CHAPTER III

METHODOLOGY
In this chapter the methodology adopted for the study is described in brief. The Chapter is divided into two parts. The first part deals with the sampling procedure adopted and the second describes the analytical tools used in the study.

3.1 SAMPLING DESIGN

The farm level data relating to the cost of cultivation of paddy collected for the year 1979-80 under the Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in Andhra Pradesh are used in this study. The design adopted under the scheme is described below.

The design followed was the three stage stratified random sampling procedure with tahsil as the primary sampling unit, a cluster of three villages as the secondary unit and an operational holding within the cluster, as the third and ultimate sampling unit.

For the purpose of ascertaining the cost of cultivation of crops, Andhra Pradesh was demarcated into five homogeneous agro-climatic zones having regard to the cropping pattern, irrigation, rainfall, fertility (soils) and productivity. The five demarcated zones in the State are: Zone-I (Northern Circars) consisting of Srikakulam, Vizianagaram and Visakhapatnam Districts,
Fig 3.1 - MAP OF ANDHRA PRADESH DEPICTING AGRO-CLIMATIC ZONES

1. NORTHERN ANDHRA
2. SOUTHERN ANDHRA
3. RAYALASEEMA
4. SOUTH-TELANGANA
5. NORTH-TELANGANA
Zone-II (Delta areas) comprising East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore districts, zone-III (Rayalaseema) including Cuddapah, Kurnool, Chittoor and Anantapur districts, Zone-IV (Southern Telangana) consisting of Nalgonda, Khammam, Rangareddy, Hyderabad and Mahabubnagar districts and Zone-V (Northern Telangana) comprising the districts of Medak, Warangal, Karimnagar, Nizamabad and Adilabad. These zones are shown in Map-1. The available 1st stage units were then allocated to different zones in proportion to the area under paddy crop in the respective zone. The zone-wise distribution of paddy area and clusters presented in Table-3.1.

Table-3.1. Zone-wise Distribution of Paddy Acreage and Number of Clusters Selected in Andhra Pradesh (1979-80)

<table>
<thead>
<tr>
<th>Zone No.</th>
<th>Name of the zone</th>
<th>Area under paddy (in hectares)</th>
<th>No. of clusters allocated in each zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Northern Circars</td>
<td>4,14,187</td>
<td>4</td>
</tr>
<tr>
<td>II</td>
<td>Southern Circars</td>
<td>18,31,409</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(Coastal A.P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Rayalaseema</td>
<td>4,01,723</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>Southern Telangana</td>
<td>5,01,585</td>
<td>4</td>
</tr>
<tr>
<td>V</td>
<td>Northern Telangana</td>
<td>5,13,572</td>
<td>4</td>
</tr>
<tr>
<td>Andhra Pradesh (Total)</td>
<td>36,62,281</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

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Fig 3.2 - MAP OF ANDHRA PRADESH DEPICTING SELECTED DISTRICTS
Zone-II which had the maximum acreage under paddy has been chosen for this study. This zone is homogeneous, contiguous and represented the old delta areas of Godavari, Krishna and Perna under paddy production in the State. Cultivators in this zone are considered to be far advanced in the State and they had adopted the modern technology in paddy production. Moreover, no studies of this type have been conducted in this zone. All these factors prompted us to select this zone and the paddy crop. The study is given in Map-II.

3.1.1 Selection of Tahsils

The second stage in the sampling procedure envisaged the selection of tahsils from each stratum. For this purpose the tahsill-wise paddy area was obtained and the tahsils were randomly selected with probability proportional to the acreage under paddy crop in the tahsil. Thus, 15 tahsils (clusters) were chosen in Zone-II.

3.1.2 Selection of Villages

It was also envisaged in the sampling design that in each selected tahsil a cluster of three villages would be taken as a second stage unit, with probability proportional to the acreage under paddy in the village. For this purpose the village-wise paddy acreages were
obtained for all those selected tahsils and then the first village (Nucleus) was randomly selected. The nearest village to the South of the Nucleus village was taken as the second village, moving in clockwise direction, the next nearest village (third village) was selected. These three villages constituted the ‘cluster’ and they were located adjacent to each other. However, if one of the first two villages happened to be sufficiently big, the clusters were formed with two villages only. In all, the total number of sample villages were fixed at 40.

