round employment, conservation of natural resources and stabilizing the income over the seasons, crop diversification is regarded as an important strategy to overcome the challenges in agriculture. This study has been undertaken to examine the status and trend of crop diversification in different states in India. Moreover, the paper maps the spatial distribution of diversification index in India. The results indicate that cereals cover the major share of area in gross cropped area among different crop groups during TE years between 1952-53 and 2021-22. Interestingly, the concentration of crops has increased in majority of agricultural states including Chhattisgarh, Telangana, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Bihar, Odisha, Maharashtra, Punjab, Karnataka, Gujarat, Uttar Pradesh as well as at All India level. The southern and western regions were the only regions having higher agricultural growth during 1990s due to movement towards non-cereal crops. The northern region has more concentration in favour of wheat and rice crops. The eastern region is most backward with respect to growth in agriculture, income and infrastructure and therefore, has relatively low diversification index as compared to other regions. In order to harness the potential benefits of diversification, the appropriate technologies be introduced and suitable infrastructure be created. Domestic reforms in the markets are necessary which support the agricultural diversification in the districts.

Keywords: Simpson's Crop diversification index, district wise diversification, agriculture

INTRODUCTION

Agriculture is the predominant source of livelihood and major source of employment in India. The agriculture sector employs 45.76 percent of the workforce (GOI-PLFS, 2023) and contributes about 18.19 per cent of the

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gross domestic product (GOI-NAS, 2024) in the country. Sustained economic growth, globalization and urbanization are triggering rapid growth along with demand for high value food products in India. This extends window of opportunities as well as challenges to the millions of farmers in India. There is comparative advantage in labor absorption and production in the high value crops which augments the income and employment for the smallholders (Joshi *et al.*, 2003). The foodgrain production went up to 308.65 million tonnes between 2021 and 2022 (GOI, 2022). The rise has been restricted mainly to cereals and the production of other crops such as pulses, fruits, coarse cereals, oilseeds has not been satisfactory (Chand & Pal, 2003; Chand and Singh, 2023). However, the economy experiences degradation of natural resources, shrinking size of holdings and declining investment in agriculture (Joshi *et al.*, 2004). Before mid-1960s, the concept of crop diversification was not widespread in India. The introduction of new agricultural technology brought a radical change in the pattern of land utilization in different agricultural states in India where farmers shifted towards the high value crops (Joshi *et al.*, 2006; Singh, *et al.* 2013). In order to improve incomes, generating year round employment, conservation of natural resources and stabilizing the income over the seasons, crop diversification is regarded as an important strategy to overcome the challenges in agriculture.

The transformation in agriculture has regional variations due to differences in infrastructural development, adoption of agricultural technology, markets in different states etc. The literature on analysis of crop diversification in India is available (Kumar *et al.*, 2012; Kundu *et al.*, 2018; Anwer *et al.*, 2019; Birthal *et al.*, 2020; Swamy *et al.*, 2020). In order to combat the challenges in agriculture and overall development of any region, crop diversification is essential. However, a sound and empirical understanding about crop diversification spatially is needed. Such an attempt would provide support to recommend appropriate policies for promoting crop diversification in different regions in India. In this backdrop, this study has been undertaken to examine the status and trend of crop diversification in different states in India. Moreover, the paper maps the spatial distribution of diversification index in India.

DATA AND METHODOLOGY

This study uses secondary data which is collected from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare.

National level data compiled for 11 crop groups named Cereals (sum of rice, maize and wheat); Other cereals & millets; Pulses; Sugarcane; Condiments and Spices; Fruits & Vegetables; Oilseeds; Fibers; Fodder Crops; Other Non-Food Crops; and Other crops for analyzing of change in cropping pattern and construction of diversification index for the period of 1950-51 to 2021-22. For the construction of diversification index at the district and state level, area under crop was compiled for the period of 2010-11 to 2021-22. District wise area under major 29 crops (from cereals & millets group: Rice, Wheat, Maize, Jowar, Bajra, Barley, Ragi, and Small millets; from pulses group: Arhar, Gram, Horse gram, Masoor (lintel), Moong (green gram), Urad (black gram), Moth, and Rajmash Kholar; from oilseeds group: Groundnut, Linseed, Rapeseed & Mustard, Soyabean, Sunflower, and Sesamum; from commercial crop group: Sugarcane, Cotton, Guar seed, and Sannhamp, and from vegetable group: Onion, Potato, and Tomato has been collected.

