CHAPTER III

Research Methodology

For the purpose of study the problem “Distribution, consumption and economic response of fertilizers on wheat and bajra crops in district Sawai Madhopur, Rajasthan”, the sampling design used was multi-stage stratified random sampling. The sampling technique consists three main parts.

1. Research design
2. Data gathering procedure and statistical measures used
3. Variables and their measurement

1. Research Design

The sampling design is further divided into the following heads.

i. Selection of the district
ii. Selection of Sub-division
iii. Selection of Villages
iv. Selection of the respondents
v. Selection of crops
vi. Selection of Officers and Non-officers

(i) Selection of the district

District Sawai-Madhapur was purposely selected in order to approach easily and timely for the selection of Sub-division, villages, respondents and collection of data desired for the present study.

(ii) Selection of Sub-division

The district Sawai-Madhopur has been divided into three divisions. The area under wheat and bajra alongwith consumption of fertilizer of all three
divisions were recorded and one division namely, Sawai Madhopur was selected with probability proportion of areas under wheat and bajra and consumption of fertilizer.

(iii) Selection of the villages

A list of all the villages of selected sub-division along with area under wheat and bajra and consumption of fertilizer in the villages was obtained from the head-quarter of sub-division. Thereafter, 10 villages from selected sub-division were randomly selected with probability proportion to the area under wheat and bajra and consumption of fertilizer. Keeping in view to have atleast 10 per cent area under wheat and bajra crops to total cropped area of each selected village.

(iv) Selection of respondents

A complete list of all the wheat and bajra growers having atleast 10 per cent area under each crop to the total cropped area of the farmers of each selected village was prepared form selected sub-division of the district under study. The total farms of each selected village were further classified into four size of farms below, viz. 1 hectare (marginal farmers), 1-2 hectares (small farmers), 2-4 hectare (medium farmers) and 4 hectares and above 4 hectares (Big farmers). The respondents from each selected village were randomly selected under different categories of farms keeping in view that number of selected farms were in proportional to the number of farmers falling in each category of farms.

(v) Selection of Crops

Wheat and bajra crops were selected in view of the facts that these crops occupied higher percentage area to the total cropped area of the district under study in comparison to the other major crops of the study area as evident from table IV-9 given in Chapter IV.

(vi) Selection of Officers and Non Officers
Officers and non-officers who are directly or indirectly engaged in fertilizer distribution and its promotional work in the study area were selected and interviewed for their reactions in order to get their suggestion to promote the fertilizers distribution and consumption. Different fertilizer dealing agencies were also interviewed with their distribution pattern. All officials and non-officials in the Sub-Division of the District engaged in the distribution and promotional work of fertilizer were interviewed for collection of information.

(2) Data gathering procedure and statistical tools used

This aspect is being presented in two sub-parts as under

(a) Data gathering procedure and method of enquiry

(b) Statistical tools used

(a) Data gathering procedure and method of enquiry

Information regarding the present study was gathered by personal interviews with the individual respondent. In few cases, the respondents were also interviewed in groups especially when information received through individual interview were to be verified. Prior to collect the desired data from the respondents they were fully and thoroughly explained about the purpose of interview. The constructed schedules and questionnaires along with specified scales and instruments were used for collecting the data comprehensively and accurately. The respondents were interviewed as and when they were available. Survey method of sampling technique was used for the collection of desired data. The study was conducted during 1992 and 1993.

(b) Method, technique of analysis and statistical tools

The data which were collected by personal interviews and questionnaires from the respondents, were statistically tested to get the desired results. Various statistical techniques and statistical tools used in the analysis and interpretation of data are discussed below.

(i) Tabular analysis
The collected data were classified and tabulated. This type of representation has proved very useful in comparing all sorts of data.

