CHAPTER - III

DESIGN OF THE STUDY

Farmers decide acreage under different crops after considering a number of economic and non-economic factors. The natural factor constitutes most significant among non-economic factors in influencing the area under different crops. The natural factor here refers to the physical conditions of topography, temperature, rainfall or irrigation, soil characteristics etc. All of these factors not only have direct bearing upon the cropping pattern but also influence the acreage by way of affecting the productivity of land. Given the natural condition of the area, the allocation of acreage depends to a great extent on the variation in economic factors such as price, amount of input, size of land holding, agricultural knowledge, institutional condition etc. At the outset, it is not possible to particularise the key variable responsible for acreage shifts. Hence, in the present study, an attempt has been made to examine the impact of variation in price and other explanatory key variables on the acreage under different crops in the homogeneous geographical areas under the changing technological and institutional milieu.
3.1 Objectives of the Study

In a free market economy with the given free fluctuating prices, the area under the crop is expected to vary directly in response to change in the price of that crop. However, in an area capable of growing different alternative crops, the acreage under a particular crop also depends upon the prices of its substitute crops. Hence it is expected that the relative price of the crop in relation to the prices of substitute crops rather than the absolute price of the crop is having a great bearing upon the acreage of that particular crop. But when there is difference in the yield of the crops, the area may not be expected to change in response to change in its relative price. Under such condition, it is the relative profitability which influences the area under a particular crop. Given the relative profitability condition of the crop, the acreage of the crops also vary according to the availability of inputs, credit, the risk involved in the cultivation, institutional environment of the farmers etc. Some of these factors vary in the long period while others are varying over short and long period. Hence, the broad objective of the study is to analyse the factors influencing the acreage under different crops in various homogeneous geographical sub-regions from cross section and time series data. The specific objectives of the study are
(1) To analyse the factors affecting the supply of major agricultural produces under the changing institutional and technological condition.

(2) To estimate the supply elasticities with respect to explanatory factors.

(3) To study the variation in supply response between crops.

(4) To study the regional variations in the supply response result and

(5) To make a comparative study of the price response results arrived through time-series and cross-sectional data.

The first objective of the study will give a clear idea about the farmers' behaviour while deciding the acreage under different crops. It will indicate the relative significance of various factors affecting the acreage. The second objective will highlight the dimension of response of farmers with respect to different explanatory variables. The third and fourth objectives will throw light on the difference in the behaviour of farmers between regions and between crops. The last objective of the study will show how far the results of cross-section analysis is in conformity with the results of time-series analysis.
3.2. HYPOTHESIS OF THE STUDY

A few relevant hypotheses for the objectives mentioned above are presented as follows:

1. Price is the most important determinant of acreage under different crops.

2. The price response result improves with the inclusion of technology, risk and institutional variables in the supply model.

3. Relative profitability rather than absolute price of the crop has a great say in the acreage decision of the farmers.

4. Price elasticity of acreage is different for the long-run and short-run.

5. Significant difference exists in the response of food crop and commercial crop acreage to changes in their absolute price.

6. Significant variation occurs in the price response of farmers between various geographical sub-regions.

7. There is no significant difference between the results of time-series and cross-section data.

3.3 CONCEPTS

3.3.1 SUPPLY Generally supply describes the amount of goods or services that will come on to the market at a particular moment at a given price. Since the availability of correct data on agricultural output is limited,
measurement of absolute supply of various agricultural commodities at various prices is not possible. The area under different crops may be taken as the measure of supply of various agricultural produces. For the present analysis, the supply is defined as the area of land that farmers are willing and able to allocate under a particular crop at each possible price of the produce of that crop in a particular crop year.

3.3.2 SUPPLY FUNCTION Conceptually, a static supply function shows relationship between the output as a whole and the general price level. It depicts the various amounts of a commodity that producers wish to offer at various possible prices during a particular period. Normally, supply curves are said to be positively sloping, indicating a positive relationship between the price and the amount that will be offered for sale. This static relation holds good when all other influencing conditions other than price are held constant. Besides, this static relation is time-bound; it shows the flow (supply) per unit of time; whatever be the length of the time unit, it is fixed. In short, it explains the net supply relation.

In supply response relation, the product price explains only a part of the variations in supply. There are many other factors that influence supply. These factors include economic as well as social factors. Supply in
agriculture, for instance, is influenced by the price of the substitute products, total irrigated area of all crops in the season, climatic conditions, technological advancement, liquidity position of the farmer, his access to credit, market information, the risk involved in the cultivation etc. In economic terminology these factors are called supply shifters. The response relation, thus describes what will happen to the quantity of a commodity offered for sale when all other things are not kept constant. In a sense, it is a study of shifter of supply.

In the light of the above definitions, a clear cut distinction can be made between the supply function and the supply response function. The supply function describes a price quantity relation when all other supply shifters are held constant. Whereas, the response relation is a more general concept. It is in fact, inclusive of net supply function. It refers to the change in quantity offered for sale due to changes in price as well as shifters and therefore approximates to the long-run dynamic concept of supply in theory.

3.3.3 SUPPLY ELASTICITY Elasticity of supply is a concept used to measure the response of the quantity of commodity supply to changes in price. The definition of the elasticity of \( Y \) is mathematically given as the ratio of the rate of
change in Y to the rate of change in X. It is given by
\[
\frac{\Delta Y}{Y} = \frac{\Delta X}{X} = \frac{\Delta Y}{\Delta X} \cdot \frac{X}{Y} = \frac{\Delta Y}{\Delta X} \cdot \frac{1}{Y/X}
\]
Where \( \Delta Y/ \Delta X \) is the marginal value and \( Y/X \) is average value. In the supply response function, the short-run elasticities of acreage with respect to various variables employed in the function can be found out by multiplying the respective marginal value (parameter values) with the reciprocal of the respective average values. The mean values of the respective variables have been considered to find out respective average values. In the present analysis, this method has been adopted to find out the short-run elasticities.

