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Diversification towards High Value Crops: An Assessment of Extent and Pattern of Crop Diversification in Bihar

Dr. Mudasir Hassan Bhat
Assistant Professor of Economics, Millat College, Lalit Narayan Mithila University, Darbhanga, Bihar-846004 mudasirbhat85@gmail.com

Abstract
This study relates to the changes in cropping pattern and diversification in Bihar over the period 1980-81 to 2018-19. The State best endowed with fertile Gangetic alluvial soil with abundant water resources, particularly ground water resources, forms the basis of agriculture in Bihar. The study reveals that though there is no significant change in the land-use pattern in the state over the last two decades, the cropping intensity which had declined initial phase has seen an upward trend. Food grains dominated the cropping pattern and there has not been any substantial change in this regard over the period as the acreage under food grains, even after a decrease in recent years, is more than 90 percent.
Various indices were used to measure the extent of diversification and the data has been analyzed at periodic intervals and on yearly basis. The analysis reveals increased diversification over the period of study but the pace of diversification has been slow. As the diversification indices indicating the spread, gives only the extent of diversification, the nature of diversification was assessed through diversification towards high value crops. The analysis shows that the diversification towards high value crops remained almost stagnant from 1980-81 to 1995-96. The diversification accelerated at a good pace from 1995-96 to 2010-11, but off late process has somewhat slowed down. Overall the agriculture sector in Bihar is diversifying towards high value crops.
Keywords: *Agricultural diversification, Cropping pattern, High Value Crops*

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I. Introduction

The concept of agriculture diversification emerged from the allocation of resources among multiple crops so as to minimize the risk of crop failure and market risk, with the food security was an important aspect of this strategy. But later on diversification assumed multi-dimensional importance ranging from reducing the risk, augment the farm income to achieving the food security. However in recent decades, diversification has emerged as allocation of more resources towards high value crops having high returns. The rationale is that income generated from high value crops can be used to meet the household food and other requirements. (Goletti, 1999; Fafchamps, 1992; Govereh and Jayne, 2003; Von Braun and Kennedy, 1994). Further, it increases the total crop productivity, reduces the risk associated with monocroping and stabilizes the farm income and generated employment opportunities in rural areas (Hyami and Otsuka 1995). It is also suggested that diversification towards high value crops will increase the competitiveness of agriculture at international level and meet the challenges emerging out of liberalization and globalization (Radhakrishna and Reddy, 2004).

The Indian economy has experienced several changes in its agricultural development policies with Green Revolution and Economic Reforms being the most significant. The new agriculture strategy popularly known as "Green Revolution" proved to be the most important step towards the change in cropping pattern and improvement in the food security. The new agricultural policy successfully achieved the food self-sufficiency and improved the growth of agriculture sector (Hazra, 2003). However, the strategy was confined to high yielding varieties of few crops in selected areas.

In the post trade liberalization and globalization period, the changes in pattern of domestic demand, huge surplus of food grain and export demand led to changes in resource use. Diversification of agriculture in favour of more competitive and high value commodities emerged as a significant strategy to overcome the emerging challenges of globalization and as a source of growth in agriculture sector (Joshi *et al.* 2002). The diversification towards high value crops emerged as the most important source of agricultural growth both during 1980s and 1990s. The agriculture sector witnessed a sharp change in cropping pattern, increasing the share of high value crops such as oilseeds, horticultural crops, spices and sugarcane in gross-cropped area (Joshi et.al, 2004).

The economy of Bihar has undergone structural changes over the last two decades. The changes are reflected in the changes in sectoral composition of GSDP. The state GDP witnessed a decline in the relative

share of agri-sector from 35.8 percent in 2000-01 to 19.7 percent in 2017-18. But the decline has been mainly due to increase in share of Tertiary Sector, and has not reduced the importance of Agriculture sector. The sector not only supports livelihood of about three-fourth of its population, but also crucial for food and nutritional security, employment generation and poverty alleviation. Besides this, the sector also provides raw material to large number of industries. With the bifurcation of the state in 2000 and bulk of the mineral resources areas falling in the state of Jharkhand, agriculture has assumed crucial importance in overall economic growth of Bihar. With 8.6 percent of India's population, Bihar's agricultural land area is only 3.8 percent. The gross and net sown area in the State is estimated at 76.4 lakh ha and 54.0 lakh ha, respectively. The State best endowed with abundant water resources, fertile soil, good rainfall that forms the basis of agriculture, farmers in Bihar grow almost all types of crops with three crops a year. Though, rice, wheat and maize are the major crops, the state also produces other crops like oilseeds, pulses, fiber crops, sugarcane, fruits, vegetables etc. In 2018-19, the crop sector was largest contributor with 10.6 percent, a decline from 14.2 percent in 2013-14 to 3.6 percentage points (Table 1).