(ii) **Average**:

The simplest and important measure of average used in the statistical analysis of collected data was the weighted average

\[
\text{Weighted average} = \frac{WX}{X}
\]

Where as,

\(X = \text{Variate}\)

\(W = \text{Weight of } X\)

(iii) **"t" test**:

To test the significance differences of two variables, "t" test was used

\[t' = \frac{\bar{D}}{S.E.\ of\ D}\]

Where, \(\bar{D} = \frac{D}{N}\) mean difference

\[
S.E.\ of\ D = \sqrt{\frac{D^2 - (\bar{D})^2}{N}}
\]

\(N\) (\(N - 1\))

(iv) **Test of significance of difference of marginal value products of an input with its price**

\[t' = \frac{MVP_{x_1} - \text{Price}_{x_1}}{S.E.\ of\ MVP_{x_1}}\]

Where, S.E. of MVP\(_{x_1}\) = \(\sqrt{AVP^2\{x_1\} - V(b_1)}\)

\(MPV_{x_1}\) = Marginal value product of an input
\(\text{Price}_{x_1}\) = Price of an input
\(AVP^2\{x_1\}\) = Square of average value product of an input
\(V(b_1)\) = Variance of \(b_1\)

(v) **Correlation coefficient**:  

76
The correlation coefficient was worked out to examine the relationship between two variables. The formula used to estimate the value of coefficient of correlation is given below.

\[ r' = \frac{\sum XY}{\sqrt{\sum X^2 \cdot \sum Y^2}} \]

Where,
\[ \sum x^2 = \sum (X - \bar{X})^2 \]
\[ \sum y^2 = \sum (Y - \bar{Y})^2 \]
\[ \sum xy = \sum (X - \bar{X})(Y - \bar{Y}) \]

X and Y being the means of X and Y series

**Multiple Regression analysis**

The multiple regression analysis used as the analytical tool to study the input output relationship and the productivity of fertilizers used in the production of wheat and bajra along with other significant independent variables.

**Choice and specification of mathematical model**

The physical and biological factors involved in the production were given due consideration in selecting a mathematical model for the production function. The relationship between the input factors and the product (output) can be established in several plausible algebraic forms such as Linear, Cobb-Douglas, quadratic and square root functions. The exposition of the relative merits and demerits of the various forms have been done by Heady and Dillon. The choice of particular algebraic form of production largely depends on the nature of relationship between the input and output data observed on a scattered diagram. On the basis of this criteria, Cobb-Douglas production function was selected and used in the present study to find out the economic response of fertilizer on the production of wheat and bajra crops.
The partial regression coefficient (B1) in Cobb-Douglas function directly indicates the elasticity of production with respect to X which measures the percentage change in output per unit percentage change in input. The sum of these elasticities denote the return to scale. It is increasing, constant or decreasing return to scale when bj = or <1. The mathematical form of Cobb-Douglas equation fitted as follows.

\[ Y = ax_1^{b_1} x_2^{b_2} x_3^{b_3} \ldots \ldots \ldots \ldots \ldots X_n^{b_n} \]

Whereas,

Y = Output in quintal per hectare (dependent variable)
Xj = Independent input variables
bj = Production elasticities with respect to XI
a = Constant

The variables considered in the production function in the present study were
X1 = Cost of human labour per hectare (Rs)
X2 = Cost of seeds per hectare (Rs)
X3 = Cost of fertilizers per hectare (Rs)
X4 = Cost of irrigation per hectare (Rs)

The Cobb-Douglas equation was transformed into Linear form by taking the log of dependent and independent variables

Thus,
\[ \log y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 \]

This multiple regression equation was fitted by the usual method of least square. Test of significance of b1

(1) S.E. of \(b_1 = \sqrt{SC^2_{c_{11}}} \)
(2) \(t = \frac{b_1}{S.E.ofb_1} \)

D.F. = N-K-1

Whereas,
ECONOMIC ANALYSIS

Estimation of marginal physical products

The marginal physical product of a particular input factor (x1) used in the production of wheat and bajra was worked out by taking the first order partial derivative concerned shown in the production equation. As an illustration to work out marginal physical product of x1 at its mean level,

\[ Y = a_1^{b_1} \cdot x_2^{b_2} \cdot x_3^{b_3} \cdots \cdots \cdots x_n^{b_n} \]

Y is the output and x1, x2, x3, xn are the input variables used for the production of (Y). The first order partial derivative of output with respect to input variable x1 is gained by the following equation.

