Chapter – 3

Objectives, Data and Methodological Issues

3.1. Objectives of the study:

The study attempts to analyze the time series data relating to agriculture of West Bengal during the period 1970-71 to 2005-06. It also attempts to make a cross section study to examine the input-output analysis of West Bengal agriculture. The specific objectives of the study are:

(i) To estimate the growth rate of aggregate agricultural output in West Bengal as well as that of principal crops and to examine the pattern of changes in the growth rates during the period 1970-71 to 2005-06, both at the state and district levels;

(ii) To examine the variability in the production of agricultural output and then to establish the relationship between growth and variability in West Bengal agriculture;

(iii) To identify the major factors contributing to the growth of output in West Bengal and to decompose the output growth rate into its principal components both at the state and district levels;

(iv) To examine the nature of changes in cropping pattern in West Bengal both at the state and district level during the period 1970-71 to 2005-06;

(v) To examine the input output relation in West Bengal agriculture and to identify the factors in explaining decelerating trend of West Bengal agriculture.

3.2. Data Sources:

The Secondary Data: The secondary data regarding the area, production and yield of crops, Gross Cropped Area, cropping intensity in the districts of West Bengal were
collected from various issues of Statistical Abstract and also from various issues of Economics Reviews of West Bengal. District Statistical Handbooks of the districts of the state also provide data regarding various aspects of the agriculture of the districts. All these sources are published by Bureau of Applied Economics and Statistics, Government of West Bengal. The Directorate of Agriculture, Government of West Bengal also provides data regarding the prices of crops. The Statistical Abstract of India, published by Ministry of Statistical and Programme Implementation, Government of India, is another important source of our data of the state as well as all-India levels. Census of West Bengal, published by Directorate of Census General, Government of India also provides data on some important topics.

Primary Data: The study uses both primary and secondary data. The primary data were collected through the survey of agricultural households. In total 200 households were surveyed purposively and from this set of 200 households we finally chosen 185 households data for carrying out our analysis. Five villages of Purbasthali block of Burdwan district of West Bengal was surveyed during the agricultural year 2005-06.

3.3. Period of Study:

The general period chosen for the analysis of growth and cropping pattern changes in West Bengal agriculture is from the year 1970-71 to 2005-06. One point should be mentioned in this connection that though our study covers the period 1970-71 to 2005-06, but due to non-publication of the final official data in time (for the year 2005-06) we have restricted the time series analysis covering the period 1970-71 to 2004-05. However, the primary data were collected to examine the determinants of agricultural growth in West Bengal for the agricultural year 2005-2006.

This whole period of thirty five years is again divided into three sub-periods, namely, from 1970-71 to 1980-81, from 1981-82 to 1991-92 and 1992-93 to 2004-05.
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Clearly, these three sub-periods have special significance to the West Bengal economy. The second sub-period captures the impact of implementation of land reforms and Panchayat Raj System on the agricultural development of the state while the final sub-period of nineties and thereafter coincides with the periods of full phase globalization.

3.4. Hypotheses of the Study:

The present study intended to examine the growth performance of West Bengal agriculture during 1970-71 to 2004-05. The study also focuses on the dynamics of cropping pattern changes in West Bengal with the objective to identify the growth components of agriculture. The study intended to test the following the hypotheses:

(i) The slowing down of growth rate of agricultural production in West Bengal is mainly due to the slowing down of the yield growth rate rather than the growth rate of operated area;

(ii) The higher growth path is directly associated with the higher degree of variability of production in West Bengal agriculture and vice versa;

(iii) Though foodgrain crops explain the dominant cropping pattern in West Bengal, in recent years, crop diversification appears to be an important source of agricultural growth in West Bengal; foodgrain crops are being replaced by gradually by more profitable commercial crops and this replacement has an important bearing upon the agricultural productivity;

(iv) To identify the factors affecting agricultural growth in West Bengal, it is hypothesized that improvement in irrigation intensity, access to institutional credit, better support of government extension service, easier access to market etc. have important bearings on crop-diversification and thus, on agricultural productivity.
3.5. Methodology:

Various statistical and econometric methods were used for examining our hypotheses. For example, for measuring the growth rates we use the simple linear exponential growth model \( Q_t = a + bt + u_t \). The log-quadratic form of growth equation \( Q_t = a + bt + ct^2 + u_t \) has been used for measuring the acceleration or deceleration in the growth trend. As already mentioned that the whole period is further divided into three specific sub-periods. For measuring the growth rates of area, production and yield of crops during the three sub-periods the kinked exponential model has been used.

The general form of the kinked exponential model for \( m \) sub-periods and \( m-1 \) kinks \( (k_1, k_2, \ldots, k_{m-1}) \) and the sub-period dummy variables are \( D_1, D_2, \ldots, D_m \) with no continuity restrictions is given as

\[
\ln Q_t = a_1 D_t + a_2 D_{t+1} + \ldots + a_m D_m + (b_1 D_t + b_2 D_{t+1} + \ldots + b_m D_m)t + u_t.
\]

Applying the appropriate \( m-1 \) linear restrictions,

\[
a_i + b_i k_i = a_{i+1} + b_{i+1} k_i \quad \text{for all } i=1, \ldots, m-1
\]

We get the generalized kinked exponential model as

\[
\ln Q_t = a + b_1 \left(D_t + \sum_{j=2}^{m} D_j k_1 \right) + b_2 \left(D_{t+1} + \sum_{j=3}^{m} D_j k_2 \right) + \ldots + b_i \left(D_{t-i} + \sum_{j=i+1}^{m} D_j k_i \right) + \ldots + b_m \left(D_{m-1} + D_m k_{m-1} \right) + u_t
\]

where \( b_i \)'s are growth rates for different sub-periods.

