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**Working Paper**

**No. 2017-06**

**[www.indialics.org](http://www.indialics.org)**

# **CROP DIVERSIFICATION AND SUSTAINABLE AGRICULTURE IN INDIA**

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## **ABSTRACT**

The basic challenge for sustainable agriculture is to make best use of available biophysical and human resources. But growth being at the centre- stage of the policy agenda of almost all countries in the world has led to fast depletion of natural resources. Land and water constitute two important renewable resources extensively used in agricultural sector. The diversification of agriculture is an alternate way for the regeneration and conservation of land and water.

The present paper attempts to study if diversification can ensure sustainability in agriculture. For this purpose, secondary data at two points of time 2007-08 and 2013-14 are used. Herfindahl Index is used to measure agricultural diversification with respect to 7 major crops i.e. Coarse Cereals, Pulses, Oilseeds, Sugarcanes, Vegetables, fruits and spices. It is observed that area under Coarse Cereals has declined from 2.10 to 1.76 percent. For rest of crops it has increased and in case of sugarcane it is constant. The index values for the country as a whole reveals the fact that there is crop concentration in favour of fruits and vegetables. At the state level, crop diversification is found to be highest in Andhra Pradesh followed by West Bengal, Bihar, Maharashtra and Karnataka. Rest of the states have concentration of crops with highest in Odisha followed by Madhya Pradesh. Using linear Regression it is found that the significant factors influencing crop diversification are fertiliser consumption, pesticides, seeds, credit and irrigation. The shifting of cultivation from cereal production to fruits and vegetables at all India level gives positive indication for sustainability in agricultural sector.

**Keywords: Agriculture, Sustainable, Diversification, Concentration**

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## **I. Introduction**

India is a country of about one billion people with more than 70 percent of population living in rural areas where the main occupation is agriculture. India is now the largest producer of wheat, fruits, milk and tea in the world and second largest producer of vegetables and fruits. It is the largest producer, consumer and exporter of spices in the world. Food security strategy of the country promotes the adoption of sustainable agriculture with an ecological approach to resource conservation and mitigation of environmental impact of climate change aiming at increasing agricultural production and productivity to support rising population of the country.

“We strongly believe that agriculture that is environmentally, economically and socially sustainable can make a vital contribution in our response to most urgent challenges, reducing poverty and ensuring food security” (Dacian Ciolos and Andris Piebalgs). The basic challenge for sustainable agriculture is to make best use of available biophysical and human resources. It has a crucial role to play in preserving natural resources, reducing greenhouse gas emission and ensuring efficiency. A judicious use of natural resources in a sustainable manner is the basic requirement to set the wheel of economic progress in motion. Both economic use of exhaustible natural resources and conservation of renewable natural resources are equally important for the purpose. But growth being at the centre- stage of the policy agenda of almost all countries in the world has led to fast depletion of natural resources (Mallick and Lenka, 2006). The natural resources as a form of capital, if depleted, either has to be regenerated or substituted if countries are to maintain or expand their asset base and thus ensure a constant or rising trend of economic growth (Dasgupta and Heal, 1979).

Land and water constitute two important renewable resources extensively used in agricultural sector (Dasgupta, P.S. and G.M. Heal, 1979). A change in climate, non-economic use of land and water, cultivation of highly water consuming crops have resulted in a fall in fertility of soil, soil erosion and depletion of water table. The conservation of these renewable resources is of utmost importance for viability and sustainability of farm enterprises.

The diversification of agriculture is an alternate way not only for the regeneration and conservation of land but also for enhancing its productivity. Moreover, it may result in conserving the most important resource that is water. National Agricultural policy (NAP), 2001, emphasized the need for efficient use of soil, water, bio-resources to meet the increasing requirement at home and face the competition in world market efficiently.