\[ \frac{\sqrt{Y}}{\sqrt{x_1}} = x_1^{b_1} \cdot x_2^{b_2} \cdot x_3^{b_3} \cdots \cdots \cdots x_n^{b_n} \]

\[ = b_1 \cdot \frac{Y}{x} \]

\[ \frac{Y}{x} \] = Marginal physical product of X1 (MPP) substituting the geometric mean values in place of x1, x2, x3 \ldots \ldots \ldots xn in the above expression, the marginal physical product of x1, at its geometric mean is obtained. A similar approach was used to find out the marginal physical products of other inputs, i.e. x2, x3 \ldots \ldots \ldots xn

Estimation of Marginal Value Products

The marginal value product of fertilizer along with other significant independent variables was calculated by multiplying the marginal physical product of the input variable by the price of output (Product) taken as dependent variable in the equation.
**Determination of economic optimum levels of fertilizer along with other inputs**

The return from any crop can be maximized by increasing the use of each input as long as its added returns are higher than its added costs. Due to operation of ‘Law of Diminishing Return’ added returns diminish and sooner or later a point is reached where the added returns become equal to added cost. At this point, the profit is at its maximum and marginal value product of each variable input is equal to its price.

Presume that the equation is

\[ Y = ax_1^{b_1}x_2^{b_2}x_3^{b_3}x_4^{b_4} \]

\[ \frac{\sqrt{Y}}{\sqrt{x_1}} = ab_1x_1^{b_1-1}x_2^{b_2}x_3^{b_3}x_4^{b_4} \]

\[ \frac{\sqrt{Y}}{\sqrt{x_2}} = ab_2x_2^{b_2-1}x_1^{b_1}x_3^{b_3}x_4^{b_4} \]

\[ \frac{\sqrt{Y}}{\sqrt{x_3}} = ab_3x_3^{b_3-1}x_1^{b_1}x_2^{b_2}x_4^{b_4} \]

\[ \frac{\sqrt{Y}}{\sqrt{x_4}} = ab_4x_4^{b_4-1}x_1^{b_1}x_2^{b_2}x_3^{b_3} \]

Solving the above equations simultaneously will give the value of \( x_1, x_2, x_3 \) and \( x_4 \) indicating optimum levels of \( x_1, x_2, x_3 \) and \( x_4 \). The above solution is only possible, if the capital available with the farmers is unlimited or there is not capital constraint.

However, in the real situation the capital available with the farmers is generally restricted and limited, hence the recommendations regarding optimum levels of inputs is based on the assumption of restricted and limited capital availability with the farmers. Under such conditions, a restricted profit maximizing solution can be achieved. The marginal value product of each input variable remains higher that its price and the returns are maximized by
shifting funds from the uses where its marginal value product is higher, till marginal value product in one use becomes equal to the other. This is obtained, when

\[
\frac{MPP_{x1}}{P_x} = \frac{MPP_{x2}}{P_x} = \frac{MPP_{x3}}{P_x} = \frac{MPP_{x4}}{P_x} = \frac{MPP_{xn}}{P_x}
\]

The economic optimum levels of inputs for wheat and bajra for all the farms as a whole (all forms) were calculated under limited capital availability. Assume Cobb-Douglas production function with only four independent input variables, we have.

\[
y = ax_1^{b1} \cdot x_2^{b2} \cdot x_3^{b3} \cdot x_4^{b4} \quad \cdots \quad (A)
\]

and assuming ‘c’ is the limited capital available for the wheat and bajras, the total variable cost function becomes.

\[
C = P_{x1}x_1 + P_{x2}x_2 + P_{x3}x_3 + P_{x4}x_4 \quad \cdots \quad (B)
\]

where, \( P_{x1}, P_{x2}, P_{x3} \) and \( P_{x4} \) are the prices of input variables and \( x_1, x_2, x_3 \) and \( x_4 \) are the levels of inputs used.

Total net return function will be.

\[
Z = Py \cdot Y - \lambda (P_{x1}x_1 + P_{x2}x_2 + P_{x3}x_3 + P_{x4}x_4)
\]

where \( Z \) is total net return and \( \lambda \) is the lag range’s multiplier.