Since the supply response relation approximates to long run the long run elasticities of acreage with respect to the explanatory variables employed in the function can also be calculated. The long-run elasticities can be found out by dividing the estimated co-efficients \((b_1)\) by the co-efficient of adjustment. One minus the co-efficient of lagged acreage gives an estimate of the adjustment co-efficient. Then, the long-run elasticity can be expressed as
\[
b_1 / (1 - b_n)
\]
Where \( b_n \) is the co-efficient of lagged acreage.
3.3.4 RELATIVE PROFITABILITY Profitability refers to a condition of maximum return to fixed resource. Relative profitability, therefore, refers to the highest return of one enterprise in relation to the maximum return of the competitive enterprise out of a given amount of resource. It is defined as the ratio of per unit cost return of a crop enterprise to per unit cost return of competing crop enterprise. Representing symbolically,

$$\text{Relative Profitability} = \frac{Y}{Y_c} \times \frac{C}{C_c} \times 100$$

where \( Y \) and \( Y_c \) represent per hectare value of the crop and competing crop respectively and \( C \) and \( C_c \) denotes per hectare cost of cultivation of the crop and competing crop respectively.

3.3.3 WEATHER

Weather refers to a metrological conditions over a particular area at a specific time period. It denotes the condition of sunshine, temperature, wind, rainfall, humidity in the air etc. In the present study weather refers to atmospheric condition prevailing over a particular area, conducive for crop growth at a specified period of time. Due to limitations of data on sunshine, temperature, wind, and humidity in the air, the data on rainfall has been taken to
represent weather condition over a particular area. From the point of view of increasing the yield of a crop, a particular amount of rainfall turns out to be optimum. Hence the optimum rainfall corresponds to the maximum weather condition. The condition of both excessive rainfall and insufficient rainfall denotes the lesser weather condition. Due to non-availability of optimum rainfall statistics, normal rainfall has been adopted as an approximation to optimum rainfall. Hence, to calculate weather variable, deviations of actual rainfall from the normal rainfall has been taken into account. It is supposed that the value representing weather varies inversely with the deviated amount of rainfall from the normal rainfall. The value of the weather variable can be found out by applying the formula

\[
\frac{\sqrt{(R - R^*)^2}}{R^*} x 100
\]

Where \( w \) is the value of the weather variable, and \( R \) and \( R^* \) respectively represent actual and normal amount of rainfall. The above formula states that the value of the weather diminishes in an arithmetic progression with the arithmetically increased deviation of rainfall from the normal level. However, the formula considers that the yield reducing effect of more than normal level of rainfall is
same as the yield reducing effect of less than normal level of rainfall. But it is the general observation that the excessive rainfall over the normal rainfall is having stronger yield reducing effect at its minimum excessive level than at its maximum excessive level. Taking this into consideration, the formula has been modified to compute the value of the weather variable from the rainfall above the normal level. The modified formula is

\[
 w = \left[1 - \frac{\sqrt{(R - R^*)^2}}{R^* \cdot \log \sqrt{(R - R^*)^2}}\right] \times 100
\]

This formula may not apply in the case of the amount of actual rainfall deviated from the normal rainfall by one mm. Hence, the formula has been further modified to take into account all positive deviations of rainfall from the normal amount. The modified formula is

\[
 w = \left[1 - \frac{\sqrt{(R - R^*)^2}}{R^* \cdot \log \left[\sqrt{(R - R^*)^2} + 1\right]}\right] \times 100
\]

Using this formula weather index has been calculated from the rainfall exceeding the normal level of rainfall.

3.4 Scope of the Study

The study is confined to Periyar District of Tamil Nadu. It considers eleven important crops grown in this district. It consists of four food crops viz., Paddy,
Sorgham, Cumbu, Ragi and Eight commercial crops viz., Cotton, Groundnut, Gingelly, Tobacco, Tumeric, Chillie, Banana and Sugarcane. The importance of these crops is not the same all over the Periyar District. What is important in one region may turned out to be less important in the other region of the district. Hence, different crops appear important in different regions. The study analyses the problem both at the cross-section level and over a period of time. The time-series study covers a period of twelve years stretching from 1976-77 to 1987-88, which more or less synchronises with the period of planned credit. The cross-section survey is with reference to the crop year 1986-87 and it has been made during the month of July, August and September 1987.

3.5 METHODOLOGY

The importance of a study to a great extent lies in the method followed in the selection of statistical unit, collection of data and in the method adopted for their analysis. While deciding the validity of the results of a study, a clear understanding of the methods followed in the study is considered important. A detailed picture of the procedures and methods adopted are given below.

3.5.1 SELECTION OF STUDY AREA

In the present study it is intended to analyse the supply response of farmers by homogeneous geographical sub-
regions within the revenue district. In this context, Periyar District has been selected purposively since it comprises of different areas with various public irrigation projects and varying in soil and other natural environment. Some part of the district is in their hilly terrain; some others are in their valley environment and the rest are in their plains. Due to this, the amount of rainfall received by various regions differ significantly. Hence the area of district varies between dry belts and wet land. The physical condition of land is such that it is capable of raising multi-crops, given the irrigation condition of the area. Moreover, there is significant development in the infrastructure of the district, particularly in banking and Marketing. All of these conditions synchronizes with the conditions presupposed by the objectives of the study. Hence the choice of Periyar district for the study of farmer’s supply response. The agriculturally progressive nature of Periyar district also stands for its selection for the study.

