RESEARCH ARTICLE

CROP DIVERSIFICATION IN INDIA: EMERGING TRENDS, DETERMINANTS AND POLICY IMPLICATIONS

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ABSTRACT

Now, agricultural sector of India has undergone a major shift from traditional crops to modern high value crops and got a tremendous potential to push overall agriculture growth. The pattern of crop diversification of India has been analyzed by using secondary data from 1980-81 to 2011-12. Simpson Index of Diversification (SID) and regression analysis have been used to analyze the patterns and determinants of crop diversification in India. This study reveals that India is moving from food grain crops to non-food grain crops. After economic reforms, change in cropping pattern from low priced food grains crops to high priced non-food grain crops has been the engine of agricultural output growth. The result also shows that irrigated area as percentage of gross cropped area, consumption of fertilizer, cropping intensity, agricultural export, education, direct institutional credit for agriculture and size of average land holdings has been found the main determinants of crop diversification in India. Therefore, the study suggested that policy supports, in terms of price protection, insurance coverage, expenditure on agriculture research & education, subsidized inputs and technology should be extended to them. Further, public--private participation needs be encouraged to step up agriculture infrastructure facility in India.

INTRODUCTION

After independence, the structure of the Indian agricultural economy has achieved a remarkable change due to green revolution. With the advent of the green revolution, India has transformed itself from a food-deficient to a food-surplus economy. During the last two-three decades, a shift has been noticed in the consumption pattern, wherein the consumption of cereals has declined in favor of a more varied and nutritious diet of fruit, vegetables, milk, fish, meat and poultry products. Consequently, the Indian agricultural sector which was originally a traditional agriculture-based sector, has now transformed in pursuance of high value agriculture. Generally, crop diversification is intended to give a wider choice in the production of a variety of crops in a given area so as to expand production related activities on various crops. In other words, crop diversification is highlighted as it serves two purposes, i.e. increasing the income and decreasing the risk – both the aspects of the quality and quantity of diversification. The argument is that farmers must be in a position to produce high

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value crops and with the increase in commercialization, should also be able to maintain the diversity in the cropping pattern in order to deal with the risk in this sector (World Bank, 1988). Crop diversification is a tactic to maximize the use of land, water, and other natural resources for the overall agricultural development and provides the farmers with viable options to grow different crops in different agro-climatic conditions (Acharya *et al*., 2011). In India, crop diversification is viewed as a shift from traditionally grown less remunerative crops to high value more remunerative crops. Crop diversification also takes place due to governmental policies and thrust on some crops over a given time.

There is need for agricultural diversification in India as many parts of country have witnessed a grossly huge number of farmer suicides and diversification of the crop mix can be an efficient mechanism for diminishing the impact of risk on farmers' welfare (Jorge and Valdes, 1995). Furthermore, Indian agriculture is also critically influenced by the several restrictions and opportunities offered by the WTO regime; which requires India to import food products from abroad at subsidized prices on one hand which might have severe ramifications for Indian agriculture sector; while it also

authorizes the production of high-value horticulture and livestock products to meet the ever rising consumption demand by the more affluent foreign as well as domestic consumers on the other hand. Apart from this, Indian agriculture oversees a greater emphasis being laid upon the cultivation of wheat and paddy which involves some serious social, economic, and ecological implications such as decline in the rate of growth of productivity, fall in agricultural self employment, excess utilization of groundwater resources and deteriorating soil fertility (Chand, 1999). In view of these challenges, agricultural diversification towards horticulture and livestock products can prove to be an expedient solution, thus deepening the employment opportunities while augmenting the incomes of the farmers, scaling down the spatial and temporal irregularities, containing the dilapidation of natural resources; and also increasing exports. (Chand, 1999; Joshi, *et al.*, 2004, 2006; World Bank, 2005; Weinberger and Lumpkin, 2007). The faith in agricultural diversification to enhance the farm employment opportunities, is borne out of the fact that horticulture and livestock products engage a larger workforce than the traditional crops.