Taking the partial derivative of ‘\( Z\)’ with respect to \( x_1, x_2, x_3 \) and \( x_4 \) equating them to zero for maximizing the function, we get

\[
\frac{dz}{dx_1} = Py \cdot \frac{dx}{dx_1} - P_{x1} = 0 \quad \cdots \quad (1)
\]

\[
\frac{dz}{dx_2} = Py \cdot \frac{dy}{dx_2} - P_{x2} = 0 \quad \cdots \quad (2)
\]

\[
\frac{dz}{dx_3} = Py \cdot \frac{dy}{dx_3} - P_{x3} = 0 \quad \cdots \quad (3)
\]
\[
\frac{dz}{dx_4} = Py \frac{dy}{dx_4} - Px_4 = 0 \quad \text{(4)}
\]

\[
\frac{dz}{d} = Px_1x_1 + Px_2x_2 + Px_3x_3 + Px_4x_4 - C = 0 \quad \text{(5)}
\]

Differentiating (A) with respect to \(X_1\), we get
\[
\frac{dY}{dx_1} = \frac{b_1Y}{x_1} \quad \text{(6)}
\]

Now, rearranging the equations (1), (2), (3), (4) and substituting the values of \(\frac{dy}{dx_1}\) we get,

\[
Py \frac{b_1y}{x_1} - Px_1 = 0
\]

\[
Py \frac{b_2y}{x_2} - Px_2 = 0
\]

\[
Py \frac{b_3y}{x_3} - Px_3 = 0
\]

\[
Py \frac{b_4y}{x_4} - Px_4 = 0
\]

Multiplying equations of (7) successively by \(x_1, x_2, x_3, x_4\) and adding we get,

\[Py.Y (b_1, b_2, b_3, b_4) = \lambda (x_{1px_1} + x_{2px_2} + x_{3px_3} + x_{4px_4}) \text{ or } Py.Y \sum bj = \lambda C\]

\[
\frac{Py.yb_j}{C} \quad \text{(8)}
\]

From (7) and (8),

\[
\frac{Py.b_1y}{x_1} \quad \text{or } x_1 = \frac{b_1C}{Px_1 \cdot \sum bj}
\]

Similarly,

\[
x_2 = \frac{b_2C}{Px_2 \cdot \sum bj}
\]

\[
x_3 = \frac{b_3C}{Px_3 \cdot \sum bj}
\]

\[
x_4 = \frac{b_4C}{Px_4 \cdot \sum bj}
\]
Thus, optimum level of inputs under limited capital availability can be obtained by

\[ x_4 = \frac{b_4 C}{P_{x4} \sum b_j} \]

Thus, optimum level of inputs under limited capital availability can be obtained by

\[ Opt. X_1 = \frac{b_1 C}{\sum b_j P_{x1}} \]

Where,
- Opt. \( X_1 \) = Optimum level of input \( X1 \)
- \( B_1 \) = Elasticity with respect to input
- \( C \) = Sum of the values of all input variables taken in the function
- \( \sum b_j \) = Sum of the elasticities with respect to inputs
- \( P_{x1} \) = Price of input \( x1 \)

**Other variables and their measurement**

This part deals with the measurement procedure of the various variables involved in the present study. Table-III describes the variables undertaken and the instruments / either adopted or developed used for the present study.

**Table-III. Variables and their empirical measurement**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Empirical Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Size of holding</td>
<td>Schedule developed</td>
</tr>
<tr>
<td>2.</td>
<td>Socio-Economic status</td>
<td>Trivedi and Pareek (1964)</td>
</tr>
<tr>
<td>3.</td>
<td>Educational level</td>
<td>Trivedi and Pareek (1964)</td>
</tr>
<tr>
<td>4.</td>
<td>Age</td>
<td>Schedule developed</td>
</tr>
<tr>
<td>5.</td>
<td>Caste</td>
<td>Schedule developed</td>
</tr>
<tr>
<td>6.</td>
<td>Type of family</td>
<td>Schedule developed</td>
</tr>
<tr>
<td>7.</td>
<td>Scientific orientation</td>
<td>Schedule developed</td>
</tr>
<tr>
<td>8.</td>
<td>Risk bearing capacity</td>
<td>Supe (1968)</td>
</tr>
<tr>
<td>9.</td>
<td>Infrastructure of fertilizer distribution</td>
<td>Schedule developed</td>
</tr>
<tr>
<td></td>
<td>agencies</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Sources of information for judicious use of</td>
<td>Schedule developed</td>
</tr>
<tr>
<td></td>
<td>fertilizer</td>
<td></td>
</tr>
</tbody>
</table>
### Concept of Variables

