CHAPTER - III

METHODOLOGY

This chapter has been divided into the following broad sections for clear exposition of the concepts and various aspects of methodology used in the present study:

3.1 Sampling procedure

3.2 Enterprises covered under the study

3.3 Analytical technique

3.1 Sampling procedure

For deriving the results of this study both primary as well as secondary data have been used. The necessary primary data for the study were collected from the selected sampled farmers with the help of well structured and pre-tested schedules. Primary data regarding inventory of farm resources, cropping pattern, input use pattern and operations performed for each farm activity along with the farmer’s expected level of return from each and every farm enterprise were recorded carefully. The secondary data were collected from various published sources such as Economic Survey of Assam (various issues), Statistical Hand Book of Assam (various sources) publications of Directorate of Agriculture, Govt. of Assam, Char Area Development Authority, Govt. of Assam etc.

A multistage stratified random sampling technique was used to select the ultimate sample unit. The present study was designed to analyse the crop production risks and measures adopted by the farmers of riverine areas in the Upper Brahmaputra Valley (UBV) zone of Assam. The Upper Brahmaputra Valley zone of Assam comprised of the districts of Sivasagar, Jorhat, Golaghat, Dibrugarh and Tinsukia with a geographical area of 16,192 km². In the first stage two districts viz. Jorhat and Dibrugarh were randomly selected. In the second stage the riverine areas within the district were identified and three blocks that had riverine areas within its jurisdiction from each district were selected. In the next stage block wise list of villages was prepared and two villages were selected randomly from each block. Thus a total of six block and twelve villages were selected from the two districts of Upper Brahmaputra
Valley Zone of Assam. Village-wise list of farmers was prepared and the farmers were categorised into four size groups that is small (less than 2 ha), medium (2 and less than 4 ha) and large (4 ha and above 4 ha). A random sample of 20 per cent of the farmers was drawn from each size group and its detailed break up is presented in Table 3.1

For deriving the results of this study both primary as well as secondary data have been used. The primary data necessary for the study were collected from the selected sampled farmers through well structured and pre-tested schedules. For recording data, each of the selected farmer was personally interviewed. The primary data collected from the sampled farmers comprising of the general information regarding the inventory of farm. resources, input-output coefficients for various crops, prices of inputs and outputs and packages of practices in the cultivation/production of various crops/farm products and

Table 3.1 Distribution of sample farmers according to size of their operational holdings.

<table>
<thead>
<tr>
<th>Name of districts</th>
<th>Name of blocks</th>
<th>Name of villages</th>
<th>Small (less than 2 ha)</th>
<th>Medium (2 and less than 4 ha)</th>
<th>Large (4 and above 4ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jorhat</td>
<td>Dhakorgora</td>
<td>Malowpam</td>
<td>12</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gohaingaon</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Majuli Development block</td>
<td>Bhokotchapari</td>
<td>12</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mohkinagaon</td>
<td>12</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Chipahikhula</td>
<td>Hatikhal</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hindolguri</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dibrugarh</td>
<td>Lahowal</td>
<td>Bortichuk</td>
<td>10</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goalchuk</td>
<td>9</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Borboruah</td>
<td>Lezai</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kolakhua</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Tengakhat</td>
<td>Kacharipathar</td>
<td>11</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Khulaumpur</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total sample size</td>
<td>122</td>
<td>74</td>
<td>35</td>
<td>122</td>
<td>74</td>
</tr>
</tbody>
</table>
quantum of crop damages due to various factors and farmers perceptions towards various risks involved in crops production. All primary data along with data on farmer’s expected level of return from each and every farm enterprise were recorded carefully. The primary data collected pertained to the period 2013-14. The secondary data regarding area, production and productivity of selected crops were collected from the Economic Survey of Assam (various issues), publications of Directorate of Agriculture, Assam, District offices of the State department of Agriculture etc. The zonal level aggregate data have been computed from the district level data compiled for the period 2003 to 2012. Monthly rainfall and temperature data were collected from Department of Agricultural Meteorology, AAU, Jorhat and Toklai Research Association, Dikom, Dibrugarh.