SIMPSON’S INDEX OF DIVERSIFICATION

The degree of crop diversification has been estimated using Simpson’s Index of Diversification (Singh, Yadav & Singh, 2013; Joshi *et al.*, 2004; Anwer *et al.*, 2019) as under:

$$SDI = 1 - \sum_{i=1}^n P_i^2$$

Here

SDI = Simpsons index of diversification

Pi = area proportion of ith crop in gross cropped area at tth time

The index value lies between 0 and 1, where 0 shows the complete concentration on a single crop, and on the other hand, 1 shows the complete diversification (means equal distribution of area in each crop)

RESULTS AND DISCUSSION

There are two sources of diversification of crops: Crop substitution and area augmentation. Area augmentation is done by utilizing the fallow lands and increasing the cropping intensity. Therefore, to examine the nature of diversification, the area expansion of different crops has been assessed.

Table 1 shows the changes in share of area covered under different crop groups during triennium (TE) years in India. It is clearly noticeable that

cereals cover the major share of area in gross cropped area among different crop groups during TE years between 1952-53 and 2021-22. Moreover, the share of area has been increasing persistently during the TE years. The share of area of other cereals and millets as well as pulses has been declining continuously over the years although having the larger share of area in gross cropped area as compared to the other crop groups. The share of all the other crop groups including sugarcane, condiments and spices, fruits & vegetables, fibers, fodder crops and other non-food crops has shown slight fluctuations in area share except that of oilseeds having increase in area share in the gross cropped area from 8.36 per cent to 14.29 per cent during TE year 1952-53 to TE year 2021-22. However, the gross cropped area of different crop groups has increased over the period of time except the TE year 2021-22 when it declines. The high value food products (vegetables, fruits, tea, coffee, spices) contribute 40 per cent to the gross value of agricultural output at the All India level (Rao *et al.*, 2006).

Table 1: Changing cropping pattern over time in India

Crop Groups	Area Share (%) in Gross cropped area during TE year				
	1952-53	1972-73	1992-93	2012-13	2021-22
Cereals (Rice+Maize+Wheat)	32.64	37.61	39.23	41.88	43.92
Other cereals and millets	28.34	23.60	15.78	9.22	6.60
Pulses	15.31	13.65	12.85	12.07	12.78
Sugarcane	1.37	1.52	2.16	2.75	2.72
Condiments and Spices	0.93	1.10	1.34	1.79	1.99
Fruits & Vegetables	1.60	2.22	3.72	4.90	5.68
Oilseeds	8.36	9.19	14.21	14.59	14.29
Fibers	5.40	5.71	4.77	6.50	6.35
Fodder Crops	3.85	4.18	4.43	4.05	3.48
Other Non-Food Crops	1.11	0.48	0.78	1.42	1.36
Other crop	1.11	0.75	0.74	0.85	0.83
Gross cropped area (000 ha)	153935.0	172989.7	187250.1	215541.4	205792.2

Source: Author's estimation based on DES data

The crop sector is steadily having concentration of crops in India which can be clearly seen in figure 1 which pertains with the degree of diversification. The deep insights of the figure depict the declining trend of diversification index of crop groups over the time between 1950-51 and

2019-20. The highest SDI of crop groups has been observed to be during 1965-66 with 0.785. The SID slowly moved down with some fluctuations from 0.775 in 1950-51 to 0.76 in 2019-20, the value of R^2 being low.