Crop diversification in India means a shift from traditionally grown less remunerative crops to more remunerative crops. It depends on geo- climatic, socio-economic conditions and technological development in a region. Due to diverse agro climatic conditions in the country, a large number of agricultural products are produced in our country. Crop diversification designed to a shift from the regional dominance of one crop to regional production of a number of crops and to meet ever increasing demand of coarse cereals, pulses, vegetables, fruits, oilseeds and sugarcane. It aims to improve soil health and to maintain dynamic equilibrium of the agro ecosystem. Crop diversification is intended to promote technological innovations for sustainable agriculture and enable farmers to choose crop alternatives for increased productivity and income.

With this backdrop the present paper makes a modest attempt to analyse the trends and determinants of agricultural diversification in the states of India along with a bird's eye

view on the cropping pattern. The paper is organized as follows. The second section presents the Review of Literature. Data and Methodology are given in section –III. Results and discussion are presented in Section-IV followed by the concluding section.

## **II. Review of Literature**

In this section a review of past research in the field has been compiled to enable better understanding of the problems concerned to the study.

Bhattacharyya, R., (2008) in her study relating to “Crop Diversification: A search for an Alternative Income of the Farmers in the state of West Bengal in India” has found that the agricultural sector of West Bengal is gradually diversifying towards high value commodities namely fruits, vegetables and flowers. The diversification has come through individual efforts of the small farmers with little support from the government. It is because food security issues are still critical in the state as well as the country and government policy is still obsessed with self sufficiency in cereals. However, the speed of diversification is rather slow and is much less than that of the country as a whole.

De and Chattopadhyay (2010) in their study “Crop Diversification by poor peasants and Role of Infrastructure: Evidence from West Bengal” have observed that the expansion of infrastructure like road network, irrigation facilities through different modes whenever possible, marketing and storage facilities power supply especially to the minor irrigation setups, availability of fertiliser and facilitating or empowering those especially the poor farmers are important preconditions for the diversification of crops across the districts. As the poor farmers take the leading role here in diversification, markets and other infrastructure should be fair and competitive for their rational use. However, many of the poor farmers suffer from lack of capital and provision of capital through cooperative and regional rural banks need to be will warranted.

Brenda (2011) in his study “Resilience in Agriculture through Crop Diversification: Adaptive Management for Environmental change” has highlighted that the potential of increasing diversity within farm systems is essential to helping farmers adopt to greater climate variability of the future. By adopting farm systems that promote ecosystem services for pest and disease control and resilience to climate change variability, farmers are less at risk to production loss and are more generally resilient to environmental change.

Singh et.al (2011) in their study titled “The Economic Sustainability of Cropping System in Indian Punjab: A Farmers Perspectives” have examined that the present set of marketing infrastructure and agricultural technology know how is likely to produce the highest and more stable incomes for Punjab agriculture in the short term. The lack of marketing infrastructure for crops other than wheat and rice may also help the concentration on WRCP and reluctance to try new cropping systems.

Kalaiselvi (2012) in his work “Patterns of Crop Diversification in Indian Scenario” has found that there is a mixed picture the typology of diversification within the states. Some states exhibit more diversification though there is no direct link between the number of crops and spread in the cropping pattern. The picture for states is completely diverse in terms of relationship of different dimensions of diversification with income and risk and inverse and positive relationship of increasing spread of the cropping pattern with income and risk.

Huang et.al (2014) in their study titled “Crop Diversification in Coping with extreme weather events in China” has analysed that the farmers diversify their crops to mitigate the risks and some negative impacts from the shocks of extreme weather events.

Idowu et.al (2014) in their study “Living condition, Livelihood and Crop Diversification among Rural Farm Households in Remo Division of Ogun State Nigeria” have stated that majority of the farmers had no formal education. There were marginal increases in crop diversification with increase in household size, farm size and educational level but decrease with age and farming experience.