During the recent years, agricultural sector has undergone a major shift from traditional to modern agriculture and got a tremendous potential to push overall agriculture growth above the country's targeted 4% level due to growth of technology, modernization, and changes in food habits of the people (Bahadur, 2010). It also observed that the sector can directly address poverty and food security issues in both urban and rural areas of the developing world (Abou- Hadid, 2005). Now, crop diversification has, perhaps, become the most profitable venture of all farming activities, as it provides ample employment opportunities and scope to raise the income of the farming community in the country (Choudhary, Singha, & Vishnu, 2013). Development of infrastructural facilities such as motorable roads, irrigation facilities, electricity used for agricltural purposes, market infrastructure are the some of the important parameters that determine the change in cropping pattern and subsequently the extent and profitability of crop diversification. It is also observed by various studies that the size of land holdings is seen as another noticeable factor defining the nature and intensity of crop diversification (Chand, 1995; Narain, 1965; Sarkar, 1988; Nayyar and Sen, 1994; Vyas, 1996; Chand and Chauhan, 2002).

Crop diversification is a farming practice which offers an extensive choice in the cultivation of various crops within a certain limited area in order to extend production related activities on various crops and also to minimize the risk involved in the production of specialized food grain crops. In Indian perspective crop diversification entails the dislodgement of traditional cropping practices wherein precedence was given to specialized cropping of food grains which bore relatively low returns and were primarily cultivated for subsistence purpose; and the subsequent adoption of diversification in the cropping system wherein a variety of high paying commercial crops such as horticulture crops and crops such as tobacco, oilseeds, jute, cotton etc are cultivated on the same piece of land. Government policies also promote crop diversification.
In view of the above mentioned challenges, the significance of the present study lies in the fact that the decomposition effects

mentioned above have not been addressed so far, in a detailed and comprehensive manner by the earlier studies and hence a novel attempt is made here so as to address the issues laid down in the objectives, hence emphasizing the importance of the study.

It is in this context, the main objectives of the present research paper are

- To examine the emerging trends of crop diversification in India by different crop groups.
- To identify the determinants of crop diversification in India and assess the policy implications for crop diversification in India

After the introduction and objectives of the problem, the paper discusses the methodological framework and the data sources. This is followed by the elucidation of the empirical results and finally the conclusions and policy implications derived from the study.

Methodology and data sources

Crop Diversification is an important aspect for economic development to take place in the rural sector of India. The measurement of the extent of crop diversification at a given point in time may be done means of several indices namely; Index of maximum proportion, Herfindal Index, Simpson Index, Ogive Index, Entropy Index, Modified Entropy Index and Composite Entropy Index. Every method has some superiority and/or limitation over the other method. The Simpson Index approach is used in the present study for the realization of the research objective, which is to assess the extent of diversification in crop sector of India. This method provides a clear dispersion of commodities in a geographical region and is rather easy to compute and interpret. The Simpson index is given by:

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

Where,   SID $\rightarrow$ Simpson index of diversification
     Pi $\rightarrow$ Proportionate area of ith crop/crop sector in the gross cropped area

Simpson index of diversification (SID) ranges between zero and one. When the value of *SID* is close to one, there is evidence for high diversification; and when it is closer to zero, then there is no diversification. When *SID* for a crop group increases, it will imply that the area under the non food grain crops is rising. This indicates that the area used for production of traditional crops has shifted towards the production of high value crops, subsequently hinting towards the implicit presence of crop diversification in the region.

In the present paper, we have estimated the crop diversification index for the group of cereals, pulses, food grain crops, cash crops, food crops, oilseeds, non-food crops and the total crop sector in Indian agriculture during 1980/81-2001/12. Cereal group included rice, jowar, bajra, maize, ragi, wheat, barley and other cereals & millets; while the pulses group comprised of gram, tur and other pulses. The food grain group

encompassed all the cereals and pulses. Cash crops consisted of sugarcane, total condiments and spices, total fruits & vegetables and other food crops, whereas the food crop group included all cereals, pulses and cash crop. Oilseeds group constituted groundnut, sesame, castor-seed, rape-seed, mustard, linseed, coconut and other oilseeds. Total non-food grain crops group incorporated all oilseeds, cotton, tobacco, jute, other fibers, indigo, tea, coffee, opium, fodder crops and other non-food crops. The total crop sector group included all food crops and all non-food crops.

