

CROP DIVERSIFICATION IN WEST BENGAL: A DISTRICT LEVEL ANALYSIS FOR THE PERIOD 1980-81 TO 2011-12

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ABSTRACT

This paper examines the dynamics of crop diversification in the pre and post-liberalisation period addressing questions on the nature and scope of crop diversification in a small farm dominated economy like West Bengal and the factors influencing it. The analysis reflects the positive impact of operational area and cropping intensity on the degree of crop diversification. In contrast, factors like availability of irrigational facilities, degree of electrification, usage of fertilisers and price of output have a negative influence on the same in a particular region. Besides, a significant inter-district variation in the degree of crop diversification is noticed during the period under consideration. The study points out that a high level of diversification in an area does not essentially correspond to the district having a traditional resource base or a high endowment of modern inputs.

Introduction

India's adoption of New Economic Policy in the 1990's led to dramatic policy change from State intervention to that of market reform. IMF-World Bank directed market economic regime in the Indian economy in the early 1990's led to a drastic fall in food and fertiliser subsidy, promotion of private investments in agriculture, reduction in space for rural credit, priority sector lending and withdrawal of land reforms (Karmakar and Mukhopadhyay, 2007). Indian agricultural

export sector became more open with import liberalisation on food, further deteriorating the situation. The proposals on development of Agricultural Export Zones (AEZs) implied a gradual drift towards market orientation and commercialisation of agriculture. The farmers lacked motivation to produce as they did not receive reasonable prices for their crop owing to high cost of production. Besides, government no longer had the authority to distribute the surplus foodgrains. Indian agriculture was, thus, going

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through a difficult phase with agriculture gradually becoming an unrewarding profession (Ibid).

Following such policy transformations, India has experienced crop diversification with fruits and vegetables in particular acquiring importance in the post-liberalisation period (Chand, 1996). In particular, demand for high value food commodities increased on account of sustained economic growth and rising tendency towards urbanisation which in turn facilitated the trend towards crop diversification (Rao, Birthal and Joshi, 2006). Change in the composition of consumption, as reflected through significant shift in the pattern of consumption away from foodgrains, induced producers to increase the production of high value crops (Gulati and Batila, 2001). World Bank (2005) observed that increased diversification in Indian agriculture resulted primarily from crop substitution rather than increased cropping intensity. Agricultural diversification in India was driven by factors like rising income, changing relative prices between cereals and high value agriculture, access to infrastructure and more open trade policy. Volatility in prices, together with yield and return risks, also acted as a major constraint in the way of changing the existing crop portfolio (World Bank, 2005). Dev and Rao (2005) categorically argued that the lack of an appropriate degree of price support to different classes of farmers can clearly be interpreted as a barrier to crop diversification.

On the supply side, high value agriculture is found to be more dominating in high rainfall

areas with low levels of irrigation and mechanisation. Moreover, in these areas landholdings are relatively smaller, though labour endowment is higher, possibly because of cheap availability of family labour (Rao, Birthal and Joshi, 2006; Chakraborty and Kundu, 2009). Singh and Sidhu (2004) identified the availability of irrigation facilities at subsidised rate and the market support as the driving forces behind the shift towards crop diversification in Punjab. Institutionalised support also facilitates the opening up of new crop horizons. There is a need to support crop diversification drive based on the philosophy of marketisation and promotion of industries only under the conditions of improving technological and financial infrastructure (Chakraborty and Kundu, 2009).

Joshi, Gulati, Birthal and Tewari (2004) observed a similar diversifying trend during 1990's in favour of high value commodities like fruits, vegetables, livestock and fisheries among the South Asian Countries with some inter-country variation, mainly on account of area augmentation. Much of the diversification in these countries came with negligible support from the government as the national policy goal was aimed towards achieving self-sufficiency in the production of foodgrains. The study further identified supply and demand side drivers of agricultural diversification. They are: technology adoption in terms of area under HYV foodgrains, fertiliser use, irrigated area and degree of mechanisation, rainfall, infrastructure in terms of market intensity and road length, relative profitability of high value commodities in

comparison to other crops, proportion of smallholders, literacy rate in rural areas, urbanisation and per capita income. The study emphasised on the aspect of strengthening farm-firm linkages through appropriate institutional arrangements in the form of creation of cooperatives or contract farming system to ensure markets for such crops. This, in turn, would effectively link up the small farm holders with limited resources to the sources of seeds, fertilisers, credit, extension advice, mechanisation and guaranteed profitable markets for produce.

Among the Indian States, diversification in cropping pattern is a modern phenomenon in West Bengal which produces the largest quantity of rice in the country. The small farmers of the State are gradually diversifying in favour of high value crops like fruits, vegetables and flowers with little government support (Bhattacharya, 2007). There are, of course, inter-district variations in the degree of diversification. High value crops being less costly and less water-intensive are easily affordable by the farmers of the State. One recent study on West Bengal found that the farmers in extremely backward regions, lacking irrigational facilities and having adverse natural conditions, resort to crop diversification as a means to protect their income and consumption requirements and in such situations high value crop production involves inefficiency, low productivity, low profit and negative returns (Mukherjee, 2015). However, in places well-endowed with irrigational and other infrastructural facilities, high value labour-intensive crops generate higher income, relative efficiency and profitability by emphasising on

intensive family labour. Against this background, this paper, using available secondary data for all the districts of West Bengal over the period 1980-81 to 2014-15, engages with the issues of crop diversification in West Bengal.

Methodology

The present research work was conducted by undertaking an analysis of crop diversification from 1980-81 to 2014-15 across the 19 districts of West Bengal spread over diverse agro-climatic zones on the basis of secondary data collected from Statistical Abstracts and District Statistical Handbook, published by the Bureau of Applied Economics and Statistics of the Government of West Bengal (in short, "BUREAU") and Statistical Appendices to Economic Reviews of the State government. While some of our research questions and objectives could be addressed properly with an analysis of secondary data, a number of data gaps and information inadequacies confronted us. The objective of studying the dynamics of crop diversification over time could not be met with sufficiently available time series data over different periods. For example, due to non-availability of quantitative data on variables relating to infrastructure, marketing, storage, farm machinery, specific soil qualities, etc., our analysis of the factors influencing crop diversification behaviour had to rely, to a great extent, on qualitative information and wherever possible on quantitative data on this aspect.

In order to determine the extent of any variation in area allocation, production and

productivity of crops since the early 80's in the State of West Bengal and to examine the dynamics of crop diversification in the pre and post-liberalisation period together with identification of the factors influencing crop diversification, we used the following statistical tools.

Growth Rate Estimation: Having the time series of area, production and yield of different crops over a specified period, growth rates can be computed by several methods. The simplest method is to take the absolute or percentage difference in the levels of the first and final years divided by the number of intervening years. However, this method is not quite appropriate for measuring the growth rate of agricultural variables. In the face of wide year-to-year fluctuations, the computed growth rates from such an exercise would be heavily dependent on the choice of terminal years.

Other methods of computing the rate of growth consist of fitting linear or non-linear trends (such as exponential or second degree polynomial) which quite frequently give excellent fit to time series (which are not too long) data and work well for estimation of trends within the limits of the observed series. In our study, two alternative forms of regression models, viz., linear and exponential were attempted to find out which suits comparatively better to the available data on the basis of "goodness of fit" (in terms of the values of r^2). On the whole, the exponential form was found to be more appropriate. In particular, the following function is fitted to the variables of area,

production and yield for computation of annual compound growth rates: $Y = A(1+r)^t = A.B^t$, Where, Y = the variable under study; t = time; A , B = parameters to be estimated. $B = 1+r$, r = annual compound growth rate. The form $Y = A.B^t.u$ is subjected to linear logarithmic reductions so that the regression model assumes the form: $\log y = \log A + t \cdot \log B + \log u$ Where, u = a random error term. Having the estimate of regression co-efficient, this model allows for the computation of annual compound growth rate as: $r = (b^{\wedge}-1) \times 100$, Where, b^{\wedge} = Antilog of the estimated regression co-efficient.

Instability Analysis: To study the nature of fluctuations in the variant values, we have calculated the Co-efficient of Variation (CV). This part of the present study is carried out entirely on the basis of secondary data collected from three major sources. These are Statistical Abstracts, and District Statistical Handbook, published by "BUREAU" and Statistical Appendices to Economic Reviews of the State government. The occasional data gaps have been bridged by using the figures for the corresponding years as made available in Economic Reviews of the Government.