Table 1: Share of Agriculture Sector in Gross State Value Added.

Sector	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Agriculture, Forestry and Fishing	22.8	22.0	21.2	21.6	21.0	19.3
Crops	14.2	13.1	12.4	12.7	12.1	10.6
Livestock	5.4	5.7	5.7	5.6	5.6	5.6
Forestry and Logging	1.7	1.6	1.5	1.8	1.6	1.6
Fishing and Aquaculture	1.6	1.7	1.7	1.5	1.6	1.5

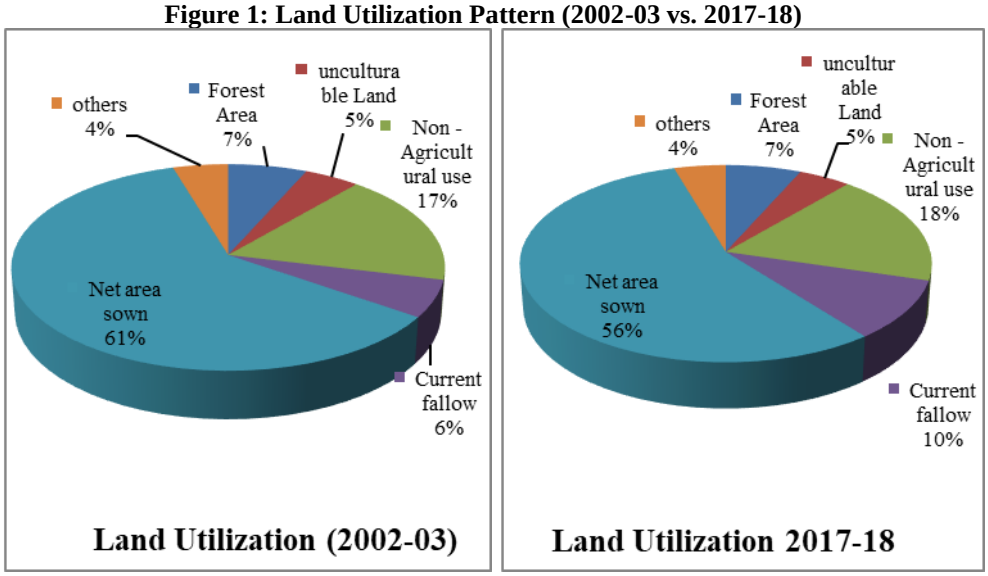
Source: Economic Survey of Bihar (Various Issues)

The fishing and aquaculture with 1.5 percent, has the lowest contribution. The livestock sector has shown increasing contribution whereas the contribution of Forest and logging sector was 1.6 percent of total GSVA in 2018-19. The data indicates the importance of and the prospects of crop, livestock and fisheries in the agricultural growth in Bihar.

Land Utilization Pattern

Land resources are finite. With increasing demand and competing use, it forms the basis of production of food and other economic activities. Further, increasing population, migration, erratic rainfall, fragmentation, floods, soil degradation and risks of climate change pose serious challenge to sustainable management of land resources for agriculture. As compared to other states, Bihar's topography permits increased allocation of land for agricultural activities, with a marginal decline in net sown area from about sixty percent in 2000-01 to about fifty six percent of the geographical area in 2017-18 (Fig. 1).

Figure 1: Land Utilization Pattern (2002-03 vs. 2017-18)



Source: Based on data in Table 3

Table 2: Changes in Land Utilization Pattern in Bihar (000 Hect.)