Majumdar (2014) in her article titled “Nature and Pattern of Crop Diversification in West Bengal” have argued that the nature of crop diversification in terms of the changes in cropping pattern with respect to acreage and production distribution reflects that in the last three decades the cropping pattern in West Bengal is increasingly dominated by paddy, oilseeds and potato. These crops are either HYVs or cash crops and hence are more remunerative over other crops. The oilseeds have another advantage. They also require less irrigation which makes them ideal for cultivation in the areas with less rain or irrigation. Pulses as a whole, have lost both in terms of acreage and production in West Bengal. The indices of diversification mostly indicate an increasing degree of crop diversification over time.

Nishan (2014) in his work “Crop Diversification for Sustainability” examined that the diversification in agriculture will have a tremendous impact on the agro socio economic areas and also in the uplifting of resource inadequate farming communities. It will be able to generate income and employment opportunities for rural youth around the year for the utmost benefit of Indian farmers. There are still numerous opportunities for crop diversification present and location specific approaches and full packages need to be prepared.

Rani and Nalayini (2014) in their study titled “Sustainability of Diversified Vs Non-Diversified Cotton Farms in Tamil Nadu, India: An Empirical Analysis” have revealed that the sustainability level of diversified cotton farms was significantly higher than non-diversified cotton farms and the diversified cotton farms were more economically and ecologically efficient than the non-diversified farms.

### **III. Data and Methodology**

The present study makes use of secondary data drawn from Statistical Abstracts of India, Economic Survey of India and Economic Survey of different states and Agricultural Statistics in India. The analysis is based on the data at two points of time 2007-08 and 2013-14.

A change in the agricultural cropping pattern is measured through the variation in the proportion of area under different categories of crops in the gross cropped area. For measurement of agricultural diversification, Herfindahl Index (HI) is used in the present study.

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

Where  $P_i$  refers to the proportion of area under  $i^{\text{th}}$  category of crops in the Gross Cropped Area (GCA). It takes the value between 0 and 1, when  $HI=0$  it indicates perfect diversification whereas  $HI=1$  presents perfect concentration.

The determinants of crop diversification is analysed using the linear regression model

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + U$$

Where

Y=Herfindahl Index of crop diversification.

$X_1$ =Fertiliser consumption per hectare of GCA

$X_2$ =Pesticides consumption (000 tonnes)

$X_3$ =Seeds consumption (000 Qtls)

$X_4$ =Agricultural credit in Crore

$X_5$ =Proportion of Irrigated Area (Million hectare)

$X_6$ = Rainfall in millimetres

U=Stochastic disturbance

In order to study the impact of these factors on crop diversification, a cross section regression model is estimated taking HI of crop diversification as dependent variable. The positive sign of the coefficient indicates declining diversification and negative sign indicates the increasing diversification.

#### IV. Results Discussion

##### Cropping Pattern

A number of crops are grown in different states of the country depending upon the local agro climatic conditions. For simplicity of the analysis these crops have been divided into seven broad categories such as Coarse Cereals, Pulses, Oilseeds, Sugarcane, Vegetables, Fruits, and Spices. In order to understand the changes in the cropping pattern that have been taking place at the national level from 2007-08 to 2013-14, the proportions of the area under crops grown to gross cropped area have been estimated and presented in Table-1.

**Table-1 Area under Different Crops as Proportion of GCA**

Crops	2007-08	2013-14	% Change
Coarse Cereals	0.1458	0.1335	-8.43
Pulses	0.1210	0.1312	8.42
Oilseeds	0.1367	0.1484	8.55
Sugarcane	0.0259	0.0260	0.38
Vegetable	0.0299	0.0375	25.41
Fruits	0.0299	0.0375	25.41
Spices	0.0134	0.0164	22.38

It is observed that coarse cereals are the major crops in the country. It covered an area of 14.58 per cent of GCA in the year 2007-08 that decreased to 13.35 per cent in the year 2013-14 registering a decline by 8.43 per cent during the study period. The same trend is also observed in almost all the states of the country.

