Nature and Pattern of Crop Diversification in West Bengal

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Abstract:
The present article analyses the nature of crop diversification in terms of the changes in cropping pattern with respect to acreage and production distribution. From both the aspects of area and production it is observed that over the time span of three decades the cropping pattern in West Bengal is increasingly dominated by boro paddy, oilseeds (including, rapeseed and mustard) and potato. 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.

Keywords: *Crop, Crop diversification, Cropping pattern, Nature*

1. Introduction

Cropping pattern is defined as a combination of agricultural crops that are grown in a particular geographical area. It can be viewed either in terms of the area allocated for each crop, or, by the production composition in value terms for any specific area. Therefore, changes in cropping pattern can be seen as the changes in proportion of acreage or the value of production under different crops to total agricultural area or production. The cropping pattern usually changes over time with the development of agriculture, as is evident in the case of agriculture in India (Vyas, 1996). This type of change is largely characterised by an increasing trend towards commercial crops over the years (Nadkarni and Vedini, 1996). There are spatial variations in cropping pattern and its change, which is visible not only across the states but also within them. Taking the case of West Bengal, the present article will explore the changes in the cropping pattern with respect to acreage and production distribution between 1980-81 to 2007-08.

Cropping pattern change is of great interest to the agricultural economists for its notable impact on agricultural output (Ranade, 1980). It is a well noted fact that the growth of agricultural production depends on both acreage and productivity growth[1]. Productivity growth can be further decomposed into two parts. One is the yield growth and other is the cropping pattern change. The former measures the impact of changes in output per unit of area, while, the latter captures the shift of acreage from crops with relatively low values of output per unit of area to higher value crops (Boyce, 1987).

Now, gross cropped area (GCA) can be increased either through an increase in net cropped area (NCA) or intensity of cultivation. A rise in intensity of cultivation is brought about by the extension of area under multiple cropping systems. In the post green revolution period, increase in GCA was made possible by the development of high yielding varieties (HYVs), short period crops or introducing multiple crops' production in a year. NCA, on the other hand, ceased to grow

[1] Here, 'agricultural production' means the total value of agricultural output of any region. This is the sum of individual crop output in value terms. Therefore, total output of a particular region depends on the area and yield of individual crops, assuming prices are constant. Thus, the growth of agricultural output of any region is contingent upon the growth of total cultivated area or gross cropped area (GCA), yield of each crop and a shift of area from low yielding to high yielding crops, with prices remaining constant.

significantly, since most of the cultivable area has already been brought under cultivation. Coupled with this is the extension of area under irrigation in all seasons of the year, which has resulted in a significant expansion of agricultural output.

It is important to note that the adoption of a scientific cropping pattern best suited to the technological changes and that maximizes the net value of agricultural production is extremely essential. The decision of the cultivators to allocate available resources to different crop production in a particular region largely depends on the economic, geographical, technological, social and institutional factors. In general, the farmers have a tendency to stick to a stable cropping pattern under any given agro-climatic region unless they are dictated by the price factors in adjusting acreage allocation (Murthyunjaya and Kumar, 1989). A shift from traditional varieties of crops to new HYVs and relatively more remunerative crops has added a new dimension to the agriculture of West Bengal. This change is associated with the redistribution of land resources to different crops, which ultimately has a bearing on accelerating growth and efficiency of agriculture in West Bengal.

The changes in absolute and proportion of area under different crops may reasonably be considered for the analysis of change in cropping pattern, since the farmers' interest in producing different crops is primarily reflected in the acreage of each crop in most cases[2]. In general, the farmers are guided by the relative profitability of crops in the system of commercialized agriculture. Thus, area under crops changes depending upon the past prices and changes in technology, expansion of irrigation and possibility of productivity change in the respective area.

Agricultural production in West Bengal is largely characterized by wide diversification among different crops. Inter-crop and intra-crop variation in production has been substantial over time.

2. Changes in Cropping Pattern in West Bengal during 1980-81 to 2007-08

This section is devoted to the examination of cropping pattern change in West Bengal during 1980-81 to 2007-08. For the purpose of analysis, first of all, changes in proportion of area under different crops to total agricultural area are considered. Since, data on GCA is not available throughout the whole period; an approximation is made by aggregating the area of major crops grown in West Bengal from 1980-81 to 2007-08. For the rigorous presentation, the whole period is divided into a number of sub-periods.

