CHAPTER III
METHODOLOGY

The design of the study is an important component of research. To realize the various objectives of the study, an appropriate methodology describing sampling design, data collection tools and analytical techniques are indispensable. In this chapter, the methodology adopted for the present study, "An Analysis of Pattern, Growth and Determinants of Fertilizer Use in Tamil Nadu", are presented under the following heads.

1. Description of the study area
2. Nature and Sources of data
3. Sampling procedure
4. Period of study
5. Concepts used in the study
6. Tools of analysis
7. Scope of the study
8. Limitations

1. DESCRIPTION OF THE STUDY AREA

An assessment of any development activity can be made with a detailed understanding of the physical and natural characteristics and socio-economic status of the region. Hence an attempt has been made to describe the physical, natural and socio-economic features of the study area. According to Fertilizer Statistics (2010), China held the first place in fertilizer consumption with 48421.7 thousand tonnes. India is the second place amounting to 24909.3 thousand tonnes of fertilizer consumption. The fact that, India's position in the consumption of fertilizer is remarkable when compared with other countries. India has made spectacular progress in the consumption and production of fertilizer over the last 45 years. It was estimated that over 50 percent increase in production of food grains was because of the increased use of fertilizers.
A state-wise and district-wise analysis on fertilizer consumption has been made in this study. It was observed that the fertilizer consumption recorded the highest in Uttar Pradesh amounting to 4261.5 thousand tonnes (Fertilizer Statistics, 2010). Maharashtra came second with a usage of 3065.46 thousand tonnes and Tamil Nadu held the tenth place in fertilizer consumption with 1196.85 thousand tonnes in 2009-2010. Among the states of India, Tamil Nadu state with a salubrious climate is suited for cultivating a wide variety of crop ranging from high value crops like coffee and pepper to field crops like jowar and red gram. Tamil Nadu has seven agro climatic zones comprising transition, dry, hilly and coastal zones. The fertilizer consumption per hectare among the districts in Tamil Nadu varies a lot according to the crops grown, amount of rain fall, soil, sources of irrigation, weather conditions such as temperature etc. Hence Tamil Nadu was selected as the area of study as it would provide ample scope to understand the pattern, growth and determinants of fertilizer use.

A district-wise analysis on fertilizer consumption in Tamil Nadu was done in the study. During the year 1980-81 there were only 15 districts in Tamil Nadu, but their number increased to 32 by the end of 2009-10. The calculations were carried out accordingly. It was observed that the fertilizer consumption recorded the highest in Tiruchirapalli amounting to 94626 tonnes and Coimbatore recorded the fifth place with a fertilizer consumption of 78198 tonnes in 2009-10 (Fertilizer and Agriculture Statistics 2009-10).

Tamil Nadu has been divided into five agricultural zones, based on the agro-climatic conditions and soil profile. Coimbatore district falls under Zone-II. Coimbatore is the second largest city in Tamil Nadu and the 15th largest urban agglomeration in India with a metropolitan population of over two million. It is a major commercial Centre and has often been referred to as the "Manchester of South India". Population of the district is 3,472,578 consisting of 1,735,362 Male and 1,737,216 Female. Total literates are 2,678,637 and Sex Ratio is 940. The number of cultivators is 1.72 lakhs while agricultural laborers are 3.36 lakhs. Most of the people who depend on agriculture in the district are wage earners.
Coimbatore district is positioned in the top five ranks in per capita income and longevity. The district fares well in terms of both Human Development Index (HDI) and Gender Development Index (GDI). In general, the urbanized Coimbatore district has high per capita income ranging from ₹14,000 to ₹20,000 per month. Equally, important, the manufacturing and tertiary sectors contribute a high percentage of the total income while the primary sector's contribution in these districts is insignificant.

On an average, the district gets 700 mm. of rainfall in a year. Coimbatore receives a higher rainfall from North East Monsoon of 444.3 mm. Rainfall distribution is also good. Temperature varies between 18.6 Celsius to 35.7 Celsius. Of the total geographical area 182306 ha and 191147 ha are under net sown area and gross cropped area respectively while 8841 ha is sown more than once. The gross cropped area under all crops has sharply decreased to 1.91 lakh ha in 2010-11 from 3.51 lakh ha in 2004-05. While the area under food crops accounted for 54.17 per cent and that of non-food crops formed 45.83 percent of the gross cropped area, during the year 2009-10.

The soil types of a particular area play critical role in determining the fertility status and cropping pattern. More than 50 percent of area comes under Irugur and Palladam series which are poor in productivity. Much of soil is deficient in Zn (more than 90 per cent) followed by Cu. Mg and Fe deficiency varies in between 10-20 per cent. The soil is predominantly black soil which is suitable for cotton crop. The soil in Coimbatore taluk is enriched with organic matter from the hill ranges. The red soils around the Anamalais are fertile. Major well and tank irrigated blocks exploit ground water which fall under critical and semi critical category.