The next major crops in the country are Pulses and Oilseeds. Area under these crops as a proportion of GCA stand in the order of 12.10 per cent and 13.67 per cent respectively in the year 2007-08. It is found that area under Pulses as a proportion of GCA has increased by

13.12 per cent in the year 2013-14 while it has increased by 14.84 per cent in the case of vegetables.

In the case of Sugarcane this figure has also increased from 2.59 per cent in the year 2007-08 to 2.60 per cent in the year 2013-14.

Area under Vegetables, Fruits and Spices constitute only around 6 per cent of the GCA in the country. A cursory glance at the table reveals that observed that the vegetables and fruits have covered same proportion of area that has increased by 25 per cent over these years. Area under spices has also increased during the period of study by 22 per cent.

Though the coarse cereal continues to be the major crop in the country, changes in the cropping pattern in the country during the period is seen. The area under the commercial crops like pulses, oilseeds and sugarcane has increased. There is a clear shift in favour of the cultivation of vegetables, fruits and spices reflecting crop diversification during the period.

### **Crop Diversification Indices**

Herfindahl indices are estimated to show the crop diversification across the states of India. These estimates are shown in Table-2. A cursory glance at the HI values for the country as a whole (0.0575) for the year 2007-08 and 0.0616 for the year (2013-14) reveals the fact that there is crop diversification as the absolute value is closer to zero but the HI has increased slightly during the study period. It is supported by the observation in the previous section that there has been decrease in area under coarse cereals.

**Table-2 Herfindahl Index of Crop Diversity in Various States in India**

Sr. No.	States	2007-08	2013-14	% Change
1.	Andhra Pradesh	0.0765	0.0442	-42.22
2.	Bihar	0.0259	0.0278	7.33
3.	Gujarat	0.5525	0.2122	-61.59
4.	Haryana	0.024	0.018	-25
5.	Karnataka	0.1542	0.199	29.05
6.	Madhya Pradesh	2.5971	5.254	102.30
7.	Maharashtra	0.1463	0.1202	-17.84
8.	Odisha	0.0166	0.0151	-9.03
9.	West Bengal	0.0473	0.7128	1406
	India	0.0575	0.0616	7.13

At the state level, crop diversification is found to be highest in Gujarat followed by Andhra Pradesh, West Bengal, Haryana, Maharashtra and Odisha. The rest of the states are observed to have concentration of crops and it is highest in Madhya Pradesh followed by Karnataka and Bihar.

### **Factors influencing crop Diversification**

Several factors influence the pace of agricultural diversification from staple food to high value commercial crops and horticulture crops. Crop diversification is generally possible when the conditions required for various crops exists for growing varieties of crops .The required conditions include water resources, suitable soil, moisture and climatic conditions, use of seeds, fertilizers and pesticides, agricultural equipments, availability of finance, insurance provisions and facilities for marketing of the produce. The present study examined these factors of crop diversification and it is found that the most significant factors

influencing crop diversification are fertilizer consumption, pesticides and seeds consumption, agricultural credit, rainfall and irrigation. The estimated value of the parameters of the regression for 2007-08 and 2013-14 are presented in Tables-3 and 4 respectively.

The model estimated for 2007-08 reveals that the factors retained in the model together explain 81.7 per cent of the variation in the crop diversification index.

Fertilizer consumption, consumption of pesticides, seeds and agricultural credits have positive impacts on the crop diversification. But the coefficient of agricultural credit is not statistically significant. On the other hand irrigation and rainfall have significant negative impact on crop diversification.

In 2013-14, factors influencing crop diversification could explain only 45.4 per cent of the variation in crop diversification index. It is observed that the factors that were exercising positive influence on crop diversification continues to be the same in the year 2007-08 but they fail to influence significantly. Though the coefficient of irrigation is found to be statistically significant but has a negative impact on crop diversification. Similarly rainfall is having a negative impact though not significant on crop diversification. That is why the overall explaining capacity of the variables has reduced to such a low level as compared to that in 2007-08.