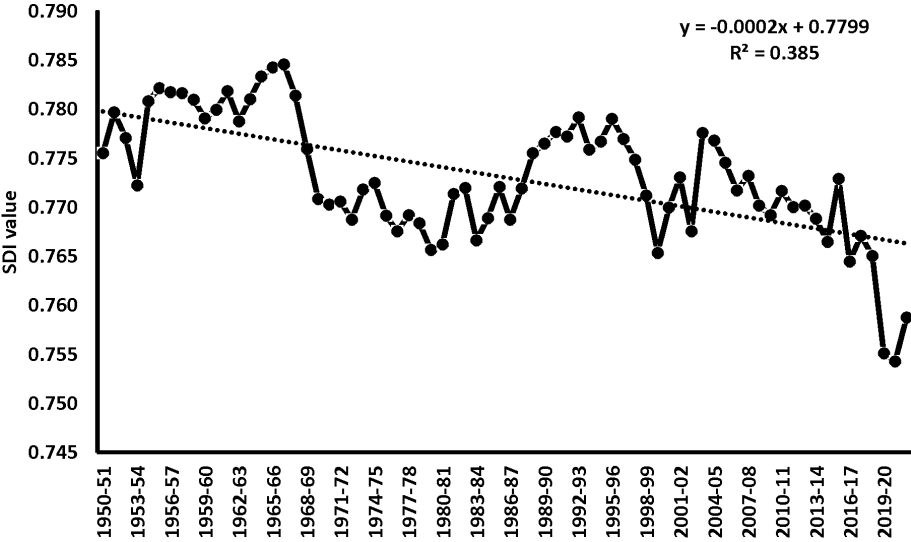


Figure 1: Trend of crop group diversification index over time

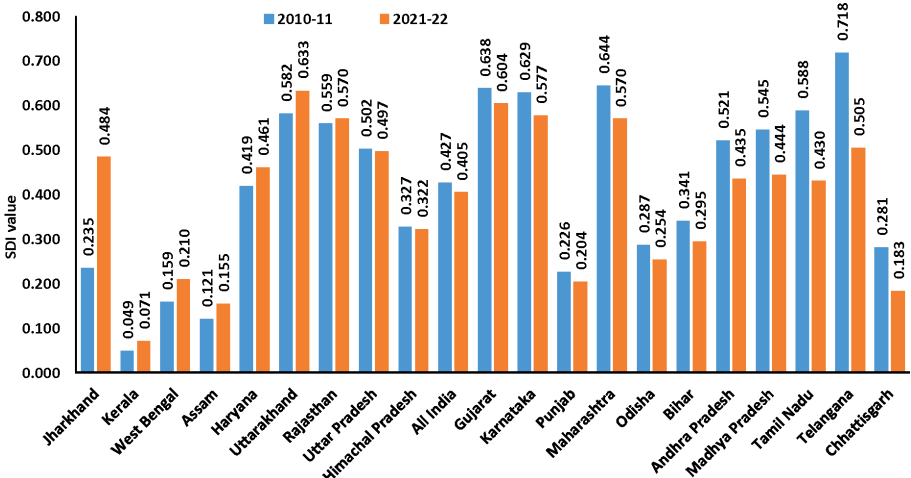


Figure 2: Trend of crop diversification among major agricultural states during 2011-12 to 2021-22

Interestingly, the picture is different at the state level as there are some states with increase in diversification of crops. Figure 2 depicts the trend of crop diversification among major agricultural states during 2011-12 to

2021-22. It can be seen that Telangana has the highest diversification of 0.71 during 2010-11 and the lowest diversification index value has been found to be in Kerala during the same period. However, the diversification reduced in Telangana during 2021-22 but it increased slightly in Kerala during the same period. Interestingly, the concentration of crops has increased in majority of agricultural states including Chhattisgarh, Telangana, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Bihar, Odisha, Maharashtra, Punjab, Karnataka, Gujarat, Uttar Pradesh as well as at All India level. The crop specialization has been found to increase in Madhya Pradesh, Haryana, Punjab, Bihar, Gujarat etc. (Saha, 2013; Anwer *et al.*, 2019; Singh, *et al.* 2019). The use of fertilizers, mechanization in agriculture, high returns, irrigation facilities and stable yield are the drivers for reducing the crop diversification and shift towards mono-cropping in Punjab (Singh *et al.*, 2021).

Table 2: Average with standard error of district-wise diversification index among states and its change