3.1.3 Selection of Operational Holdings

The lists of the operational holdings growing paddy in these villages were prepared for the cluster and holdings were arranged in ascending order of their size. Then each list of holdings was divided into five groups in such a way that each group would have approximately equal holding area. Two holdings were selected at random from each of the five groups thus formed. In this way a sample of 10 holdings were selected from each cluster. In addition, two more progressive cultivators were randomly selected from the list of the progressive cultivators in the cluster. Thus 12 cultivators from each cluster and 180 cultivators in all for the study area were selected for collecting farm level data. However, for the purpose of this study, all those 180
cultivators were pooled and arranged in the ascending order based on their holding size and then divided into three farm size groups, so as to get 60 cultivators in each size class and they were designated as small ($S_1$) (less than 1.51 ha); Medium ($S_2$) (1.52 to 3.21 ha) and Large ($S_3$) farms (3.22 ha and above). This regrouping was done with a view to increasing the number of observations in each section as the area was homogeneous. It was also felt that after the enactment of ceiling laws on agricultural holdings there would be a few big holdings. Therefore, the selected farms were categorised into three farm size groups for the purpose of this study. Farm size-wise analysis was also attempted as resource productivity and resource use management might depend upon the farm size. Because of land reforms and other socio-economic measures, the optimum size of farm has become a very controversial issue in recent times. Keeping this in view, the sample farms were grouped into three size groups. In the ensuing chapters, these farm size groups are referred to as $S_1$, $S_2$ and $S_3$ farms, while the pooled farms as All Farms.

Thus the sample covered six districts, 15 tahsils, 40 villages and 180 cultivators (grouped into three farm size categories) (List of selected districts, Tahsils and Villages is given in Appendix Table (1)).
3.1.4 **Data collection**

Exhaustive schedules were prepared for the purpose of obtaining information on all the farm enterprises. The data collection was done by Cost Accounting method, employing a whole time investigator. The investigator stayed in one of the cluster villages and used to contact the selected cultivators at least once in two days to obtain the input-output data and at times, he personally observed certain operations. In other words, the investigator himself maintained the Farm Records on behalf of the selected cultivators. A whole-farm modeling approach developed under the comprehensive scheme, was adopted to collect input-output data on all agricultural enterprises that the selected farmers undertook during the agricultural year 1979-80.

3.1.5 **Sources of Data**

As already pointed the source for primary farm level information was the disaggregated data from the comprehensive scheme. Under the Comprehensive Scheme Crop-wise cost of cultivation estimates were only made available for the year. However, in the present study, the estimates were made according to farm size, variety and season. Disaggregated data (from the schedules) were tabulated to meet the requirements of the present study. Suitable compilation forms were constructed to obtain the data required. The secondary data were taken from the
various reports of the Bureau of Economics and Statistics, the Commissioner of Census, Revenue Records at Tahsil and Village level, the Director of Agriculture and the Andhra Pradesh Agricultural University. These sources formed the basis for the data so as to evaluate the objectives of the study.

Varieties

During the past one decade and a half, development of high yielding varieties was the main prank of the paddy breeding programmes in Andhra Pradesh. Adoption of High Yielding Varieties technology was proved to be the quickest means of increasing productivity of paddy. The paddy varieties under cultivation were classified as High Yielding Varieties and other locally improved varieties (IV). More than 80 per cent of the paddy area was under HYVs only. The popular HYVs that were under extensive cultivation were Gautami, Vasishta, Surekha, Sona Mashuri, Vijaya Mashuri, FLA 1100, Kotta Malagolukulu (72574) in kharif season and BPT 1235, Surekha, Tella Hansa and IR56 in rabi season, while Aksallu and Masuri were the LVs (Kharif only).

3.2 ANALYTICAL TOOLS USED IN THE STUDY

For evaluating the objectives of the study and testing the hypotheses formulated, certain analytical tools were employed. These are briefly described below.
3.2.1 Tabular analysis

The time-honoured tabular analysis was the main
analytical tool used for arriving at estimates of costs,
returns, other measures of farm income and to assess the
resource availability so as to evaluate the first and
second objectives, costs and returns and resource avail-
ability.

3.2.2 Production Function

Production function is a versatile tool through
which resource productivity, resource use efficiency,
returns to scale, technical change, factor shares etc.
were studied. Like many farm management studies, this
study also relied heavily on production function approach.
Throughout the study, it was assumed that the farm was
an economic unit and the decisions of the farmers were
motivated by profit maximization. The starting point
in the analysis was the estimation of the production
function for paddy in the study area. The choice of the
algebraic form of the function and the specification of
the variables are important in the production function
analysis.

