Chapter-III

MATERIALS AND METHODS

This chapter deals with the locale of the study, selection of the study sample, methods of data collection and analytical tools used for this investigation.

3.1 Locale of the Study: The sub-mountainous areas of the Punjab State are located in Gurdaspur, Hoshiarpur, Roopnagar, Shahid Bhagat Singh Nagar and S.A.S. Nagar districts. Among these districts two, eight, three, two and three blocks were demarcated as the sub-mountainous blocks of the respective districts. Thus, the sub-mountainous areas existed in the eighteen blocks falling in the above mentioned five districts of the Punjab State.

3.2. Selection of the Study Sample: The sample for this study was drawn using the three stages stratified random sampling technique. The block was taken as the first stage unit, village the second stage unit and operational farm the third and ultimate unit of sampling.

3.2.1 Selection of Blocks: Among the above mentioned eighteen sub-mountainous blocks, seven blocks mainly falling in Hoshiarpur (five blocks), Shahid Bhagat Singh Nagar (one block) and S.A.S. Nagar (one block) were those where development activities were carried out under the Kandi Watershed and Area Development Project. The remaining eleven blocks did not receive such public developmental intervention. So, the first category of seven blocks was termed as the Project blocks and the second category of eleven blocks were designated as Non-project blocks. Two blocks from each above group were randomly selected for this investigation. These blocks were Balachaur and Bhunga as the Project Blocks and Dhar Kalan and Talwara as the Non-project Blocks.

3.2.2. Selection of Villages: The villages constituting each sample block were listed. In total there were 110 and 174 villages in the two Project Blocks and 62 and 83 villages in the two Non-Project Blocks. In these sub-mountainous blocks, purely sub-mountainous villages were identified. It was found that there were 30 pure sub-mountainous villages in each of the Project Blocks and 61 and 73 pure sub-mountainous villages in the respective Non-project Blocks. Ten per cent of thesepure sub-mountainous villages were randomly selected for this study. It provided a sample of six villages in Project Blocks and thirteen villages in Non-project Block (Appendix 3.1).
3.2.3. Selection of Operational Farms: The operational holdings in the sample villages were enlisted along with their size with the help of village elders and other key informants. The data for the size of farm operational holdings in all the sample villages were pooled for the Project and Non-project Blocks and arrayed in the ascending order. Their distribution was transformed to bring out the size-ranges of marginal (below one hectare), small (below two hectares), medium (below four hectares) and large (above four hectares) using the Cube-root method (Singh, Ravindra, 1975). Keeping in view the time and other resource constraints, a sample of ten percent farms was randomly drawn without replacement from each size group of farms in each selected village. This provided a total study sample of 77 and 96 farms from Project and Non-project blocks. However, for better estimates, the sample size was raised to 100 farms an each category of blocks. This increase was proportionally affected in each size group of farms (Appendix 3.1).

3.3. Collection of Data: The primary as well as secondary data were collected for this investigation. The elaboration is made in the sections below.

3.3.1. Primary Data: The primary data relating to the inventory of available farm resources, land use capability, resource use, production pattern and productivity levels for the year 2005-06 were collected with the help of specifically designed and pre-tested questionnaire using the survey method. The accuracy of these data was ensured by making frequent visits to the respondent farmers during the course of this investigation and creating a close rapport with each of them.

3.3.2. Secondary Data: The secondary data on the input-output coefficients for the improved level of production technology were obtained from the research experimentation related to the sub-mountainous areas of the Punjab State.

3.4. Analytical Framework: The primary data for 2005-06 collected for this investigation were used to study the differences in the resource endowments product-mixes, intensity of cropping, pattern of resource use and returns to fixed farm resources (RFFR) on various categories of sample farms in Project and Non-project Blocks.

3.4.1. Regression Analysis: For bringing out the efficiency/inefficiency of the use of farm resources by the farm operators through their existing farm practices, the regression analysis was carried out. The functional analysis was employed for the major farm production activities
such as maize, kharif and rabi fodder and the wheat crops including the livestock activities of rearing buffaloes and cows both linear and log-linear functions were attempted for this purpose.