Hereafter, a widely accepted exponential model, $y = a\ b^t\ e^u$, has been fitted to the time series data for estimating the compound annual growth rates of different variables. The logarithmic form of this function is given by;

$$\ln(y) = \ln(a) + t\ \ln(b) + u$$

Where,

> $y \rightarrow$ Dependent variable whose growth rate is to be estimated.
> $t \rightarrow$ Independent variable (Time)
> $u \rightarrow$ Disturbance or error term.

'a' and 'b' are the parameters to be estimated from sample observations. The regression coefficient b is estimated by ordinary least squares (OLS) technique.

The Compound Average Growth Rate (CAGR) in % term is estimated as:

$$\text{CAGR} = \{\text{antilog}(b) - 1\} * 100$$

Apart from measuring the Simpson Index of Diversification (SID) and Compound Average Growth Rate (CAGR) of various aspects, the determinants of crop diversification in India have also been examined. The following multiple regression model is applied to the time series data from 1980/81 to 2011/12 in order to examine the determinants of crop diversification;

$$SID = f\left(AUHYV, COF, EVNOS, CI, \frac{GIA}{GCA}, AGEXP, PCNNP, SOALH, DICFAG\right)$$

Where, SID is expressed as a function of a set of independent variables. On this basis, the following regression equation is formed to analyse the determinants of crop diversification;

$$SID = \beta_0 + \beta_1 AUHYV + \beta_2 COF + \beta_3 EVNOS + \beta_4 CI + \beta_5 \left(\frac{GIA}{GCA}\right) + \beta_6 AGEXP + \beta_7 PCNNP + \beta_8 SOALH + \beta_9 DICFAG + Ui$$

Where;

SID$\rightarrow$ Annual Growth Rate of Simpson Index of Diversification
AUHYV$\rightarrow$ Annual Growth Rate of Area under High Yield Varieties
COF$\rightarrow$ Annual Growth Rate of Consumption of Fertilizer (N+P+K)
EVNOS$\rightarrow$ Annual Growth Rate of Education Variable in-terms of No. of Schools
CI$\rightarrow$ Annual Growth Rate of Cropping Intensity

(GIA/GCA)$\rightarrow$Annual Growth Rate of Gross Irrigated Area as percentage of Gross Crop Area
AGEXP$\rightarrow$ Annual Growth Rate of Agricultural Exports
PCNNP$\rightarrow$ Annual Growth Rate of Per Capita Net National Product
SOALH$\rightarrow$ Annual Growth Rate of Size of Average Land Holdings
DICFAG$\rightarrow$ Annual Growth Rate of Direct Institutional Credit for Agriculture
$U_i \rightarrow$ Stochastic Error Term

To avoid the problem of multicollinearity, we have taken annual growth rates of all the variables, i.e., dependent as well as independent variables.

The present research paper is based on secondary data sources such as National Accounts Statistics prepared by the Central Statistical Organization (CSO), Ministry of Statistics and Program Implementation, Government of India, Agricultural Statistics at a Glance prepared by Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, Handbook of Statistics on Indian Economy prepared by Reserve Bank of India, Government of India, Land Use Statistics prepared by Department of Agriculture and Co-operation Network (DACNET), Ministry of Agriculture, Government of India.

Agricultural scenario in India

The growth spurt experienced by Indian agricultural sector during mid 1960's had led to the introduction of high yielding variety seeds, better irrigation facilities and adoption of mechanization in the farming sector. Thereafter, the growth of agricultural output was mainly fuelled by total factor productivity growth or yield growth; wherein, yield witnessed relatively higher growth rates than acreage during the following two decades. Also, the change in the pattern of cropping played a crucial role in agricultural growth in India during the same period. Another noticeable fact was that the agricultural sector performance during eighties has been impressive due to the extension of green revolution technologies in terms of enhanced investments in irrigation facilities and rural infrastructural development. Consequent to these efforts was a sharp growth in productivity, which was reflected by the massive increase in the yield of crops, though a declining trend has been observed for area expansion.

