CHAPTER-III

METHODOLOGY

The methodology adopted for the present investigation is discussed in this chapter. It deals with details of analytical procedure adopted to fulfill the objectives of the study. The various phases are discussed as under.

3.1 Coverage of the study area
3.2 Source of data
3.3 Sampling designing and pre-testing of survey schedule
3.4 Analytical tools

3.1 Coverage of the study

3.1.1 The study area

There are large variations in the input practices and output levels among farms in different regions and the regional level analysis generally ignore the inter–farm variations within region (Mythili and Shanmugam, 2000). Therefore, an analysis at the farm level is desirable to get a clear understanding of the existence of gap between actual and potential output of agricultural crops in different regions. However, in recent past no attempt has been made to analyze the economics and resource use efficiency of groundnut + castor inter cropping system especially for Saurashtra region in Gujarat, where groundnut + castor inter cropping system is largely practiced. Therefore, the present study is confined to the Saurashtra region of Gujarat state.

3.2 Source of data

The primary data on inter cropping (groundnut + castor) and sole groundnut and sole castor including acreage, yield, harvest prices, input cost etc. were collected by visiting each of the selected farmers personally and interviewing them with a pre tested questionnaire. The information were collected by survey method for the kharif season of the year 2016–17.
3.3 Sampling design

Multi stage sampling technique was adopted for the selection of sample farmers. Two districts of Saurashtra region of Gujarat state viz., Junagadh and Gir-Somnath were selected purposively, where the farmers of these districts follows the practice of inter cropping system in large numbers. One taluka from each selected district, adopting this system was also selected purposively as the first unit of sampling. In the selected talukas, a pilot survey was carried out and the list of villages having large number of farmers adopting groundnut-castor inter cropping has been prepared. As shown in (Table 3.1) Two villages were selected randomly from each taluka adopting intensive inter cropping system. From each village, 12 farmers practicing inter cropping system (groundnut + castor), 12 farmers growing sole groundnut and sole castor each, were selected randomly as the ultimate sampling unit. The sample size of 48 for inter cropping of groundnut + castor, 48 for sole groundnut and 48 for sole castor, were selected making the sample size total to 144. Out of the 12 farmers in a village, 3 marginal (up to 1.00 ha), 3 small (1.01–2.00 ha), 3 medium (2.01–4.00 ha) and 3 large (above 4.00 ha) farmers, has been interviewed.

Table 3.1: Sampling procedure to be involved in the study

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>District</th>
<th>Taluka</th>
<th>Village</th>
<th>No. of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Groundnut +Castor</td>
<td>Sole Groundnut</td>
</tr>
<tr>
<td>1</td>
<td>Junagadh</td>
<td>Keshod</td>
<td>Movana</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kevadra</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>Girsonnath</td>
<td>Sutrapada</td>
<td>Vadodra</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pasnavda</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

3.3.1 Pre–testing of survey schedule

Considering the nature of the study and for obtaining correct and perfect information from the respondents, it was decided to collect information through personal interview using the interview using the interview schedule. While preparing the interview schedule, the available related literature and research reports has been referred.
3.4 Analytical tools

The collected data was analysed using various statistical analyses to draw meaningful inferences, keeping in view of the objective of the study and requirement. The major analytical tools employed for the study include tabular analysis and resource use efficiency analysis, and logistic regression, and Cobb-Douglas production function were used to work out the resource use efficiency. The methods of analysis employed are described below:

3.4.1 Tabular analysis

The tabular analysis was employed to workout farm structure and socio-economic characteristics of inter crop (groundnut + castor), sole groundnut and sole castor farmers.

3.4.2 Calculation of cost and returns

Cost concepts used widely in farm management studies such as Cost A₁, Cost A₂, Cost B₁, Cost B₂, Cost-C₁ and Cost-C₂ were adopted for computing cost of cultivation/production of the intercropping and sole crop of groundnut and castor.

3.4.3 Cost concepts

The costs concepts used in the present study are as under,

1) Cost A: It includes all actual expenses in cash and kind incurred in production process as,
   1. Value of hired human labour;
   2. Value of bullock labour (both hired and owned);
   3. Value of machine power (both hired and owned);
   4. Value of seeds (both owned and purchased);
   5. Value of insecticides and pesticides, weedicides;
   6. Value of manures (both owned and purchased);
   7. Value of fertilizers;
   8. Depreciation of implements and farm buildings;
   9. Irrigation charges;
   10. Land revenue, cess and other taxes;
   11. Miscellaneous expenses; and
   12. Interest on working capital;

2) Cost B: Cost A+ interest on value of fixed capital (excluding land) + rental value of owned land.
3.4.4. Farm income measures

Farm income refers to profits and losses incurred through the operation of a farm. A farm income statement (sometimes called a farm profit and loss) is a summary of income and expenses that occurred during a specified accounting period. It includes both farm profitability measures and farm income measures such as, gross return, farm business income, family labour income, owned farm business income, net income, intensive income, farm investment income. The following are the farm income measures considered in the present study.

