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Methodology, data and its Limitations

3.1 Introduction

Inquiry into the economics of crop diversification in West Bengal during 1970-71 to 1994-95 has been done in several parts. Here, three major aspects of crop diversification viz. Nature, causes and consequences have been examined rigorously. In the next part of the analysis, nature of crop diversification that has taken place in West Bengal during 1970-71 to 1994-95 has been discussed from different angles. Thereafter, impact of crop diversification, mainly on agricultural production has been evaluated and finally an attempt has been made towards the discussion of important reasons behind this diversification.

3.2 Nature of Diversification

Nature of crop diversification is first examined through changes in allocation of land towards the cultivation of different crops grown in different seasons over the years. Inter-crop variations in output are also considered in contrast to the changing acreage allocation and also to know the regional pattern of diversification. In addition to that, inter-district disparity in agricultural productivity and its movement over time has been analysed in relation to cropping pattern change in chapter-6.

Changes in acreage distribution is explained by comparing the proportion of area under different crops to gross cropped area (GCA) during 1970-73, 1977-80, 1984-87 and 1991-94. Triennia average values of area under crops and that of GCA have been calculated for those years. Then the average proportion of area of each crop has been computed. The years 1970-73 and 1991-94 are considered, as they are the initial and final year of the period of discussion. The year 1977-80 represents the years of change of political scenario, when left-front government took over the power of the state. The arrival of left-front led government has enforced the redistribution of land resources among the people through rigorous implementation of land reform measures. Moreover, a close look
at the data on different aspects like, area and production of major crops reveals that there was a remarkable shift in area and production of various crops during mid-eighties.

Average annual exponential rate of growth of area under crops is estimated by fitting regressions of the type $\ln Y_t = \alpha + \beta t$, where $Y_t$ represents the value of dependent variable (here it is area under ith crop at time $t$), $\alpha$ and $\beta$ are the two parameters and $t$ is the time in years. The coefficient $\beta$ represents the exponential rate of growth of $Y$. The trend equations have been fitted by ordinary least square method (OLS) for the whole period. Truncated regressions have also been fitted, by dividing the entire period into different sub-periods. Those are 1970-71 to 1978-79, 1979-80 to 1994-95, 1970-71 to 1981-82, 1982-83 to 1994-95 and 1986-87 to 1994-95.\(^1\) Thereafter the change in rate of growth is estimated by forming the trend equations of the type $\ln Y = \beta_0 + \beta_1 t + \beta_2 t^2$ where $Y_t$ is the area under ith crop, $t$ is the time in years and $\beta_0, \beta_1, \beta_2$ are the coefficients. Here $2\beta_2$ represents the rate of change in the rate of growth. If the estimated value of it is positive and significant then growth is accelerating. On the other hand a negative value of $\beta_2$ represents a deceleration in the rate of growth.

Having considered the rate of growth and changes in rate of growth of acreage of different crops, analysis has been done to consider the substitution and expansion of area under different crops. First of all, to ensure the existence of inter-crop shift of area a simple method is followed. For this purpose, the area under crops that have experienced an increasing trend during the entire period under consideration is aggregated. Then sum of area under crops, having a negative trend or feature of stationarity during the same period is calculated for all the years. The former aggregate is denoted by $X_i$ and the latter by $X_j$. $X_i + X_j = X$ represents the gross cropped area. An equation may be formed to show the division of total change into substitution and expansion terms as follows:

$$\frac{\partial X_i}{\partial X_j} = \frac{\frac{dx_i}{dt} - \frac{\partial x_i}{\partial x} \cdot \frac{dx}{dt}}{dx_i/dt}$$

(Since, $X_i = F(X, X_j)$ and

$$\frac{dx_i}{dt} = \frac{\partial x_i}{\partial x} \cdot \frac{dx}{dt} + \frac{\partial x_i}{\partial x_j} \cdot \frac{dx_j}{dt}$$)