Years	Geographical area	Net Sown Area	Gross Sown Area	Cropping Intensity
2000-01	9359.56	5662.57 (60.50)	7992.27 (85.39)	1.41
2001-02	9359.56	5663.55 (60.51)	7896.88 (84.37)	1.39
2002-03	9359.56	5725.47 (61.17)	7957.40 (85.02)	1.39
2003-04	9359.56	5712.08 (61.03)	7882.37 (84.22)	1.38
2004-05	9359.56	5472.40 (59.54)	7399.31 (79.06)	1.33
2005-06	9359.56	5556.18 (59.36)	7396.49 (79.02)	1.33
2006-07	9359.57	5665.12 (60.50)	7718.95 (82.47)	1.36
2007-08	9359.57	5662.20 (60.50)	7764.65 (82.95)	1.37
2008-09	9359.57	5554.08 (59.40)	7670.95 (81.95)	1.38
2009-10	9359.57	5331.73 (57.00)	7295.81 (77.95)	1.37
2010-11	9359.57	5258.70 (56.20)	7194.00 (76.86)	1.37
2011-12	9359.57	5395.75 (57.60)	7646.76 (81.69)	1.42
2012-13	9359.57	5402.39 (57.70)	7777.52 (83.09)	1.44
2013-14	9359.57	5252.21 (56.10)	7580.14 (80.99)	1.44
2014-15	9359.57	5230.60 (55.91)	7576.40 (80.95)	1.45
2015-16	9359.57	5204.90 (55.60)	7572.41 (80.91)	1.45
2016-17	9359.57	5292.93 (56.61)	7654.36 (81.78)	1.45
2017-18	9359.57	5241.97 (56.02)	7525.18 (80.40)	1.44

Source: Bihar Statistical Handbook and Economic Survey of Bihar (Various Issues)

The cropping intensity has also declined from 1.41 percent in 2000-01 to 1.33 percent in 2004-05, but has increased significantly in 2005-06 (2.06). There was a decline in net sown area from 60.5 percent in 2006-07 to to 57.6 percent in 2011-12, with marginal increase in the cropping intensity to 1.38 in 2008-09. It has remained unchanged since 2009-10 to 2010-11 (1.37), but it has marginally increased since 2012-13.

The Table 3 also reveals that there are no significant changes in the land-use pattern in the state over the last two decades. The net area sown has marginally reduced from 61 percent in 2002-03 to 56 percent in 2017-18. The Gross sown area has also declined from 7992 thousand hectares in 2000-01 to 7525 thousand hectares in 2017-18. The cropping intensity which declined from 1.41 in 2000-01 to 1.36 in 2006-07 has seen an upward trend and has increased marginally to 1.44 in 2017-18.

Table 3: Land Utilization Pattern (2002-03 to 2017-18)

Particulars	2002-03	2017-18
Geographical area	9359.57	9359.57
Area under Forest	619.91	621.64
Barren and unculturable Land	436.46	431.72
Land put to non -agricultural use	1641.05	1718.31
Culturable waste land	46.22	44.28
Land under trees & groves	234.21	248.15
Fallow land other than current fallow	134.21	118.92
Current fallow	545.86	919.5
Total unculturable land	3675.7	4117.6
Net area sown	5683.87	5241.97

Source: Economic Survey of Bihar (Various Issues) Directorate of Economics and Statistics, GoB

Changes in Cropping Pattern

Foodgrains dominate the cropping pattern in Bihar. There has not been any substantial change in this regard over the period of last decade or so. The figures in the Table 4 indicate the subsistence nature of agriculture, with large proportions allocated to foodgrains. With declining trends, the area under foodgrains is still more than 90 percent. The area under pulses has registered a decline, whileas the share of cereals has increased to around 85 percent. The share of non-food crops has marginally changed but remains only at 7 percent of the cultivated area.