2.1 Relative Changes in Proportion of Area under Different Crops

Inter-crop variation in growth of area and proportion of area is discernibly large over time in West Bengal, as is evident from Table 1 below. From Table 1, it can be observed that rice still continues to remain the most important crop of the state. This is because of the well-known fertile great plain land, which is suitable for the cultivation of paddy is the staple food crop for the majority of the population in the state. Table 1 will represent the three-year moving average value of the proportion of acreage under some selected crops. Within the category of rice, the proportion of area to total cropped area under aus and aman is seen to be declining gradually over time. Boro, on the other hand, being a HYV rice variant, has experienced a rapid increase in the proportion of area to total cropped area over the years. In case of wheat, it can be observed that the proportion of area has been more or less stable at around 3% over the years with moderate fluctuations as is evident from the table below.

[2] In some cases, the farmers are forced to cultivate some crops on account of agro-climatic conditions, institutional reasons and also for their own consideration. As for example, the case where in spite of high prices, farmers in the southern districts of West Bengal cannot cultivate tea due to unfavorable climatic conditions.

Table 1.
Proportion of Area under some selected Crops to Total Cropped Area in West Bengal
(percentage)

Crops	Time Period			Rankings		
	1981-84	1991-94	2005-08	1981-84	1991-94	2005-08
Rice	**72.67**	**66.76**	**59.44**	1	1	1
rice: *aus*	9.65	6.23	2.95			
rice: *aman*	57.42	49.59	41.64			
rice: *boro*	5.47	10.97	14.85			
Wheat	**3.81**	**3.20**	**3.70**	5	4	5
maize	0.77	0.59	0.81	7	7	7
Total Cereals	**78.00**	**70.90**	**64.16**			
Total pulses	**5.86**	**3.15**	**2.22**	3	5	6
Total food grains	**83.86**	**74.05**	**66.38**			
Rapeseed & Mustard	2.18	4.58	4.32			
Total Oilseeds	**4.76**	**6.29**	**7.10**	4	2	2
Jute	**6.63**	**5.96**	**6.10**	2	3	3
Sugarcane	**0.35**	**0.16**	**0.17**	8	8	8
Potato	**1.80**	**2.63**	**4.02**	6	6	4

Source: Government of West Bengal, Bureau of Applied Economics and Statistics, Statistical Abstract (various issues)
Government of West Bengal, Bureau of Applied Economics and Statistics, Economic Review (various issues)

Over all, total foodgrains have registered a decline in the proportion of area to GCA over time in West Bengal. This result implies the change of preference in the consumption basket of food habits of the people of West Bengal. A rapid fall in the area under pulses is seen over time in West Bengal. Coming to the oilseeds, it can be observed that in West Bengal, oilseeds are gaining importance in terms of rapid increase in the proportion of area to GCA under them. The proportion of acreage to GCA under jute, on the other hand, is more or less stable at around 6% during the selected time span. Over the years, potato has gained importance in the cropping pattern of West Bengal. This is evident from the fact that the proportion of area to GCA under potato has registered a rapid increase from 1.8% to around 4% as can be seen from Table 1.

2.2 Growth of Absolute Area under Different Crops

In this section, the growth of absolute area under each crop has been examined. For this purpose, a semi-logarithmic trend equation is fitted as shown below.

$$Log\ Y_{it} = \alpha + \beta t$$

where, Y_{it} = area under i^{th} crop at time t;
t = time in years;
α , β = parameters; and,
β gives the annual exponential rate of growth of area and its fluctuation around the trend can be estimated by using standard error.

From the semi-logarithmic trend equation, an idea about the changes in relative importance of different crops in terms of absolute area can be formed. The result is given in Table 2, which reveals a quite different pattern of change to that of inter-crop proportion of area.

Table 2.
Exponential Rate of Growth of area under Selected Crops in West Bengal During 1980-81 to 2007-08 and Different Sub-Periods

Crops	Time Period			
	1980-81 to 89-90	1990-91 to 2000-01	2001-02 to 2007-08	1980-81 to 2007-08
Rice	0.050	-0.011	-0.005	0.005
	0.030	***0.016***	***0.003***	***0.003***
rice: *aus*	0.122	-0.094	-0.041*	-0.076*
	0.161	***0.054***	***0.017***	***0.011***
rice: *aman*	-0.019*	-0.046	-0.015*	-0.005
	0.003	***0.030***	***0.005***	***0.003***
rice: *boro*	0.195*	0.141*	0.030*	0.082*
	0.084	***0.061***	***0.012***	***0.009***
Wheat	0.034	0.174*	-0.042*	0.027*
	0.029	***0.039***	***0.015***	***0.011***
Maize	-0.003	-0.094	0.070	0.023
	0.042	***0.082***	***0.041***	***0.020***
Total cereals	0.048	-0.003	-0.006*	0.006*
	0.026	***0.013***	***0.003***	***0.003***
Total pulses	-0.109	0.003	-0.037*	-0.049*
	0.116	***0.007***	***0.013***	***0.005***
Total food grains	0.038*	-0.003	-0.007*	0.004
	0.018	***0.012***	***0.002***	***0.002***
Rapeseed & Mustard	0.225	0.014	-0.035*	0.029*
	0.154	***0.031***	***0.011***	***0.010***
Total Oil seeds	0.138	0.015	0.024	0.043*
	0.084	***0.034***	***0.017***	***0.005***
Jute	-0.269	0.016	0.027*	0.015
	0.171	***0.065***	***0.011***	***0.012***
Sugarcane	0.079	0.032	0.034	0.019
	0.093	***0.168***	***0.018***	***0.016***
Potato	0.199*	0.085	0.081*	0.081*
	0.064	***0.048***	***0.023***	***0.006***