On the contrary, there has been an apparent change in the cropping pattern, i.e., increasing the share of non-food grains crops such as oilseeds, vegetables, horticultural crops, spices and sugarcane in gross cropped area as compare to food grain crops during the post-reform period (Joshi *et al*., 2004). Following the economic reform in India, it was realized that the changing pattern of crop was primarily attributable to the relative price changes among various crops and crop diversification, which took place after the economic reforms. Before analyzing the trends and sources of growth of crop diversification in India during the study period, firstly let us have a look at the growth performance of Indian agricultural sector and allied sector since 1980's.

The growth rate of gross domestic product (GDP) by sectors and agricultural sub-sectors during the study period, i.e., 1980-81 to 2011-12 as well as sub-periods of study i.e., pre reform and post reform periods are presented in the Table 1. It is observed that the growth rate of non agricultural sector is always higher than the growth rate of agricultural sector during the study period. Gross domestic product (GDP) from agricultural and allied sectors has shown marginal increase in growth rate in the initial phase of liberalization compared to the pre-reform decade, mainly due to impressive growth rates witnessed in horticulture (fruits and vegetables) i.e. 5.92 per cent per annum and other allied sectors. However, in the second phase of the post-reform period agricultural sector as a whole experienced a drastic reduction in the growth rates by 1.92 percentage per annum, again principally due to decline of growth rate of cereals and fruits and vegetables. During the post-reform period, except for the fruits and vegetables which have shown significant growth in the first phase of reforms, all other subsectors of agriculture have undergone substantial growth deceleration. This significant deceleration in the growth rate of output in respect of the food grain crops has serious implications for food security of the country. It means that food grain crops are now viewed as less profitable, and the farmers are likely to shift resources away from the production of this crop to high value crops.

of non food grain crops per acre of cultivated area attracted farmers to shift from traditional crops to high value crops.

Figure: 2a presents the trends of cultivated area under food grain and non-food grain crops during the year 1980-81 to 2011-12. As could be seen from it, area cultivated under non-food grain crops shows a rising trend with small fluctuations during the study period. On the other hand, area cultivated under food grain crops shows a decreasing trend.

In the above discussion, it has been observed that although the agricultural GDP has declined but in view of this, the area share of non food grain crops has increased steadily between 1980-81 and 2011-2012, whereas the share of food grain crops has declined over the same period, subsequently making the presence of crop diversification evident in Indian agriculture.

Trends of Growth Rate of Area under Various Crops and Crop Groups

The trends of growth rate of cultivated area under various crops and crop groups during the study period, i.e., 1980-81 to 2011-12 as well as sub-periods of study, i.e., 1980's, 1990's and 2000's are given in the Table 3. It was observed that the total food grain crops accounted a negative growth rate of

Table 1. Growth Rate of Gross Domestic Product (GDP) by Sectors at Factor Cost (Base 2004-05)

Period's	GDP at Factor Cost	Non_Agricultural GDP	Agriculture & Allied activities GDP	Agricultural GDP
1980-81 to 1989-90	5.17	5.24	2.97	3.09
1990-91 to 1999-2000	6.11	6.14	3.34	3.36
2000-01 to 2011-12	7.98	7.98	3.21	3.35
1980-81 to 1995-96	5.23	5.30	3.12	3.17
1996-97 to 2011-12	7.26	7.27	2.80	2.86
1996-97 to 2004-05	5.83	5.86	1.92	1.85
1980-81 to 2011-12	6.17	6.20	3.01	3.04
Agricultural Growth Rate by Sub-Sectors Group (Based on Source: Chand *et al* 2007)				
Period's	Crop sector	Cereals	Fruits and Vegetables	Non-Horticulture crops
1980-81 to 1989-90	2.71	3.15	2.42	2.77
1990-91 to 1996-1997	3.22	2.23	5.92	2.59
1996-97 to 2004-05	0.79	0.02	3.28	0.05
Sources: Central Statistics Office (CSO)				