Fig. 3.1 – Dhakorgora block of Jorhat district.

Fig. 3.2 – Majuli Development block of Jorhat district.
Fig. 3.3 – Chipahikhula block of Jorhat district

Fig. 3.4 – Lahowal block of Dibrugarh district.

Fig. 3.5 – Borbouarh block of Dibrugarh district.
3.2 Enterprises covered under the study

Important crop enterprises grown in the study area are included in the study. The selected crops are (1) autumn rice (2) winter rice (3) summer rice (4) green pea (5) potato (6) pumpkin (7) green gram (8) brinjal (9) rapeseed (10) okra (11) black gram (12) cabbage (13) cauliflower (14) sugarcane and (15) chilli. In order to optimise resource use on the selected farms, the following farm activities/production processes were also identified for being considered in deriving the synthetic risk minimised optimal production plans.

1. *Ahu* rice HYV lowland
2. Sali rice HYV medium land
3. *Sali* rice local lowland
4. *Boro* rice lowland
5. Green pea medium land
6. Potato medium land
7. Pumpkin local medium land
8. Green gram upland
9. Brinjal upland
10. Rapeseed medium land
11. Okra upland  
12. Black gram upland  
13. Cabbage upland  
14. Cauliflower upland  
15. Sugarcane upland  
16. Chilli upland  

3.3 Analytical technique

3.3.1 Coefficient of variation

To measure the quantum of risks associated with the yields of major activities in the study area, coefficient of variation (CV) was used and ranked them in descending order. As time series farm level data on area, production and productivity were not available some alternative procedure had to be followed. It was assumed that aggregate district level data reflected the yield variations at the farmers’ field levels. Coefficient of variation (C.V.) of productivity for each activity in the riverine area of Upper Brahmaputra Valley Zone of Assam was calculated by the following formula:

\[ CV = \sqrt{\frac{\sum (Y_i - \bar{Y})^2}{N \bar{Y}}} \]

\( Y_i = \) area/production/productivity of the crop in \( i^{th} \) year/period  
\( \bar{Y} = \) arithmetic mean  
\( N = \) total number of observations

3.3.2. MOTAD (Minimisation of Total Absolute Deviation) MODEL

To suggest appropriate risk minimization crop production plans for the farmers of riverine area in the Upper Brahmaputra Valley Zone (UBVZ) of Assam, MOTAD (Minimisation of Total Absolute Deviation) MODEL was used in the study. In agricultural planning problems the farmers face multiple objectives, often conflicting in nature. In situations where multiple objectives are involved, the farmer is interested not in optimizing a single objective but finding a compromise among several objectives. In
general two conflicting objectives *viz.*, profit maximization and risk minimization, are attempted to be solved. Profit maximizing linear programming based on the data of representative farms has been frequently used for finding the optimum use of farm resources. However, due to the risk involved in different profit outcomes, some method of incorporating risk considerations into the analytical framework is desirable. Quadratic Programming (QP) has been suggested as the most useful tool for incorporating risk in farm planning. Scarcity of computer time and code and some other limitations of QP itself necessitate a linear rather than a QP approach (Hazell, 1971, a, b). Minimization of Total Absolute Deviation (MOTAD) programming which is a linear and an efficient alternative to QP has been applied in most cases to identify the compromise set of risk efficient plans for these two conflicting objectives.

The present study also considered the fact that an element of risk is always present in the agricultural production process in the riverine areas. Risk of damage to crops due to inundation during periods of flood has been periodical in such areas. Ignoring risk in farm planning model often leads to the results that are unacceptable to the farmers or bear little relevance (Hazell and Northon, 1986). Considering this fact risk minimization optimum plans have been developed for different levels of technology adoption. Risk programming model in the line of MOTAD has been formulated. Hazell (1971) proposed the use of MOTAD (minimization of total absolute deviation from mean) as an alternative to the mean variance criteria for planning under risk. It attracted the attention of researchers in India and abroad as it can be solved on conventional linear programming code and also enables better post optimal analysis. Mruthunjaya *et al.* (1979), Singh *et al.* (1983), Randhir *et al.* (1993), Jha (1996) used MOTAD to formulate risk efficient farm plans. Risk is incorporated in the model as mean absolute deviation of expected income.