In choosing the form of the function, one can
either experiment with a number of alternative forms or
choose a function on a priori considerations. Several
studies relating to Indian agriculture employed the Cobb-
Douglas production function. In this study also the Cobb-
Douglas production function was preferred. Besides a priori
considerations, lack of time and resources were also responsible for this decision.

The postulated production function can thus be specified in the following algebraic form:

\[ Y = a x_1^b_1 x_2^b_2 x_3^b_3 x_4^b_4 x_5^b_5 \ldots \ldots \ (1) \]

Where, \( Y \) = gross income in rupees from paddy and paddy straw per farm

\( x_1 \) = gross area under paddy measured in hectares per farm,

\( x_2 \) = human labour input utilised for paddy per farm in Rupees,

\( x_3 \) = motive power (bullock labour & tractor) used for paddy in rupees per farm,

\( x_4 \) = manures and fertilizers applied to paddy per farm in rupees, it includes the value of chemical fertilizers, farm yard manure, green-manure and other forms of manure used for paddy,

\( x_5 \) = measures of other capital services per farm in rupees viz., value of seed, plant protection charges, irrigation and land revenue charges, interest on fixed (excluding land) and working capital and depreciation values on owned capital assets.
'a' is the constant (or intercept) and $b_1$ to $b_5$ are the output elasticities of land, labour, motive power, manures and fertilisers and capital services, respectively.

Parameters of regression equation (1) are estimated by the least squares method, using the following logarithmic form

$$\log Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 \quad \ldots \ldots \ldots \ldots \ldots (2).$$

The above function (2) was employed for the perform data to evaluate the objectives.

3.2.3 Models for the study of Technical Change

The Hicksian model of technical change was used to measure the nature of technical change. In the production function context, technical change is denoted either by change in the value of 'a' (constant or intercept) the efficiency parameters or by change in slope parameters $b_i$. A change in efficiency parameter alone, denotes neutral technical change, whereas changes in slope parameters only or changes in slope parameters along with change in the efficiency parameter indicate non-neutral technical change.

'Chow-test' and covariance analysis were used to determine the nature of technical change involved in
shifting from local varieties of paddy to HYV paddy during the kharif season. In the second season (rabi), none of the farmers grew local varieties.

An attempt was made to identify the structural break, if any, in the production function where a shift from the local varieties (LVs) to the HYVs of paddy took place. Then the cause of structural break was identified as to whether it was due to change in efficiency parameter, or slope parameters or in both. This was tried first at the aggregate level of LVs and HYV kharif paddy and an attempt was also made to find out whether the technical change was present in different size groups of farms.

The 'Chow test' was employed, for identifying the structural break in production function of LVs and HYVs of paddy and the analysis of covariance for identifying the cause of structural break.

**Empirical Model-I**

Production function equations were used for the purpose of identifying the structural break in the production functions of LVs and HYVs of paddy in kharif season.

To test the structural break in production function of LV and HYV paddy, 'Chow test' was used (Chow, 1960).
The null hypothesis for the purpose was that the parameters of production functions of local varieties of *kharif* (LVK) and High Yielding Varieties of *kharif* (HYVK) were the same.

This null hypothesis was tested against the alternative hypothesis that the parameters of the production functions of LVK and HYVK were not the same.

The $F$ ratio was computed as

$$F^* = \frac{SSE_2 - SSE_1 - SSE_3}{(SSE_1 + SSE_2)/(n+m-2k)}$$  \hspace{1cm} (3)

where $SSE_1$, $SSE_2$, and $SSE_3$ represent the sum of squares of residuals of regressions from LVK, HYVK and All Farms respectively; $n$ the number of observations in LVK; $m$, the number of observations in HYVK; and $k$ the number of parameters estimated (including constant '$a$'). This $F^*$ was compared with $F$ critical to draw inferences.

**Empirical Model-II**

To determine the cause of structural break analysis of covariance was employed.

Once the structural break in production function was identified, the next task was to determine the causes of structural break. To accomplish this, a 'binary' or 'dummy' variable was used to capture the varietal differences in production functions. A value of one was
assigned to the observations relating to LVK and a value of two to those relating to the HYVK paddy. Intercept dummy was used, assuming that the slope parameters involved in the production functions were the same, and only the intercepts were different. The estimating production function was specified as
\[
\log Y = a' + r d_1 + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 \tag{4}
\]

By employing the above expression four production functions were fitted, first one for All Farms and next three for the data relating to S_1, S_2 and S_3 farms using intercept dummy variable for the varieties. The equations so obtained were used to test whether the intercepts in the production functions of LVK and HYVK were the same or different.