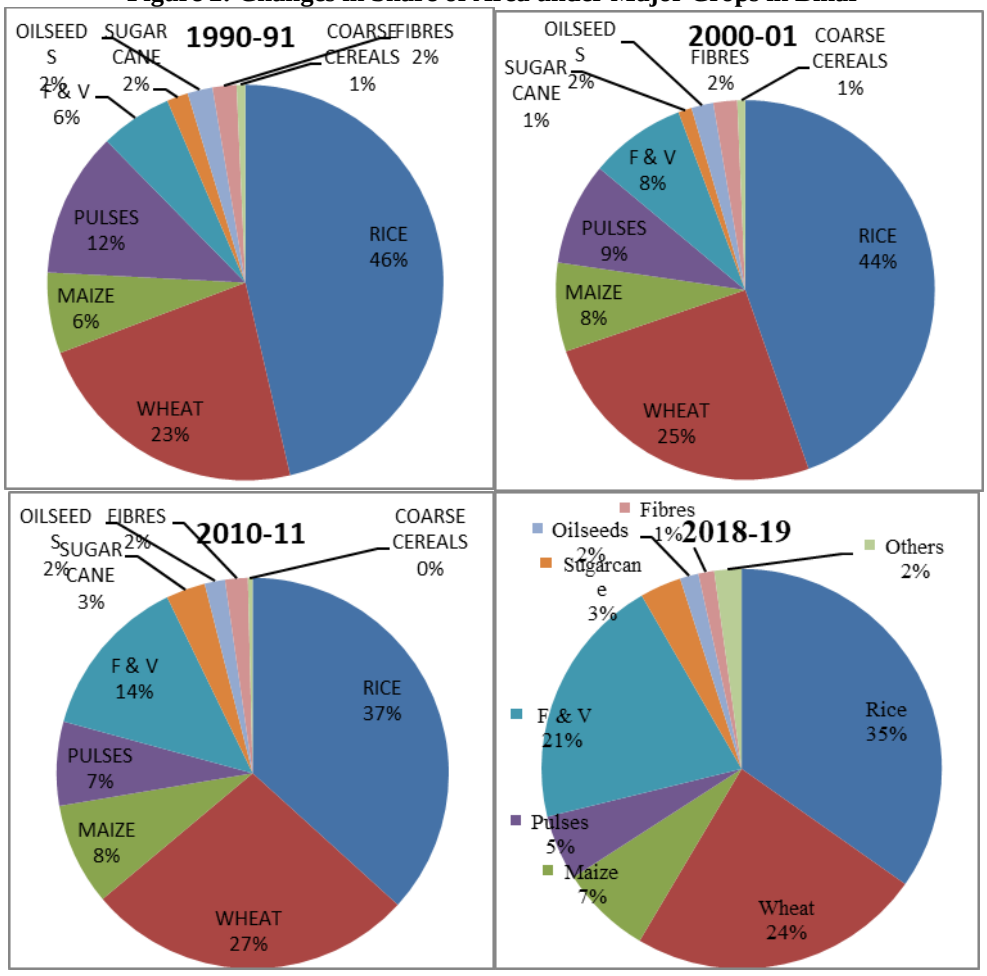
Table 4: Cropping Pattern in Bihar (*Percentage of Gross Area Sown*)

Years	Cereals + Pulses = Foodgrains			Oilseeds	Fibres	Sugarcane
2001-02	84.92	9.38	94.30	1.90	2.10	1.50
2002-03	85.10	9.30	94.40	1.80	2.30	1.40
2003-04	85.20	9.20	94.40	1.90	2.40	1.40
2004-05	84.80	9.40	94.20	1.90	2.20	1.40
2005-06	85.80	8.60	94.40	1.90	2.10	1.50
2006-07	85.90	8.40	94.30	1.90	2.10	1.60
2007-08	86.50	8.00	94.40	1.90	2.10	1.50
2008-09	86.80	8.00	94.70	1.80	1.90	1.50
2009-10	86.30	8.00	94.30	1.90	1.90	1.90
2010-11	84.03	8.03	92.06	1.94	2.27	3.73
2011-12	85.73	7.28	93.01	1.85	2.11	3.03
2012-13	85.90	7.11	93.02	1.59	1.94	3.46
2013-14	85.80	7.08	92.89	1.74	1.71	3.66
2014-15	86.16	7.09	93.25	1.63	1.56	3.51
2015-16	86.18	7.07	93.27	1.69	1.58	3.46
2016-17	84.88	6.76	91.63	1.49	3.59	3.28
2017-18	86.94	6.77	93.72	1.46	1.5.	3.33
2018-19	87.10	6.94	94.04	1.46	1.24	3.26

Source: Economic Survey of Bihar (Various Issues)

Table 4 shows that the cropping area for fiber crops, has decreased from 2.1 percent in 2001-02 to 1.24 percent in 2018-19. The sugarcane has registered an increase in area whereas area of oilseeds and fibers has reduced. The acreage under sugarcane has increased from 3.73 percent in 2010-11 to 3.26 percent in 2018-19. The changes in share of area under major crops from 1990-91 to 2018-19 are presented in figure 2.

Figure 2: Changes in Share of Area under Major Crops in Bihar



Source: Economic Survey of Bihar (Various Issues)

II. Data Source And Methodology

Crop Diversification in Bihar

Data Sources

The study spans a period from 1980-81 to 2018-19. From 1980 to 2018-19 the data analysis is carried at an interval of 5 years and also from year 2000 onwards the analysis is done on yearly basis. The rationality is the availability of meaningful data from authentic sources. The data was collected from different Government sources viz. Finance Department GOB, Directorate of Economics and Statistics GOB, Economic Survey of Bihar.