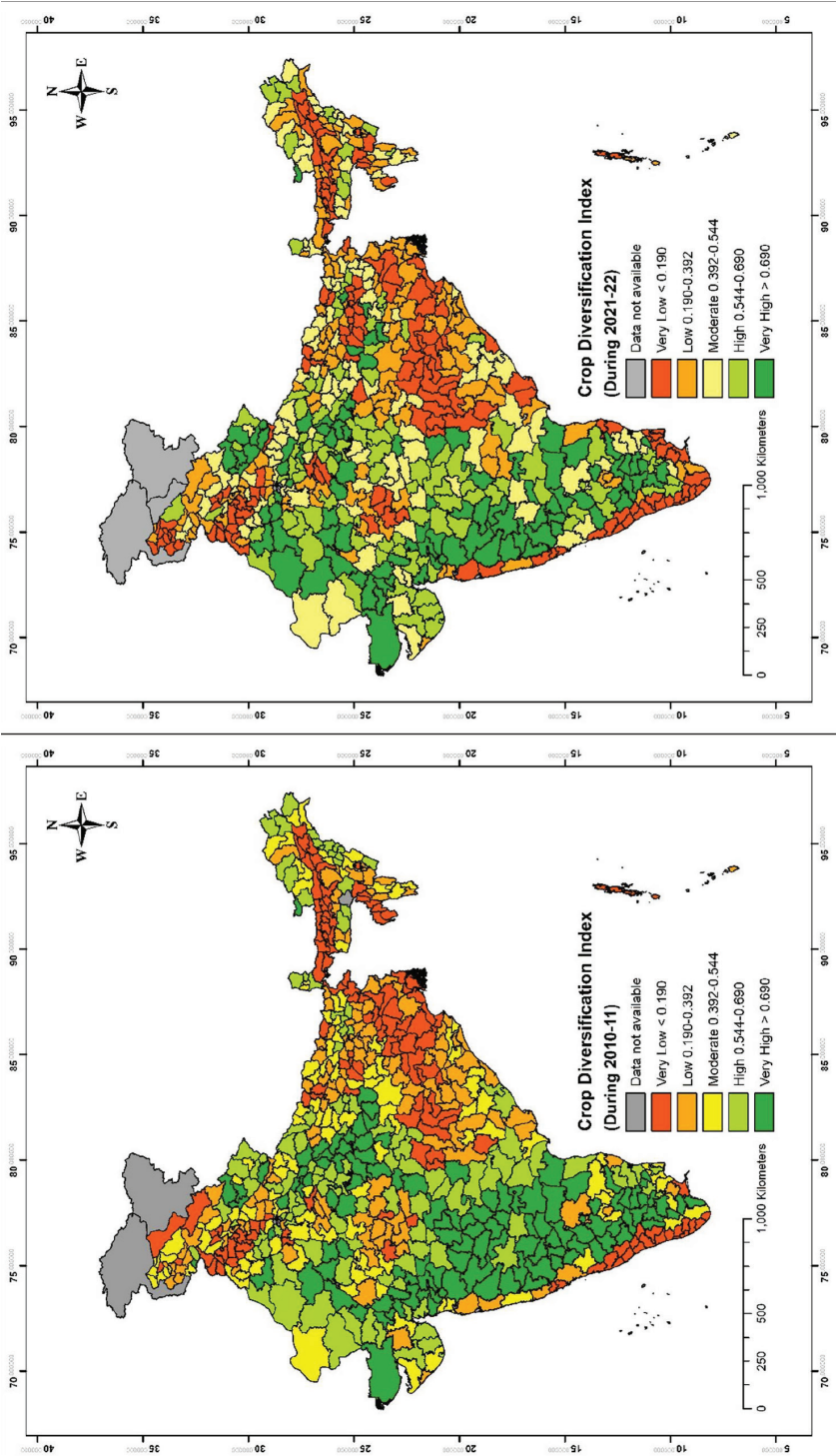
State	2010-11		2021-22		Change sign between 2010-11 and 2021-22
	Avg.	Std. Err	Avg.	Std. Err	
A & N Islands	0.176	0.076	0.034	0.034	–
Andhra Pradesh	0.521	0.060	0.435	0.062	–
Arunachal Pradesh	0.531	0.029	0.468	0.027	–
Assam	0.121	0.021	0.155	0.019	+
Bihar	0.341	0.028	0.295	0.032	–
Chhattisgarh	0.281	0.042	0.183	0.029	–
Goa	0.094	0.026	0.04	0.032	–
Gujarat	0.638	0.029	0.604	0.028	–
Haryana	0.419	0.047	0.461	0.040	+
Himachal Pradesh	0.327	0.055	0.322	0.052	–
Jammu and Kashmir	0.362	0.041	0.177	0.046	–
Jharkhand	0.235	0.033	0.484	0.029	+
Karnataka	0.629	0.047	0.577	0.045	–
Kerala	0.049	0.035	0.071	0.046	+
Madhya Pradesh	0.545	0.032	0.444	0.031	–
Maharashtra	0.644	0.040	0.570	0.043	–
Manipur	0.348	0.045	0.350	0.050	+
Meghalaya	0.406	0.055	0.402	0.047	–
Mizoram	0.403	0.036	0.369	0.030	–
Nagaland	0.551	0.031	0.468	0.033	–
Odisha	0.287	0.027	0.254	0.027	–

State	2010-11		2021-22		Change sign between 2010-11 and 2021-22
	Avg.	Std. Err	Avg.	Std. Err	
Pondicherry	0.447	0.093	0.252	0.160	–
Punjab	0.226	0.045	0.204	0.041	–
Rajasthan	0.559	0.028	0.57	0.031	+
Sikkim	0.56	0.037	0.374	0.106	–
Tamil Nadu	0.588	0.043	0.430	0.049	–
Telangana	0.718	0.032	0.505	0.026	–
Tripura	0.083	0.017	0.221	0.035	+
Uttar Pradesh	0.502	0.023	0.497	0.022	–
Uttarakhand	0.582	0.038	0.633	0.054	+
West Bengal	0.159	0.032	0.210	0.025	+

Source: Author's estimation based on DES data

Crop diversification is gradually strengthening in favour of high value crops to augment the income and employment in the states in India. However, the diversification differs across districts due to socio-economic and agro-climatic conditions. Therefore, it would be interesting to map the key regions of agriculture with diversification index as it can be seen in table 2 that there is change in the average and standard error of district wise diversification index between 2010-11 and 2021-22.