The algebraic forms of the functions are as under:

**Linear Function:**

\[ Y = a + b_1 x_1 + b_2 x_2 \ldots \ldots + b_n x_n + u \]

**Log-linear Function**

\[ Y = ax_1^{b_1} x_2^{b_2} \ldots \ldots x_n^{b_n} e^u \]

In log farm;

\[ \log Y = \log a + b_1 \log x_1 + b_2 \log x_2 \ldots \ldots + b_n \log x_n + u \]

Where,

\[ Y = \text{Gross value product (Rs.)} \]

\[ a = \text{a constant term} \]

\[ x_1 \ldots x_n = \text{Independent variables} \]

\[ b_1 \ldots b_n = \text{Regression Coefficients of } x_1 \ldots x_n \]

The number of independent variables differs for each farm size category and each crop keeping in view the degrees of freedom. However, independent variables included in different equations are given hereunder:

1. Nitrogenous Fertilizer (kg)
2. Phosphatic Fertilizer (kg)
3. Nitrogenous + Phosphatic Fertilizer (kg)
4. Total fertilizers (Rs.)
5. Farm yard manure (qtl.)
6. Hoeings (No.)
7. Crop area (ha)
8. Value of Seed (Rs.)
9. Irrigation (Acre cm.)
10. Plant protection measures (Rs.)
11. Human labour (man hours)
12. Bullock labour (pair hours)
13. Tractor use (hours)

In case of dairy farming, the independent variables included are as under:
1. Milch animals (No.)
2. Green fodder (Rs.)
3. Dry Fodder (Rs.)
4. Concentrates (Rs.)
5. Human labour (man hours)
6. Veterinary Care (Rs.)

The choice of the functional form was made keeping in view:
(i) The value of $R^2$;
(ii) economic significance of the regression coefficient; and
(iii) logical significance of the regression coefficient.

3.4.2: Statistical Significance of Estimates

(i) The significance of $R^2$ was tested by working out F-ratio as follows:

$$F\text{-ratio} = \frac{R^2 / k}{(1-R^2) / (n-k-1)}$$

Where, $R^2 =$ value of coefficient of multiple determination;

$n =$ no. of observations; and

$k =$ no. of independent variables included in the equation.

(ii) The students’ t-test was applied to test the statistical significance of the coefficients at

$n-k-1$ degree of freedom. The t-value was worked out as under:

$$t_{(n-k-1)} = \frac{b}{\text{S.E.} (b)}$$
3.4.3: The Timmer Measure of Technical Efficiency

Technical efficiency of ‘jth’ farm is the ratio of actual output as observed on the farm to the potential output as given by the frontier production function at a given level of input use on ‘jth’ farm. It would, thus, indicate how much extra output could be as obtained if ‘jth’ farm would have operated at the frontier function surface. Thus, technical efficiency (TE) for different crops as well as farm as a whole on different farm size categories was obtained as under:

Timmer TEj = Yj | Y* j 

Where

Yj = output of a given activity on ‘jth’ farm; 
Y* j = potential output of the same activity for ‘jth’ farm; and 
J = No. of farms.

In order to make it more meaningful and understandable, the TE was converted into percentage.

3.5: Optimal Production Plans: The optimal farm production planning was attempted through the use of the profit maximization variant of the linear programming model. Two sets of optimal farm plans were constructed. Firstly (Optimal Plan I), the assumption was the existing farm technology with the resource use relaxation in terms of human labour and draft power hiring and the capital borrowing. Secondly (Optimal Plan II), the assumption was the improved level of technology along with the above relaxations of resource use. The linear programming model used is given as under:

\[
\text{Maximize } Z = \sum_{j=1}^{n} C_j X_j \\
\text{Hence } Z \text{ is the total RFFR, } C_j \text{ is the RFFR of } j\text{th activity or resource, } X_j \text{ is the value of the } j\text{th resource/activity which run from 1 to } n.
\]

\[
Bi \geq \sum_{j=1}^{k} bij X_j
\]
\[
B_i \geq \sum_{j=1}^{k} b_{lj} X_j
\]

\[
B_n \geq \sum_{j=1}^{k} b_{nj} X_j
\]

Here \(B_i\) is for farm resource level (\(B_1, B_2, \ldots; B_n\)), \(b_{ij}\) is the input of resource (\(b_{lj}, b_{2j}, \ldots; b_{nj}\)) for an activity \(x_j\). Activities run from 1 to \(k\).

3.5.1 Land resource: The available land for the sample farms was classified on the basis of its use capability into five categories as under:

(a) Kharif land suitable for raising:
   (i) fodder, pulses, oilseeds, maize, sugarcane, paddy and
   (ii) sugarcane crops.

(iii) Sugarcane land: This land was inclusive in the land in categories (i) and (ii). This enterprise, therefore, competed with fodders, pulses, oilseeds, maize and paddy in this area.

(b) Rabi land suitable for growing:
   (i) Wheat, barley, pulses, oilseeds, fodders and sugarcane;
   (ii) Sugarcane and fodder land. This land was not mutually exclusive from the land in (i) above. The crops raised in this area were, therefore, in competition with wheat, barley, pulses and oilseed crops also.

The land required for the fixed activity related to fodder for draft animals was worked out under both the existing and improved levels of technology.