Methodology

The Diversification is measured with few indices- having some special features and limitations. Some of the important methods are Herfindal Index, Simpson Diversity Index, Ogive Index, Entropy and Modified Entropy Index. To measure the degree of diversification, different diversity indices have been used. The assessment of diversity is carried through the Herfindhal index, Simpson Diversity Index, Entropy and Modified Entropy Indices. The assessment of nature of diversity is accomplished through changes in land allocation in favour of cultivation of major crops over the years.

Diversity Indices

The various indices used to assess the extent of diversification are as following:

a) Herfindahl Index (HI)
b) Transformed Herfindahl Index (THI)
c) Simpson Index (SI)
d) Entropy Index (EI)
e) Modified Entropy Index (MEI)

In the literature of agriculture diversification, the HI, SI, EI and MEI are widely used. All these indices are calculated on the basis of proportion of gross cropped area under various crops cultivated in a particular geographical area.

a) Herfindahl Index (HI)

Herfindahl Index is calculated by taking sum of squares of proportionate area under each crop in the total cropped area. Mathematically, the index is expressed as below. **HI** = $\{\sum_{i=1}^{n} \mathbf{P}i^2\}_{/\mathbf{N}}$

Where N represents the total number of crops and P_i denotes area proportion of the i^{th} crop in total cropped area. The index takes a value one (1) when there is complete concentration and approaches zero (0) when diversification is perfect. The Herfindahl Index decreases with the increase in diversification. Since Herfindahl index being a concentration index, the index of diversification is obtained by subtracting it from one. This is known as ***Transformed Herfindahl Index*** i.e**. (THI= 1-HI)**. Thus THI value is Zero for perfect concentration and has increasing value for increase in diversification.

b) Simpson Index (SI)

This formula for Simpson Index is as:

SID = 1- (proportionate area of food grains in the gross cropped area)

With the more number of crops grown the value of Simpson's index increases. The provides an assessment of horizontal diversification

The foodgrains have the largest share of area is indicated in the SID. Thus the Simpson index provides an assessment of diversification away from the foodgrains.

c) Entropy Index (EI)

The Entropy Index has been widely used to measure diversification. This is an inverse measure of concentration (Shiyani and pandya, 1998).

Mathematically, the index is expressed as below.

$EI = \sum_{i=1}^{N} P * logP_i$

Where, P_i - proportionate area under i^{th} crop. The higher value of EI indicates more diversification. With complete concentration, the index value approaches zero. The index value varies between zero and one. But for total number of crops exceeding the value of logarithmic base (10), value of index can exceed.

d) Modified Entropy Index (MEI)

The MEI has a shifting the base of the logarithm to the number of crops. Therefore, with complete concentration index has a lower limit equal to zero and for perfect dispersion assumes upper limit of one.

Thus it overcomes the limitation of the Entropy index which has no upper limit

Modified Entropy index MEI = $\sum_{i=1}^{N} P$i * $\log_N P_i$

III. Results And Discussion

Analysis of Data

The study collected data from various secondary sources and measured Diversification through various indices. The indices are calculated for the period 1980-81 to 2018-19 at the state level with five-year interval periods. Also from 2000-01 onwards the data analysis is carried on yearly basis. To analyze the change over the period and provide measurement of extent of diversity HI, SI, EI and MEI are used. All these indices are based on the basis of proportion of gross cropped area under various crops cultivated in a particular geographical area. For concentration index like Herfindahl index, - lower values indicates higher diversification and vice-versa.

Table 5: Diversification Indices at State Level from 1980-81 to 2015-16

	Concentration Index	← Diversification Indices →		
Year	Herfindhal Index (HI)	Simpson Index = 1-HI	Entropy Index EI	Modified Entropy Index MEI
1980-81	0.0316	0.968	0.6775	0.7100
1985-86	0.0324	0.968	0.6763	0.7087
1990-91	0.0329	0.967	0.6774	0.7099
1995-96	0.0345	0.965	0.6818	0.7145
2000-01	0.0282	0.972	0.6638	0.6957
2005-06	0.0259	0.974	0.6818	0.7145
2010-11	0.0236	0.976	0.7037	0.7374
2015-16	0.0243	0.976	0.7028	0.7365
2018-19	0.0270	0.973	0.7163	0.7506
St. Dev.	0.004	0.004	0.017	0.018
Mean	0.029	0.971	0.687	0.720
C.V.	13.892	0.421	2.456	2.452

Source: Various issues of Directorate of E&S, Govt. of Bihar

The Diversification Indices HI, SI, EI and MEI provide the extent of Diversification. The concentration index HI is transformed by subtracted from one, i.e. (1-HI) to make indices comparable. The transformed HI is simple form of Simpson Index (SI), with higher value of indices implying more diversification.

