



An Analysis of Spatio -Temporal Changes in the Pattern of Crop Diversification in Indian Agriculture

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Abstract

The key objective of this study is to analyze the spatial variation and temporal perspective of the changing pattern and level of crop diversification in Indian agriculture between 2002-03 and 2012-13. Crop diversification signifies practicing of multiple cropping systems which is also an integral part of structural transformation of an economy. Data related to the study were collected from Ministry of Agriculture, Government of India. For measuring the level of crop diversification, Bhatia's method, Herphindal's method, Gibb's and Martin's methods have been used. Results of the study have revealed that the level of crop diversification in Indian agriculture has increased during the study period. Karnataka has topped among the most crop diversified states in India which is followed by Jammu and Kashmir, Uttarakhand, Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh and Tamil Nadu. Chhattisgarh, Tripura and Odisha have been found among the less crop diversified states. It has also been noticed that the level of crop diversification in larger states of India have shown a decreasing trend whereas in smaller states it has increased during the study period.

Keywords: Crop diversification, cropped area, Indian agriculture, Herphindal's Method, Bhatia's Method, Gibb's and Martin's Method.

Introduction

Agriculture is a primary economic and productive activity on earth surface which provides fundamental sustain to all living beings¹. Agriculture has remained the prime sector of Indian economy in view of its major share in employment and livelihood creation. Though, it has played a significant role in poverty alleviation, meeting the food requirements of the existing population and providing raw materials to various industries but its share in gross domestic production of the nation has continuously declined over the period². Agriculture demand land, labour, capital and energy inputs as basic requirement. Chemical fertilizers and agricultural machineries are the vital inputs of agriculture. Indian agriculture has achieved remarkable progress in the level of agricultural mechanization³. The increasing use of chemical fertilizers has increased the crop production besides it has deteriorated the soil health and created some major environmental problem such as destruction of agricultural biodiversity, soil and water pollution⁴.

The introduction of Green revolution had remarkably increased the agricultural production and productivity besides it has also tended to push the mono cropping system. Expansion of irrigation facilities, high use of chemical fertilizers and high yield variety seed especially in wheat and rice crop cultivation had converted the various states as mono crop. Mono cropping system affects the soil health which creates biotic and abiotic pressure to the soil⁵. Therefore, Crop diversification has been introduced in Indian agriculture against the mono cropping

system to maintain the adequate level of agricultural production. Crop diversification is a sub-division of agricultural diversification whereas the later includes the sub sector of agriculture i.e. crops, horticulture, fisheries, agro-forestry animal husbandry, truck farming, apiculture, floriculture and sericulture^{6,7}.

Generally, crop diversification refers to the diversity among crops grown in a specific region. It is opposite to the concept of crop specialization which refers to change in the combination of crops cultivated in an agricultural region and measured by the proportion of area occupied by various crops⁸. Crop diversification also describes as the shift from single crop farming to multiple crops farming or practice of increasing number of crops with their varieties or from subsistence farming to commercial farming. Crop diversification is an agricultural method which largely depends on physical-environmental and socio-economic factors beside agricultural, geographical, institutional and technological structure and composition of that region^{9,10}. If this method is practiced in appropriate ways then it helps to generate employment, increase crop intensity, increase diversification of agricultural production, enhance farm income thereby alleviating poverty. It also minimizes adverse effect of crop specialization or mono cropping system, avoid risks and uncertainty of crop failure due to climatic and biological changes^{11,12}.

Since the period of liberalization, Indian agriculture has experienced a significant change with crop diversification from traditional less remunerative food crops to more remunerative

commercial crops, horticulture crops and plantation crops. Crop diversification has accelerated in Indian agriculture due to economic growth, improving rural education level, increasing middle class people, better innovative market institutions, accessibility and expansion of credit facilities, infrastructure development and practices of contract farming¹³. The specific objective of the present study is to analyze spatial variation and temporal changes in the nature and extent of crop diversification pattern in Indian agriculture.