Note: Figures in bold italics represent standard errors
** indicates that the coefficient is significant at 5% level of significance by two-tailed test.*
Source: Government of West Bengal, Bureau of Applied Economics and Statistics, Statistical Abstract (various issues)

The table reveals that the annual exponential rate of growth of area under foodgrains is only 0.04% during 1998-81 to 2007-08. The sub-period growth rates, however, indicate a decreasing trend except for the sub-period 1980-81 to 1989-90. Though, the rate of growth of absolute area under foodgrains is positive, yet proportion of the same to GCA show a substantial decline during the period under consideration as can be observed from Table 1. Within foodgrains, area under the cereals has registered a positive rate of growth during 1980-81 to 2007-08. This growth is accounted for by the significant positive growth rate; even though moderate in magnitude, of rice, wheat and maize. The overall rate of growth of total cereals is only 0.06% per annum. A look at the sub-periods show that except for the first sub-period (that is, 1980-81 to 1989-90), the growth rate in cereals has experienced a negative growth trend across the remaining sub-periods. The rise in the area under cereals is also at the cost of area under pulses. Acreage allocation under pulses decreased by 5% per annum during 1980-81 to 2007-08. The growth rate of the area under pulses

also remained significantly in the negative zone during the sub-periods. The area under rice increased at the annual exponential rate of 0.05% throughout the entire period. Among different kinds of paddy, boro (or, summer rice) has recorded a maximum gain with respect to the rate of rise in acreage under crop. A large portion of land that formerly used to remain uncultivated and uncropped during summer season has been brought under boro paddy cultivation after the gradual development of irrigation infrastructure in West Bengal. The rate of growth of area under boro paddy has been around 8% per annum throughout the entire period under consideration. The growth rate of area under boro paddy has witnessed a rapid increasing trend throughout the sub-periods, too. Aman (or, winter paddy) has registered a moderate declining trend in terms of absolute area throughout the whole period. Aus (or, bhadoi paddy) have experienced a sharp decline in the annual growth rate of area during the entire period under consideration. Among others, a notable increase in the rate of growth of area has been noticed in case of potato and oilseeds, whose principal component is rapeseed and mustard. The rate of overall increase in area under potato is around 8% and that of oilseeds is around 4% per annum during 1980-81 to 2007-08. Annual exponential rate of growth of acreage under rapeseed and mustard is around 3% during the entire time period. Acreage allocations under jute and sugarcane have registered an annual exponential growth rate of around 2% during the period under consideration.

From the above analysis, it is clear that the cropping pattern in West Bengal in terms of allocation of acreage has been skewed towards boro paddy, potato and oilseeds (especially, rapeseed and mustard), the three important emerging remunerative crops during the last three decades. The cropping pattern turned against pulses and other less remunerative crops throughout the period of discussion. From the values of standard errors, it is found that variations in the acreage growth rate are greater for the rapid growing crops. For each individual crop, in most cases, the variations in growth rates are on the average greater in the first sub-period as compared with that of the latter sub-periods. This is mainly because during the early years, irrigation facilities were not so much developed and consequently agriculture was highly weather dependent.

2.3 Comparative Ranking of Crops in West Bengal in terms of Acreage Distribution

In order to have a glimpse of comparative ranking among different crops across different time periods, this section again reverts back to Table 1, where a comparison of inter-crop proportion of area to GCA is shown.

From Table 1, it can be observed that rice is at number one position throughout the entire period. Oilseeds as a group becomes the second most important crop of the state from its number four position in 1981-84. Wheat, jute and sugarcane have more or less stable at their relative positions of 5, 3 and 8, respectively. Potato is elevated to number 4th position in 2005-08 from its number 6 position in 1981-84. However, it is a huge gainer of area in absolute sense. Pulses as a whole registered a demotion to 6th position in 2005-08 from its 3rd position in 1981-84.