#### 1. Size of holding

It refers to the land unit owned by a farmer under cultivation. Leased area does not come under this concept. In the present study, the size of holding was measured in terms of the number of hectares of land owned by the farmer. The scores were assigned in the light of the scale developed by Trivedi and Pareek (1964). On this basis, the farmers were categorized as below.

- **(i) Big farmers**: Farmers having 4 and more than 4 hectares of land under his possession
- **(ii) Medium farmers**: The farmers who possess 2-4 hectares of land
- **(iii) Small farmers**: The farmers having 1-2 hectares of land under own cultivation
- **(iv) Marginal farmers**: The farmers having less than 1 hectare of land are called marginal farmers
2. Socio-economic status

Chapin (1928) defined economic status as 'The position of an individual or a family occupies with reference to the prevailing average standard of cultural possession, effective income, material possession and participation in the group activity of the community'.

The socio-economic status of the selected respondents was measured with the help of socio-economic status scale (rural) developed by Trivedi and Pareek (1964). Data were collected from the respondents through interview schedule and scored according to the procedure given in the manual of the scale with a little modification as desired. Changes in the existing points of the scale were made and a few points were added in order to make the scale more feasible to the prevailing situation (Appendix – I).

3. Education

Education refers to the formal education one has achieved. Education Pareek (1964) theoretically the score ranged from 0 to 1 – Appendix II.

4. Age

The age was measured in terms of year one has completed in his life on the date of interview.

5. Caste

Caste has theoretically been defined as a hereditary endogamous group having a traditional association with an occupation and a particular position in the hierarchy of caste.

In the present study, the term 'cast' was operationally measured by asking a question to each respondent about his caste. In this way caste of each respondent was noted and fixed in given category developed earlier, like upper caste, backward caste and scheduled caste.
6. Type of family

The type of family was measured in terms of family members, in away that the family consisting five members called single type of family and if more than 5 members, is called joint family of the respondent.

7. Scientific Orientation

Scientific orientation portrays the level of progressiveness and advancement of the farmers in the adoption of advanced technology of crop cultivation like adoption of high yielding varieties of seed, use of sophisticated method of fertilizer application, plant protection measures and use of up-to-date method of interculture operations, soil testing and sowing, well tested and inoculated seeds etc. The scores were computed for each respondent on the basis of cultivation of H.Y.V. seeds, use of fertilizer, use of implements and other improved cultural practices.

8. Risk Orientation

It denotes the extent to which the farmer is well-known towards the risk and uncertainty and has the courage to face the problems oftenly appears in the farming. The risk preference has been measured by the risk preference scale developed by Supe (1968).

9. Social participation

For the purpose of present study, social participation has been defined as the voluntary sharing in person to person and the group to group, relationship beyond household. Social participation has been interpreted as including both formal and informal group activities. The principles given by Chap (1926) was the basic orientation “A rough measure of the volume of the social stimuli may be had by counting the number of different activities an individual, participant (within a unit time) with supplementary facts on the number of executive posts held within the range of these activities”.

86
Social participation for the present study was measured by the social participation scale (rural farm families) developed by Chaudhary and Singh (1964). Social participation score for each respondent was computed by the sum of scale item values on which agreed. This scale consists of 13 items. Each item was weighted by its scale value as calculated by paired comparison technique. Theoretically, the range of scale on this scale varied from 0 to 27.