Out of the numerous economic, social, demographic, institutional and other non-economic variables influencing the farm efficiency and rational farming decisions, the most dominant ones are operational area of the crop, the yield rate and the level volume of production. These are also the most significant indicative variables on the nature and patterns of crop diversification as well as imply a causal

link among different decisions at different levels for diversification in farm practices. Also, the data available on area, production and yield are mostly organised through time series coverage with a detailed district-wise account. Hence, in order to study the dynamics of crop diversification and changes in area allocation as well as the physical performance efficiency of agriculture over time, these variables are found to be highly useful and revealing. Thus, the principal variables on which data are collected and scrutinised include:

- i. Area ('000 hectares)
- ii. Production ('000 tonnes)¹
- iii. Yield (kg/hectare)

The divisions of West Bengal include 19 districts. However, at the time of scrutinising the collected data on relevant variables, it was found analytically convenient to reduce the number of districts studied effectively to 15. This was done according to the following method of combination:

- i. Howrah + Kolkata \equiv Howrah.
- ii. 24 Parganas (North) + 24 Parganas (South) \equiv 24 Parganas.
- iii. Medinipur (East) + Medinipur (West) \equiv Medinipur.
- iv. Dinajpur (North) + Dinajpur (South) \equiv Dinajpur.

The original data in our sources are provided for a wide variety of crops ranging from 25 to 30 or more. For the sake of analysis, this unwieldy number has to be made manageable in terms of specific weightages on crops to be

studied. The actual number of crops considered in the study amounts to the classification given below.

- i. Autumn Rice.
- ii. Winter Rice.
- iii. Summer Rice.
- iv. Total Rice = Autumn Rice + Winter Rice + Summer Rice.
- v. Wheat.
- vi. Other Cereals = Barley + Maize + Jowar + Bajra + Ragi + Small Millets.
- vii. Total Cereals = Total Rice + Wheat + Other Cereals.
- viii. Total Pulses.
- ix. Total Foodgrains = Total Cereals + Total Pulses.
- x. Rapeseed and Mustard.
- xi. Other Oilseeds = Linseed + *Til* + Others.
- xii. Total Oilseeds = Rapeseed and Mustard + Other Oilseeds.
- xiii. Tea.
- xiv. Jute.
- xv. Sugarcane.
- xvi. Potato.
- xvii. Fruits and Vegetables.
- xviii. Others = Sun hemp + Mesta + Cotton + Tobacco + Dry chillies + Ginger (Dry).
- xix. All Crops = Total Foodgrains + Total Oilseeds + Dry Chillies + Ginger (Dry) + Tea + Sugarcane + Total Fibres + Tobacco + Potato.

Out of the above crop scheme, the groups are as under:

- vi. Other Cereals.
- xi. Other Oilseeds.
- xviii. Others.
- xx. All crops are not exposed to the regression analysis.

Nonetheless, we have considered all crops from (i) to (xix) for the general analysis. The collected data were subjected to a number of logical adjustments to conduct the statistical analysis. Firstly, the available time series spread over 35 years (1980-81 to 2014-15) was decomposed into the following sub-periods:

- A. Sub-divisions for general analysis:
 - i. 1980-81 to 1984-85.
 - ii. 1985-86 to 1989-90.
 - iii. 1990-91 to 1994-95.
 - iv. 1995-96 to 1999-2000.
 - v. 2000-01 to 2004-05.
 - vi. 2005-06 to 2009-2010.
 - vii. 2010-11 to 2014-15.
- B. Sub-divisions for trend and stability analysis:
 - i. 1980-81 to 1989-90.
 - ii. 1990-91 to 2013-14
 - iii. 1980-81 to 2013-14.

The sub-division (i) for general analysis gives us an opportunity to examine the earlier spurt in the process of agricultural growth revival in West Bengal which brought about a turnaround in the early 1980's. The sub-division

(ii) helps us to capture the phase when the growth revival appeared to have gathered momentum. The next sub-division (iii) captures the impact of economic liberalisation during the early years, while sub-division (iv) incorporates the impact of introduction of WTO agreements. The sub-division (v) is considered to examine whether there has been any saturation in the growth process following a good record during the earlier periods. Finally, the sub-division (vi) helps us to examine whether there has been any significant impact on the crop diversification dynamics in the State following the implementation of neo-liberal economic reforms even in a stronger manner than ever before. In fact, West Bengal has been one of the States which lagged behind the economic reforms process during the earlier periods and could somewhat pick up only of late. The last sub-division, thus, incorporates the effects of development of more recent origin including agribusiness, contract farming and rural market retail chains. The sub-divisions as under II provide us with an opportunity to study the problem of changes in cropping pattern over a period, capturing the agricultural growth resurgence of West Bengal (1980-81 to 1989-90) over another (1990-91 to 2013-14) that contains the impact of the neo-liberal economic reforms following GATT² negotiations and WTO³ agreements. The grand time series, 1980-81 to 2013-14, focuses on the long-run perspective of the problem. The second logical adjustment in the mode of presenting the data necessitated from the requirements of grouping the districts according to some standard norm, such as

topographical, agro-climatic or geographical characteristics. Although, agriculture of the State can be represented in terms of well-defined agro-climatic zones, it involves the problem of overlapping of districts. Hence, segments of the same district may spill over among different agro-climatic zones leading to a double-counting problem. Since our purpose is to examine the

nature of actual variations in cropping patterns over time, such a problem must be avoided. In effect, the only possible way that remains is to consider an administrative sub-classification of districts. Specifically, we distributed 15 districts in our study according to the following classification (Table 1).

Table 1: Administrative Sub-classification of Districts

S.No.	Administrative Division	District Cluster
I.	Burdwan	Burdwan, Birbhum, Bankura, Midnapur, Hooghly and Purulia
II.	Presidency	24 Parganas, Howrah, Nadia, Murshidabad
III.	Jalpaiguri	Dinajpur, Malda, Jalpaiguri, Darjeeling and Coochbehar

Source: Mukherjee, 2010.

Crop Diversification Trend in West Bengal: Growth and Instability Analysis

Table 1 reveals that the cropping pattern in West Bengal is still dominated by foodgrains with 83.05 per cent area allocated under total foodgrains in 1980-81 and 66.2 per cent in 2014-15. Within this, the share of area under rice dominates (58.3 per cent in 2013-14). Since early 80's, following agrarian reforms and land redistribution programme, West Bengal experienced a revival of the small farm economy in rural areas. In fact, about 97 per cent of the operational holdings in the State are below 2 hectares in size. The high relative share of foodgrains is perhaps due to the impact of small farm size. However, in percentage terms, the area allocated under non-foodgrains has increased over time viz, area devoted to total oilseeds increased from 4.32 to 8.03 per cent while potato increased from 1.57 to 4.35 per cent during 1980-81 and 2013-14, respectively (Table

1). Fruits and vegetables started gaining significance in the post-liberalisation period with about 12.7 per cent area devoted to their cultivation in 2013-14.

The declining tendencies of share of food crops over time clearly reflect signs of diversification. There is little evidence of change in area through substitution effect between rice and wheat. But within rice, substitution effect seems to be present through a shift from local to high yielding varieties. Since early 80's, HYV area increased through the boro component of rice and the penetration of irrigation through private shallow tube wells. Thus, there has been an area extension from 395.78 thousand hectares during the period 1980-81 to 1984-85 to 1279.18 thousand hectares during the period 2010-11 to 2014-15 under HYV variety of rice (Table 2). The impact of expansion effect on crop pattern (through a rise in gross cropped area)

also appears to be present in certain degrees. As observed in Table 2, the shift in area for the period under consideration has been more towards commercial crops like oilseeds (from 344.50 to 716.76 thousand hectares), potato (from 129.28 to 400.16 thousand hectares), tea (from 94.86 to 130.02 thousand hectares), jute (from 510.68 to 575.5 thousand hectares), etc. Moreover, fruits and vegetables have gained since the 90's. Overall, in spite of being a traditionally rice-growing State, the region's enormous water reserves, fertile soil, the various agro-climatic zones and extensive Land Reform Programme have made the agricultural activity of the State vastly diversified.