Looking into Map 1A and Map 1B, it can be noticed that larger area of districts have very high and high degree of diversification during 2010-11 and 2021-22. In order to have deep understanding of location wise performance of crop diversification, it is necessary to know the performance of crop diversification of states at the district level as the regional patterns in diversification in the maps is quite stark. Table 3 depicts the number of districts according to trends of crop diversification during 2010-11 to 2021-22. The concentration of crops has increased in majority of the districts in Chhattisgarh, Telangana, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Bihar, Odisha, Maharashtra, Punjab, Karnataka, Gujarat, Uttar Pradesh and as well as at All India level. According to Saha (2013), western and south-western regions have higher levels of crop diversification as compared to eastern and north-eastern regions during 1990-91 and 2008-09. The southern and western regions were the only regions having higher agricultural growth during 1990s due to movement towards non-cereal crops (Joshi *et al.*, 2004). The northern region has more concentration in favour of wheat and rice crops. The eastern region is most backward with respect to growth



Map IA: Categorisation of districts based on SDI value during 2010-11

Map IB: Categorisation of districts based on SDI value during 2021-22

Source: Author's creation using ARC-GIS software

in agriculture, income and infrastructure and therefore, has relatively low diversification index as compared to other regions. The high rainfall makes rice cultivation more favourable in the eastern region (Joshi *et al.*, 2004).

Table 3: Number of districts according to trends of crop diversification during 2010-11 to 2021-22

State	Number of districts where crop Diversification		Total number of District
	Decrease	Increase	
A & N Islands	0	3	3
Andhra Pradesh	11	2	13
Arunachal Pradesh	13	3	16
Assam	9	18	27
Bihar	29	9	38
Chhattisgarh	17	1	18
Goa	2	0	2
Gujarat	14	12	26
Haryana	10	11	21
Himachal Pradesh	7	5	12
Jammu and Kashmir	16	5	21
Jharkhand	0	24	24
Karnataka	24	6	30
Kerala	6	8	14
Madhya Pradesh	39	11	50
Maharashtra	27	6	33
Manipur	7	2	9
Meghalaya	1	5	6
Mizoram	6	2	8
Nagaland	10	1	11
Odisha	20	10	30
Pondicherry	1	2	3
Punjab	13	7	20
Rajasthan	14	19	33
Sikkim	4	0	4
Tamil Nadu	25	6	31
Telangana	9	0	9
Tripura	0	4	4
Uttar Pradesh	45	26	71
Uttarakhand	4	9	13
West Bengal	4	14	18
All selected State	387	231	618

Source: Author's estimates

The growth performance of some states like Andhra Pradesh and Madhya Pradesh was very impressive during the last decade. Punjab, Haryana and western part of Uttar Pradesh was initial reach in agricultural development but recently facing mono cropping pattern as a result losing its growth pace (Chand and Singh, 2024). With such matters it is very important to be planed a proper crop plan for the nation.

CONCLUSION

Sustained economic growth, globalization and urbanization are triggering rapid growth alongwith demand for high value food products in India. In order to improve incomes, generating year round employment, conservation of natural resources and stabilizing the income over the seasons, crop diversification is regarded as an important strategy to overcome the challenges in agriculture. This study has been undertaken to examine the status and trend of crop diversification in different states in India. Moreover, the paper maps the spatial distribution of diversification index in India. This study uses secondary data which is collected from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare. The degree of crop diversification has been estimated using Simpson's Index of Diversification. The results indicate that cereals cover the major share of area in gross cropped area among different crop groups during TE years between 1952-53 and 2021-22. Interestingly, the concentration of crops has increased in majority of agricultural states including Chhattisgarh, Telangana, Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Bihar, Odisha, Maharashtra, Punjab, Karnataka, Gujarat, Uttar Pradesh as well as at All India level. The southern and western regions were the only regions having higher agricultural growth during 1990s due to movement towards non-cereal crops. The northern region has more concentration in favour of wheat and rice crops. The eastern region is most backward with respect to growth in agriculture, income and infrastructure and therefore, has relatively low diversification index as compared to other regions.

In order to harness the potential benefits of diversification, the appropriate technologies be introduced and suitable infrastructure be created. Domestic reforms in the markets are necessary which support the agricultural diversification in the districts.

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