10. **Infrastructure of fertilizer distribution agencies**

The dictionary meaning of infrastructure is “inner structure, structure of component parts or a system of communication and services as backing for other operation”. In the present study, it has been used to include target and distribution of fertilizer, staffing pattern of fertilizer distribution agencies at different (from state to village), means of transportation and communication used for fertilizer, nature and location of buffer stock and godowns and scale points, agencies preferences for fertilizer distribution and reasons thereof, sources of information about judicious use of fertilizer, problems faced by respondents in obtaining the fertilizer from different agencies and opening of sale points year to year at different convenient location etc. of different fertilizer distribution agencies like Department of Agricultural, cooperatives, agro-industries, cane unions and private agencies etc.

(i) **Target and distribution of fertilizer**

The schedule used to determine the target and achievement of the fertilizer distribution through various agencies who provided information with regard to the target and achievement in metric tones in different seasons of the year. The targets and achievement have been calculated and presented in terms of percentage.

(ii) **Preference for fertilizer distribution agencies and reasons thereof**

Opening of sale points etc. have been worked out by obtaining the response of the respondents. Response of the farmers were converted into the percentages. Staffing pattern etc. were shown simply by obtaining his
position at proper place from state to village and nature of work explained according to the job requirement and status.

(iii) Sources of information for judicious use of fertilizer

Scoring procedure as suggested by the scale developed by Singh (1964) has been used in the present study. Four points scale, much, medium, less and nil was utilized. To stress the importance of source of information, a score of 4 was allotted to 'much', 3,2 and 1 score of points were allotted to the medium, less and nil source of information respectively for judicious use of fertilizers etc. In this scoring method, higher the score, prominent is the source of information. The source liking on the basis of its capacity and effectiveness, the farmers were given the opportunity to point out their preference or likings to the source of information. The preferences shown by the respondents were assigned weightage of 4,3,2 and 1 to much, medium, less and nil preference respectively. The total rank score for each source of information was obtained by summing the four different responses multiplied by their respective weight. Finally, the total scores were worked out by summing them and on the basis of this overall sum scored the rank assigned. Due to some reasons and problems, it has been considered necessary to include a category on the continue where such response could be recorded. A middle category designated as "undecided" was thus added in the 4-point continue scale and scoring was followed as 5,4,3,2 and 1.

(iv) Problems faced in obtaining fertilizer through different fertilizers distribution agencies.

It has been noticed that there were five agencies in the distribution of fertilizers to the farmers. They were Department of Agriculture, Cooperatives, Agro-industries, Cane Department and Private Agencies. It was also observed that there was wide variation among the farmers in their problems in obtaining fertilizer from different agencies. The problems faced were categorized in rank order according to the urgency and need of the farmers. A problem might be more important to one agency and might be least importance for the
other agency. The problem also varied according to location and convenience of the farmers.

Score assigned for the items were “very often-4” “often-3”, “rarely-2” and “never emphasized problem rank-1”. The total score of each respondent was obtained by summing the problems of four different responses multiplied by their respective weight. On the basis of sum score, ranking order of the problem were assigned for that agency.

11. **Review of fertilizer distribution policies of Govt. Quasi Govt. and Private Agencies**

The information in respect with fertilizer distribution policy of different fertilizer distribution agencies were collected for review. All the organizations were personally approached and persuaded for providing information’s about their policies. The review includes the key points such as system of fertilizer sale, prices, credit for fertilizer, rate of interest on credit, fertilizer distribution margin, transportation, fertilizer promotional work, policies of leading fertilizer manufacture, mode of fertilizer sale, sale ratio as a trade and bulk, security for whole sale dealers, marketing charges, storage charges and subsidy etc. were taken into account in fertilizer distribution policy.

12. **Changes in fertilizer use and cropping patterns**

Changes in fertilizers use under different crops and cropping pattern under different categories of farmers have been taken into account. It has been calculated as an average of fertilizers in kilogram and acreage changes under different cropping pattern were observed in hectare (total cropped area).

13. **Extent of irrigated area and consumption of fertilizer**

It becomes an established fact that irrigation has direct and positive relationship with the consumption of fertilizers. The availability of irrigation water creates the avenue for a higher fertilizers consumption. In the present study, an analysis has been made to visualize the extent of increase in the irrigated area in one category over another category of farm alongwith the
relative increase in the consumption of fertilizer. The extent of change has been shown in percentage. The relationship was also tested by calculating coefficient of correlation.