Methodology

The present research work is primarily based on secondary data. The data related to state-wise actual area under various crops and total cropped area for the years of 2002-03 and 2012-13 were collected from Ministry of Agriculture (MoA)¹⁴. The proportion of area under various crops for each state has been calculated with the help of actual area of each crop in a state and total crop area of the same state. The index of crop diversification in this study has been worked out by using three different methods namely, Gibb's and Martin's method, Bhatia's method and Herphindal's method. Statistical equations of these methods can be expressed as:

Gibb's and Martin's Method

$$\text{Index of Crop Diversification} = 1 - \frac{\sum X^2}{(\sum X)^2}$$

Here, X is the percentage of gross cropped area or total cropped area covered by an individual crop. Magnitude of crop diversification computed by this formula varies from 0.1 to 0.9. According to this formula the index value is directly related to magnitude of crop diversification. It means higher the index value higher the magnitude of crop diversification and vice versa.

Bhatia's Method

$$\text{Index of Crop Diversification} = \frac{\text{Sum Percent of cropped Area under X crops}}{\text{Number of X crops}}$$

Here, X crops are those crops which separately cover 5 % or more than 5 % of the gross cropped area or total cropped area in each state. The index value calculated by this formula is inversely related to magnitude of crop diversification. It means lower the index value higher the magnitude of crop diversification and vice versa.

Herphindal's Method

$$\text{Index of Crop Diversification} = \sum_{i=1}^n P_i^2$$

$$P_i = A_i / \sum A_i$$

Where, P_i = Proportion of Area under i^{th} Crop

A_i = Actual Area under i^{th} Crop $\sum A_i$ = Total Cropped Area

The index value worked out by this formula varies from 0 to 1. It is 0 in case of perfect crop diversification whereas 1 represents the perfect crop specialization.

Results and Discussion

For analysis of the present study, crops grown in the states of India have been grouped into food crops and cash crops category. Food crops include the wheat, rice, maize, bajra, jowar, ragi, oilseeds and pulses whereas cotton, sugarcane, tea, rubber, jute, spices, fruits and vegetables kept in cash crop category. Almost all state of India excluding Goa, Kerala, Meghalaya and Sikkim were food crops dominated states covering more than 65 per cent area of their total cropped area during both the period of 2002-03 and 2012-13 Table-1. Additionally, it has also been found that the proportion of area under food crop has decreased in almost all states excluding Haryana, Punjab, West Bengal and Manipur between study periods. Goa, Kerala, Meghalaya and Sikkim were cash crop dominated states. The proportion of area under cash crops has increased in almost all states of India excluding Haryana, Punjab, Manipur and West Bengal between same periods.

The level of crop diversification in Indian agriculture has been divided in three categories i.e. low, moderate, and high on the basis of index value of crop diversification computed by above mentioned three methods. The spatial pattern of crop diversification has been analyzed in following heads.

Pattern of Crop Diversification in 2002-03: According to Gibb's and Martin's formula, the index value of crop diversification in Indian agriculture was 0.69 in 2002-03 Table-2 and Figure-1. It varies from 0.28 in Tripura to 0.88 in Karnataka. The higher level of crop diversification has been found in Nagaland, Andhra Pradesh, Arunachal Pradesh, Karnataka, Bihar, Gujarat, Haryana, Jammu and Kashmir, Kerala, Maharashtra, Himachal Pradesh, Meghalaya, Rajasthan, Tamil Nadu, Uttarakhand and Uttar Pradesh. Moderate level of crop diversification has covered the Punjab, Goa, Jharkhand, Odisha, Sikkim, Assam, Mizoram and West Bengal whereas lower level of crop diversification was in Chhattisgarh, Tripura and Manipur.

The overall Index value of crop diversification in Indian agriculture calculated by Bhatia's Method was 21.88 in the same period. It varies from 11.53 in Karnataka to 42.36 in Tripura. Andhra Pradesh, Haryana, Tami Nadu, Arunachal Pradesh, Gujarat, Jammu and Kashmir, Karnataka, Madhya Pradesh, Bihar, Maharashtra, Rajasthan, Sikkim, Uttarakhand and Uttar Pradesh showed higher level of crop diversification. The level of crop diversification was moderate in Assam, Chhattisgarh, Himachal Pradesh, Punjab, Jharkhand, and Odisha.