As the crop pattern changes, the effect of the dynamics of crop-mix is expected to be reflected on agricultural production. Both production and yield rate of crops indicated a rise. As reported in Tables 3 and 4, it is observed that the production of rice increased from 6856.04 ('000 tonnes) during the period 1980-81 to 1984-85 to 14849.32 ('000 tonnes) during 2010-11 to 2014-15 while the yield rate recorded increase from 1323 kg/ hectare to 2762.4 kg/ hectare during the same period. The growth in production peaked up during 1980's mainly due to the yield rate effect. But, the yield growth could not be sustained during the 90's (Table 4). Similarly, for production of potato, the rise was from 2495.05 (in '000 tonnes) to 11544.6 (in '000 tonnes) and for yield rate it was from 19129.00 kg/hectare to 28806.6 kg/hectare during the same period.

We have also calculated the crop-wise growth rates of agricultural production in West

Bengal (Table 5) by subdividing the entire period into three phases: Phase-I (1980-81 to 1989-90) focusing on the phase of Agricultural Growth Resurgence of West Bengal, Phase-II (1990-91 to 2013-14) highlighting the impact of the Neo-liberal Economic Reforms following GATT Negotiations and WTO Agreements and Phase-III (1980-81 to 2013-14), emphasising on the problem from the long-run point of view. The results indicate that compared to the other two phases, the first phase reported remarkable growth rates of area, production and yield for most of the crops. For example, the total cereals grew at a rate of 6.41 per cent per annum during the first phase and the growth rates of area and yield were 1.16 and 5.2 per cent, respectively, implying that growth rate of yield was a significant contributor of the output growth.

The growth rate of production of total rice which includes all three varieties of rice grown in the State, namely, Aus or autumn rice, Aman or winter rice and Boro or summer rice declined from 6.91 per cent in the first phase to 2.57 per cent in the third phase (as reported in Table 5) owing to a fall in both growth rate of area as well as yield growth rate during the entire period taken into consideration. In fact, paddy crop reported the best performance regarding output growth both individually and in total in the first phase. The same picture also holds for the growth rate of output of cereal crops, which include all varieties of rice and wheat.

The output growth of production of rapeseed and mustard in the first phase could

not be sustained primarily because of a reduction in area expansion to 2.8 per cent in the third phase together with a drop in yield growth to 1.39 per cent during the entire period. The growth rate of tea has however, improved marginally in the third phase to 2.09 per cent per annum mainly on account of increase in the growth rate of yield (1.39 per cent) over the first phase (0.46 per cent). Jute reported a decline in output growth on the whole as the marginal increase in area under cultivation (from -2.5 per cent in the first phase to 0.69 per cent in the third phase) has been outweighed by the declining growth rate of yield (3.99 per cent in the first phase to 1.86 per cent in the third phase as reported in Table 5).

Sugarcane experienced an enormous increase in production in the third phase (12.7 per cent) primarily caused by a substantial increase in growth rate of yield (from 2.33 per cent in the first phase to 12.2 per cent). The output growth of potato fell severely from 9.9 per cent in the first phase to 4.71 per cent in the third phase because of a fall in both growth rate of area (from 6.91 per cent in the first phase to 3.99 per cent in the third phase) and growth rate of yield (from 2.8 to 0.69 per cent, respectively, as reported in Table 5).

Fruits and vegetables occupied a significant position only in the post-liberalisation era indicating a trend towards diversification of cropping pattern with a growth rate of 3.04 per cent in the second and third phases (Table 5). It appears that the small and marginal farmers have resorted to crop diversification as a mechanism

to avoid the risks associated with monocropping as well as to augment their income in order to accomplish their increased consumption requirements. On the whole, it is observed that the output growth of most of the crops declined significantly in the post-liberalisation period mainly as a result of decrease in both the area and the yield growth of most of the crops suggesting that the agricultural sector has been subjected to severe shocks in the post-liberalisation period.

Nature of Instability: We have complemented our analysis of growth performance with a study of the nature of stability with reference to area, production and yield of crops, including both aggregated variables and their decompositions at comparatively disaggregated levels under different phases (Tables 6 to 9).

Variability in Area, Production and Yield at the State Level: Broadly, it is found that the area under total foodgrains was highly variable in Phase I as compared to that in Phase II (Table 6). Similarly, non-foodgrains recorded greater stability in the post-liberalisation period. The situation is quite similar in case of production and yield of different crops which reflects the relative stabilising effect of the post-liberalisation period possibly indicating saturation of opportunities in expansion of foodgrains due to the deflationary policy package followed in the 90's for the economy as a whole. However, the slow adjustment towards market-oriented high valued non-food crops is clearly indicated.

Variability by District Divisions: The division-wise variations in crop diversification point out

to the fact that production conditions prevailing in such divisions are heterogeneous (Table 7). It appears from our study that the overall stabilising impact of Phase II in area under crops, e.g., as observed in case of Jalpaiguri division is an indication of physical and resource constraints towards crop experimentation in the new liberalised regime. This is particularly surprising since this division accounts for a considerable portion of crops like tea, jute, fruits and vegetables where the potential for diversification under new incentives appear to be high. Interestingly, for Burdwan division (which accounts for a good part of traditionally advanced areas), it is seen that estimates of Coefficients of Variation (C.V.) have decreased for food crops from Phase I to Phase II. Presidency division appears to be at an intermediate level in this context. However, irrespective of the division, the variability in HYV summer rice has reported a decline in Phase II. With respect to yield of crops, it is seen that the Jalpaiguri division has become highly unstable in the period following economic liberalisation though an overall stabilising effect prevails for both Burdwan and Presidency divisions indicating a trend towards regional disparities subsequent to the New Economic Policy and reform measures.

Variability by Crop Clusters: The estimates of C.V. indicate that the overall instability in area under crops has increased between Phase I (4.08) and Phase II (7.38) as reported in Table 8. However, in case of foodgrains it increased only marginally in the second phase from 3.75 to 4.02. Similar is the case of non-foodgrains which reported a rise in variability from 9.13 to 10.69

possibly indicating an area adjustment and a trend towards experimenting with non-foodgrains in the post-liberalisation era. However, non-foodgrains involve a very high degree of risk in yield fluctuations with variability increasing from 5.16 in Phase I to 11.61 in Phase II as reported in Table 8 which might act as a significant disincentive. This, in turn, points to the inefficiency of a systematic infrastructural intervention in agriculture in providing a positive stimulus to market-oriented diversification.

Inter-district Variation: As revealed from Table 9, between 1980-81 and 1990-91, stability of area under crops point to a mixed pattern of rise and fall for the State as a whole. However, in the second phase, inter-district variations have gone up on the whole. In case of production, inter-district heterogeneity has been on the rise in recent time periods for all crops except potato as compared to 1980-81. The variability of crops like rice, total foodgrains, total oilseeds and potato has decreased while the same has increased for crops like wheat, total pulses, other oilseeds, tea, jute and sugarcane. The yield of crops also reports similar facts. All these further corroborate the ineffectiveness of the neo-liberalised environment in agriculture towards reduction in inter-district gap, indirectly indicating the failure of the policy packages of New Economic Policy to provide positive incentives in the areas of comparative advantage of production.

In essence, our growth and instability analysis clearly points to the fact that growth rates of area, production and yield of most of the crops during the first phase (1980-81 to 1989-90) have been most noteworthy compared to Phase-II and

III, viz., 1990-91 to 2013-14 and 1980-81 to 2013-14. The high yield growth rate of foodgrains during the 1980's led to the high growth rate of production. Crop pattern is still found to be dominated by foodgrains and within this the share of area under rice dominates. Growth rate of output of most of the crops was considerably high during 1980-81 to 1989-90 and in the subsequent period (1989-90 to 2013-14), the growth rates declined rapidly.

Instability in area under crops in case of foodgrains declined during Phase-II while that of non-foodgrains increased considerably indicating an area adjustment and a tendency towards crop experimentation in favour of non-foodgrains, though at a slow rate. During 1989-90 to 2013-14 (Table 9), the yield and the area growth rates of most of the crops had fallen leading to a fall in output growth rate. Both in cases of production and yield, there are clear indications of growing inter-district heterogeneity in recent time period. Yield fluctuations in case of non-foodgrains clearly indicate the inadequacy of a systematic infrastructural intervention in agriculture to motivate the process of market-oriented diversification.