\(^1\) For some crops, data are not available for 1994-95 and hence the periods for them are considered up to 1993-94 for regression analysis.
Here, \( \frac{\partial x_i}{\partial x_j} \) represents the rate of change in area under ith crop-group due to one marginal change in area under jth crop-group when total area under cultivation is assumed to remain constant. If X is kept as if constant, \( \frac{\partial x_i}{\partial x_j} \) must be negative; which indicates the rate of rise in area under ith crop-group at the expense of area under jth group. Thereafter elasticity of area under each crop with respect to GCA is calculated to identify the crops that have a gain in area from other crops and those, who lose area to formers. If the elasticity is greater than unity for any crop then it can be said that the area under that crop has increased due to both expansion of area under cultivation as well as substitution for area under decreasing crops. On the other hand if the elasticity is negative for any crop then it can easily be asserted that the crop has lost area to crops having elasticity greater than one. However if the elasticity is positive but less than one then it is very difficult to assert whether the rise in area is due to the expansion of total area under cultivation or due to substitution of area from other crops. Here one can only say that the area of the crop has increased at a rate less than that of the GCA.

The absolute quantity of gain or loss of area under each crop can be approximated in the following way:

Suppose \( a_0 \) and \( a_t \) are the area under an individual crop in the base and final period and Ao and At are the gross cropped area in the base and final period. Then actual change in area under that individual crop during the period is \( (a_t - a_0) \). If the proportion of area under that crop to GCA remains same throughout the whole period as was in the initial year \( (a_0/A_0) \) then \( (a_0/A_0)A_t \) would be the final year area under that crop. Therefore, \( (a_0/A_0)A_t - a_0 \) may represent the change in area under an individual crop due to expansion of gross cropped area. It is then subtracted from the actual change in area under the reference crop \( (a_t - a_0) \) to get the change in area due to substitution effect. In other words, absolute amount of change in area due to substitution effect is estimated by subtracting from the final year area under each crop, the initial year area under it multiplied by the ratio of final and base year GCA, i.e., \( \{a_t - a_0 . (A_t / A_0)\} \).

Variability and instability of acreage growth of different crops are also considered at district level. Variability of acreage growth around trend is tested by using Goldfeld-Quandt test\(^2\) while instability of the same is tested by Chow test.\(^3\)

\[ \sum e_i^2 / (n_1-k) \]
\[ \sum e_i^2 / (n_2-k) \]

\(^2\) Gold-feld Quandt Test: \( F_{n-k,n-k} = \frac{\sum e_i^2 / (n_1-k)}{\sum e_i^2 / (n_2-k)} \). Actually it is done after eliminating some central
Inter-crop and intra-crop variation in production of different crops is considered in chapter-5. Crop-wise changes in contribution of each district to total production of state (in terms of proportion to total state’s production) during 1970-71 to 1994-95 is considered first. Inter-district disparity has been measured by the coefficient of variation of proportion to state’s total production. Then rate of change in production of each crop during last two and half decades is measured by simple growth rates. Average annual exponential rate of growth of production of each crop has been estimated by least square regression, for the whole as well as all sub-periods, as was done in case of area under crops.

Inter-district disparity in agricultural productivity has been considered in chapter-6. Here log-linear trend equations are fitted for the estimation of annual exponential rate of yield growth for major crops as was done in case of area and production. Then triennia average yield of different crops has been calculated for four discrete years 1970-73, 1977-80, 1984-87 and 1992-95. Inter-district disparity of crop-yield and its change during 1970-71 to 1994-95 has been considered in terms of coefficient of variation and its change over time. Change in absolute yield of major crops in terms of simple growth rates during 1970-71 to 1994-95 has also been considered and compared. Finally, in order to show the inter-district disparity in agricultural productivity in aggregate and its variation over time a composite productivity index is formed at the district level for various years. The index is formed in the following way:

First of all, a yield index or yield relative has been calculated for different crops for each district and that in the state is calculated. Suppose \(Y_{ij}\) and \(Y_{io}\) are the average yield of \(i^{th}\) crop in the \(j^{th}\) district and in the state. Then yield relative \((K_{ij})\) when expressed in percentage can be written as \(K_{ij} = \left( \frac{Y_{ij}}{Y_{io}} \right) \times 100\). \(K_{ij}\) is the yield relative for \(i^{th}\) crop in the \(j^{th}\) district. Thereafter, these values are multiplied by the proportion of area under corresponding crop to total cropped area in the district and then added up to get the

\[
\text{observation and comparing residual sum of squares (RSS) of two sub-periods. In this study, at first it is calculated without omitting any observation and then RSS of 1970-71 to 1978-79 sub-period is compared with the RSS of 1985-86 to 1993-94 sub-period. The two statistics are represented by } F_1 \text{ and } F_2 \text{ respectively.}
\]

\[
\text{Chow test, } F_k = \frac{\left( \sum e_i^2 - \left( \sum e_1^2 + \sum e_2^2 \right) \right) / k}{\left( \sum e_1^2 + \sum e_2^2 \right) / (n_1 + n_2 - 2k)}
\]

where \(n_1 + n_2 = n\). Here \(\sum e_1^2\) is the residual sum of squares considering the whole period or set of data and \(\sum e_2^2\) are the residual sum of squares of first and second sub-periods, \(k\) is the number of parameters.
composite productivity index (CPI). Then \( \text{composite productivity index (CPI)} \) for the \( j \)-th district can be written as \( \text{CPI}_j = \sum(Y_{ij}/Y_{0j} \cdot (A_{ij}/A_{0j}) \cdot 100) \), where \( A_{0j} = \sum A_{ij} \) and \( A_{ij}/A_{0j} = \) proportion of area under \( i \)-th crop in the \( j \)-th district, \( j = 1, 2, \ldots, 15 \). The index is calculated for the year 1970-71, 1978-79, 1985-86 and 1993-94. Inter-district disparity has been considered by coefficient of variation of these district level indices. The same index is also constituted for the food and non-food crops separately.

### 3.3 Impact of Changes in Cropping Pattern

Major impacts of cropping pattern change are explained with a special stress to its impact on agricultural production in chapter-7. In order to analyse the impact of changes in cropping pattern on agricultural production (crop output only) in west Bengal during 1970-71 to 1993-94, the seven factor additive scheme as suggested by Minhas, is used. For this purpose, output of major crops in any year is computed first from the log linear trend equations.

Value of each crop-output at each point of time is then calculated by multiplying with base year price (triennia average of 1969, 70 and 71). Thereafter they are added to arrive at the total value of agricultural output. Thus the change in agricultural output during 1970-71 to 1993-94 has been computed and split up according to the source of variation by using additive scheme of decomposition. The same analysis has also been done for the two sub-periods namely, 1970-71 to 1981-82 and 1982-83 to 1993-94. The decomposition is done in the following way:

\[
Q_t - Q_0 = A_t \sum C_{it} Y_{it} P_t - A_0 \sum C_{i0} Y_{i0} P_t ,
\]

Or,

\[
Q_t - Q_0 = (A_t - A_0) \sum C_{i0} Y_{i0} P_t + A_0 \sum (C_{it} - C_{i0}) Y_{i0} P_t + A_0 \sum (C_{it} - C_{i0}) (Y_{it} - Y_{i0}) P_t + (A_t - A_0) \sum (C_{it} - C_{i0}) (Y_{it} - Y_{i0}) P_t + (A_t - A_0) \sum (C_{it} - C_{i0}) (Y_{it} - Y_{i0}) P_t .
\]

Where \( Q_0 \) and \( Q_t \) represent base and final year value of gross agricultural output at constant prices \( (P_t) \), \( A_0 \) and \( A_t \) are the gross cropped area during period 0 and \( t \) respectively. \( C_{i0} \), \( C_{it} \) and \( Y_{i0} \), \( Y_{it} \) represent respectively the proportion of area under \( i \)-th crop to the gross cropped area in the base and final period and yield of \( i \)-th crop in the base and final year. \( P_t \) is the price of \( i \)-th crop in the base (triennia average of harvest price in 1969, 70 and 71) year. The first three components on the right hand side of the equation represent direct effect of area, cropping pattern and yield on output. The next three are the
interaction effects of area and cropping pattern, area and yield, cropping pattern and yield. The last one shows the interaction effect of changes in all these three area, yield and cropping pattern in the growth of output.