Analyzing the outcome in Table 5 indicates that the indices values have a gradual increasing trend over the entire period of study. This shows an increased diversification over the period under consideration. As the coefficient of variation the index values have not varied significantly over the time period, implying that the diversification process is slow.

Table 6: Indices of Crop Diversification at State Level from 2000-01 to 2015-16

	Concentration Index	← Diversification Indices		→
Year	Herfindhal Index (HI)	Simpson Index = 1-HI	Entropy Index EI	Modified Entropy Index MEI
2000-01	0.0282	0.972	0.6638	0.6957
2001-02	0.0277	0.972	0.6672	0.6991
2002-03	0.0273	0.973	0.6720	0.7043
2003-04	0.0270	0.973	0.6744	0.7067
2004-05	0.0255	0.974	0.6839	0.7167
2005-06	0.0259	0.974	0.6818	0.7145
2006-07	0.0265	0.974	0.6772	0.7096
2007-08	0.0264	0.974	0.6643	0.6961
2008-09	0.0270	0.973	0.6614	0.6931
2009-10	0.0257	0.974	0.6748	0.7071
2010-11	0.0236	0.976	0.7037	0.7374
2011-12	0.0258	0.974	0.6866	0.7195
2012-13	0.025	0.975	0.6885	0.7215
2013-14	0.0193	0.981	0.6864	0.7193
2014-15	0.0250	0.975	0.6909	0.7241
2015-16	0.0243	0.976	0.7028	0.7365
2016-17	0.0259	0.974	0.6983	0.7318
2017-18	0.0271	0.973	0.7073	0.7412
2018-19	0.0270	0.973	0.7163	0.7506
Mean	0.026	0.974	0.684	0.717
St. Dev.	0.002	0.002	0.016	0.017
C.V.	7.601	0.204	2.329	2.329

Source: Various issues of Directorate of E&S, Govt. of Bihar

Table 6 shows the year on year diversification trends from year 2000-01 to 2018-19. All the indices value shows that there is slight increase in diversification from 2000-01 to 2018-19. It is to be noted that the diversification indices only indicates concentration i.e., give only the extent of diversification in the cropping pattern. These indices do not give nature of diversification. The diversification towards high value crops provides an assessment of the nature of diversification.

Diversification towards High Value Crops

The diversification indices only give the extent of diversification, indicating the concentration in the cropping pattern. These indices do not give nature of diversification. The diversification towards high value crops (HVC) provides an assessment of the nature of diversification. The HVC including fruits, vegetables, oilseeds, etc. As the state of Bihar has cropping pattern dominated by cereals or food crops, the diversification towards HVC provides an assessment of nature of crop diversification.

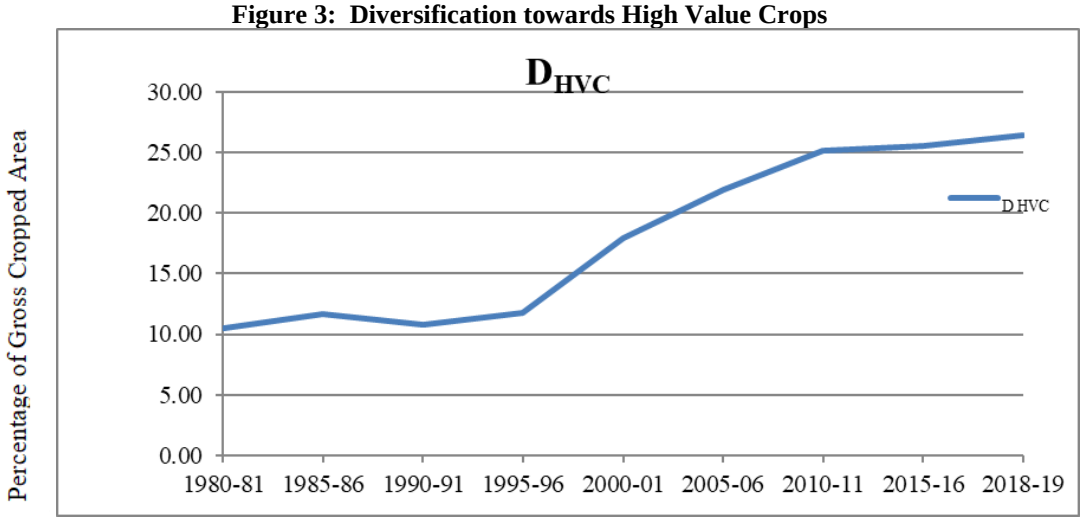
We have calculated the diversification in favour of HVC for the years 2000-01 to 2018-19. The diversification towards high value crops is given by