We have constructed Simpson's Index⁴ for crop diversification for 15 districts in West Bengal covering the period 1980-81 to 2013-14 as reported in Table 10. There is a significant inter-district variation in the degree of crop diversification during 1980-81, 1990-91 and 2000-01 with the degree of variation recording a decline in 2013-14. This reconfirms the fact that agriculture in West Bengal is gradually on

the way of being diversified across the space. Among the districts, Purulia is the least diversified district (with a crop diversification index of 0.24) in the State followed immediately by Birbhum (with a crop diversification index of 0.37 as reported in Table 10). Though the extent of diversification in cropping pattern increased in both the districts over time, yet it is quite negligible in comparison with other districts. The traditionally paddy growing district of Burdwan (with a crop diversification index of 0.39 as reported in Table 10), though considered to be one of the agriculturally advanced and enterprising district, is lagging well behind the districts of North Bengal in terms of diversification (with a crop diversification index of 0.53, 0.54, 0.7, 0.66 and 0.6, respectively, for the districts Dinajpur, Malda, Jalpaiguri, Darjeeling and Coochbehar). The same is also applicable for the district of Midnapur. An interesting feature is that diversification in Burdwan, though increased between 2000-01 and 2013-14, remains at a much lower level than the diversification achieved in Hooghly over time (with a crop diversification index of 0.65 in 2013-14 as reported in Table 10).

It is observed that the districts of North Bengal, namely Jalpaiguri, Darjeeling, Coochbehar, Dinajpur and to some extent Malda were diversified right from the initial years (with a crop diversification index of 0.5, 0.49, 0.43, 0.39 and 0.27, respectively, in the year 1980-81). Among other districts, Hooghly was diversified from the beginning though the pace of diversification undoubtedly increased in the later half of the liberalisation era (crop diversification

index increasing from 0.42 in 1980-81 to 0.65 in 2013-14). The same also applies to the districts of Nadia and Murshidabad (as reported in Table 10). In general, it is found that excluding the district of Hooghly all other districts belonging to South Bengal (namely Burdwan, Birbhum, Bankura, Midnapur, Purulia, 24 Parganas and Howrah) are lagging behind the districts of North Bengal in terms of diversification. However, there is no systematic way to conclude that a high level of diversification essentially corresponds to the districts having a traditional resource base or a high endowment of modern inputs. For example, diversification indices for the districts of Coochbehar, Darjeeling and Jalpaiguri compare fairly close with that of Hooghly, Murshidabad and Nadia (with a crop diversification index of 0.65, 0.63 and 0.68, respectively, for the districts of Hooghly, Murshidabad and Nadia as reported in Table 10). This indicates that crop diversification in resource constrained areas might be need-induced corresponding to a low-yielding basket of crops.

Factors Influencing Crop Diversification in West Bengal

Given the trend towards crop diversification, as evident from our analysis in the preceding section, it is imperative to examine the factors influencing such trend in West Bengal. This section employs tobit regression models to identify the determinants of crop diversification by different size classes of farmers on the basis of aggregated data of all the districts of West Bengal. In particular, Simpson Index of diversification has been regressed on Average Area Operated under Potato (AAOP),

Cropping Intensity (CI), percentage of Area Irrigated (AI), Fertilisers Per unit of GCA (FPGCA), Number of Electrified Villages (NEV) and District-wise Harvest Price of Potato (DHPP) and Road Length maintained by PWD (RLPWD). The regressions are considered separately for the four time points- 1980, 1990, 2000 and 2010 (Tables 11 to 14). Average Area Operated under Potato (AAOP) is obtained by dividing the total land area operated under potato cultivation by the respective size class of farmers by the number of households in that particular size class. Cropping Intensity (CI) is the percentage of gross cropped area to net cropped area. The percentage of AI is represented as the percentage of land brought under irrigation coverage out of the total land cultivated by the household. Fertilisers Per unit of GCA (FPGCA) refer to the amount of fertilisers used per unit of Gross Cropped Area. Number of Electrified Village (NEV) denotes the number of villages electrified in each district. District-wise Harvest Price of Potato (DHPP) indicates the harvest price of potato in West Bengal by district. Since potato is the diversified crop taken into consideration in all the districts of the State, we have considered the District-wise Harvest Price of Potato as a possible explanatory variable influencing the crop diversification by different size classes of farmers. Road length maintained by PWD represents the road length maintained by P.W.D department measured in kilometres. The regressions are considered separately for the four time points- 1980, 1990, 2000 and 2010.

Our Tobit regression results for the time point 1980 indicate that both average area

operated under potato and cropping intensity have a positive influence on crop diversification index (SI) which is just as expected. The estimated regression coefficients remain positive for all the four years for which multiple regressions are considered. Moreover, the coefficient of average area is found to be significant for the time points 1980, 2000 and 2010, whereas the coefficient of cropping intensity has a significant estimate for the year 1990 and 2000. As average area operated under potato increases, the output of potato also increases which brings greater cash value at the disposal of the farmers. Since, crop diversification primarily implies a shift away from the traditional non-commercial crop basket, as average area operated under potato increases there is a greater inducement to diversify the crop basket in expectation of earning high cash returns. Hence, there is a positive relation between SI and average area operated under potato as greater the value of SI, higher is the degree of diversification and vice versa. As regards cropping intensity, it is also expected to influence crop diversification positively. Hence, the coefficient of cropping intensity has a positive sign. It appears that these variables have gained importance over time, particularly during the liberalisation period in influencing the degree of crop diversification (Joshi, Gulati, Birthal and Tewari, 2004). This is quite reasonable as both these variables incorporate the effects of the limiting most input of land being instrumental in crop experimentation.

However, the percentage of canal irrigated area contradicts our expectation as the estimated regression coefficient gives a negative

sign in 1980. It remains with a negative sign except for the time reference 1990. In the context of West Bengal, canal irrigation potentials confront various constraints so that it is hardly favourable to crop experimentation and diversification. Normally, it is observed that the more is the percentage of area irrigated, the more willing is the farmer to undertake risk with new crops which ultimately has a positive influence on crop diversification. But, the percentage of area irrigated in the present model refers exclusively to canal irrigation which is mostly season and crop-specific. It is not fully under the control of the farmer and hence, is utilised mainly in the traditionally raised paddy crops during the kharif and summer seasons. The canal irrigation system runs on the basis of season, time-bound schedules and does not provide a uniform and even distribution of water throughout the year. Even within the prevailing time schedules of canal water, it is mainly biased in favour of kharif crops due to technological reasons. Hence, it seems that whatever canal irrigation is available that might be utilised by the farmers in favour of the traditional crops with a greater intensity in order to reap as much returns as possible out of them. Hence, canal water appears to be encouraging the farming of traditional crops which serve as a constraint to crop diversification and canal irrigation, which in general has a positive influence on specialisation in the main staple food crops of the area. As a result, the coefficient of percentage of canal irrigation is negative as a lower value of SI points towards specialisation rather than diversification. It is important to mention that the negative coefficient of

percentage of canal irrigated area is found to be significant in the years 1980 and 2010. Canal irrigation provides cheap and assured availability of water. In general, traditional crops are more water-intensive. When there is lack of cheap availability of canal irrigation, the farmers are compelled to diversify to ensure a reasonable level of income. If there is proper irrigation facility, they do not find it necessary to diversify. This may be taken to imply that in West Bengal diversification is induced as a coping strategy to meet adverse conditions with regard to irrigation.

As regards fertilisers per unit of GCA, it is found to be negatively related with crop diversification index in the years 1980, 1990 and 2000, while it is positively related with crop diversification index in the year 2010. The negative sign of the estimated regression coefficient is found to be significant for the years 1990 and 2000. This apparently puzzling phenomenon may be explained in terms of the following possible factors:

a. An increase in fertiliser use per unit of GCA might be mainly accounted for by increased area allocation under traditional crops which are more secure involving lesser risks in output compared to the crops which are newly introduced in the crop basket.

b. It might be that the increased doses of FPGCA create adverse technological conditions in terms of soil quality and other factors which prevent the introduction of new crops. Thus, it is likely that the farmers find it profitable to concentrate on the fertiliser input more in the cultivation of stylised crops.