Alternatively change in total agricultural output due to inter-crop substitution of acreage is estimated in the following way:

Total change in output over a period can be written as $Q_t - Q_0 = \Delta Q_{(A,C,Y,P)} = \sum A_i \cdot Y_i \cdot P_{i0} - \sum A_{i0} \cdot Y_{i0} \cdot P_{i0} = f(A, C, Y, P)$ where $P_{i0}$ and $P_i$ are the prices of $i$th crop in the base and final period. $A_{i0}$ and $A_i$ are area under $i$th crop in the base and final period respectively. $\Delta Q_{(A,C,Y,P)}$ represents the change in output due to changes in above mentioned four responsible factors, area, cropping pattern yield, and price. The other symbols are used in the same sense as used in former analysis. This methodology is followed because it is necessary and easily possible to eliminate the effects of other factors from the total change for isolating the cropping pattern effect.

From the total change in output, effect of changes in yield rates and prices can be eliminated by multiplying the areas in the final period with the respective yield rates and prices as in the base period and then subtracting from it the total production (value) in the base period. Therefore, $\Delta Q_{(A,C)} = \sum A_i Y_{i0} P_{i0} - \sum A_{i0} Y_{i0} P_{i0}$ represents the change in output due to changes in GCA and cropping pattern. From this again the effect of change in gross cropped area can further be eliminated, assuming that the increase or decrease in area under the crops has changed in the same proportion as that of total cropped area. Therefore, the effect of cropping pattern changes on agricultural output alone, is given by $\Delta Q_{(A,C)} - \Delta Q_{(A)} = \Delta Q_{(C)} = \sum A_i Y_{i0} P_{i0} - \sum A_{i0} Y_{i0} P_{i0} \cdot \left( \frac{A_t}{A_0} \right)$ $\Delta Q_{(C)}$ represents the effects of area changes of different crops occurred due to substitution effect, on total value of output. The same sort of analysis was earlier followed by National Council of Applied Economic Research (NCAER, 1966) in order to explain the impact of Cropping pattern change in Punjab.4

3.4. Reasons behind Diversification

Having considered the nature and consequences of crop diversification, an analysis of basic causes of crop diversification has been made in chapters 8-10. In the present study mainly the reasons behind the growth of area under crops that have experienced a

remarkable growth during the period under consideration is considered first. To find out the impact of basic determinants for rapid increase in area under some crops than others, price and non-price factors are identified. The methodology applied has been explained elaborately with justification in the relevant section. Here a precise description of the steps followed is presented.

Since both price and non-price factors like, rainfall, irrigation, availability and use of chemical fertiliser, yield of crops etc. have some kind of influence on the acreage allocation by the farmers for the production of different crops, here all of them are incorporated in the regression analysis. The regression analysis has been done in two parts. First of all, only the non-price factors like rainfall, irrigation, chemical fertiliser (which are essential for the cultivation of crops) and yield, are included in the analysis. Then the price factor is introduced in the extended version.

Firstly area under a crop or crop group is expressed as a function of rainfall $R$, irrigation ($I$), chemical fertiliser $C$ and yield ($Y$). The stochastic form of relationship can be written as

$$\ln A_{it} = b_0 + b_1 \ln R_t + b_2 \ln I_t + b_3 \ln C_t + b_4 \ln Y_{it} + U_{0i} \quad (1)$$

where $A_{it}$ is the acreage of $i$th crop in the year $t$, $R$ is the level of rainfall measured in millimetre, $I$ is the area under irrigation, $C$ represents consumption of chemical fertiliser, $Y$, the yield of the particular crop. All of them are the explanatory variables. $b_j$'s are the coefficients representing elasticities of acreage growth with respect to the corresponding explanatory variables and $U_{0i}$ is the conventional random disturbance term with usual classical linear regression properties.