3.5.2 SELECTION OF VILLAGES The statistical unit for the study is revenue village. Two revenue villages in each block have been selected in such a way that their selection represents the general geographical and other conditions of the block. For instance, if a block has been irrigated in majority, by the two public irrigation schemes, one village under each public irrigation scheme has been selected.
While selecting village under a particular irrigation scheme, the village which is irrigated to the greatest extent by that irrigation scheme has been selected. Similarly in a block which is partially dry and partially irrigated by a public irrigation scheme, one village in the dry belt and another village in the public irrigation belt have been selected. The geographical distribution of cultivated area under different category of land has been considered for the selection of the villages. With the help of block statistical inspectors, the villages have been selected on the above said lines and confirmed for the study after verifying the conditions of the village with the concerned village administrative officers. Selecting the villages in such a way enables the researcher to group the villages by the homogeneous areas. Hence the selection of the village is also purposive. On the whole, 40 villages have been selected from the 20 blocks of the district. Table 3.1 provides the list of villages selected in each of the blocks of Periyar district.
### TABLE 3.1

List of Sample villages by the name of the block and Taluk

<table>
<thead>
<tr>
<th>Name of the Taluk</th>
<th>Name of the Block</th>
<th>Name of the sample village</th>
</tr>
</thead>
</table>
| 1. Sathyamangalam | Thalavady         | 1. Thalavady
|                   |                   | 2. Doddakajanur             |
|                   | Sathyamangalam    | 1. Akkarai Negamum          |
|                   |                   | 2. Pattavarthayyam-palayam |
|                   | Bhavanisagar      | 1. Doddampalayam            |
|                   |                   | 2. Panayampalli             |
| 2. Gobichetti-palayam | T.N.Palayam       | 1. Vaniputhur               |
|                   |                   | 2. Nanjaipuliampatti        |
|                   | Gobichettipalayam | 1. Modachur                 |
|                   |                   | 2. Kugalur                  |
|                   | Nambiyur          | 1. Elathurchettipalayam     |
|                   |                   | 2. Kosanam                  |
|                   |                   | 2. Jambai                   |
|                   | Andhiyur          | 1. Kuppandampalayam         |
|                   |                   | 2. Ennamangalam             |
|                   | Ammapet           | 1. Vellithirpur             |
|                   |                   | 2. Nerinji pettaí           |
| 4. Erode          | Erode             | 1. Attayampalayam           |
|                   |                   | 2. Brahmana Agraharam       |
|                   | Modakurichi       | 1. Avalpoondurai            |
|                   |                   | 2. Palamangalam             |
|                   | Kodumudi          | 1. Nanjai Kolanalli         |
|                   |                   | 2. Ichipalayam              |

(Contd.)
Table 3.1 (Contd.)

<table>
<thead>
<tr>
<th>Name of the Taluk</th>
<th>Name of the Block</th>
<th>Name of the sample village</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Perundurai</td>
<td>Uthukuli</td>
<td>1. Uthukuli</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Kuruchipudhur</td>
</tr>
<tr>
<td></td>
<td>Perundurai</td>
<td>1. Thingalur</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Kanchikoil</td>
</tr>
<tr>
<td></td>
<td>Chennimalai</td>
<td>1. Varapalayam</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Basuvapatti</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Nathakadaiyur</td>
</tr>
<tr>
<td></td>
<td>vellakoil</td>
<td>1. Vellakoil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Muthur</td>
</tr>
<tr>
<td>7. Dharapuram</td>
<td>Kundadam</td>
<td>1. Kolumanguli</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Suriyanallur</td>
</tr>
<tr>
<td></td>
<td>Dharapuram</td>
<td>1. Thoppampatti</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Thalavaipattinam</td>
</tr>
<tr>
<td></td>
<td>Mulanur</td>
<td>1. Peramium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Mulanur</td>
</tr>
</tbody>
</table>

3.5.3 SELECTION OF FARMERS

In each selected village 10 farm households have been randomly selected from the list of farm households furnished by the respective village administrative officers. The decision making individuals in these households have been interviewed with the well structured schedule prepared for that purpose. The persons who are actually making decisions on agricultural productions are considered as
decision making farmers in the cultivating household. While selecting households, the tenent households have been omitted, since the decision of the tenent farmers to a greater extent is influenced by other factors besides the factors influencing the farmers operating with owned land. In total 400 decision making farmers have been identified and interviewed.

3.5.4 COLLECTION OF DATA

The study has been made with the help of time series secondary data and cross sectional primary data. Cross-sectional data have been collected by personal interview with the decision making farmers, through comprehensive and well structured schedules prepared for that purpose. The schedule has been prepared in such a way that it gathers information relating to family size, education, land and operational holdings, crop pattern, yield of the crop, cost of cultivation of the crop, agricultural and other asset position of the cultivating holdings, competing crops, HYV area cultivated, expected and realised prices, basis of price expectation, risk involved in the cultivation and other related information considered important for the present study. While collecting the data, it is verified whether the operational holdings of the decision making farmers, have changed during the study period. The farmers whose operational area have changed
during the study period have been dropped and farmers in the reserved list of random selection have been considered for interview. In order to get correct data and good response for the questionnaire, the persons known to the researcher in that particular area have been taken to the respondent and the respondent is made to convince that the data will be used only for the research purpose. The researcher has considered it necessary because the people are generally afraid of divulging the correct particulars on the notion that the data may be used for the tax purpose.