Our expectation that an increase in the number of electrified villages tends to produce a positive impact on crop diversification is also contradicted through the estimated regression coefficient which is found to be negative for all the time references used in the multiple regression framework. Moreover, these estimates are found to be highly significant for the years 1980, 2000 and 2010. This points out that the required power infrastructure is used by the farmers under constraints. For example, there might be problems of inadequate power supply to agricultural activities and use of electricity for unproductive consumption. Another thing is that the available power supply is utilised by the farmers primarily during the summer season (the time for raising a major component of the HYV paddy, the so-called 'Boro' variety) when canal water is not always available such that the remaining operative capacity to employ other mechanised instruments in non-paddy crops is reduced significantly.

Turning to the harvest price of potato as a determinant of crop diversification, quite contrary to our expectations, it is found to have a positive relation with SI except for the year 1990 where it remains negative. However, none of these estimates are found to be statistically significant. The positive relation between harvest price and SI might be explained through the inference that a rise in harvest price of potato can induce the farmers to diversify their crop baskets more in favour of cash crops other than potato to maximise their total returns. On the other hand, one possible reason behind the estimated inverse relation seems to be the fact that a higher harvest

price promises a higher return on potato to the farmers which might induce them to specialise in potato as one of the dominating cash crops. Hence, a rise in harvest price might reduce the degree of crop diversification.

Summing Up

In the post-liberalisation period, the State of West Bengal, dominated mainly by the small and marginal farmers, has experienced a growing tendency towards diversification of cropping pattern. However, there is no systematic way to conclude that a high level of diversification essentially corresponds to the districts having a traditional resource base or a high endowment of modern inputs. Crop diversification in resource constrained areas might be need-induced corresponding to a low-yielding basket of crops. Diversification in cropping pattern is found to be influenced by factors like operational area, cropping intensity, availability of irrigation facilities, degree of electrification, usage of fertilisers, price of output, etc. Average area operated under potato and cropping intensity has a positive influence on crop diversification. Canal water appears to be encouraging the farming of traditional crops. Overdosing of the fertiliser input

creates a negative impact on crop diversification while the power infrastructure used by the farmers under constraints primarily during the summer season for raising 'Boro' variety of paddy, too adversely affects crop diversification of a region. Similarly, harvest price of potato was found to have a negative impact on crop diversification in an area as higher harvest price induced specialisation rather than diversification.

It is true that successful implementation of the process of agricultural diversification in any region depends to a great extent on the technological, infrastructural and institutional developments as well as solution to problems related to land acquisition, prices, taxation, etc. In this context, government has recently introduced market-oriented dynamic policies to address the new emerging pattern of agriculture. But in order to ensure a higher growth path, macro policies should emphasise on upliftment of the State's agriculture by undertaking suitable programmes for bringing about changes in the cropping pattern. In an agriculturally advanced State of West Bengal, further growth prospects can be enhanced only through a regulatory rather than a promotional role of government.

Notes

- 1 For few selected crops, data on production and yield are expressed in units other than tonnes or kg/hectare.
- 2 GATT stands for General Agreement on Tariffs and Trade.
- 3 WTO stands for World Trade Organisation.
- 4 Simpson index as used by Joshi et al (2003) in case of several South Asian countries to measure the degree of crop diversification is given as: $CDI = 1 - \sum (P_i / \sum P_i)^2$, where P_i is the area under i^{th} crop and $i = 1, 2, 3, \dots, n$ is the number of crops.

References

- Bhattacharya M, Bhattacharya S (2007), "Agrarian Impasse in West Bengal in the Liberalisation Era", *Economic and Political Weekly*, Vol. 52, (No. 42).
- Chakrabarti S, Kundu A (2009), "Rural Non-farm Economy: A Note on the Impact of Crop-Diversification and Land-Conversion in India", *Economic and Political Weekly*, Vol. XLIV, (No. 12), pp. 69-75.
- Chand R (1996), "Diversification through High Value Crops in Western Himalayan Region-Evidence from Himachal Pradesh", *Indian Journal of Agricultural Economics*, Vol. 51, (No. 4), pp. 652-663.
- Government of West Bengal, "Cost of Production of Principal Crops in West Bengal, Evaluation Wing, Directorate of Agriculture, (various issues).
- Dev S M, Rao N C (2005), "Food Processing and Contract Farming in Andhra Pradesh: A Small Farmer Perspective", *Economic and Political Weekly*, Vol. XL, (No. 26), pp. 2705- 2713.
- District Statistical Handbook, Published by the "BUREAU", (various issues).
- Gulati A, Bathla S (2001), "Capital Formation in Indian Agriculture", *Economic and Political Weekly*, Vol. 36, (No. 20).
- Joshi P K, Gulati Ashok, Birthal S P, and Tewari L (2004), "Agricultural Diversification in South Asia: Patterns, Determinants and Policy Implication", *Economic and Political Weekly*, Vol. 39, (No. 24), pp. 2457-2467.
- Karmakar AK and Mukhopadhyay S (2007), "A Review of the West Bengal Economy with Reference to Agriculture" in Sen RK, Dasgupta A (ed.) 'West Bengal Today 25 Years of Economic Development'.
- Mukherjee A (2015), "Evaluation of the Policy of Crop Diversification as a Strategy for Reduction of Rural Poverty in India", In Heshmati A et al (eds.) 'Poverty Reduction Policies and Practices in Developing Asia', Economic Studies in Inequality, Social Exclusion and Well- Being.
- Mukherjee S (2010), "A Study of Crop Dynamics and Diversification in West Bengal over 1980-81 to 2004-05", *The IUP Journal of Agricultural Economics*, Vol. VII, (No. 3), pp. 51-74.
- Rao P P, Birthal PS and Joshi PK (2006), "Diversification towards High Value Agriculture: Role of Urbanization and Infrastructure", *Economic and Political Weekly*, Vol. 41 (No. 26), pp. 2747-2753.
- Singh J and Sidhu RS (2004), "Factors in Declining Crop Diversification: A Case Study of Punjab", *Economic and Political Weekly*, Vol. 39, (No. 52), pp. 5607-5610.
- Government of West Bengal, Statistical Abstracts, Published by the Bureau of Applied Economics and Statistics (various issues).
- The World Bank (2005), "India Re- Energizing the Agricultural Sector to Sustain Growth and Reduce Poverty", OUP (India) Publications.

APPENDIX

Table1: Percentage Allocation of Area under Different Crops in West Bengal (Cropping Pattern)

Crop/s	Period							
	1980-81	1985-86	1990-91	1995-96	2000-01	2004-05	2009-10	2014-15
Autumn rice	8.37	6.57	7.73	6.34	4.43	3.45	2.3	2.41
Winter rice	57.38	55.52	54.55	53.18	40.94	43.90	42.9	42.3
Summer rice	4.72	6.97	11.35	14.41	15.77	14.79	15.4	13.6
Total rice	70.48	69.05	73.63	73.92	61.14	62.13	60.6	58.3
Wheat	3.85	4.15	3.41	4.19	4.79	4.30	3.4	3.53
Other cereals	1.58	1.32	1.26	0.88	0.64	0.91	1.2	1.74
Total cereals	75.91	74.52	78.30	79.00	66.58	67.34	65.2	63.6
Total pulses	7.14	5.72	3.98	2.64	3.09	2.43	1.963	2.63
Total foodgrains	83.05	80.24	82.28	81.65	69.66	69.77	67.18	66.2
Rapeseed and mustard	1.78	3.15	4.79	4.07	4.90	4.91	4.415	4.74
Other oilseeds	2.54	1.90	1.71	2.10	1.83	2.32	2.92	3.29
Total oilseeds	4.32	5.04	6.50	6.17	6.73	7.23	7.339	8.03
Tea	1.28	1.33	1.28	1.26	1.21	1.22	1.239	1.48
Jute	8.31	9.93	6.34	6.40	6.90	6.11	6.612	5.98
Sugarcane	0.19	0.18	0.15	0.21	0.24	0.17	0.15	0.19
Potato	1.57	1.88	2.46	3.18	3.37	3.44	4.163	4.35
Fruits and vegetables	0.00	0.00	0.00	0.00	10.82	11.11	12.28	12.7
Others	1.27	1.39	0.99	1.14	1.07	0.94	1.041	1.08
All crops	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Computed from data collected from Statistical Handbook (various issues).