Table 2. Share of Foodgrain and Non-Foodgrain Crops in Area

Year	Foodgrain Crops	Non-Foodgrain Crops
1980-81	78.50	21.50
1990-91	74.10	25.90
2000-01	72.37	27.63
2011-12	69.91	30.09

Source: Handbook of Statistics on Indian Economy, RBI

The share of food grain crops to non-food grain crops in total cultivated area during the study period, i.e., 1980-81 to 2011-12 as well as sub-periods of study i.e., pre reform and post reform periods are given in the Table 2. It is observed from the table that the area cultivated under non-food grains crops has been increased from 21.5 per cent in 1980-81 to 30.09 per cent in 2011-12 and area cultivated under food grains has been decreased from 78.5 per cent in 1880-81 to 69.91 in 2011-12. It is also revealed that the non-food grain crops accounted for only thirty per cent of total cultivated area but contributed to more than fifty per cent of value of output. So, the high value

area i.e. -0.13 during the study period 1980-81 till 2011-2012, where in rice showed a decline in growth rate of area from 0.38 in 1980/81-1989-90 to 0.01 in the decade 2000/01- 2011/12; whereas the area under wheat recorded a rise in growth rate from 0.53 in pre reform period i.e 1980/81- 1989-90 to 1.45 in the second decade following reform i.e. 2000/01 – 2011/12. Rate of growth of area under the cultivation of coarse cereals remained negative throughout the study period with minor fluctuations, standing at -1.53; while the growth rate of area under pulses happened to increase to a positive figure of 0.75 in 2000/01 – 2011/12 from that of -0.19 in 1980/81- 1989-90.
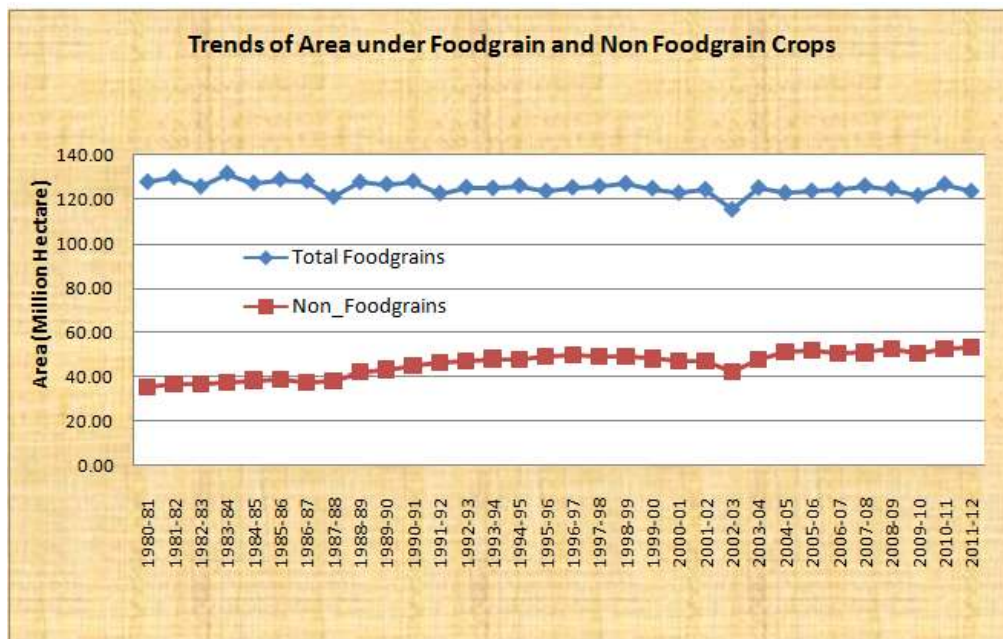
Figure 2a

Table 3. Compound Annual Growth Rate of Area under Different Crops and Categories of Crops   (1980/81-2011/12)