D_{HVC*} = 1- (proportionate area of foodgrains in the GCA)

HVC- High Value Crops , Foodgrains = Cereals + Pulses*

The value of D_{HVC} Index value ranges from Zero to One. An index value close to one implies more diversification towards HVC and vice-versa. The index values are converted to percentage and the results are presented in Figure 3.

Figure 3: Diversification towards High Value Crops



Source: Economic Survey of Bihar (Various issues)

The analysis shows that the diversification towards HVC remained almost stagnant from 1980-81 to 1995-96 with area under high value crops remaining around 11 percent of gross cropped area. However diversification towards high value crops gained pace from 1995-96 onwards. The area under these crops rapidly increased to 25 percent of GCA in 2010-11. But since 2010-11 the diversification towards high value crops is going at a slow pace. The analysis shows that overall the agriculture sector in Bihar is diversifying towards high value crops.

IV. Conclusion

The economy of Bihar has undergone structural changes over the last two decades. The changes are reflected in the changes in sectoral composition of GSDP. In state's GSDP, relative share of agricultural sector has come down to 19.7 percent in 2017-18. But the decline has been mainly due to increase in share of Tertiary Sector, and has not reduced the importance of Agriculture sector. The sector not only supports livelihood of about three-fourth of its population, but also crucial for food and nutritional security, employment generation and poverty alleviation. Besides this, the sector also provides raw material to large number of industries. Hence development of agriculture and allied sectors is vital for the economic development. Bihar primarily depends on agriculture for their means of sustenance and livelihood. The State best endowed with fertile Gangetic alluvial soil with abundant water resources, particularly ground water resources, forms the basis of agriculture in Bihar. With increasing demand and competing use, the land forms the basis of production of food and other economic activities. Further, increasing population, migration, erratic rainfall, fragmentation, floods, soil degradation and climate change pose serious challenge to development of agriculture. In Bihar, the topography allows higher

proportion of total land being used for agri-activities compared to the other states of India. However, there are no significant changes in the land-use pattern in the state over the last two decades. In 2002-03, the net area sown was around 61 percent and it has reduced over the period to 56 percent in 2017-18. The Gross sown area has also declined from 7992 thousand hectares in 2000-01 to 7525 thousand hectares in 2017-18. The cropping intensity which declined from 1.41 in 2000-01 to 1.36 in 2006-07 has seen an upward trend and has increased marginally to 1.44 in 2017-18

The cropping pattern in Bihar is dominated by foodgrains. There has not been any substantial change in this regard over the period of last decade or so. The agriculture in Bihar has subsistence nature of cropping and still dominated by foodgrains, though reduction in share in the recent year. The non- food crops has a meager share of around 7 percent of the total area cultivated. The extent of diversification measured through diversification indices reveals that the indices values have a gradual increasing trend, indicating increasing diversification in the state. The year-on-year trend from year 2000-01 to 2018-19 shows that there is slight increase in diversification from 2000-01 to 2018-19. The diversification indices only indicate the spread or concentration and do not give nature of diversification. The assessment of nature of diversification is provided by measuring diversification towards HVC -including fruits, vegetables, oilseeds, etc. The analysis reveals stagnantion from 1980-81 to 1995-96 with area under HVC remaining around 11 percent of GCA. However, the process has gained pace from 1995-96 onwards. The area under these crops rapidly increased to 25 percent of GCA in 2010-11. But since 2010-11 the diversification towards HVC is going at a slow pace, but the agriculture sector in Bihar is diversifying towards high value crops.

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