Table 2: Quinquennial Averages of Area under Different Crops in West Bengal (in ' 000 hectares)

Crop/s	Period						
	1980-81 to 84-85	1985-86 to 89-90	1990-91 to 94-95	1995-96 to 99-00	2000-01 to 04-05	2005-06 to 09-10	2010-11 to 14-15
Autumn rice	659.68	614.70	548.32	449.50	368.42	272.02	213.62
Winter rice	4102.90	4126.36	4270.78	4222.60	4023.04	4022.86	3879.82
Summer rice	395.78	692.26	955.90	1269.64	1405.88	1456.22	1279.18
Total rice	5163.76	5433.32	5773.80	5941.78	5797.34	5751.1	5372.62
Wheat	285.66	340.76	284.36	357.60	418.24	338.54	324.16
Other cereals	109.32	99.10	80.98	64.56	64.82	104.06	134.84
Total cereals	5558.74	5873.18	6139.14	6363.94	6280.40	6193.7	5831.58
Total pulses	429.34	357.02	271.26	217.40	248.74	201.9	219.22
Total foodgrains	5988.08	6230.20	6410.40	6581.34	6529.14	6395.44	6051
Rapeseed and mustard	167.86	329.60	388.44	332.88	438.68	414.66	435.16
Other oilseeds	176.64	143.48	145.95	168.90	187.18	273.34	281.6
Total oilseeds	344.50	473.08	534.38	501.82	625.86	688	716.76
Tea	94.86	99.61	101.24	102.82	111.76	114.86	130.02
Jute	510.68	502.74	510.00	600.70	618.10	592.44	575.5
Sugarcane	20.42	13.58	13.10	23.54	19.38	15.98	16.4
Potato	129.28	177.28	221.50	297.64	315.56	387.22	400.16
Fruits and vegetables	0.00	0.00	0.00	0.00	1006.07	1105.4	1180.51
Others	78.22	80.51	83.60	94.18	92.18	94.8	99.18
All crops	6755.98	7452.11	7874.22	8752.42	9318.05	9394.14	9169.53

Source: Computed from data collected from Statistical Handbook (various issues).

Table 3: Quinquennial Averages of Production under Different Crops in West Bengal (in ' 000 tonnes)

Crop/s	Period						
	1980-81 to 84-85	1985-86 to 89-90	1990-91 to 94-95	1995-96 to 99-00	2000-01 to 04-05	2005-06 to 09-10	2010-11 to 14-15
Autumn rice	633.56	773.54	889.34	790.12	738.92	563.7	496.08
Winter rice	5200.44	6630.76	7876.96	8242.76	9245.02	9681.58	10125.66
Summer rice	1022.04	2037.54	2871.28	3934.42	4342.06	4425.54	4227.36
Total rice	6856.04	9441.84	11637.58	12967.3	14326	14670.82	14849.32
Wheat	626.86	657.84	610.32	800.74	946.94	820.38	902.08
Other cereals	111.16	161.18	157.54	127.02	131.68	307.74	505.2
Total cereals	7594.06	10260.86	12405.44	13895.06	15402.82	15798.94	16256.6
Total pulses	233.48	222.32	174.62	147.26	188.28	153.42	200.32
Total foodgrains	7827.54	10483.18	12578.06	14042.32	15591.1	15952.38	16457
Rapeseed and mustard	108.38	265.2	305.08	259	368.9	368.32	446.72
Other oilseeds	78.46	99.66	123.94	135.08	180.7	288.42	320.94
Total oilseeds	186.84	364.86	429.08	394.08	549.6	656.74	767.66
Tea	136541.4	148812.4	156501.2	173244.2	189021.8	229453	273931.6
Jute	3433.24	5102.36	5743.92	7138.86	8198	8362.86	8500.9
Sugarcane	113.4	89.06	78.16	1180.52	1403.22	1385.1	1696.42
Potato	2495.05	3793.38	4986.86	6970.32	7425.24	8074.92	11544.6
Fruits and vegetables	0.00	0.00	0.00	0.00	12514.03	15075.22	16935.77
Others	202.48	150.406	146.38	158.06	183.42	228.16	239.6
All crops	150799.94	168795.646	180463.6	209866.8	234886.4	279188.38	330073.56

Source: Computed from data collected from Statistical Handbook (various issues).

**Table 4: Quinquennial Averages of Yield under Different Crops in West Bengal
(in kg/ hectare)**

Crop/s	Period						
	1980-81 to 84-85	1985-86 to 89-90	1990-91 to 94-95	1995-96 to 99-00	2000-01 to 04-05	2005-06 to 09-10	2010-11 to 14-15
Autumn rice	960.00	1245.60	1625.80	1762.40	2009.80	2077.6	2318.8
Winter rice	1261.80	1603.80	1844.80	1933.60	2290.40	2406.2	2606.6
Summer rice	2575.40	2930.60	3003.60	3089.40	3087.80	3040.8	3303.6
Total rice	1323.00	1732.80	2015.20	2182.20	2468.40	2551	2762.4
Wheat	2155.60	1952.60	2144.20	2239.20	2261.40	2432.4	2783.4
Other cereals	1020.32	1594.60	2002.80	1959.20	1979.00	2929.35	3704.76
Total cereals	1360.40	1743.80	2020.60	2183.20	2448.80	2551.4	2786
Total pulses	550.00	624.00	642.60	675.40	755.20	760.6	913
Total foodgrains	1302.40	1672.20	1864.60	2133.40	2386.00	2494.6	2717.86
Rapeseed and mustard	596.80	788.60	786.60	778.80	840.80	888.8	1025.2
Other oilseeds	446.64	682.02	851.86	802.96	960.74	1055.98	1142.03
Total oilseeds	513.20	757.00	803.40	785.20	876.80	955.49	1095.81
Tea	1425.40	1494.68	1553.60	1685.00	1712.00	1986.6	2075.6
Jute	1491.00	1832.40	2028.20	2134.20	2388.20	2508.2	2660
Sugarcane	5625.40	6519.80	17025.20	74257.00	71788.40	86108.6	102721.2
Potato	19129.00	21290.80	22547.80	23414.20	23667.60	20917.2	28806.6
Fruits and vegetables	0.00	0.00	0.00	0.00	12436.00	13630.14	14344.12
Others	2559.80	1797.20	1744.08	1678.26	1991.78	2412.78	2414.12
All crops	21053.40	22284.60	22914.80	23955.4	25208.60	29717.97	35904.44

Source: Computed from data collected from Statistical Handbook (various issues).

Table 5: Exponential Growth Rates in Area, Production and Yield under Different Crops in West Bengal (Percentage)

Crop/s	Phase I			Phase II			Phase III		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Autumn rice	-0.23	4.95	5.2	-4.72	-3.17	1.62	-3.84	-1.1	2.8
Winter rice	-0.23	5.44	5.44	-0.46	1.39	1.62	0	2.33	2.33
Summer rice	11.7	14.29	2.09	1.62	2.09	0.23	4.23	4.95	0.69
Total rice	1.16	6.91	5.68	-0.23	1.39	1.39	0.23	2.57	2.33
Wheat	3.51	2.8	-0.69	0.46	1.62	1.16	0.69	1.62	0.93
Total cereals	1.16	6.41	5.2	0	1.39	1.39	0.23	2.57	2.33
Total pulses	-4.28	-1.37	3.04	-1.37	0.23	1.39	-2.5	-0.9	1.39
Total foodgrains	0.93	6.41	5.44	-0.23	1.39	1.86	0	2.57	2.57
Rapeseed and mustard	14.6	19.4	5.44	0.93	2.09	1.16	2.8	3.99	1.39
Total oilseeds	6.17	13.76	7.65	1.86	3.28	1.62	2.33	4.23	2.09
Tea	0.69	1.62	0.46	1.16	2.8	1.39	0.93	2.09	1.39
Jute	-2.5	7.65	3.99	0.46	2.09	1.39	0.69	3.99	1.86
Sugarcane	-5.16	-2.95	2.33	0	15.3	10.2	0.23	12.7	12.2
Potato	6.91	9.9	2.8	3.04	3.28	0.23	3.99	4.71	0.69
Fruits and vegetables	0	0	0	1.86	3.04	1.16	1.86	3.04	1.16

Source: Computed from data collected from Statistical Handbook (various issues).