3.5.4.1 DATA ON CROP ACREAGE

Time series data on the area under different crops grown by the farmers have been collected at the two levels, i.e., at the village level and at the district level. The cropping pattern data at the village level has been collected for the selected villages from two different sources. For the last five years, 1983-84 through 1987-88, the data has been collected from the 'G' returns (a record maintained by the Block Statistical Inspectors). For the remaining seven years preceding to 1983-84, the data has been collected from the number 1 and number 1A accounts (Monthwise record of crop acreage) of villages kept at Taluk head quarters under the name of fasil patti. The same data for the district as a whole has been collected from the season and crop report of Tamil Nadu for the years 1979-80 through 1987-88. For the years 1976-77 through 1978-79,
the data have been obtained by consolidating the taluk figures of Periyar district.

3.5.4.2 PRICE DATA

Time series data of month-wise price of various commodities under study have been collected from two different sources. For cereal crops like paddy, cumbu, cholam and ragi, it has been collected from Taluk Statistical Offices. For cotton, Sugarcane gur, Tobacco, Groundnut and chillie, the price data have been obtained from the Coimbatore Marketing Committee and Periyar Marketing Committee. Turmeric price has been collected from the Erode Regulated Market Committee, the most important Turmeric centre of South India. The prices collected for various crops from different sources are only whole sale prices prevailing in the respective centres and the prices of each commodity among these centres differ slightly. Hence for the commodities whose prices are collected from more than one centres, average of these centres have been taken for analysis.

3.5.4.3 YIELD DATA

As the yield figures for a particular block is not available for all the crops for all the years under study, yield figures for the district has been collected from season and crop report of Tamil Nadu State, Records of District Statistical Office and Agricultural Department.
For the twelve years starting from 1973-74, the data has been collected from the season and crop reports of Tamil Nadu. For the three years succeeding to 1984-85, the data has been collected from the records of District Statistical Office, Erode and District Agricultural Department, Erode.

3.5.4.4 CREDIT DATA

Time series data on the amount of Agricultural Credit made by all the banks combined together in Periyar District has been collected from the Consolidated Lead Bank Schedule - 4 (LBS-4) of Periyar District compiled by the Canara Bank, Erode in the capacity of Lead Bank of Periyar District. For the years prior to 1979-80, the data has been collected from First District Credit Plan report published for Periyar District. In this report the performance of banks by the Scheme of Credit has been furnished for each of the crop years. However, in the following credit plan reports, the data have been published for the calendar year. Therefore, the data may not be useful for the present purpose. Hence, the amount of credit dispersed during the crop years following 1978-89 have been obtained by consolidating the data of the respective four quarters of each of the crop years available with the Canara Lead Bank Office at Erode.

3.5.4.4 COST OF CULTIVATION STATISTICS

Reliable time-series data on the cost of cultivation of different crops under study for Periyar District is not
available. However, realising it's importance in the estimation of supply response, a proxy variable has been adopted to represent the cost of cultivation. It is understood from the credit plan reports of the Lead Bank that the scale of finance in each year for each of the crops cultivated in Periyar district has been fixed in such a way that it covers the cent percent cost of cultivation of each of the crops. Hence, the scale of finance for each of the crop under study has been taken as a good approximation to the cost of cultivation of the respective crop. These figures have been collected from the district credit plan and annual action plan reports of Canara Lead Bank.

3.5.4.6 RAINFALL STATISTICS

Monthwise rainfall data for the period of study have been collected from three different sources

(1) Season and Crop Reports of the Tamil Nadu State,
(2) The Records of District Statistical Office, and
(3) The Records of District Collector's Office.

Rainfall recorded at twelve raingauge stations situated all over Periyar district has also been collected for the regional analysis. The normal rainfall data for the Periyar District have been collected from the general statistics and agricultural progress of Periyar district published by the Joint Director of Agriculture, Erode. The same data for the Raingauge Stations of Periyar District have been obtained from the Rainfall Statistics of Tamil Nadu published by the Department of Statistics, Tamil Nadu.
3.5.5 Model

Fifteen different types of models have been used for the study of Supply Response. The first model adopted in the study is essentially a four equation Nerlovian type partial adjustment lag model. It is used in the analysis of time-series data.

The first equation of the model states the hectarage response function and it is as follows -

\[ X_t^* = a_0 + a_1 P_t^* + a_2 P_{c_t}^* + U_t \]  \(\ldots(1)\)

where

- \(X_t^*\) = The area that farmers would plant in the year \(t\), if there were no barriers.
- \(P_t^*\) = The expected price of the crop in time \(t\).
- \(P_{c_t}^*\) = The expected price of the competing crop in time \(t\).
- \(U_t\) = a random residual term.

The second equation is

\[(X_t - X_{t-1}) = \beta (X_t^* - X_{t-1}) + \delta A_t \text{ (or } W_t) \quad \ldots(2)\]

where

- \(X_t\) = Actual hectarage under the crop.
- \(X_t^*\) = Desired hectarage.
- \(X_{t-1}\) = Actual hectarage under the crop in the previous year.
- \(A_t\) = Total irrigated area of all crops in the season.
- \(W_t\) = Rainfall in the pre-sowing season, i.e., the rainfall in the three months (June, July and August) preceding the sowing time.
The third equations is,

\[ P_t^* - P_{t-1}^* = \alpha (P_{t-1} - P_{t-1}^*) \quad 0 < \alpha \leq 1 \quad \ldots \quad (3) \]

where \( P_t^* \) and \( P_{t-1}^* \) are expected prices of the crop in time \( t \) and \( t-1 \) respectively and \( P_{t-1} \) represents the actual price of the crop in the previous year.