**Farm profitability measures;**
1) **Returns/ha over cost** = \( \text{Gross income} / \text{individual cost concept} \)
2) **Input-output ratio over cost** = Ratio of gross income to individual cost concept
3) **Profitability** = \( \text{Value of output} - \text{Cost C}_2 \)

**Farm Income measures;**
1) **Gross returns** = Value of main product plus by product.
2) **Farm business income** = \( \text{Gross return} - \text{Cost A} \)
3) **Family labour income** = \( \text{Gross return} - \text{Cost B} \)
4) **Net income** = \( \text{Gross return} - \text{Cost C}_2 \)
5) **Intensive income** = Net income + rental value of owned land + interest of fixed capital
6) **Farm investment income** = Farm business income – Imputed value of family labour

3.4.5 Imputation procedure for input costs

The value of purchased input was taken into account as reported by the cultivation with due verification. The procedure adopted for deriving imputed value of these inputs is as given below.

1) The value of family labour was worked out at the wage rate prevailing for different agricultural operations in the selected villages.
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2) The cost of bullock labour utilized in farm operation of the crop was worked out as per the prevailing market rate in the villages.

3) The value of own seed and farm yard manure were computed as the rates prevailing in the concerned villages.

4) The costs of irrigation, tractor and owned machinery charges, (viz., thrasher/opener, etc.) were considered at the market rate custom service.

5) The kind payments are evaluated at prices prevalent in the village at the time of those operations.

6) Interest on working capital was charged at the rate of 12 per cent per annum, according to duration of the crops.

7) Interest on owned fixed capital was charged at the rate of 10 per cent per annum.

8) Depreciation of owned farm buildings was calculated at the rate of 5 per cent for kuchcha and 2 per cent for pucca buildings per annum.

9) Rental value of farmers owned land was charged at the rate prevailing in the villages in the season.

10) Management charges was calculated at the rate of 10 per cent of the Cost-C1.

3.4.6 Apportionment of joint costs

The apportionment of total cost of cultivation between the main product and the by product was done in proportion to their contribution to the total value of output, when the value of by product is greater than or equal to 10 per cent. But when the value of by product is less then 10 percent, it is deducted from the total cost. To calculate the cost of production per quintal of intercrops (groundnut + castor), the yield of inter crop was converted in to equivalent yield to main crop (groundnut). The equivalent yield is then added to the main crop (groundnut) thus making total yield of inter cropping (groundnut + castor).

3.4.7 Resource use efficiency:

The resource use efficiency in agriculture shows how an, efficient farmer allocates his land, labour, water and other resources in an optimal manner, so as to maximize his income, at least cost, on sustainable basis. While some farmers may attain maximum physical yield per unit of land at a high cost, some others achieve maximum profit per unit of inputs used. Also in the process of achieving maximum yield and returns, some farmers may ignore the environmentally adverse consequences, if any of their resource use intensity (Haque, 2006).
3.4.8 Measurement of resource use efficiency

Resource productivity is definable in terms of individual resources input or a combination of them. Optimal productivity implies and efficient utilization of scarce resources in production process, hence productivity and efficiency are synonymous in this content. Following Majumder et al. (2009), Cobb-Douglas production function was employed to estimate the effects of various inputs in the production of sole and intercropping system. Data pertaining to crop production concerning all the factors which are likely to have an impact were taken in the analysis. All variables were expressed in monetary terms. To determine the contribution of the technical factors in the production process, the following specification of the model was applied:

\[
Y = \alpha X_1^\beta_1 X_2^\beta_2 X_3^\beta_3 X_4^\beta_4 X_5^\beta_5 X_6^\beta_6 X_7^\beta_7 X_8^\beta_8 X_9^\beta_9 X_{10}^\beta_{10} X_{11}^\beta_{11} e^u \tag{1}
\]

Where,
- \( Y \) = Gross return from groundnut / castor / groundnut + castor (Rs/ha)
- \( X_1 \) = Seed cost (Rs. / ha)
- \( X_2 \) = family labour cost (Rs. / ha)
- \( X_3 \) = hired labour cost (Rs. / ha)
- \( X_4 \) = machine power (Rs./ ha)
- \( X_5 \) = nitrogenous fertilizers cost (Rs./ ha)
- \( X_6 \) = phosphoric fertilizers cost (Rs./ ha)
- \( X_7 \) = potassic fertilizers cost (Rs./ ha)
- \( X_8 \) = sulphur fertilizer cost (Rs./ ha)
- \( X_9 \) = manures cost (Rs./ha)
- \( X_{10} \) = insecticides / pesticides cost (Rs. / ha)
- \( X_{11} \) = irrigation cost (Rs./ ha)
- \( \beta_1-\beta_{11} \) = parameters to be estimated
- \( e \) = error term.
For the purpose of estimation, the equation was expressed in logarithmic form,
\[ \ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + b_{10} \ln X_{10} + b_{11} \ln X_{11} + e \]  
--(2)