In matrix notation the MOTAD model is specified as:

\[
M = S - 1 \sum_{t=1}^{S} \left( \sum_{j=1}^{n} (C_{ij} - \bar{C}_j) X_j \right) \tag{1}
\]

\(M\) = Mean absolute deviation that can be minimized for a given level of expected income.

\(S\) = Number of years.

\(C_{ij}\) = Gross margin per unit of \(j^{th}\) crop activity in the \(t^{th}\) year (unit here is one hectare)

\(\bar{C}_j\) = Sample mean gross margin per unit of \(j^{th}\) crop activity.
X_j = Level of \(j^{th}\) crop activity to be obtained from the solution of the model.

\(j = \) Refers to \(j^{th}\) activity \((j = 1\) to \(n\) activities\)

\(t = \) Refers to \(t^{th}\) year \((t = 1\) to \(S\) years\)

\(| \| = \) Modulus denotes absolute value of the figures \(i.e.,\) ignoring the signs within the two vertical bars.

The negative deviations of gross margin from their mean in the \(t^{th}\) year of sample data were defined by a new variable, \(Y_t^-\) and it was defined as:

\[
Y_t^- = \sum_{j=1}^{n} (C_{ij} - \overline{C}_j) X_j
\]

\(j = 1\) to \(n\) crop activities,

\(C_{ij} = \) Gross margin from \(j^{th}\) crop activity in the \(t^{th}\) year

\(\overline{C}_j = \) Mean gross margin of \(j^{th}\) crop activity.

The LP problem is formulated as minimization of \(Y_t^-\) in the objective function subject to usual technical constraints and parametric constraints on expected income from crops. The MOTAD model was formulated as:

Minimize \(Y_t^\)  
Subject to,

\[
\sum_{j=1}^{n} \alpha_j X_j (\geq \gamma) b_i, i = 1 \text{ to } m \text{ constraints}
\]  

\[
\sum_{j=1}^{n} (C_{ij} - \overline{C}_j) X_j + Y_t^\geq 0
\]  

\[
\sum_{j=1}^{n} Y_t^- \leq \lambda
\]  

\(X_j \geq 0, Y_t^- \geq 0\) for \(j = 1\) to \(n\), \(t = 1\) to \(S\) years  

Equation (3) is technical constraint,
Equation (4) is deviation constraint,
Equation (5) is parametric constraint, and
Equation (6) is non-negativity constraint,

\[ Y_t = \text{The negative deviation of total gross margin from mean of crop for each year, i.e., } t=1 \text{ to } 10 \text{ years.} \]

\[ a_{ij} = \text{The technical requirements of the } j^{th} \text{ activity for the } i^{th} \text{ resource or constraint.} \]

\[ X_j = \text{Level of } j^{th} \text{ crop activity to be obtained from the solution of the model.} \]

\[ b_i = \text{The } i^{th} \text{ constraint level.} \]

\[ C_{ij} = \text{Gross margin from } j^{th} \text{ crop activity in the } t^{th} \text{ year} \]

\[ \bar{C}_j = \text{Mean gross margin of } j^{th} \text{ crop activity.} \]

\[ n = \text{The number of activities.} \]

\[ m = \text{The number of constraints.} \]

\[ \lambda = \text{A parameter to be parameterised to the maximum level of expected income.} \]

The Standard Deviation (S.D.) of each risk efficient crop production plan generated by the MOTAD model for small, medium and large farm were calculated by the following statistic:

\[ \text{S.D.} = d \left( \pi s / 2(s-1) \right)^{1/2} \]