The equation (3) states that each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period.\textsuperscript{182} As the prices prevailing during the farm harvest periods alone are considered important by farmers for the purpose of formation of future price expectations, the whole sale prices prevailing during harvest months have been specified for the study.

Likewise the fourth equation represents the expectational equation for the price of the competing crop i.e.,

\[ P_{c_t}^* - P_{c_{t-1}}^* = \gamma (P_{c_{t-1}} - P_{c_{t-1}}^*) \quad 0 < \gamma \leq 1 \quad \ldots \quad (4). \]

Equations (2), (3) and (4) can be written in the following way.

\[ X_t^* = \frac{X_t - X_{t-1}}{\beta} + X_{t-1} - \delta A_t \]

\[ P_t^* = \alpha (P_{t-1}) + (1 - \alpha) \alpha P_{t-2} + \ldots. \]

By substituting these values in equation (1)

\[
Pc_t^* = Y (P_{t-1}) + (1-Y) Y P_{t-2} + \ldots.
\]

Although in theory all past prices must be included, practically, the prices in the very distant past have negligible effect. Thus, by considering the values lagged one year only,

\[
X_t = (1-\beta) X_{t-1} + \delta \beta A_t + a_0 \beta + a_1 \beta P_{t-1} + a_2 \beta P_{t-2} + \beta U_t
\]

OR

\[
X_t = a_0 \beta + a_1 \beta P_{t-1} + a_2 \beta P_{t-2} + \delta \beta A_t + (1-\beta) X_{t-1} + \beta U_t
\]
\[ X_t = w_0 + w_1 P_{t-1} + w_2 P_{c_{t-1}} + w_3 A_t (\text{or } W_t) + w_4 X_{t-1} + V_t \]  

Where  
\[
\begin{align*}
  w_0 &= a_0 \beta; \\
  w_1 &= a_1 \alpha \beta; \\
  w_2 &= a_2 \gamma \beta; \\
  w_3 &= \delta \beta; \\
  w_4 &= (1 - \beta)
\end{align*}
\]

With the introduction of technology and risk variables in the hectarage equation [eq.(2)], the equation becomes,

\[
(X_t - X_{t-1}) = \beta (X^*_t - X^*_{t-1}) + \delta A_t (\text{or } W_t) + \delta T + \varepsilon S_t
\]

The equation can be written as

\[
X^*_t = \frac{X_t - X_{t-1}}{\beta} + X_{t-1} - \delta A_t (\text{or } W_t) - \delta T_t - \varepsilon S_t \quad \ldots (6)
\]

Where \( T_t \) represents technology which is defined as the index of yield per unit of input deflated by the index of weather. The yield per unit of input is obtained by taking the ratio of yield per hectare to the real cost of cultivation (per hectare). The real cost cultivation, in turn, is calculated by taking the money value at 1971-72 base. On the same base period the technology index has been computed.

\( S_t \) denotes the amount of risk involved in the cultivation which is defined as the combined three year moving standard deviation of the indices of price, yield and cost of cultivation.
Using relative price instead of absolute price of the crop, the hectarage response equation becomes,

\[ x_t^* = b_0 + b_1 P_t^* + U_t \]  \hspace{1cm} \text{(7)}

The exceptional equation for the relative price of a crop is,

\[ P_t^* - P_t^{*-1} = \psi (P_{t-1} - P_{t-1}^*) , \quad 0 < \psi \leq 1 \]  \hspace{1cm} \text{(8)}

Equation (8) can be written as

\[ P_t^* = \psi (P_{t-1}) + (1 - \psi) P_{t-1}^* + \ldots \]

By substituting eqn. (6) and eqn. (8) in eqn. (7)

\[ \frac{x_t - x_{t-1}}{\beta} + x_{t-1} - \beta A_t \text{ (or } W_t) - \theta T_t - \varepsilon S_t = \]

\[ b_0 + b_1 \psi \{ P_{t-1} + (1 - \psi) P_{t-2} + \ldots \} + U_t \]

\[ x_t - x_{t-1} + \beta x_{t-1} - \beta A_t \text{ (or } W_t) - \theta T_t - \varepsilon S_t = \]

\[ \beta \{ b_0 + b_1 \psi \{ P_{t-1} + (1 - \psi) P_{t-2} + \ldots \} + U_t \} \]

\[ x_t = (1-\beta) x_{t-1} + \beta A_t \text{ (or } W_t) + \theta T_t + \varepsilon S_t + \]
\[ \beta \{ b_0 + b_1 \psi P_{t-1} - b_1 \psi P_{t-2} - b_1 \psi^2 P_{t-2} \} \]
\[ + \beta \{ \ldots \} + \beta U_t \]

\[ x_t = (1-\beta) x_{t-1} + \beta A_t \text{ (or } W_t) + \theta T_t + \varepsilon S_t + \]
\[ \beta b_0 + b_1 \psi \beta P_{t-1} + b_1 \psi \beta P_{t-2} \]
\[ + b_1 \psi^2 \beta P_{t-2} + \beta \{ \ldots \} + \beta U_t \]

Since the relative effect of distant past prices is negligible, the values lagged more than one year can be safely ignored. Thus by considering values lagged one year only,

\[ x_t = (1-\beta) x_{t-1} + \beta A_t \text{ (or } W_t) + \theta T_t + \varepsilon S_t + \]
\[ \beta b_0 + b_1 \psi \beta P_{t-1} + \beta U_t \]

\[ X_t = \beta b_0 + b_1 \psi \beta PR_{t-1} + S \beta A_t \text{ (or } W_t) + \rho \beta T_t + \gamma \beta S_t + (1-\beta) X_{t-1} + \theta U_t \]

(OR)

\[ X_t = s_0 + s_1 PR_{t-1} + s_2 A_t \text{ (or } W_t) + s_3 T_t + s_4 S_t + s_5 X_{t-1} + v_t \] ......(9)

where

- \( s_0 = \beta b_0 \)
- \( s_1 = b_1 \psi \beta \)
- \( s_2 = \gamma \beta \)
- \( s_3 = \theta \beta \)
- \( s_4 = \gamma \beta \)
- \( s_5 = (1-\beta) \)
- \( v_t = \theta U_t \)

The above model represents the second model of the study used in the analysis of Time-series data.