A dummy variable $(D_i)$ is also included as another explanatory variable which is assumed to incorporate the effect of land reform measures undertaken by the government of West Bengal on the acreage variation of crops. Then, the new stochastic form of equation will be

$$\ln A_{it} = b_0 + b_1 \ln R_t + b_2 \ln I_t + b_3 \ln C_t + b_4 \ln Y_{it} + b_5 D_i + U_{1i} \quad (2).$$

Where, $D$ takes value 0 in a pre-land reform year and it assumes value 1 in the post-land reform years starting with 1979. The equation is called the modified Cobb-Douglas form. Here it may be observed that explanatory variables are more or less correlated as yield of a crop is influenced by the quantity of rainfall, irrigation and chemical fertiliser or there is a complementarity between the level of irrigation and use of chemical fertiliser. So the multicollinearity problem and related issues would arise. In such a situation it is very difficult to form a consistent and perfect model, free from any kind of limitation. Any of
the explanatory variables that have a strong correlation with some others may be excluded from the expression. But later it is found that the correlation coefficient is not exactly equal to one. Moreover the identified variable has a particular type of influence on farmers’ decision on acreage allocation. So all the variables are retained despite the presence of near-exact multicollinearity to avoid the specification error. The regression is run on shifting basis. At first, only one independent variable is included and then number of explanatory variables are increased. By doing so it is possible to examine the increase in percentage of total variation explained after the introduction of additional variable. Simultaneously significance of the coefficients can be judged.

Prices of crops are also incorporated into the regression analysis in the same way, as the other explanatory variables were included in the model. Initially area under crops has been regressed only on price lagged one year or total proceeds per acre (price lagged one year multiplied by yield) to know the direct impact of price or per acre revenue on the planning of acreage. In the multiple regression equations price of the crop itself and that of its competing crops, yield of the competing crops along with the others are included in the extended version. In this context three different forms of extended versions are considered. These are:

\[
\ln A_{it} = a_0 + a_1 \ln R_{it} + a_2 \ln l_{it} + a_3 \ln C_{it} + a_4 \ln Y_{it} + a_5 \ln P_{i-1} + a_6 \ln Y_{jt} + a_7 \ln P_{j-1} + a_8 D_t + \epsilon_{2t} \quad (3)
\]

\[
\ln A_{it} = a_0 + a_1 \ln R_{it} + a_2 \ln l_{it} + a_3 \ln C_{it} + a_4 \ln T_{it} + a_5 \ln Y_{jt} + a_6 D_t + \epsilon_{3t} \quad (4)
\]

\[
\ln A_{it} = a_0 + a_1 \ln R_{it} + a_2 \ln l_{it} + a_3 \ln C_{it} + a_4 \ln (P_{i-1} Y_{it} / P_{j-1} Y_{jt}) + a_6 D_t + \epsilon_{4t} \quad (5)
\]

Here \(P_{i-1}\) and \(P_{j-1}\) represent respectively price of ith crop and jth crop lagged one year. Suffix j is used to denote the crop or crops that can be grown during the same season on the same field on which ith crop is cultivated, \(\epsilon_t\) s are the random disturbance terms. \(a_6\) and \(a_7\) in equation-3 are the cross yield and price elasticities of area under ith crop with respect to yield and price of jth crop. \(T_t = (P_{i-1} Y_{it})\) and \(T_j = (P_{j-1} Y_{jt})\) are the proceeds per hectare of ith and jth crop evaluated at the previous year’s prices. \(a_4\) and \(a_5\) in equation-4 represent direct and cross elasticities of area under ith crop with respect to proceeds per hectare of ith and jth crop respectively. In equation-5 total turnover in ratio form are introduced, as explanatory variables on the presumption that, farmers would still continue to produce ith crop if its relative revenue remains higher than the others (competitors), irrespective of the direction of price movement. This is done to examine whether the
cultivators are much concerned with the relative revenue of crop or price, whatever is the cost. It is however true that; variation in yield and thus revenue is also associated with a change in cost per unit of area. The implicit assumption is therefore that, the cost of production per unit of area either has not changed or even if it has happened, had affected all the crops in a similar fashion and/or the farmers had taken it at a discount.