Through diversification the farmers shift from cultivation of water covering crop like coarse cereal to high value crops which consume less water. As the rainfall has increased by 36 percent over these years it has negatively affected the crop diversification same in the case with irrigation. Other variables ensure high production so have positive impact.

## V. Conclusion

The main findings that emerged from the above discussion are as follows:

- ✚ There is crop diversification rather than crop concentration in the country. The pattern of cropping has shifted in favour of commercial crops like pulses, oil seeds, sugar cane, vegetables, fruits and spices during the study period.
- ✚ The state of Gujarat tops the list in following diversification of crops followed by Andhra Pradesh while it is lowest in Odisha.
- ✚ The factors that have significant influence on crop diversification are fertilizer consumption, Consumption of pesticides, seeds but impact of agricultural credit is found to be weak in the country.

Looking to the necessity of diversifying agriculture in the wake of climate change and rapid degradation of natural resources and the present status of diversification in our country followings are some suggestions we would like to make.

- ✚ Government should take immediate steps to encourage crop diversification in the country by investing more on research and development, provision of efficient support services and institutions for credit, marketing, processing and packing of farm products.
- ✚ To encourage crop diversification, extension education on some prospective cropping patterns, improved farm practices and irrigation management should be provided to farmers.
- ✚ NGOs and Panchayats Raj Institutions may be involved in creating awareness among the farmers regarding the commercialisation of farming and



availability of different government provided schemes for the purpose and benefits of crop diversification.

Foreign Direct Investment may be encouraged for development of agricultural infrastructure so as to facilitate agricultural diversification.

Considering the importance of crop diversification for increasing farmers' income and employment opportunities, reducing production risk and improving soil fertility and human nutrition, farmers must be continuously motivated and encouraged to take up the task. The population could be better off, because fruit crops high nutritional value. The soil will benefit because crop rotation is a proven management technique. So it is imperative to sustain crop diversification.

In India the area under commercial crops has almost doubled in the last three decades. Among the food grain crops, the area under superior cereals, i.e., rice and wheat is increasing while that of coarse cereals (millets) is on decline. Like any other economy, the share of agriculture in the GDP is also declining in India. An accelerated pace of diversification to create positive impact on income, higher employment and conservation and efficient use of natural resources emphasizes the need for efficient policies, especially in technological development, selective economic reforms and institutional change. Care need be taken so that the direct benefits from diversification should reach the marginal and small farmers as well as landless labourers.

**Table-3 Estimated Value of the Parameters of Regression Model 2007-08**

N=10		Adjusted R <sup>2</sup> =0.817	R <sup>2</sup> = 0.939	Standard Error of Estimate=0.342	
Variables	$\beta$	Standard Error	T		
Constant	0.683	0.396	1.726		
Fertilizer Consumption	-0.013**	0.003	-4.109**		
Pesticides Consumption	-0.337**	0.099	-3.409**		
Seeds Consumption	-0.384**	0.093	-4.152**		
Agricultural Credit	-1.127E-005	0.000	-1.134		
Proportion of Irrigated Area	0.515*	0.111	4.658*		
Rainfall	0.007***	0.003	2.291***		

\* Significant at 1 per cent level

\*\* Significant at 5 per cent level.

\*\*\* Significant at 10 per cent level.

**Table-4 Estimated Value of the Parameters of Regression Model 2013-14**

N=10		Adjusted R <sup>2</sup> =0.454	R <sup>2</sup> = 0.818	Standard Error of Estimate=1.200	
Variables	$\beta$	Standard Error	T		
Constant	1.604	2.814	0.570		
Fertilizer Consumption	-0.012	0.019	-0.606		
Pesticides Consumption	-0.222	0.408	-0.544		
Seeds Consumption	-0.271	0.159	-1.699		
Agricultural Credit	-3.985E-005	0.000	-1.571		
Proportion of Irrigated Area	0.698***	0.289	2.414***		
Rainfall	0.003	0.007	0.378		

\*\*\* Significant at 10 per cent level.

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