3.5.2 Human Labour Resource: The human labour resource availability on sample farms was assessed by pooling the family labour and permanent labour on the farm. The computation was based on the assumption that an hour’s work put in by an adult male over 16 years was equivalent to one adult man hour, while that by an adult female of the same age group and a child between 12 and 16 years as equivalent to 0.67 and 0.50 adult man hour.
(Sharma, A.C. 1976) respectively and that each worker contributed his labour for 10 hours a day during the peak periods. Four human labour periods were identified during the year keeping in view the existing human labour use pattern on sample farms. These periods included (i) 15th April to 15th May, (ii) 22nd June to 21st July, (iii) 22nd September to 15th October and (iv) 22nd October to 21st November.

The net availability of human labour during the peak periods was computed after providing for human labour requirements of such fixed farm activities as the raising of fodder for bullocks and tending of these animals, repair of farm buildings and the attendance in socio-religious functions, besides illness of the workers and other unforeseen circumstances where labour could not be employed for farm work.

3.5.3 Draft Power Resource: Bullocks and tractor were the main sources of draft power in the study areas. Based on draft power use pattern on sample farms, two draft power peak periods were identified. The first extended from 22nd June to 21st July while the second one from 22nd October to 21st November. During the first period, the farm operations like seed-bed preparation and sowing of kharif crops were accomplished. In the second period seed-bed preparation and sowing of rabi crops were completed.

The net availability of the draft power was calculated by deducting the number of days on which the farmers did not use this power for work due to socio-religious reasons, illness, unfavourable weather conditions and their use for raising fodder for bullocks.

3.5.4 Operational Capital Resource: The availability of the operational capital resource was computed in terms of kharif and rabi capital. This estimation was based on the assumption that a portion of the sale proceeds of the farm produce disposed of during the rabi season was set aside for investment in the following kharif season and that of the sale proceeds pertaining to the kharif season for investment in the following rabi season. Total availability of funds during the two seasons was worked out separately by adding to the amounts for investment in the farming business, the money made available by relatives, friends and other sources on gratis for use in the relevant season. The net operational capital resource availability for farm planning was estimated by deducting from total funds available in the two seasons, the cash requirement of fixed farm activities relating to kharif and rabi crops under the existing as well as the improved levels of technology.
3.5.5. Technical Coefficients: The technical coefficients for farm production planning were developed in terms of input-output coefficients for both the existing and the improved levels of technology in respect of the crop as well as the livestock activities for the Project and Non-project Blocks as detailed below:

3.5.5.1 Input Coefficients: The input coefficients for the existing level of technology were derived by averaging out the cross-sectional information collected from the sample farmers. For the improved level of technology, these coefficients were developed on the basis of the Package of Practices recommended recently by the Punjab Agricultural University (2006-07) and in the consultation with the University experts.

The cash requirements of various crops included the value of purchased seeds, manures, fertilizers and chemicals, wages paid to casual labour, custom charges for farm power and machinery and cost of marketing. The variable cash needs during the inter-calving periods of milch animals comprised expenses on concentrates, medicines, ropes, chains, hired human labour and the like. The lactation periods of milch animals, however differed with the type of animal and also these periods did not match with the growth periods of crops. To render the crop and milch animal activities comparable, it was decided to reduce the cost of maintenance of milch animals to 12 months period so that both the crop and the livestock activities could compete with each other in programming analysis. The monthly requirement of working capital on dairy enterprise was identified by distributing the total variable costs uniformly over twelve months of the year. Since these enterprises provided regular cash flow through the sale of their products, their cash coefficients were identified by estimating the difference between the receipts and the expenditure in each month separately.

3.5.5.2 Output Coefficients: The RFFR from crop as well as livestock activities were computed for both the existing and improved levels of technology for the Project and Non-project Blocks as follows:

\[
\text{RFFR} = [(P_M Y_M + P_B Y_B) - VC]
\]

where \( \text{RFFR} = \) Returns to fixed farm resources per unit of the enterprise.

\( P_M = \) Price per unit of the main product of the enterprise.

\( Y_M = \) Yield of the main product of enterprise.
\[ P_B = \text{Price per unit of the bye-product of enterprise.} \]
\[ Y_B = \text{Yield of the bye-product of the enterprise.} \]
\[ V_C = \text{Variable cost per unit of the enterprise.} \]

3.6 Hypotheses

The major hypotheses for this study would focus on the resource endowments, pattern of resource-use and the income levels. These hypotheses as follows:

1. The farm resource endowments were small but improved under the development project activities.

2. The existing use of farm resources was sub-optimal. Though, it improved under the project activities but was still away from the optimal level of use.

The farm incomes rose under the development project activities. But these levels could improve further through the optimization of the resource use.