		Categories of Crops	1980-81 to 1989-90	1990-91 to 1999-2000	2000-01 to 2011-12	1980-81 to 2011-12
		Rice	0.38	0.71	0.01	0.30
	Food grain Crops	Wheat	0.53	1.75	1.45	0.86
		Coarse Cereals	-1.43	-2.05	-1.00	-1.53
Total Food Crops		Pulses	-0.19	-0.28	0.75	0.06
		Total Food grain	-0.27	0.01	0.23	-0.13
		Sugar-cane	1.10	0.69	1.12	1.73
	Cash Crops	Total Condiments and Spices	1.99	2.35	1.35	1.58
		Total Fruits & Vegetables	3.38	2.23	1.03	2.39
		Total Food Crops	-0.05	0.23	0.35	0.09
		Total Oilseeds	4.17	0.52	1.61	1.73
		Cotton	-0.98	2.51	2.93	1.14
Total Non-Food Crops	Commercial Crops	Jute	-2.41	1.57	-0.84	-0.02
		Total Fibers	-1.24	2.27	2.45	0.91
		Tobacco	-1.82	0.66	1.66	-0.27
		Tea	1.60	1.07	0.33	1.73
		Coffee	2.04	0.55	1.18	1.02
		Fodder Crops	-0.27	0.14	-0.60	-0.05
		Other Non-Food Crops	6.04	2.43	2.77	3.43
		Total Non-Food Crops	1.90	0.88	1.45	1.24
		Total Crop Sector	0.37	0.39	0.63	0.36

Sources: Land Use Statistics prepared by Department of Agriculture and Co-operation Network (DACNET), Ministry of Agriculture

Looking at the non food grain food crops or the cash crops, it was noticed that growth rate of area under sugarcane has shown a minor increase from a figure of 1.10 in 1980/81- 1989-90 to that of 1.12 in 2000/01 – 2011/12 hence recording an average growth rate of 1.73 during the entire study period; on the other hand total condiments and spices as well as total fruits and vegetables witnessed a decline in area growth rate where the decline was more significant latter's case. In other words rate of growth of area under the former decreased from 1.99 in 1980/81- 1989-90   to 1.35 in 2000/01 – 2011/12, averaging at 1.58 in the study period; while the latter showed a decline in area growth rate from 3.38 in 1980/81- 1989-90   to 1.03 in 2000/01 – 2011/12, thus averaging at 2.39 in the entire study period. Hence the total food crops which comprise of both food grain crops as well as cash crops observed a rise in area growth rate from -0.05 in 1980/81- 1989-90 to 0.35 in 2000/01 – 2011/12. In the category of non food crops, total oil seeds

recorded a substantial decline in area growth rate from 4.17 in pre reform period to 1.67 in the second decade of post reform period; cotton on the other hand showed a significant rise in area growth rate from -0.98 in pre reform period to 2.93 in the second decade of post reform period; rate of growth of area under jute remained mostly negative throughout the study period averaging at -0.02; total fibres displayed a noticeable increase in its area growth rate from -1.24 in 1980/81- 1989/90 to 2.45 in 2000/01 – 2011/12; tobacco did not record much increase in rate of growth of area as the average growth rate of area under tobacco cultivation was computed to be negative at -0.27 in the study period; Tea observed a gradual decline in its area growth rate in the study period and averaged at 1.73; similarly the growth rate of coffee was also seen to be falling averaging out at 1.02 in the study period; fodder crops mostly witnessed a negative rate of area growth which averaged out at -0.05 in the study period; other non food crops recoded a

substantial decrease in area growth rate from 6.04 in pre reform period to 2.77 in second decade of post reform period. Subsequently the class of total non food crops witnessed a minor decline in area growth rate which averaged at

1.24 in the study period. Compositely the total crop sector observed a very small increase in rate of growth of area from 0.37 in pre reform period to 0.63 in post reform period, thus averaging at 0.36 in the entire study period. During the study period, it has been observed that the growth rate of area under food grains has been declined but on the other hand, the growth rate of area under non food grain crops has increased steadily. The changing patterns of area under various crop sectors are making the presence of crop diversification in Indian agriculture.