Table-1
State-wise Change in Proportion of Area under Crops, India

State	2002-03 (Area in Per cent to Total Cropped Area)		2012-13 (Area in Per cent to Total Cropped Area)		State	2002-03 (Area in Per cent to Total Cropped Area)		2012-13 (Area in Per cent to Total Cropped Area)	
	Food Crops	Cash Crops	Food Crops	Cash Crops		Food Crops	Cash Crops	Food Crops	Cash Crops
Andhra Pradesh	76.76	23.24	67.77	32.23	Manipur	78.87	21.13	79.68	20.32
Arunachal Pradesh	88.67	11.33	87.40	12.60	Meghalaya	50.18	49.82	45.45	54.55
Assam	79.04	20.96	73.46	26.54	Mizoram	81.72	18.28	29.84	70.16
Bihar	90.84	9.16	88.87	11.13	Nagaland	82.87	17.13	76.48	23.52
Chhattisgarh	97.38	2.62	96.90	3.10	Odisha	84.39	15.61	79.71	20.29
Goa	53.70	46.30	52.76	47.24	Punjab	89.10	10.90	90.35	9.65
Gujarat	70.84	29.16	67.04	32.96	Rajasthan	92.40	7.60	91.91	8.09
Haryana	85.77	14.23	86.32	13.68	Sikkim	31.75	68.25	20.12	79.88
Himachal Pradesh	88.22	11.78	86.88	13.12	Tamil Nadu	76.83	23.17	72.37	27.63
Jammu and Kashmir	92.44	7.56	90.64	9.36	Tripura	91.36	8.64	76.69	23.31
Jharkhand	82.24	17.76	75.75	24.25	Uttarakhand	84.06	15.94	83.97	16.03
Karnataka	80.23	19.77	76.43	23.57	Uttar Pradesh	85.41	14.59	82.89	17.11
Kerala	54.90	45.10	54.76	45.24	West Bengal	73.48	26.52	87.37	12.63
Madhya Pradesh	94.29	5.71	93.77	6.23	India (Total)	79.08	20.92	74.46	25.54
Maharashtra	76.57	23.43	69.19	30.81					

Source: MoA, 2014.

According to Herphindal’s formula, the index value of crop diversification in Indian agriculture was 0.31 in same period. The highest index value was 0.72 in Tripura which reflects lowest crop diversification whereas lowest index value was 0.12 in Karnataka with highest crop diversification. The higher level of crop diversification has been recorded in Jammu and Kashmir, Andhra Pradesh, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Tamil Nadu, Madhya Pradesh, Gujarat, Maharashtra, Kerala, Meghalaya and Arunachal Pradesh. The level of crop diversification was moderate in Punjab, Goa, Sikkim, Odisha, Jharkhand, West Bengal, Assam and Mizoram whereas Chhattisgarh and Manipur have low level of crop diversification.

Pattern of Crop Diversification in 2012-13: As per Gibb’s and Martin’s method, the overall index value of crop diversification in Indian agriculture was 0.71 during 2012-13 Table-3 and Figure-1. It varies from 0.46 in Chhattisgarh to 0.89 in Karnataka. The higher level of crop diversification has been registered in Jammu and Kashmir, Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Nagaland, Rajasthan, Tami Nadu and Uttarakhand. States under moderate level of crop diversification include Bihar, Himachal Pradesh, Punjab, Haryana, Uttar Pradesh, and Jharkhand, Sikkim West Bengal, Kerala, Goa, Arunachal Pradesh, Meghalaya and Mizoram state. The low level of crop diversification has found in Chhattisgarh, Odisha, Assam and Tripura.

The overall index value of crop diversification in Indian agriculture calculated by Bhatia’s Method was 21.53 in the same period. The highest index value was 44.44 in Tripura which shows lowest crop diversification whereas lowest index value was 9.83 in Karnataka which indicated highest crop diversification. The higher level of crop diversification has been found in Maharashtra, Jammu and Kashmir, Himachal Pradesh, Haryana, Gujarat, Rajasthan, Karnataka, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, and Bihar, Meghalaya, Nagaland and Manipur state. The moderate level of crop diversification has found in Punjab, Madhya Pradesh, Goa, Kerala, Jharkhand, Odisha, West Bengal, Sikkim, Assam, Arunachal Pradesh and Mizoram.

According to Herphindal’s method, the overall index value of crop diversification in Indian agriculture was 0.29 in the same period. The low level of crop diversification has covered the state of Chhattisgarh, Odisha and Tripura whereas moderate level of crop diversification has been found in Bihar, Himachal Pradesh, Punjab, Haryana, Goa, Kerala, Jharkhand, West Bengal, Sikkim, Assam, Arunachal, Meghalaya, Mizoram and Manipur state. Remaining states have higher level of crop diversification. Apart from the above analysis it has been also observed that there is not much variation among the Index value of crop diversification calculated by three above mentioned methods. All three methods have presented almost same results in terms of spatial pattern of crop diversification In Indian Agriculture.