Table 6: Variability in area, Production and Yield (C.V. in Percentage) under Different Crops in West Bengal

Crop/s	Phase I			Phase II			Phase III		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Production	Yield
Autumn rice	10.79	23.08	18.65	33.26	22.68	12.64	36.11	22.45	26.51
Winter rice	2.57	21.37	20.06	5.40	12.02	13.73	4.71	22.25	23.25
Summer rice	33.73	40.66	8.28	16.09	17.58	5.12	36.83	40.16	7.94
Total rice	4.52	22.78	19.09	4.37	10.29	11.49	5.66	24.53	22.5
Wheat	16.83	22.34	16.9	14.39	16.39	10.88	15.45	20.36	13.81
Other cereals	9.26	35.47	31	31.27	62.16	30.69	26.74	63.82	40.1
Total cereals	4.62	21.41	17.73	4.09	10.74	11.56	5.42	24.02	21.92
Total pulses	15.44	9.29	11.51	14.03	15.56	13.51	30.79	19.4	16.61
Total foodgrains	3.75	20.82	17.65	4.02	10.62	14.33	4.43	23.5	23.54
Rapeseed and mustard	40.92	55.36	19.8	10.42	20.38	13.56	26.58	36.22	17.59
Other oilseeds	20.73	33.63	26.39	28.31	40.30	15.19	29.14	51.71	27.42
Total oilseeds	22.14	44.38	24.16	14.35	25.57	13.65	23.01	39.14	21.57
Tea	3.67	6.57	5.36	9.65	20.79	11.42	10.41	24.08	13.81
Jute	19.73	41.78	14.63	8.54	15.61	10.4	13.38	30.86	18.24
Sugarcane	36.31	29.74	10.66	25.41	64.81	46.18	28.35	93.52	78.03
Potato	21.05	29.04	10.04	21.13	35.08	22.53	35.87	48.66	21.25
Fruits and vegetables	0	0	0	9.09	15.42	6.62	9.09	15.42	6.62
Others	14.18	41.24	29.91	6.67	20.79	17.29	11.15	27.29	21.94
All crops	4.08	7.57	5.88	7.38	21.43	16.86	10.66	26.51	18

Source: Computed from data collected from Statistical Handbook (various issues).

Table 7: Variability in Area, Production and Yield (C.V. in Percentage) under Different Crops by Divisions

Crop/s		Burdwan Division			Presidency Division			Jalpaiguri Division		
		Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Autumn rice	Phase I	17.82	36.62	18.14	19.48	27.69	17.41	13.08	16.57	14.07
	Phase II	27.51	23.64	8.76	22.65	17.49	12.65	55.14	42.82	18.5
	Phase III	24.74	29.85	18.66	32.56	20.59	19.75	59.32	39.07	30.71
Winter rice	Phase I	2.77	22.31	20.56	4.02	26.74	24.07	4.68	16.23	11.55
	Phase II	5.86	12.95	12.2	10.02	13.19	13.27	5.51	18.69	21.46
	Phase III	5.09	22.62	22.01	8.62	23.68	22.13	5.24	25.96	27.24
Summer rice	Phase I	29.37	36.59	11.44	35.79	42.48	8.85	56.09	59.82	9.54
	Phase II	16.49	18.67	5.83	13.49	15.17	5.95	24.69	24.47	8.31
	Phase III	35.69	40.25	9.69	33.7	36.72	7.92	50.01	50.81	12.49
Total rice	Phase I	4.39	23.7	19.33	7.05	26.72	20.22	5	17.11	11.75
	Phase II	4.63	11.37	10.5	7.51	10.23	9.23	5.87	14.02	19.51
	Phase III	7.19	25.2	20.56	8.47	25.05	20.29	5.79	25.04	28.01
Wheat	Phase I	23.93	24.41	11.22	13.54	28.27	18.05	26.04	18.33	17.79
	Phase II	19.8	23.94	9.81	14.73	16.47	14.32	13.58	16.67	11.38
	Phase III	22.91	23.71	11.75	15.25	21.28	15.23	18.89	23.82	14.16
Other cereals	Phase I	23.5	40.59	23.64	34.32	34.57	36.47	11.43	44.4	23.81
	Phase II	30.39	36.49	35.69	52.31	88.72	57.59	39.49	71.17	44.15
	Phase III	31.6	37.21	39.79	53.99	81.47	65.26	32.97	73.59	52.4
Total cereals	Phase I	4.45	23.22	18.89	6.43	23.37	17.8	5.42	16.75	13.72
	Phase II	4.62	11.43	10.43	7.38	9.87	9.87	3.82	16.44	15.71
	Phase III	6.92	24.86	20.39	8.22	23.37	18.69	4.38	26.14	24.97
Total pulses	Phase I	22.67	28.65	13.83	17.23	12.52	9.16	12.04	11.21	51.84
	Phase II	12.47	17.77	14.99	15.36	21.56	16.57	33.47	29.05	12.59
	Phase III	34.99	20.01	19.62	30.68	22.34	18.44	36.15	30.97	32.04
Total food-grains	Phase I	4.29	22.99	19.12	4.25	22.17	19.41	4.74	15.98	12.15
	Phase II	4.59	11.38	10.64	6.85	9.75	9.57	4.57	16.01	16.89
	Phase III	6.37	24.66	20.97	6.39	22.43	19.89	5.03	25.27	25.89
Rape-seed and mustard	Phase I	43.24	59.08	18.94	36.45	50.08	13.89	30.94	56.98	23.21
	Phase II	17.13	17.17	11.18	13.51	26.58	17.69	17.14	28.38	13.19
	Phase III	26.29	31.92	13.76	31.83	45.18	19.39	26.18	42.12	18.67

(Contd.....)

Table 7 (Contd.....)

Crop/s		Burdwan Division			Presidency Division			Jalpaiguri Division		
		Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Other oilseeds	Phase I	29.19	42.29	24.58	22.81	47.45	40.64	35.42	34.63	8.46
	Phase II	31.49	43.37	15.45	35.23	45.24	18.02	16.92	27.45	26.66
	Phase III	36.89	56.88	22.36	34.84	56.83	30.15	45.05	29.16	31.79
Total oilseeds	Phase I	27.79	46.04	40.92	22.11	45.48	23.56	14.72	41.09	19.85
	Phase II	14.56	25.25	11.95	17.81	30.38	20.94	13.19	27.14	15.27
	Phase III	22.4	36.76	22.84	29.56	46.86	27.63	15.06	37.29	21.63
Tea	Phase I	0	0	0	0	0.00	0	35.37	76.15	54.92
	Phase II	0	0	0	0	0	0	13.32	29.07	40.95
	Phase III	0	0	0	0	0.00	0.00	22.68	62.26	44.58
Jute	Phase I	26.26	41.4	17.68	17.12	25.86	13.72	22.54	39.94	13.19
	Phase II	15.49	17.93	14.14	10.51	15.26	9.84	8.65	22.62	21.74
	Phase III	19.43	27.8	17.03	16.12	28.22	18.26	13.69	32.31	26.88
Sugar-cane	Phase I	31.26	35.64	13.93	50.35	46.14	13.76	49.11	39.09	32.4
	Phase II	28.68	70.03	51.21	24.18	64.93	50.79	48.94	71.41	59.42
	Phase III	27.92	97.16	81.31	34.25	91.93	80.79	51.46	103.29	91.05
Potato	Phase I	24.24	30.51	10.25	17.19	23.99	19.47	21.74	28.23	13.84
	Phase II	16.27	30.27	22.85	26.88	41.62	20.62	41.41	63.06	30.49
	Phase III	31.98	42.11	20.38	34.54	52.53	22.72	59.08	89.83	44.89
Fruits and vegetables	Phase I	0	0	0	0	0.00	0	0	0.00	0
	Phase II	102.5	102.84	102.4	102.8	104.06	102.46	102.4	102.96	102.44
	Phase III	137.81	138.15	137.6	138.1	139.43	137.76	137.7	138.28	137.74
Others	Phase I	28.97	40.06	18.41	50.61	60.01	35.12	24.79	51.38	21.59
	Phase II	95.38	50.91	50.94	102.3	69.41	46.37	24.13	23.66	29.79
	Phase III	91.85	47.89	42.68	105	65.99	42.89	25.59	32.43	30.75
All crops	Phase I	5.18	22.61	17.67	3.6	16.7	14.4	2.94	17.51	14.89
	Phase II	7.42	24.75	20.27	9.77	32.51	23.79	7.74	42.96	37.48
	Phase III	11.11	38.44	29.76	12.19	44.61	32.46	7.71	54.79	48.71

Source: Computed from data collected from Statistical Handbook (various issues).