Introducing relative profitability variable instead of the price variables, the hectarage response function can be written as,

\[ X_t^* = C_0 + C_1 RP_t^* + U_t \] ......(10)

where \( RP_t^* \) represents the expected relative profitability of a crop enterprise.

Like price expectation equation, the relative profitability expectation equation states,

\[ RP_t^* - RP_{t-1}^* = \eta (RP_{t-1} - RP_{t-1}^*) \] ......(11)

where \( RP_t^* \) and \( RP_{t-1}^* \) denotes the expected relative profitabities in the time t and t-1 and \( RP_{t-1} \) represents actual relative profitability of a crop enterprise in time period t-1.
The equation (11) can be written as
\[ \text{sp} \varepsilon = H (R_{t-1}) + (1- \eta) \left( R_{t-2} + \ldots \right) \]

By substituting equation (6) and (11) in equation (10)
\[ X_t = \frac{X_{t-1}}{\beta} + X_{t-1} - S A_t (\text{or } W_t) - \beta T_t - \varepsilon S_t = c_0 + c_1 \left[ R_{t-1} (1- \eta) + \ldots \right] + U_t. \]
\[ X_t = X_{t-1} + \beta X_{t-1} - S A_t (\text{or } W_t) - \beta S T_t - \varepsilon S S_t = \beta \left[ c_0 + c_1 \left( R_{t-1} (1- \eta) + \ldots \right) + U_t \right]. \]
\[ X_t = (1- \beta) X_{t-1} + \beta S A_t (\text{or } W_t) - \beta S T_t + \varepsilon S S_t \]
\[ + \beta c_0 + c_1 \left( R_{t-1} + \ldots \right)^2 R_{t-2} + U_t \]
\[ + \beta U_t + \beta \ldots \ldots \ldots \]

As the relative profitability in the distant past are having negligible effect upon the relative profitability expectation of the farmers in the current year, the values lagged more than one year can be ignored. After omitting such values the equation becomes,
\[ X_t = \beta c_0 + c_1 \left( R_{t-1} + \ldots \right)^2 R_{t-2} + U_t \]
\[ + \beta U_t + \beta \ldots \ldots \ldots \]
\[ X_t = (1- \beta) X_{t-1} + \beta S A_t (\text{or } W_t) - \beta S T_t + \varepsilon S S_t \]
\[ + \beta c_0 + c_1 \left( R_{t-1} + \ldots \right)^2 R_{t-2} \]
\[ + \beta U_t + \beta \ldots \ldots \ldots \]
\[ X_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 A_t (\text{or } W_t) + \beta_3 T_t \]
\[ + \beta_4 S_t + \beta_5 X_{t-1} + U_t \]
\[ \ldots \ldots \ldots (12) \]
The equation (12) represents the third model adopted in the study.

Introducing the Bank Credit in acreage adjustment equation, the equation can be written as,

\[(X_t - X_{t-1}) = \beta (X_t^* - X_{t-1}) + \theta T_t + \varepsilon S_t + \lambda CR_t \]  \hspace{1cm} (13)

where \( CR_t \) represents the amount of institutional credit made to agriculture in time period \( t \). Rewriting Equation (13),

\[ X_t^* = \frac{(X_t - X_{t-1})}{\beta} + X_{t-1} - \theta T_t - \varepsilon S_t - \lambda CR_t \]

substituting equation (11) and (13) in equation (10)

\[
\begin{align*}
X_t - X_{t-1} & + \beta X_{t-1} - \theta T_t - \varepsilon S_t - \lambda CR_t = \\
& c_0 + \gamma \{ RP_{t-1} + (1- \gamma) RP_{t-2} + \ldots \} + U_t.
\end{align*}
\]

\[
\begin{align*}
X_t - X_{t-1} & + \beta X_{t-1} - \theta T_t - \varepsilon S_t - \lambda CR_t = \\
& \beta \{ c_0 + \gamma \{ RP_{t-1} + (1- \gamma) RP_{t-2} + \ldots \} + U_t \}.
\end{align*}
\]

\[
\begin{align*}
X_t & = (1-\beta) X_{t-1} + \theta T_t + \varepsilon S_t + \lambda CR_t + \\
& \beta \{ c_0 + \gamma \{ RP_{t-1} + C_1 \gamma RP_{t-2} - C_1 \gamma^2 RP_{t-2} + U_t \} \\
& + \theta \{ \ldots \ldots \ldots \ldots \}.
\end{align*}
\]

\[
\begin{align*}
X_t & = (1-\beta) X_{t-1} + \theta T_t + \varepsilon S_t + \lambda CR_t + \beta c_0 \\
& + \beta c_1 \gamma RP_{t-1} + \beta c_1 \gamma RP_{t-2} + \beta c_1 \gamma^2 RP_{t-2} + \theta U_t \\
& + \theta \{ \ldots \ldots \ldots \ldots \}.
\end{align*}
\]
Ignoring the values lagged more than one year, as their relative effect on acreage is negligible, the equation becomes,

\[
X_t = \beta c_0 + \beta c_1 \eta \ R_{t-1} + \theta T_t + \theta S_t \\
+ \lambda \beta \ CR_t + (1-\beta) X_{t-1} + \theta U_t
\]