2.4 Variations in Different Indices of Crop Diversification

The extent and nature of crop diversification will be tested by using different indices used earlier in several other analyses. First of all, we will start with the Harfindahl Index (HI). Mathematically, the index is defined as:

$$HI = \Sigma^{N}_{i=1} P_i^2$$

where, N = Total number of crops[3]; P_i = Proportion of acreage under ith crop to total cropped area. This index was first used to measure the regional concentration of industries (Theil, 1967). The value of HI is bounded by 0 (perfect diversification[4]) and 1 (complete specialization).

[3] The study will concentrate on the following crops: rice (*aus, aman and boro*) and wheat in the group of superior cereals; pulses and jowar in the group of inferior cereals; oilseeds, jute and sugarcane in the group of commercial crops; and, in the group of high value crops, along with vegetables and fruits, potato will also be considered.

The Simpson Index (SI) will provide a clear dispersion of crops in a geographical region (Joshi *et. al.*, 2003). Mathematically, SI is defined as:

$$SI = 1 - \Sigma^{N}_{i=1} P_i^2$$

SI assumes 1 for complete diversification and 0 for perfect concentration.
Another index, called the Ogive Index (OI), will also be computed in order to get an idea about the extent of crop diversification in West Bengal. It was first used by Tress (1938) to measure the industrial diversity. OI is given by the formula

$$OI = \Sigma^{N}_{i=1} \{P_i - (1/N)\}^2 / (1/N)$$

where, N = Total number of crops cultivated in the region.
OI also takes larger values with increasing diversification and its value decreases with rising specialization.

Two other indices will also be considered as inverse measures of concentration. They are Entropy Index (EI) and Modified Entropy Index (MEI). These two measures are widely used by agricultural economists for analyzing diversification of agriculture (Hackbart and Anderson, 1975; Singh *et. al.*, 1985; Shiyani and Pandya, 1998).The formula for EI is

$$EI = - \Sigma^{N}_{i=1} (P_i \ln P_i)$$

EI tends to 0 when there is perfect concentration and the value increases with the increase in diversification of crop. The value of EI lies between 0 and ln N. The upper limit of this index is dependent on the base of logarithm and the number of crops.
In order to get a more accurate measure, we will take MEI, which is defined as

$$MEI = - \Sigma^{N}_{i=1} (P_i \ln_N P_i)$$

MEI incorporates the number of crops as the base of the logarithm. The lower and upper value of MEI is 0 (total concentration) and 1 (perfect diversification). Having explained the indices of diversification in some details, we will present the results in table 3 below.

Table 3.
Variations in Different Indices of Diversification Across Different time Periods for West Bengal

Diversification Indices	Time periods			
	1980-81*	1990-91	2000-01	2007-08
Harfindhal Index (HI)	0.322	0.270	0.195	0.196
Simpson's Index (SI)	0.678	0.730	0.805	0.804
Ogive Index (OI)	11.927	4.089	2.826	2.879
Entropy Index (EI)	1.529	1.556	1.647	1.598
Modified Entropy Index (MEI)	0.552	0.539	0.570	0.553

** for 1980-81 total number of crops (N) considered for calculating the indices are 16. from 1990-91 onwards, N = 18*
Source: Government of West Bengal, Bureau of Applied Economics and Statistics, Statistical Abstract (various issues)

From the table it can be observed that the four diversification indices, namely, HI, SI, EI and MEI show increasing diversification from 1980-81 to 2007-08 in West Bengal. The only exception is OI, which shows increasing specialisation in West Bengal over the years. Having analysed the nature of crop diversification in West Bengal through changes in cropping pattern with respect to acreage distribution from various dimensions, the present article will now focus on the production distribution. In other words, the article will now analyse the trends in the cropping pattern with respect to production distribution in order to describe the nature of crop diversification in West Bengal. Agricultural production in West Bengal is largely characterised by wide diversification

[4] By diversification we will imply a shift from less profitable crop or enterprise to more profitable crop or enterprise. This will be the operational definition of crop diversification in our study.

among different crops. As agriculture constitutes an important part of the economy of West Bengal, hence from planning perspective it is essential to have an idea of the geographical distribution of crop production and their pattern of growth over time.