Patterns of Crop Diversification among various Crop Groups in India

The patterns of Simpson index of crop diversification by various crop groups in India during the study period, i.e., 1980-81 to 2011-12 are presented in the Table 4.

fluctuations across the time period ranging from 1980-81 to 2011-12. The only noticeable variation in SID can be seen in the crop sector whose SID has consistently increased over the years with an average of 0.615 in the decade 1980/81-1989/90 to 0.675 in the post reform decade of 2000/01-2011/2012 thus hinting at the rise in crop diversification through a rise in area under non food grain crops which implies that cropping pattern has shifted from the traditional cropping system involving specialization in food grain crops, towards of high value crops which mainly include horticulture crops and commercial crops such as cotton, tea, coffee, tobacco etc.

Determinants of Crop Diversification in India

The estimated parameters from the Simpson Index of Diversification (SID) decomposition equation of the crop sector of India for the period 1980-81 to 2011-12 are presented in the Table 5. The value of R- square is 0.485, which implies that the regression model explain 48.5 per cent of the total variations in crop diversification index.

Table 4. Simpson Index of Crop Diversification of Various Crops Group in India

Year	Cereals	Pulses	Food grain	Cash Crop	Food Crops	Oilseed	Non Food Crops	Crop Sector
1980-81	0.766	0.559	0.828	0.630	0.850	0.750	0.845	0.597
1981-82	0.764	0.575	0.829	0.634	0.852	0.759	0.849	0.607
1982-83	0.765	0.575	0.829	0.640	0.853	0.757	0.846	0.611
1983-84	0.760	0.571	0.824	0.632	0.848	0.762	0.851	0.604
1984-85	0.754	0.574	0.821	0.621	0.846	0.769	0.858	0.613
1985-86	0.754	0.579	0.824	0.620	0.848	0.777	0.863	0.619
1986-87	0.755	0.573	0.822	0.621	0.848	0.770	0.859	0.611
1987-88	0.753	0.572	0.819	0.626	0.848	0.774	0.866	0.622
1988-89	0.750	0.584	0.819	0.623	0.847	0.766	0.859	0.631
1989-90	0.745	0.575	0.816	0.619	0.845	0.768	0.860	0.638
1990-91	0.740	0.581	0.815	0.617	0.845	0.777	0.865	0.647
1991-92	0.732	0.562	0.807	0.617	0.840	0.772	0.865	0.653
1992-93	0.739	0.572	0.813	0.622	0.844	0.769	0.862	0.653
1993-94	0.731	0.566	0.807	0.618	0.840	0.767	0.862	0.656
1994-95	0.729	0.577	0.808	0.615	0.841	0.772	0.863	0.660
1995-96	0.724	0.583	0.804	0.616	0.840	0.769	0.861	0.667
1996-97	0.725	0.587	0.803	0.623	0.839	0.766	0.862	0.663
1997-98	0.722	0.581	0.803	0.620	0.838	0.757	0.859	0.665
1998-99	0.713	0.596	0.798	0.616	0.836	0.752	0.857	0.666
1999-00	0.709	0.582	0.790	0.612	0.830	0.766	0.861	0.658
2000-01	0.716	0.573	0.793	0.611	0.833	0.763	0.860	0.657
2001-02	0.713	0.566	0.795	0.616	0.836	0.763	0.860	0.666
2002-03	0.712	0.577	0.795	0.601	0.837	0.747	0.861	0.662
2003-04	0.725	0.572	0.805	0.601	0.844	0.754	0.860	0.671
2004-05	0.716	0.569	0.800	0.588	0.840	0.750	0.858	0.680
2005-06	0.712	0.578	0.796	0.584	0.837	0.750	0.857	0.678
2006-07	0.711	0.585	0.795	0.598	0.837	0.743	0.856	0.676
2007-08	0.711	0.586	0.798	0.600	0.840	0.739	0.854	0.681
2008-09	0.702	0.590	0.790	0.590	0.834	0.730	0.852	0.682
2009-10	0.710	0.603	0.794	0.605	0.836	0.724	0.851	0.677
2010-11	0.710	0.614	0.799	0.617	0.840	0.728	0.850	0.685
2011-12	0.700	0.606	0.789	0.627	0.834	0.737	0.849	0.687
Averages								
1980's	0.757	0.574	0.823	0.627	0.848	0.765	0.856	0.615
1990's	0.726	0.579	0.805	0.618	0.839	0.767	0.862	0.659
2000's	0.711	0.585	0.796	0.603	0.837	0.744	0.856	0.675