Two other forms of equations \( \ln \left( \frac{A_{it}}{A_{jt}} \right) = a_1 + b_1 \ln \left( \frac{P_{i,1}}{P_{j,1}} \right) \) ........(6)

and \( \ln \left( \frac{A_{it}}{A_{jt}} \right) = a_2 + b_2 \ln \left( \frac{P_{i,1}Y_i}{P_{j,1}Y_j} \right) = a_2 + b_2 \ln \left( \frac{T_i}{T_j} \right) \) ....(7), are also considered and these estimated forms are compared with the earlier results to have a firm idea about the relative importance of price and non-price factors on the acreage allocation decision of the farmer.

An alternative approach is also considered along with the earlier versions. The alternative explanation is based on the actual interdependence that is observed among the yield and cost (simply profitability) of different crops grown in successive seasons on the same plot of land. In the earlier approach actually price and yield of crops that can be grown during the same season are considered for the explanation of acreage variation of any crop i.e., the crops, which are directly competitive in production are considered. However profitability of crops grown successively on the same plot are partially dependent because of their overlapping harvesting and sowing season. With identical application of all inputs yield of any crop would be different due to differences in crops cultivated in the earlier season on the same plot. So focus of attention should be turned towards the profitability of different combinations of crops that can be grown on the same plot of land where the objective of the farmer is to allocate land in successive seasons over the year in such a way as to maximise net benefit over the years. Having identified the basic inputs, the growth of which has enabled the farmers to expand area under some lucrative crops, profitability of different combinations of crops that can be tried throughout the whole crop-year on a particular plot has been calculated and compared.

Farmers are interested not only in the profit earned from the cultivation of crops in each season but also in the profit earned throughout the whole crop-year. Since choice of crops to be grown in any season may affect the revenue and cost of the next possible crops, the farmer may not choose one for cultivation even if it gives highest profit in that season but it hampers the cultivation of the next season’s crops and hence the profitability in such a way that the total profit earned in a year is less than that if any other crop is
chosen in the current season. The other one may yield somewhat less profit but may not disturb the yield or profit of the next season’s crop.

Profitability of different combinations of crops that can be grown on a particular plot of land in a crop year is calculated on the basis of the data on cost and revenue of different crops available from the Study on Farm Management and Cost of Production of Crops in West Bengal, during 1993-94. This was the latest study available, conducted by the Evaluation Wing, Directorate of Agriculture, Government of West Bengal. Here cross section study is followed because the combinations, which are seen now a days, were not practised in the early years of seventies. So it is not possible to compare the relative profitability of same combination during nineties with that of seventies after the adjustment of price indices. Her, just by comparing the profitability of different combinations it is possible to show that the crops involved in the highest remunerative combination occupies the most important position in the land allocation over different seasons of the year.

The aforesaid study however has one weakness, which needs attention. Here profits of alternative combinations are calculated only by adding the profit of different crops incorporated in different combinations. This is because the data available do not present the cost or benefit of each crop for different cases i.e., corresponding to different preceding crops. Here data offered by Farm Management Study show the average cost and benefit of each crop, that is cultivated in combination with any of the possible combinations. Thus, for the purpose of analysis in the way desired, a primary survey has been conducted in the district of Burdwan.

Burdwan is one of the important agricultural districts of West Bengal. The southern part of the district is highly dominated by agricultural activities than the northern part. Over past few decades agricultural development in the district has taken place at rapid rate. A sample of 60 farms is chosen 20 from each of the three villages in Madhabdihi block of southern Burdwan. The block is well developed in the agricultural sphere and the three contiguous villages are selected purposively as those villages were known for several years, where cultivation takes place intensively. Most of the plots are under multiple cropping. So it is possible to have data on cost and benefit of each crop with different preceding and succeeding crops on separate plots of land. Cropping is done for direct consumption as well as for marketing. There is good marketing facilities as well
as co-operative and banking facilities. There exists well-organised irrigation infrastructure, mostly under private ownership and a part under government canals, river lift irrigation and deep-tubewells. Most of the plots can receive water for most of the time of the year. Farming is done with the help of both hired as well as own family labour.