14. **Consumption of fertilizer by different categories of farmers in relation to cropping pattern.**

It has been determined by summing the consumption of fertilizers in the crops by all farmers in Kg/ha of a particular category of farmer and divided by their respective number of farmers falling in that category. It showed the average consumption of fertilizer of that category.

15. **Causes of non application of recommended dose of fertilizers**

Causes of non application of recommended dose of fertilizers have also been tested on 4-point scale as explained in earlier variables. The suggestions of the farmers to promote the fertilizer consumption were processed through 4-point scale, i.e., highly suggested-4, suggested-3, low suggested-2 and no suggestion ranked-1.

16. **Suggestion of officials for enhancing fertilizer distribution and consumption**

The suggestion of officials engaged in fertilizer distribution and promotion work through different organizations and agencies have been collected by special questionnaire prepared according to their working pattern. Hence, the study of suggestion for different organization was carried out.

The respondents of this study were the development staff of the district and sub-divisions, field representatives, representative of different fertilizers manufacturers and official engaged in all fertilizers agencies like Department of Agriculture, cooperatives, agro-industries, cane department and private agencies. These respondents were approached individually and requested to not down the suggestion which were confined only to the distribution and consumption of fertilizer. After attaining a list of suggestions from each
respondent, summated and finally presented in percentage. The expression of other concept used in the present study are as follows.

1. *Wheat and bajra growers*

   Wheat and bajra growers are the farmers who have at least 10 per cent of the total cropped area under each crop.

2. *Total cost or total input cost*

   The total cost is the sum of all the fixed and variable costs incurred in the various farm operations on crop production.

3. *Fixed cost*

   The fixed cost is the cost involved in the fixed investment on the farm. The fixed cost in the present analysis includes the interest, depreciation and repairs to fixed capital and dead stock, land revenue or rental value of land.

4. *Variable cost*

   The variable cost includes the expenses incurred in cash and kind for human labour, bullock labour, seed, manure and fertilizers, irrigation, pesticides etc.

5. *Return to fertilizer use*

   It was obtained by subtracting the total input cost excluding the cost of fertilizer from the value of output and divided by the cost of fertilizer. This will be the return per rupee investment on fertilizer.

6. *Percentage return to fertilizer consumption*

   It is calculated by subtracting the total cost excluding the cost of fertilizer from total value of output and divided by the cost of fertilizer and multiplying by 100.

7. *Benefit cost ratio*

   It was obtained by subtracting the total cost from the value of output and divided by the cost of fertilizer.
Test of knowledge level of the farmers

Broadly, knowledge refers to a body of understanding the information possessed by an individual. It has been defined as “Those behaviour and test situations which emphasize remembering either by recognition or recall of ideas, material or phenomena” (Bloom et al, 1956). To test of knowledge in respect with use of recommended doses of fertilizers in the cultivation of bajra and wheat, twenty tow questions were included for each crop in the schedule to test the knowledge of the farmers. One mark was given for every right answer and zero mark was accorded for every wrong answer. The following formula was used to work out the knowledge index 1.

Knowledge index \( I = \frac{x_1 + x_2 + x_3 \ldots \ldots x_n \times 100}{N} \)

Whereas \( x_1, x_2, x_3 \ldots \ldots x_n \) are the correct answers and \( N \) is no. of question asked, i.e. 22.

Test of application of NPK

(a) Application of N = \( \frac{\text{Quantity of } N}{\text{Quantity of } N} \times \frac{N_2 \text{ / ha applied}}{N_2 \text{ / ha recommended}} \times \text{Weight} \)

(b) Application of P\(_2\)O\(_5\) = \( \frac{\text{Quantity of } P}{\text{Quantity of } P} \times \frac{P \text{ / ha applied}}{P \text{ / ha recommended}} \times \text{Weight} \)

(c) Application of K\(_2\)O = \( \frac{\text{Quantity of } K}{\text{Quantity of } K} \times \frac{K \text{ / ha applied}}{K \text{ / ha recommended}} \times \text{Weight} \)