OR

\[
X_t = \rho_0 + \rho_1 R_{t-1} + \rho_2 T_t + \rho_3 S_t \\
+ \rho_4 C R_t + \rho_5 X_{t-1} + \nu_t \quad \ldots \ldots (14)
\]

where

\[
\rho_0 = \beta c_0 \quad ; \quad \rho_1 = \beta c_1 \eta \quad ; \quad \rho_2 = \theta T_t \\
\rho_3 = \theta S_t \quad ; \quad \rho_4 = \lambda \beta \quad ; \quad \rho_5 = (1-\beta) \\
\nu_t = \beta U_t
\]

the equation (14) represents the fourth model of the study.

By taking into considerations the variable representing marketing condition, the hectarage adjustment equation can be written as,

\[
(X_t - X_{t-1}) = \beta (X_t^* - X_{t-1}) + \theta T_t + \lambda \ CR_t + \theta \ MR_t
\]

\[
X_t^* = \frac{(X_t - X_{t-1})}{\beta} + X_{t-1} - \theta T_t - \lambda \ CR_t - \theta MR_t \quad \ldots (15)
\]

Substituting the values of equation (11) and (15) in equation (10)
\[
\frac{(X_t - X_{t-1})}{\beta} + X_{t-1} - \theta \, T_t - \lambda \, \theta \, CR_t - \theta \, MR_t
\]
\[
= C_0 + C_1 \{ R_{t-1} + (1 - \theta) R_{t-2} + \ldots \} + U_t
\]
\[
(X_t - X_{t-1}) + \beta \, X_{t-1} - \theta \, \theta \, T_t - \lambda \, \beta \, CR_t - \theta \, \beta \, MR_t
\]
\[
= \beta \{ C_0 + C_1 \{ R_{t-1} + (1 - \theta) R_{t-2} + \ldots \} + U_t \}
\]
\[
X_t = (1 - \beta) \, X_{t-1} + \theta \, \theta \, T_t + \lambda \, \beta \, CR_t + \theta \, \beta \, MR_t
\]
\[
+ \beta \{ C_0 + C_1 \{ R_{t-1} + (1 - \theta) R_{t-2} + \ldots \} + U_t \}
\]
\[
X_t = (1 - \beta) \, X_{t-1} + \theta \, \theta \, T_t + \lambda \, \beta \, CR_t + \theta \, \beta \, MR_t + \beta \, C_0
\]
\[
+ C_1 \{ \beta \, R_{t-1} + \beta \, R_{t-2} + \beta \, R_{t-2} + \ldots \} + \beta \, U_t
\]
\[
+ \beta \{ \ldots \ldots \}
\]

As, the values in the very distant past have negligible effect upon acreage, ignoring the values lagged more than one year, the equation becomes,

\[
X_t = C_0 \beta + C_1 \{ \beta \, R_{t-1} + \theta \, \theta \, T_t + \lambda \, \beta \, CR_t
\]
\[
+ \theta \, \beta \, MR_t + (1 - \beta) \, X_{t-1} + \beta \, U_t
\]

Transforming the constants

\[
X_t = \mu_0 + \mu_1 \, R_{t-1} + \mu_2 \, T_t + \mu_3 \, CR_t
\]
\[
+ \mu_4 \, MR_t + \mu_5 \, X_{t-1} + V_t
\]

\[
\mu_0 = \beta \, C_0 ; \mu_1 = C_1 \{ \beta \}; \mu_2 = \theta \, \theta \; \mu_3 = \lambda \, \beta \]
\[
\mu_4 = \theta \, \beta \; \mu_5 = (1 - \beta) ; V_t = \beta \, U_t
\]
Equation (16) forms the fifth model of the study.

The remaining ten models adopted in the study are with reference to the cross section data. They are essentially the ordinary least square multiple regression models.

They are as follows:

Model 6 \( X_t = d_0 + d_1 P_t^* + d_2 P_{c_t}^* + d_3 A_t + d_4 T_{Kt} + d_5 S_t^* + U_t \) \( \ldots (17) \)

Model 7 \( X_t = e_0 + e_1 P_{Rt}^* + e_2 A_t + e_3 T_{Kt} + e_4 S_t^* + U_t \) \( \ldots (18) \)

Model 8 \( X_t = f_0 + f_1 P_{Rt}^* + f_2 A_t + f_3 T_{Kt} + f_4 S_t^* + U_t \) \( \ldots (19) \)

Model 9 \( X_t = g_0 + g_1 C_t + g_2 P_{Rt}^* + g_3 A_t + g_4 T_{Kt} + g_5 S_t^* + U_t \) \( \ldots (20) \)

Model 10 \( X_t = h_0 + h_1 C_t + h_2 P_{Rt}^* + h_3 A_t + h_4 T_{Kt} + h_5 S_t^* + U_t \) \( \ldots (21) \)

Model 11 \( X_t = i_0 + i_1 C_t + i_2 P_{Rt}^* + i_3 A_t + i_4 T_{Kt} + i_5 S_t^* + U_t \) \( \ldots (22) \)