Where,

\[ \text{S.D.} = \text{Standard Deviation} \]

\[ d = \text{Estimated Mean Absolute Deviation} \]

\[ \pi = 22/7 \]

\[ s = \text{Number of observation.} \]

3.3.2.1 The input-output coefficients

The input-output coefficients for the technological matrix were comprised of the resource requirements, output produced per unit of activity and its absolute value of the negative deviation from the expected return per unit of the activity included in the programme. The input-output coefficients of various activities considered for deriving the synthetic plans for all the size groups of farms were obtained by averaging the collected data of the selected farms, as it has been assumed that the best estimate of input-output coefficients would be the average input-output coefficients obtained from the sampled farms.
3.3.2.2 Resource constraints

In the programming model constraints mainly pertaining to land, labour, capital resources and minimum area requirement were used along with the crop area and capital flexibility constraints. These constraints are highlighted below:

**Land:**

In general, the agricultural year is divided into two broad seasons *viz.* *Kharif* and *rabi*. However, for practical suitability, the agricultural year was classified into three seasons, *viz.* (a) summer season (mid February to mid June) (b) *Kharif* season (mid June to mid October) and (c) *rabi* season (mid October to mid February). Land was also classified into three distinct categories which were termed as upland, medium land and low land. Again upland, medium land and low land were categorised under summer season, *kharif* season and *rabi* season. Thus land was classified into 9 different types *viz.*, summer upland, summer medium land, summer lowland, *kharif* upland, *kharif* medium land, *kharif* lowland, *rabi* upland, *rabi* medium land and *rabi* lowland.

**Labour:**

The month wise availability of human labour units were recorded and finally the availability of human labour units were estimated for each season for inclusion in the programming model. The labour units were computed in terms of adult man days of eight hours. Men, women and children were converted into man equivalent based on the relationship *i.e.* 3 women = 2 men and 2 children = 1 man (Tandon and Dhondyal, 1967). However, because of the non availability of data regarding the quality of labour, the labour unit could not be categorised based on the quality differences. The wage rate prevailing in the study area was considered in calculating the wage rates of labour. Labour days not available for work because of religious occasions, work-off days, illness and other purposes were subtracted while calculating the month wise availability of labour units. From the month wise available labour units estimations were made for season wise availability for each farm.

**Capital:**

Three capital constraints were used for three seasons in the programming model. In order to ascertain the total capital availability, both owned plus borrowed capital with interest charges were taken into consideration. Since working capital includes both cash
and kind expenditures, so to work out the capital constraints for each farm in each season the following items were considered:

i. Value of seed (both farm produced plus purchased).
ii. Costs of manure, fertilizers, irrigation and other plant protection chemicals.
iii. Hired equipment and machinery charges.
iv. Hired human and bullock labour charges.
v. Interest on working capital.

Minimum area requirement:

It was a common practice among majority of the farmers in the study area to devote some minimum area under some specific varieties of *ahu* and *sali* rice, hence, some minimum area constraints were also incorporated in the programming model for deriving the optimal plans. Here in the model, the minimum area restriction has been imposed to autumn rice, winter rice and summer rice only as rice is the major crop in the study area and staple food for the people of Assam. The objective function of the programming model was defined by dual criteria of parameterization of expected return and minimization of risk associated with the expected return.

3.4 Factors influencing crop production risks:

Factors influencing crop production risks in the riverine areas are identified and listed based on farmers perception. The mean values for the risk sources or factors influencing risk in crop production are calculated. The mean values are calculated by assuming that these factors together are responsible for 100 per cent of crop damage in the study area.

3.5 Risk minimization strategies adopted by the farmers:

The risk management strategies adopted by farmers in the riverine areas are identified and listed based on farmers’ perception. The mean values for the risk management or minimization strategies for crop production adopted by farmers are calculated. The mean values are calculated by assuming that these strategies were responsible for minimization of 100 per cent risk in the study area.