From each village, 20 farms have been selected by simple random sampling without replacement. From each of the scientifically selected farm various data relating to the availability of irrigation facilities, topology of plots, price about the inventory and live stock with its value and the repair, if any etc. are collected. Information like utilisation of family labour and hired labour, quantity and value of seeds, fertilisers used, manures, quantity and share of landowner (if leased in), cost of machineries (pump-set, power tiller etc.) incurred for each crop (hired or own) are gathered. Data on quantity of land allocated for different crops in a particular season and the portion of area under each crop that had been used for which particular crop in the preceding season and in the succeeding season during the last crop-year has been collected. All the information relating to expenditure and revenue have been collected for each crop separately with different preceding crops. From the collected information, profitability of each crop with different preceding crops has been calculated. Using those, profitability of different combinations has been estimated. Thereafter a flow chart showing the flow of acreage in aggregate of all the sixty farms together in successive seasons has been drawn. Then a comparison has been made between the profitability of alternative combinations of crops in contrast with the acreage allocation towards different combinations to show the nature of relationship if there exist, between the flow of land allocation and profits of alternative competitive crop-combinations. Therefore the rationality behind the increasing allocation of land towards the most remunerative combination has been explained.

3.5 Data and its Limitations

Data on area, production and yield of different crops have been collected from various issues of Statistical Abstracts and Economic Review of west Bengal, published by Bureau of Applied Economics and Statistics, Government of West Bengal. Data relating to those matters were furnished for North and South 24-Paraganas and Uttar and Dakshin Dinajpur separately for last few years. The values of area and that of production for the corresponding two districts are added to get the corresponding values for the 24-Paraganas
and West Dinajpur as a whole and to have a consistency and comparability of data. Accordingly yield of crops have been recalculated. Data on gross cropped area at district level were not available for all the years. So an approximation is made by aggregating the area of major crops grown in West Bengal, which roughly covers more than 95 per cent of actual gross cropped area. Information regarding the area under high yielding varieties of crops is not available for major crops at district level and for all the years. So district-wise pattern of use of improved seeds over time can not be explained. Area of tea is also not included in the gross cropped area calculation, though it is an important cash crop of the state and grown on a large scale in Darjeeling, Jalpaiguri and on a few places of Cooch Behar. It is not taken into consideration because it is not grown in all the districts and so it will have little relevance in explaining inter-district variation in cropping pattern change. But there may be some inconsistencies in the explanation of cropping pattern movement for those districts where it is the main cash crop. Explanation of inter-crop acreage substitution would be somewhat different from the actual case in those districts. But for the state as a whole it is not a matter of great concern.

Data on area under minor irrigation set-up like deep-tubewell, submersible pump, shallow-tubewell, river lift irrigation etc. are not available for all the years and hence they cannot be utilised along with area under canal irrigation to explain fully the role of irrigation development on the changes in cropping pattern. But minor irrigation set-up comprises an important part of total irrigation potential of the state. In the regression analysis of growth of area under crops on different factors, data on area under government canals only have been used instead of total area under irrigation potential from all sources in the respective season. It is true that canals can not supply water with identical capacity in all the seasons of the year.

Minor irrigation in West Bengal has experienced a substantial growth during the last two and half decades. Whatever data are available have been used in chapter-9 to explain inter-district differences in cropping pattern change. Capacity of each irrigation set-up are always subject to some kind of change with the progress of technology and some are not able to provide water with equal capacity throughout the whole year. In this case using conversion table, obtained from the office of the Directorate of Irrigation and Waterways, Government of West Bengal area under minor irrigation sources has been calculated. In calculation of potential irrigation, shallow-tubewell, submersible pumps and
deep-tubewells are supposed to irrigate in all the three seasons of the year with equal capacity. River pumps are assumed to function with full potential twice of the three seasons of the year, whereas open dug well, filter points are assumed to function only in one season of the year. Government canals are also able to irrigate with full potential only in one season of the year. However there is always a possibility of error remaining in the estimation of potential capacity of irrigation in the state while converting the number of irrigation set-up into area-wise contribution. This is because all the deep-tubewells, shallow-tubewells are not of equal capacity and there is a large variations of capacity and power due to differences in quality of machinery, power set-up (if electrified) and level of water table, which differs across the places. Still there is no other alternative way but to follow the above methods and data available in the manner noted above.