Table-2
State-wise Crop Diversification Index in India, 2002-03

State	Gibbs and Martins	Bhatia	Herphindal	State	Gibbs and Martins	Bhatia	Herphindal
Andhra Pradesh	0.84	14.36	0.16	Manipur	0.46	30.83	0.54
Arunachal Pradesh	0.71	18.52	0.29	Meghalaya	0.72	18.86	0.28
Assam	0.55	22.12	0.45	Mizoram	0.60	21.24	0.40
Bihar	0.71	18.75	0.29	Nagaland	0.76	18.40	0.24
Chhattisgarh	0.44	31.10	0.56	Odisha	0.65	23.00	0.35
Goa	0.67	24.54	0.33	Punjab	0.63	30.26	0.37
Gujarat	0.84	12.29	0.16	Rajasthan	0.83	14.65	0.17
Haryana	0.75	18.03	0.25	Sikkim	0.67	17.86	0.33
Himachal Pradesh	0.72	22.65	0.28	Tamil Nadu	0.83	14.25	0.17
Jammu andKashmir	0.77	18.74	0.20	Tripura	0.28	42.36	0.72
Jharkhand	0.60	22.02	0.40	Uttarakhand	0.78	20.83	0.22
Karnataka	0.88	11.53	0.12	Uttar Pradesh	0.77	20.55	0.23
Kerala	0.71	24.70	0.29	West Bengal	0.61	21.71	0.39
Madhya Pradesh	0.80	17.81	0.20	India	0.69	21.88	0.31
Maharashtra	0.86	12.82	0.14				

Source: MoA, 2014.

Table-3
State-wise Crop Diversification Index in India, 2012-13

State	Gibbs and Martins	Bhatia	Herphindal	State	Gibbs and Martins	Bhatia	Herphindal
Andhra Pradesh	0.83	15.14	0.17	Manipur	0.70	15.29	0.30
Arunachal Pradesh	0.67	22.81	0.33	Meghalaya	0.72	18.61	0.28
Assam	0.60	22.05	0.40	Mizoram	0.71	22.38	0.29
Bihar	0.72	18.52	0.28	Nagaland	0.77	18.81	0.23
Chhattisgarh	0.46	43.93	0.54	Odisha	0.52	30.75	0.48
Goa	0.68	24.54	0.32	Punjab	0.61	31.14	0.39
Gujarat	0.84	13.83	0.16	Rajasthan	0.82	17.20	0.18
Haryana	0.73	18.70	0.27	Sikkim	0.61	22.93	0.39
Himachal Pradesh	0.72	18.17	0.28	Tamil Nadu	0.83	14.15	0.17
Jammu andKashmir	0.78	18.73	0.22	Tripura	0.48	44.44	0.52
Jharkhand	0.65	21.83	0.35	Uttarakhand	0.78	17.40	0.22
Karnataka	0.89	9.81	0.11	Uttar Pradesh	0.75	14.78	0.25
Kerala	0.70	24.08	0.30	West Bengal	0.70	27.09	0.30
Madhya Pradesh	0.77	21.86	0.23	India	0.71	21.53	0.29
Maharashtra	0.86	13.74	0.14				

Source: MoA, 2014.