Table 8: Variability in Area, Production and Yield by Crop Clusters (C.V. in Percentage) in West Bengal

Crop Cluster	Phases			
		1980-81 to 1989-90	1990-91 to 2013-14	1980-81 to 2013-14
Foodgrains	Area	3.75	4.02	4.43
	Production	20.82	10.62	23.5
	Yield	17.64	14.33	23.54
Non-Foodgrains	Area	9.13	10.69	17.07
	Production	7.12	20.62	24.57
	Yield	5.16	11.61	10.29
All	Area	4.08	7.38	10.66
	Production	7.57	21.43	26.51
	Yield	5.88	16.86	18

Source: Computed from data collected from Statistical Handbook (various issues).

Table 9: Inter-district Variation in Area, Production and Yield (C.V. in Percentage) by Crops

Crop/s	1980-81			1990-91			2013-14		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Autumn rice	83.39	72.7	35.44	67.07	59.4	39.26	116.86	115.3	19.43
Winter rice	72.58	70.86	15.74	66.57	61.45	30.71	67.23	58.82	15.77
Summer rice	115.14	112.76	36.01	90.41	92.29	8.87	93.96	98.09	17.32
Total rice	63.9	66.98	19.35	61.38	61.06	27.3	69.98	64.55	14.73
Wheat	119.87	110.3	14.91	135.73	137.17	20.61	131.41	133.88	18.89
Other cereals	147.47	166.81	61.1	176.16	190.42	80.72	151.26	195.97	52.07
Total cereals	58.16	61.1	18.75	56.25	57.29	25.14	63.34	58.65	14.25
Total pulses	96.74	95.1	19.79	111.42	117.77	18.1	118.23	126.22	30.04
Total foodgrains	56.09	59.68	19.87	54.5	56.72	25.73	61.77	58.33	13.56
Rapeseed and mustard	81.24	103.6	40.19	80.29	86.21	22.45	97.92	104.95	21.95
Other oilseeds	74.2	72.84	27.6	100	116.1	37.36	137.67	139.31	47.26
Total oilseeds	68.79	76.65	27.11	64.63	70.23	19.52	81.86	87.25	35.25
Tea	280.7	468.33	155.3	314.22	885.44	286.7	105.56	77.18	93.85
Jute	94.22	86.24	100.73	111.24	131.74	98.33	111.78	118.67	95.74
Sugarcane	113.12	132.18	9.05	115.38	158.99	67.05	83.52	134.54	49.88
Potato	123.09	163.74	49.52	131.23	150.06	38.54	101.81	95.19	23.53
Fruits and vegetables	0	0	0.00	0	0	0	51.98	56.26	14.8
Others	142.03	124.64	50.18	144.61	122.2	44.26	96.15	144.14	46.45
All crops	50.39	54.92	37.15	49.12	61.5	48.8	53.59	51	20.44

Source: Computed from data collected from Statistical Handbook (various issues).

Table 10: Simpson's Index of Crop Diversification for Different Districts of West Bengal

District	Year							
	1980-81	1985-86	1990-91	1995-96	2000-01	2005-06	2010-11	2013-14
Bwn	0.24	0.25	0.3	0.22	0.28	0.36	0.41	0.39
Birbhum	0.15	0.19	0.23	0.14	0.22	0.34	0.46	0.37
Bankura	0.16	0.15	0.21	0.19	0.2	0.38	0.56	0.41
Midnapur	0.12	0.13	0.16	0.21	0.21	0.37	0.39	0.39
Hooghly	0.42	0.46	0.49	0.49	0.59	0.6	0.65	0.65
Purulia	0.04	0.05	0.06	0.05	0.03	0.23	0.37	0.24
24 Pdns	0.22	0.2	0.19	0.18	0.26	0.45	0.51	0.51
Hwh	0.23	0.19	0.14	0.17	0.28	0.36	0.4	0.41
Nadia	0.47	0.54	0.47	0.52	0.58	0.65	0.68	0.68
Murshidabad	0.36	0.44	0.41	0.44	0.52	0.56	0.65	0.63
Dinajpur	0.39	0.45	0.3	0.31	0.39	0.5	0.53	0.53
Malda	0.27	0.33	0.26	0.22	0.33	0.51	0.54	0.54
Jpg	0.5	0.55	0.51	0.54	0.55	0.48	0.68	0.7
Darjeeling	0.49	0.53	0.38	0.44	0.5	0.64	0.7	0.66
Coochbehar	0.43	0.41	0.35	0.42	0.43	0.59	0.6	0.6

Source: Computed from data collected from Statistical Handbook (various issues).

Table 11: Tobit Regression Analysis of Factors Determining Crop Diversification for the Year 1980

<i>[Dependent Variable (Y_i) = Simpson Index of Crop Diversification for the year 1980]</i>	
Explanatory Variables	Estimated Coefficients
Average Area Operated Under Potato ('000 hectares)	0.0091 (2.57)**
Cropping Intensity	0.0024
Percentage of Area Irrigated	-0.0019 (-2.03)***
Fertilisers Per Unit of Gross Cropped Area	-0.0034 (-2.33)**
Number of Electrified Villages	-0.0003 (-3.93)*
District-wise Harvest price of Potato (₹/Quintal)	-0.0009
Road Length Maintained by PWD (In km.)	0.0002 (2.44)**
Constant	0.1752
Chi square-Statistic	26.68
Sample Size	15

Notes: i) Figures in first brackets are computed t-values.

ii) *, ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.

Table 12: Tobit Regression Analysis of Factors Determining Crop Diversification for the Year 1990

<i>[Dependent Variable (Y_i) = Simpson Index of Crop Diversification for the year 1990]</i>	
Explanatory Variables	Estimated Coefficients
Average Area Operated Under Potato ('000 hectares)	0.0025
Cropping Intensity	0.0028 (2.9)**
Percentage of Area Irrigated	0.0009
Fertilisers per Unit of Gross Cropped Area	-0.0017 (-2.66)**
Number of Villages Electrified	-0.0001 (-2.4)**
Road Length Maintained by PWD (In km.)	0.00007
Constant	0.1052
Chi square-Statistic	11.99
Sample Size	15

Notes:i) Figures in first brackets are computed t-values.

ii) * , ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.

Table 13: Tobit Regression Analysis of Factors Determining Crop Diversification for the Year 2000

<i>[Dependent Variable (Y_i) = Simpson Index of Crop Diversification for the year 2000]</i>	
Explanatory Variables	Estimated Coefficients
Average Area Operated Under Potato ('000 hectares)	0.0071 (4.35)*
Cropping Intensity	0.0027 (2.87)**
Percentage of Area Irrigated	-0.0009
Fertilisers Per Unit of Gross Cropped Area	-0.0009 (-2.87)**
Number of Electrified Villages	-0.0001 (-4.51)*
District-wise Harvest Price of Potato (₹/Quintal)	0.0008
Road Length Maintained by PWD (In km.)	0.00004
Constant	-0.0874
Chi square-Statistic	24.4
Sample Size	15

Notes:i) Figures in first brackets are computed t-values.

ii) * , ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.

Table 14: Tobit Regression Analysis of Factors Determining Crop Diversification for the Year 2010

<i>[Dependent Variable (Y_i) = Simpson Index of Crop Diversification for the year 2010]</i>	
Explanatory Variables	Estimated Coefficients
Average Area Operated Under Potato ('000 hectares)	0.0033 (3.45)*
Cropping Intensity	0.0004
Percentage of Area Irrigated	-0.0067 (-3.34)*
Fertilisers Per Unit of Gross Cropped Area	0.0006
Number of Electrified Villages	-0.00005 (-4.00)*
District-wise Harvest Price Of Potato (₹/Quintal)	0.0002
Road Length Maintained by PWD (In km.)	0.00006
Constant	0.3058 (-1.77)***
Chi square-Statistic	19.16
Sample Size	15

Notes:i) Figures in first brackets are computed t-values.

ii) * , ** and *** imply significance at 1, 5 and 10 per cent levels, respectively.