In order to test the efficiency, the ratio of Marginal Value Product (MVP) to the Marginal Factor Cost (MFC) for each input was computed and tested for its equality to 1, MVP/MFC=1

Thereby,
\[ \text{MVP} (X_i) = \beta_j \times \frac{Y \text{ (GM)}}{X_i \text{ (GM)}} \]  
---(3)

Where,
- $\beta_j$ = Estimated co-efficient of elasticities for $j^{th}$ input;
- $Y$ = GM value of gross return in rupees and
- $X_i$ = GM value of the $i^{th}$ variable input in rupees,

MFC is the price of per unit of input. As the value of all inputs ($X_i$) under study was taken in monetary terms, MFC was considered equal to 1. Based on economic theory, any firm can maximize its profit with regards to resource use, when the ratio of the marginal return to opportunity cost is one. Accordingly,

- If $r< 1$; shows that resource is excessively used or over utilized hence decreasing the quantity use of that resource increase profit.
- If $r> 1$; shows that resource is under used or being under-utilized hence increase its rate of use will increase profit level.
- If $r= 1$; shows that the resource is efficiently used, that is optimum utilization of resource hence the point of profit maximization.

3.4.9 Measurement of scale of production

The concept of elasticity can be applied to the production function to determine the stage in which farmers are allocating their resources. The elasticity of production refers to the percentage change in output in relation to the percentage change in input. In this study, the scale of production for all farmers were estimated by summation the values of the co-efficient ($b_i$)of the Cobb-Douglas production functions, since the coefficients give the direct measure of returns to scale indicating the stage of production. Return to scale indicate what would happen to output if all inputs were to increase simultaneously. The sum of $b_i$ was used as indicator of return to scale. The constant return to scale occur when sum of coefficient equal to 1, below
1 indicate decreasing return to scale and for increasing return to scale above 1 (Mushunje and Belete, 2001).

The ‘t’ test for estimated return to scale was done by following formula

\[ t = \frac{\sum b_i - 1}{\text{Std. Error of } \sum b_i} \]  

---(4)

Where,

\[ \sum b_i \] = summation of elasticity.

(The efficient production was represented by an index value of 1.0, while lower value indicate a greater degree of inefficiency)

### 3.4.10 Logistic regression analysis

This study was also attempted to recognize the influence of various attributes including that of personal and social attributes of the farmers in determining the adoption of groundnut + castor intercropping. The factors influencing the farmer’s decision was analyzed using Logistic regression model. The use of the Logit model is consistent with the literature on adoption, which described the adoption process as taking on a logistic nature. The Logit model have also been applied in several adoption studies (Shanmugapriya et al., 2014).

Pointed out that the logistic distribution (logit) has advantage over the others in the analysis of dichotomous outcome variables. It is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation. The binary Logistic model does not make the assumption of linearity between dependent and independent variables and does not assume homoscedasticity. Hence, the logistic model is selected for this study. The binary dependent variable were defined as 1 if the farmer prefers intercropping and 0 otherwise. The probability that a farmer adopts intercropping is postulated as a function of demographic characteristics (such as age, education, experience and family size), economic characteristics (income from agriculture), farm infrastructural characteristics (total land holding, area under cultivation, irrigation and labour shortage) and social characteristics extension contact and social participation (Hosmer and Lemeshew, 1989).

This study has adopted the Logit model of binary choice, confines the number of dependent variable within the [0–1] scope and utilizes the maximum likelihood estimation method to compute the regression parameter. Therefore, the cumulative logistic probability model was econometrically specified as follows:
Methodology

\[ P_i = F(Z_i) = F(\delta + \sum \lambda_i X_i) = \left[ \frac{1}{1 + e^{-z_i}} \right] \]

\[ \text{---(5)} \]

Where,

\[ P_i = \text{Probability that a farmer will prefer intercropping or otherwise.} \]
\[ X_i = \text{Explanatory variables} \]
\[ \delta, \lambda = \text{Parameters to be estimated} \]
\[ e = \text{Base of natural logarithms (approximately equal to 2.718)} \]

The logit model could be written in terms of the odds and log of odds, which enables one to understand the interpretation of the coefficients. The odds ratio implies the ratio of the probability \( P_i \) that a farmer will prefer to the probability of intercropping adoption and \( (1-P_i) \) refers that the farmer will not prefer intercropping of groundnut + castor.