2.5 Growth Rate of Output of Crops/Crop Groups in West Bengal during 1980-81 to 2007-08

Table 4.
Growth Rate of Output of Different Crops During 1980-81 to 2007-08 in West Bengal

Crops	Growth Rates
Rice	97.16
rice: *aus*	-1.84
rice: *aman*	53.18
rice: *boro*	469.36
Wheat	93.85
Maize	339.75
Total cereals	97.72
Total pulses	-33.84
Total food Grains	93.92
Rapeseed & Mustard	356.69
Total oilseeds	369.22
Jute	84.93
Sugarcane	1943.83
Potato	402.12

Source: Government of West Bengal, Bureau of Applied Economics and Statistics, Statistical Abstract (various issues)

Table 4 displays a contrast among the growth rates of different crops/crop groups during 1980-81 to 2007-08. From the table it can be observed that there has been a substantial growth in output over time in case of individual crops like boro rice, maize, rapeseed and mustard, sugarcane and potato, and for crop groups like oilseeds. Aus rice and pulses have recorded a negative growth in output over the entire period.

2.6 Relative changes in Average Yield under some selected Crops

Table 5.

Average Yield of some selected Crops across Different Time Periods in West Bengal

(kg/ha)

Crops	Time 1981-84	Rankings 1981-84	Time 1991-94	Rankings 1991-94	Time 2005-08	Rankings 2005-08	Cultivation Season
Rice	**1205**	**5**	**2054**	**5**	**2558**	**3**	***kharif, rabi & zaid rabi***
rice: *aus*	939		1676		2046		*autumn (kharif)*
rice: *aman*	1125		1880		2386		*winter (rabi)*
rice: *boro*	2561		3052		3138		*summer (zaid rabi)*
Wheat	**2229**	**3**	**2155**	**3**	**2331**	**7**	***rabi***
Maize	1202		2892		3007		*kharif*
Total cereals	***NA***		**2060**	**4**	**2546**	**4**	***kharif & rabi***
Total pulses	***NA***		**668**	**9**	**758**	**9**	***kharif & rabi***
Total food	***NA***		**2000**	**7**	**2486**	**6**	***kharif & rabi***

grains							
Rapeseed & mustard	570	**6**	751		867		*rabi*
Total oilseeds	***NA***		**784**	**8**	**961**	**8**	***kharif & rabi***
Jute	**1562**	**4**	**2020**	**6**	**2514**	**5**	***kharif***
Sugarcane	**5439**	**2**	**5588**	**2**	**88149**	**1**	***kharif***
Potato	**19172**	**1**	**21923**	**1**	**19380**	**2**	***rabi***

Source: Government of West Bengal, Bureau of Applied Economics and Statistics, Statistical Abstract (various issues)
Government of West Bengal, Bureau of Applied Economics and Statistics, Economic Review (various issues)
NA - Not Available

Table 5 shows the average yield of some selected crops across different time periods in West Bengal. Three different triennia averages are chosen for the purpose of analysis. The average yield of rice over time has shown phenomenal increase in West Bengal. If we look at the three variants of rice, then it can be observed that all three variants – aus, aman and boro, have witnessed a sustained growth in average yield over time. However, the growth in average yield is sharper in cases of aman and boro paddy. The average yield of wheat shows a mixed trend over time in West Bengal, whereas, for maize, the average yield is increasing over time. For pulses, the average yield shows a steady increase over time. Total foodgrains, too, show a steady increase over time with respect to average yield. West Bengal has seen a marked increase of average yield over time under rapeseed & mustard and oilseeds as a whole. The average yields of jute and sugarcane also show sustained increases over time in West Bengal. For potato, the picture is that of a rising average yield from 1981-84 to 1991-94, and thereafter, a declining average yield from 1991-94 to 2005-08.

A look at the comparative rankings of average yields form table 5 shows that rice has improved its ranking over time in West Bengal. Wheat, on the other hand, has lost its ranking over time. Both cereals and pulses have retained their rankings intact over the decades. Foodgrains, on the other hand, have improved its ranking by one position over time. Oilseeds have kept its ranking intact in West Bengal. Jute shows a mixed picture in terms of ranking over time. Sugarcane has improved its ranking to the first position, while potato has lost its first position and moved to second position over time in West Bengal.

Table 5 also gives us some information about the different cultivation seasons that prevail in West Bengal. From the table, it can be observed that in West Bengal, rice is grown in all the three seasons – aus (kharif), aman (rabi) and boro (zaid rabi). Other crops are distributed over the kharif and rabi seasons.

3. Conclusion

This section will conclude the present discussion. The present chapter has analysed the nature of crop diversification in terms of the changes in cropping pattern with respect to acreage and production distribution. From both the aspects of area and production it can be observed that over the time span of three decades the cropping pattern in West Bengal is increasingly dominated by boro paddy, oilseeds (including, rapeseed and mustard) and potato. These crops are either HYV or cash crops and hence are more remunerative over other crops. The oilseeds have another advantage. Besides being remunerative, 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.

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