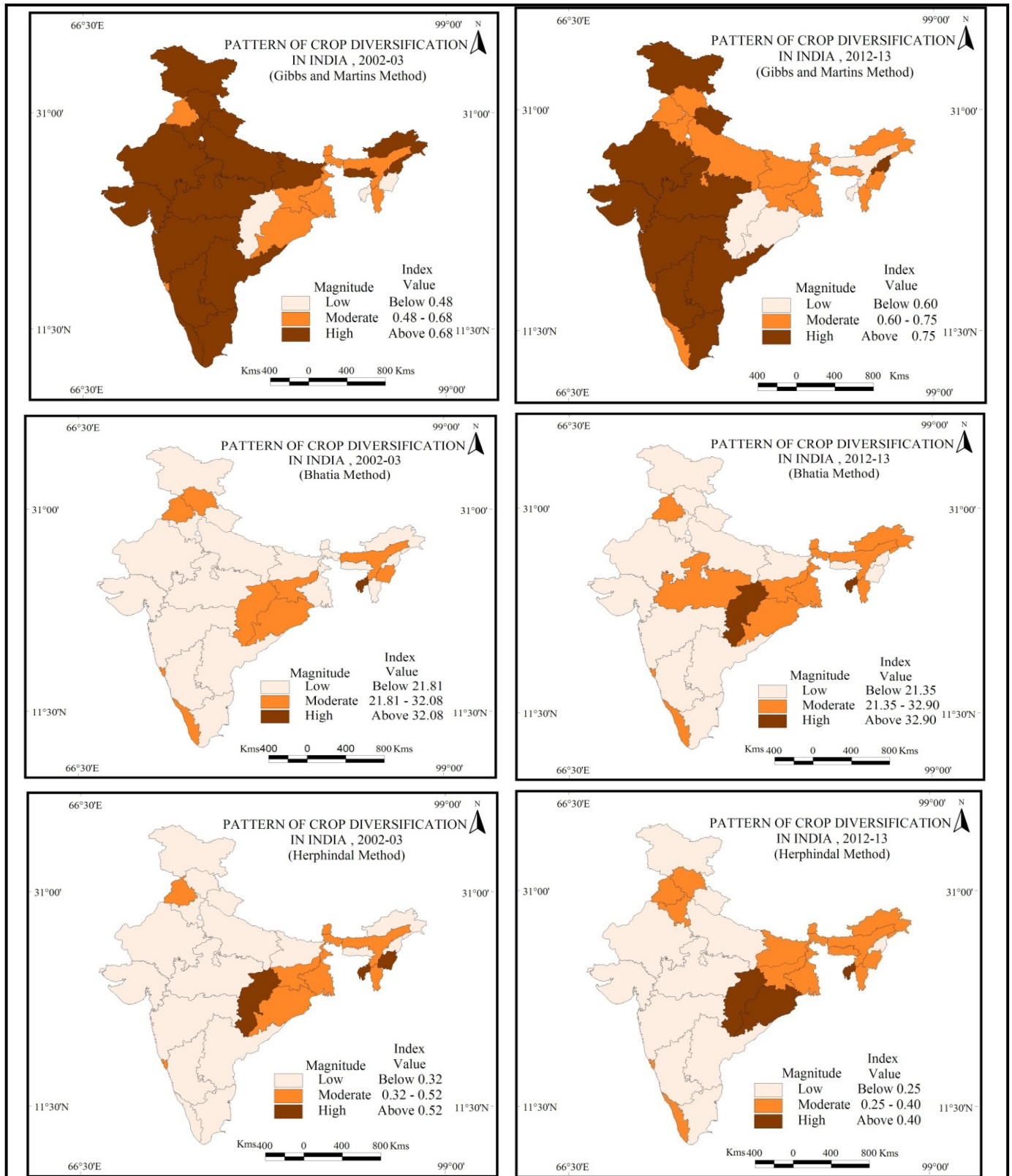


Figure-1
Pattern of Crop Diversification in Indian Agriculture

Conclusion

Results of the present study reveal that the level of crop diversification in Indian agriculture has considerably increased during the above mentioned period. The higher level of crop diversification has been found in Karnataka, Jammu and Kashmir, Rajasthan Gujarat, Maharashtra, Andhra Pradesh, Himachal Pradesh, Tamil Nadu and Uttar Pradesh in both the years. Chhattisgarh and Tripura were registered as less crop diversified states in both the years. Punjab, Bihar, Goa, Jharkhand, Odisha, West Bengal, Kerala and Assam state have moderate level of crop diversification. Further, it has been also found that the level of crop diversification has increased in Assam, Karnataka, Manipur, Tripura, Mizoram and West Bengal between above mentioned years whereas it has decreased in Andhra Pradesh, Arunachal Pradesh, Haryana, Madhya Pradesh, Kerala, Punjab, Rajasthan, Sikkim and Uttar Pradesh. Remaining states have not much changed in its crop diversification level. Therefore, it can be stated that there is still requirement of farmer's interest along with government and institutional support to increase the level of crop diversification in Indian agriculture. So that Indian agriculture can achieve more sustainability in view of agricultural production and productivity.

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