3.2.4 Analytical Tools to Assess the Impact of Technical Change on Income Distribution

For evaluating the impact of technical change on functional income distribution the changes in relative factor shares were used. In Cobb-Douglas frame work, the change in relative factor share is the same as bias in technical change, since the change in the relative factor share can occur only by change in output elasticities of production function (Brown and Bisanish). Since the elasticity of substitution is unity, change in relative
factor prices will have no effect on relative factor shares. So the terms 'change in relative factor shares' and 'bias' are used synonymously in this study.

Analysis of relative factor shares was based on the functional distribution of income derived from the neo-classical theory (Hicks, 1965 and Ferguson, 1971). The functional distribution of income and relative factor shares depend on the elasticity of substitution between factors, the relative endowment of factors and the nature of technical change.

To determine the change in relative factor shares, the Hicksian concept of bias in factor shares was used. Accordingly the bias over time

$$B_i = \frac{d b_i}{dt} = \frac{1}{d b_i} \geq 0 \quad \ldots \ldots \quad (5)$$

Where $B_i$ was the bias in factor share of $i$-th factor, $d$ was the change in factor share of $i$-th factor and $b_i$ were the relative factor shares. Wherever $B_i$ was greater than zero the relative share of $i$-th factor increases; when equal to zero, the relative factor share of $i$-th factor remains unchanged; and when less than zero, the relative factor share of $i$-th factor decreases.

The expression at (5) was modified as

$$B_i = \begin{bmatrix} b_i^1 & b_i^2 & \ldots & b_i^n \end{bmatrix}_{HYUK} \cdot \begin{bmatrix} b_i^1 & b_i^2 & \ldots & b_i^n \end{bmatrix}_{LWK} \geq 0 \quad \ldots \ldots \quad (G)$$

$$\begin{bmatrix} b_i^1 & b_i^2 & \ldots & b_i^n \end{bmatrix}_{LWK}$$
Since in the Cobb-Douglas Production function the relative share of \( i \)th factor is equal to the ratio of the output elasticity of \( i \)-th factor to the sum of output elasticities, equation (6) was employed for the purpose.

If returns to scale were constant, equation (6) would reduce to

\[
\beta_i = \frac{(b_i)\text{ HYVH} - (b_i)\text{ LWR}}{(b_i)\text{ LWR}} \geq 0 \quad \ldots \text{ (7)}
\]

For estimating the change in relative shares of factors of production between LWR and HYVH paddy, the expression (7) was used.

The estimated factor shares were compared with the actual factor shares to find out whether the factors of production are paid according to their contribution. Changes in absolute factor shares were also computed for comparison.

### 3.2.5 Decomposition of Sources of Change in Partial Productivity of Inputs

A recent study indicated that growth in paddy production in Andhra Pradesh was a productivity led (Suryanarayana, 1980). This study also revealed that the productivity of land increased with technical change in paddy production. Therefore, it was decided to analyse the source of change in productivity of land.
The basic partial productivity relationship was used for this purpose

\[
\frac{Y}{L} = \frac{Y}{X_1} \cdot \frac{X_1}{L} \quad \cdots \quad (8)
\]

Y = output of paddy per farm

L = average area under paddy per farm

\(X_1 = \) are the factors of production - labour, motive power, fertilizers and capital services per farm. The equation (8) could be rewritten as

\[y = \frac{x_1}{P} \quad \cdots \quad (9)\]

Where \(y = \frac{Y}{L}\)

\[x_1 = \frac{X_1}{L}\]

and \(P = \frac{X_1}{Y}\) or \(\frac{Y}{X_1} = \frac{1}{P}\)

By total differentiation the equation (8) would be

\[dy = \frac{P \cdot dx_1 - X_1 \cdot df}{P} \quad \cdots \quad (10)\]

Dividing both sides by \(Y\) and simplifying

\[\frac{dy}{y} = \frac{dx_1}{x_1} - \frac{df}{P} \quad \cdots \quad (11)\]
Multiplying both sides by 100, we get the relationship

\[
\text{(Percentage change in output per hectare)} = \text{(Percentage change in input per hectare)} - \text{Percentage change in input per unit of output)}
\]

This type of equation was used to find out the sources of change in partial productivities of inputs \(x_1\) to \(x_5\) with reference to output.

The second term on the right hand side of the above equation is of great significance, since it represents change in reciprocal of the partial productivity of the concerned input. It indicates to some extent the direction and magnitude of change in partial productivities of inputs.