Source: Based on Author's Calculation

Looking at the given table for Simpson index of crop diversification for various crop groups in India it can be observed that the Simpson index for crop diversification is more or less constant for all the crop groups with minute

The results indicates that consumption of fertilizer, cropping intensity, agricultural export and size of average land holdings have a statistically significant and positive impact on crop diversification index throughout the entire period of the study.

Table 5. Regression Results of Crop Diversification

Dependent Variable: Simpson Index of Diversification (SID)				
Variables	Regression Coefficient	Standard Error	't' Statistic	Level of Significance (P>t)
AUHYV	-0.0578652	0.0587968	-0.98	0.336
COF	0.0538158	0.0326276	1.65	0.114
EVNOS	0.0331276	0.0741302	0.45	0.660
CI	0.2409041	0.1474627	1.63	0.117
GIA/GCA	0.0415109	0.0851766	0.49	0.631
AGEXP	0.0228687	0.0112298	2.04	0.055
PCNNP	-0.3709225	0.1198898	-3.09	0.006
SOALH	0.2081743	0.0885095	2.35	0.029
DICFAG	0.0326206	0.0275855	1.18	0.250
Constant	0.0116401	0.0065912	1.77	0.092
R-squared =0.485, Adj. R-squared =0.264, No. of Observations = 31				
RME =0.007, Prob. > F = 0.06				

The impact of gross irrigated area as percentage of gross cropped area, number of secondary schools and direct institutional credit for agriculture on Simpson index of crop diversification is not statistically significant but positive. The result also revealed that the per capita net national product has exerted a negative influence on crop diversification index in total crop sector during the study period and this negative effect of the per capita net national product on crop diversification in India was statistically significant. The regression coefficient for proportion of area under HYV of crop sector showed an insignificant negative impact on crop diversification. In this context, the most of taking parameters are found to influence the nature and extent of crop diversification in India during the study period.

Conclusion and Policy Implications

The present research paper have been analyzed the nature, extent and determinants of crop diversification in India by using growth rate of area under different crop sector, Simpson index of crop diversification and regression analysis. This study shows that India is moving from traditional subsistence agriculture, i.e., food grain crops to high value agriculture, i.e., non-food grain crops. Diversification of crop sector in India plays a vital role in diversifying and commercializing agriculture. After economic reforms, change in cropping pattern from low priced food grains crops to high priced non-foodgrain crops has been the engine of agricultural output growth. Yet, it is necessary to taking the step in the direction of reinforcement the link between production, processing, marketing and crop management. Then the shifting of cropping pattern from food grain crops to non food crops will enable the best use of available land resources without compromising food security.

The result also shows that irrigated area as percentage of gross cropped area, consumption of fertilizer, cropping intensity, agricultural export, education, direct institutional credit for agriculture and size of average land holdings has been found the main determinants of crop diversification in India. Investments in agriculture, especially in the areas of research and development, extension and technology development need to be enhanced. Size of small holdings is found to be positively associated with the crop diversification. However, small farmers suffer due to lack of access to price support, cold storage facility, transport facility, market facility, agriculture

credit facility and crop insurance facility. Therefore, policy supports, in terms of price protection, insurance coverage, expenditure on agricultural research & education, subsidized inputs and technology should be extended to them. Further, public--private participation needs be encouraged to step up agriculture infrastructure facility in India. Thus, the demand side and supply side factors can help achieve many strides for the crop sector in India, provided policy can look beyond farming and better integrate production agriculture.

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