Model 12 \( X_t = j_0 + j_1 C_t + j_2 P_{Rt}^* + j_3 A_t + j_4 T_{Kt} + j_5 S_t^* + U_t \) \( \ldots (23) \)

Model 13 \( X_t = k_0 + k_1 C_t + k_2 P_{Rt}^* + k_3 A_t + k_4 T_{Kt} + k_5 S_t^* + U_t \) \( \ldots (24) \)

Model 14 \( X_t = l_0 + l_1 C_t + l_2 P_{Rt}^* + l_3 A_t + l_4 Y_t + l_5 S_t^* + U_t \) \( \ldots (25) \)

Model 15 \( X_t = m_0 + m_1 C_t + m_2 P_{Rt}^* + m_3 A_t + m_4 Y_t + m_5 S_t^* + U_t \) \( \ldots (26) \)

Where \( P_t^* \) represents the expected price of the Crop. 
\( P_{c_t}^* \) = Expected price of the competing Crop. 
\( A_t \) = Total irrigated area of all the Crops. 
\( R_{P_t}^* \) = Expected profitability of the Crop.
TK_t = Agricultural knowledge of the farmers.
S^*_t = Expected risk involved in the cultivation.
CR_t = Amount of crop loan taken in the current year.
C_t = Cost of cultivation of the crop.
Y_t = Yield of the crop and
T_t = Level of Technology which is measured by the form

\[ T_t = \left( \frac{F_t}{F^*_t} + \frac{HYV_t}{I_t} + \frac{M_t}{MP_t} \right) \times 100 \]

Where
- \( F_t \) = Fertilizer used per acre
- \( F^*_t \) = Recommended dose of fertilizer per acre
- \( HYV_t \) = Area under HYV of a crop
- \( I_t \) = Irrigated area of a crop
- \( MP_t \) = Total number of power Machineries that can be used
- \( M_t \) = Number of power machinaries that has been actually used

3.5.6 OTHER TOOLS USED IN THE STUDY

To assess the degree of relationship that exists between acreage and number of economic and non-economic variables, \( \chi^2 \) test, correlation test, analysis of variance test have also been adopted in the study of cross-section data.

To find inter regional and inter crop differences in price response, the following formula is adopted to calculate 't' value for the differences in price co-efficients.
Where $b_i$ and $b_j$ are the price co-efficients of $i$ and $j$th region/crop respectively and $S.E(b_i)$ and $S.E(b_j)$ are their respective standard errors. The corresponding degrees of freedom for the calculated 't' values have been obtained by the formula.

$$
 t = \frac{b_i - b_j}{\sqrt{S.E(b_i) + S.E(b_j)}}
$$

$$
\nu = \frac{(S_i^2 / n_i + S_j^2 / n_j)^2}{(S_i^2 / n_i)^2 + (S_j^2 / n_j)^2}
\frac{n_i - 1}{n_i - 1} + \frac{n_j - 1}{n_j - 1}
$$

Where $S_i$ and $S_j$ are the Standard deviations of price variables in $i$ and $j$th region / crop respectively and $n_i$ and $n_j$ are their respective number of observations.

3.6 LIMITATIONS OF THE STUDY

Due to non-availability of data on acreage and credit, the study has been limited to the period 1976-88.

The study is limited by the non-availability of regional yield figures and hence district yield figures have been adopted for various crops under study. Unlike all other crops, the district yield figures of turmeric, banana, and chillie were calculated from the standard yield in accordance with the correction factor.
Since banana is an unnotified crop, the secondary price data are not available for the study area. Hence the price data for banana have been computed on the basis of the data collected from the account books of commission mandi agents at Sathyamangalam, intermediary merchants hand books, pre-harvest contractor's record books and corroborated with the data obtained from the memories of the progressive farmers and the account books maintained by the share-cropping tenants.

As the acreage figure is not available by different varieties of each crop, the price data have been arrived at for each of the crop by taking the average of the prices of different varieties of each crop.

Price data for unirrigated cumbu and Sorgham are not separately available. As the price is expressed in terms of weights, there is not much difference between the prices of irrigated and unirrigated cumbu and Sorgham respectively. Hence the prices of irrigated cumbu and sorgham were used in the analysis of respective unirrigated crops. Hence, the results of the study should be viewed in the light of the above limitations.

3.7 SCHEME OF THESIS

The study has been presented in nine chapters. The first chapter is an introductory chapter which points out the importance of the present study.
Review of the previous studies on supply response has been made in the second chapter. It gives a brief resume of the results of various studies, examines the method adopted by them and identifies the gaps in the existing studies.

The third chapter deals with the methodology adopted in the study. It specifies the objectives of the study and advances respective hypotheses. It describes the models adopted with the appropriate definition of concepts involved in the study. It also gives the Limitations of the study.

In the fourth chapter, profile of the area under study has been given. Here, a brief description of the Socio, economic and environmental condition of the area has been made.

Chapter five is an analytical chapter, it analyses the various Socio-economic and environmental factors influencing the supply of various crops under study. By using ten different models it analyses the problem with the help of cross-section data.

In the sixth Chapter, the analysis of supply response has been made with the time-series data. Five different models have been tried for district data. The supply elasticities with respect of various explanatory factors have been estimated and analysed.
In the seventh chapter, the results of time-series data are compared with the cross section data. Differences in supply response between crops have also been analysed.

Chapter eight deals with the analysis of supply response at the stratified homogeneous sub-regions of Periyar district. Supply estimates have been calculated by adopting a model which gave best fit for the district data. Regional variation in price response has also been studied.

Chapter nine brings out the important conclusions in the light of the findings made by the study. It also suggests appropriate policy measures to get desired cropping pattern.