The odds ratio is given as:

\[ (1 - P_i) = \left[ \frac{1}{1 + e^{z_i}} \right] \]

\[ \text{---(6)} \]

Therefore,

\[ \left[ \frac{P_i}{1 - P_i} \right] = \left[ \frac{1 + e^{z_i}}{1 + e^{-z_i}} \right] = e^{z_i} \]

\[ \text{---(7)} \]

The natural log of equation, will give:

\[ Z_i = \ln \left[ \frac{P_i}{1 - P_i} \right] = \delta + \lambda_1 X_1 + \lambda_2 X_2 + \ldots + \lambda_m X_n \]

\[ \text{---(8)} \]

If the disturbance term \( i \) \( U \) is taken into account, the logit model becomes:

\[ Z_i = \delta + \sum_{i=1}^{m} \lambda_i X_i + U_i \]

\[ \text{--- (9)} \]

Equation (7) was estimated by maximum likelihood method. This procedure does not require assumptions of normality or homoscedasticity of errors in predictor variables.
In this study, the logit equation was fitted to find out the determinants influencing the adoption of intercropping. The model used in this study is given below:

\[ Z_i = \ln \left( \frac{P_i}{1-P_i} \right) = \delta + \lambda_1(X_1) + \lambda_2(X_2) + \lambda_3(X_3) + \lambda_4(X_4) + \lambda_5(X_5) + \lambda_6(X_6) + \lambda_7(X_7) + \lambda_8(X_8) + \lambda_9(X_9) + U_i \]  

---(10)

Where,

- \( Z_i = Y \)
- \( \lambda_1 \) to \( \lambda_9 \) = Coefficients of independent variables
- \( \delta \) = Intercept
- \( U_i \) = Error term

Table 3.2: Definition of the variables to be used in Logistic regression model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Y )</td>
<td>Farmer’s preference to adopt intercropping in last three years (1 if the farmer prefers intercropping, 0 otherwise)</td>
<td></td>
</tr>
<tr>
<td>( X_1 )</td>
<td>Age of the farmer (in number of years)</td>
<td>+</td>
</tr>
<tr>
<td>( X_2 )</td>
<td>Educational status of the farmer (in no. of years)</td>
<td>+</td>
</tr>
<tr>
<td>( X_3 )</td>
<td>Experience of farmer (in no. of years)</td>
<td>+</td>
</tr>
<tr>
<td>( X_4 )</td>
<td>Family size (in numbers)</td>
<td>+</td>
</tr>
<tr>
<td>( X_5 )</td>
<td>Area under cultivation</td>
<td>+</td>
</tr>
<tr>
<td>( X_6 )</td>
<td>Income from agriculture (Rs. / Annum)</td>
<td>+</td>
</tr>
<tr>
<td>( X_7 )</td>
<td>Irrigation facility (1 = Yes, 0 = Otherwise)</td>
<td>+</td>
</tr>
<tr>
<td>( X_8 )</td>
<td>Labour shortage (1 = Yes, 0 = Otherwise)</td>
<td>-</td>
</tr>
<tr>
<td>( X_9 )</td>
<td>Social participation score: summation of,</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>i) No. of visits by extension agri personnel during last season,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) No. of memberships in associations/organizations,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii) No. of training programmes attended during last season.</td>
<td></td>
</tr>
</tbody>
</table>
3.4.11 Odds-ratio

The effect of each independent variable on intercropping adoption is to be determined by the coefficient ($\lambda$) and the sign of any coefficients will represent the positive and negative effect of the variable on adoption of intercropping. To quantify the effect of each variable, odds-ratio was determined. It quantifies the probability of adoption of intercropping and it is represented algebraically by the following,

**Probability of intercropping adoption,**

$$P = \text{odds ratio of } (x_i-1) \times 100$$

Where, $x_i$ is the independent variable and $i = 1, 2, 3, \ldots, 9$.

3.4.12 Garrett's ranking technique

Garrett's ranking technique was used to analyze the constraints faced by farmers in the production of groundnut/castor and (groundnut + castor). The respondents were asked to rank the given constraints. The order of the merit thus given by the respondents were converted into rank using the following formula:

**Per cent position of the constraint**

$$\text{Per cent position of the constraint} = \frac{100 (R_{ij} - 0.5)}{N_j}$$

Where,

- $R_{ij}$ = Rank given for the $i^{th}$ constraint by the $j^{th}$ farmer,
- $N_j$ = Number of factors ranked by the $j^{th}$ farmer.

The percent position of each rank thus obtained was converted into scores by referring to the table given by Garrett and Woodworth (1971). Then for each constraint, the scores of individual respondents added together and then dividing by the total number of respondents. The mean scores obtained for all constraints would be arranged in ascending or descending order, ranks has been given and most important constraints were identified.