The above generalized kinked exponential model when applied for time series data broken at two points \( k_1 \) and \( k_2 \) (i.e. the entire time series is sub-divided into three sub-periods) is given as

\[
\ln Q_t = a_1 D_t + a_2 D_{t+1} + a_3 D_{t+2} + (b_1 D_t + b_2 D_{t+1} + b_3 D_{t+2})t + u_t
\]

This is, however, the unrestricted (discontinuous) model. The growth rates estimated from the above equation (\( \hat{b}_1, \hat{b}_2, and \hat{b}_3 \)) are the same as if separate
exponential trends were fitted independently in each sub-period. However, when we impose linear restrictions such that sub-period trend lines meet at $k_1$ and $k_2$, the kinked exponential model becomes

$$\ln Q_t = a_t + b_1(D_t + D_2k_1 + D_3k_1) + b_2(D_1t - D_2k_1 - D_3k_1 + D_3k_2) + b_3(D_3t - D_3k_2) + u_t$$

The growth rates for the three sub-periods are given by the OLS estimation of the coefficients $b_1$, $b_2$ and $b_3$.

A modified version of the kinked exponential model has been used for testing the statistical significance if the difference between the growth rates of any two sub-periods. The modified version is

$$\ln Q_t = a_t + b_1t + b_1^*(D_2t - D_2k_1 - D_3k_1 + D_3t) + b_2^*(D_3t - D_3k_2) + u_t$$

where $b_1^*$ and $b_2^*$ are the difference between the first and second sub-period growth rates and difference between the third and second sub-period respectively.

The coefficient of variation, $CV = \frac{\sum_{i=1}^{n}(x_i - \bar{X})^2}{n}$, is used for measuring the variability in the production of crops. Again for measuring the extent of variation of the crop production variability among the districts of West Bengal the Kruksal-Wallis test has been used. The Mann-Whitney-Wilcoxon test can used to test whether two populations are identical or not; but it cannot be extended to more than two populations. The Kruksal-Wallis test, however, can be used to test whether three or more populations are identical or not. Suppose we are to test whether the variation in crop production among the districts of the state is significant or not. Then the hypothesis for the Kruksal-Wallis test with $k \geq 3$ populations can be written as

$H_0 : All \text{ district-wise CVs are identical}$
$H_1 : Not \text{ all district-wise CVs are identical}$
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Here we want to test whether the populations are identical in terms of variations in production, measured by Coefficient of Variation (C.V). The Kruksal-Wallis test statistic, which is based on the sum of the ranks for each of the samples, is given by

$$W = \left[ \frac{12}{n_T(n_T + 1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} \right] - 3(n_T + 1)$$

where $k =$ the number of populations (here districts)

$n_i =$ the number of items in sample $i$

$n_T =$ total number of items in all samples

$R_i =$ sum of ranks for sample $i$

Kruksal and Wallis have shown that under the null hypothesis in which the populations are identical, the sampling distribution of $W$ can be approximated by a Chi-square distribution with $k-1$ degrees of freedom. The approximation is generally acceptable if each of the sample size is greater than or equal to five. This non-parametric test can be used with ordinal data as well as with interval or ratio data. In addition, the Kruksal-Wallis test does not require the assumption of normally distributed populations.

For examining the nature and changes in the cropping pattern of the West Bengal agriculture we mainly rely on three methods. Firstly, the broad pattern of the cropping pattern of the agriculture of the state has been analyzed with tabular method. Secondly, the concentration (or diversification) of any particular crop or crop group has been examined with the help of Herfindal’s index methodology.

Herfindal Index, $HI = 1 - \sum_{i=1}^{n} p_i^2$  

$p_i =$ Proportion of area under ith crop.

$$p_i = \frac{A_i}{\sum_{i=1}^{n} A_i}$$

$A_i =$ Area under ith crop and $\sum A_i =$ Total Cropped Area

The value of HI lies between zero to unity. As the value approaches from one to zero, the level of diversification increases. Lastly, the substitution and expansion
effects method of Venkataraman and Prahladachar (1978) has been used for in-depth analysis of the cropping pattern of the state. Accordingly they defined

\[
cropped area - gross cropped area elasticity = \frac{\% \text{ change in the growth of area under crop}}{\% \text{ change in gross cropped area}}
\]

**Micro-Analysis:** We have carried out a micro analysis on the basis of the field survey data collected from the Burdwan district of the state to give an explanation of the present status of productivity of the agricultural sector of the state with the help of input-output framework. Here the whole analysis is done in two parts. Firstly, with the help of simple regression analysis the underlying factors of productivity of agricultural sector have been identified. These productivity determining factors again depend on various other socio-economic, demographic, institutional and technological factors. Thus, these set of socio-economic, demographic, institutional and technological variables actually play the major role (via the previously identified factors) for determining the productivity of the agricultural sector in the state. We use the logit analysis for determining the factors affecting agricultural growth in the study area. The structure of logit analysis has been discussed in details in chapter seven.