Important crops grown in the district are paddy, cholam (jowar), cumbu (bajra), ragi, maize, small millets, pulses, sugarcane, spices and condiments, fruits and vegetables which constitute the food crops. It is reported that fruits, vegetables, flowers, medicinal plants and horticulture crops are cultivated in the district covering an area of 52011 ha. The major plantation crops grown are
coconut (28.2 percent of the total area), tea, coffee and cardamom. Cashew and curry leaf are also grown in a few pockets. Fibers, oilseeds, drugs and narcotics, dyes, fodder crops, green-manure crops, flowers, other miscellaneous tree crops and groves and other non-food crops are also raised in some parts of the district.

In spite of various constraints such as fragmentation of land holdings, overexploitation of irrigation sources, deterioration of soil health due to continuous intensive cropping, shrinking trend of gross cropped area and rainfall in the past few years, productivity of major crops continues to increase. This may be due to application of fertilizer. Thus there is scope for increasing production and productivity of maize, paddy, groundnut and cotton with existing technologies by implementing good crop husbandry and other crops with modern technology and application of fertilizers.
> Brief description of the block chosen for the study

Thondamuthur block is one of the major agricultural blocks in Coimbatore district and it consumes significant quantity of fertilizers. Thondamuthur is a suburb of Coimbatore city. It has a population of 124,390 males constitute 51 percentages of the population and females 49 percent. Thondamuthur has an average literacy rate of 68 percent, higher than the national average of 59.5 percent, male literacy is 79 percent, and female literacy is 56 percent. The total agricultural labours of Thondamuthur block are 11314 of which 10668 were male and 646 female (Census 2011). Its geographical area is 44932 hectares.

The average annual rainfall in Thondamuthur block is 590 mm. Most of the rainfall in the district is confined to period from May to October. The total net irrigated area is 8253.16 hectares in Thondamuthur block of which the share of tube well is (55.52 percent) followed by ordinary wells (33.20 percent), canals (11.17 percent) and tanks (1.03 percent).

The soils of Thondamuthur block are sandy clayey and loam. This type of soil is poor in nitrogen. The soil is good for growing of crops like paddy, turmeric, sugarcane, vegetable under irrigated condition. Thondamuthur block has 2888 electric motors, 802 oil engine and 58 tractors. It has two commercial banks and four co-operative banks. It is having one regulated market and there are no sub market facilities.

Thondamuthur economy is a flourishing one owing to its proximity to Coimbatore. The real estate value is at an all-time high. Many people use it as their place of residence and travel back and forth to Coimbatore for work. It is one of the fast developing neighborhoods in the Coimbatore area. There has been a spurt in housing complexes and premium old age homes in and around this location due to its proximity to Coimbatore and pollution free atmosphere.
2. NATURE AND SOURCES OF DATA

In the present study both primary and secondary data were used for evaluating the specific objectives of the study. The secondary data on consumption of chemical fertilizers (NPK), season-wise consumption, consumption per gross cropped area and price of fertilizer were collected for the study from sources like:

- Fertilizer statistics.
- Fertilizer and agriculture statistics.
- Agro-stat
- Season and crop report of Tamil Nadu.
- Tamil Nadu - An Economic Appraisal, and
- Census of India

The data on demographic profile, pattern of land utilization, crops grown and other relevant data about the district and block was obtained from the Coimbatore district statistical office.

The primary data for the present study were elicited for the agricultural year 2009-10 from the selected farmers by using a well-structured and pre-tested interview schedule. The data relating to general information about the respondent, land holding, irrigation source, cropping pattern, fertilizer use, pattern of fertilizer consumption, and cost of cultivation were elicited from sample farmers through personal interview method.

3. SAMPLING PROCEDURE

Keeping in view the objectives of the study, a multi-stage sampling method was adopted in the selection of the district as universe, blocks as a stratum, Panchayat villages as a primary unit and the number of sample respondents as an ultimate unit. Coimbatore district consists of sixteen blocks, of which Thondamuthur block was selected on the basis of fertilizer consumption and gross cropped area. From Thondamuthur block, all the ten panchayat villages, Thennamanalur, Jagirnaickenpalayam, Devarayapuram, Viraliyur, Narasipuram,
Mathampatti, Pooluvapatti, Vellimalaipatinam, Theethipalayam and P.C palayam were selected for the study. All the villages are agriculture dominated and a large proportion of population are engaged in farming. Thirty farmers each, from ten villages were selected making a sample of 300 farmers.

4. PERIOD OF STUDY

The secondary data covered the period of thirty years from 1980-81 to 2009-10. The choice of the period had been largely determined by the reliability of the available data. The field survey was carried out from the month of October 2009 to February 2010. The study pertained to the agricultural year 2009-10.

5. CONCEPTS USED IN THE STUDY

Fertilizer

Fertilizers are artificially produced inorganic substances of concentrated nature, which supply plant nutrients like nitrogen, phosphorus, potash, sulphur and others. This includes urea, di-ammonium phosphate, ammonium chloride, calcium ammonium nitrate, complex fertilizers, mixed fertilizers, super phosphate and micronutrients. The three major fertilizers are nitrogenous (N) phosphatic (P) and Pottasic (K) fertilizers.

Fertilizer Consumption

The application or usage of NPK fertilizers, in cultivation of land, in order to increase crop productivity is termed as fertilizer consumption.

Cropping intensity

\[
\text{Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net sown area}} \times 100
\]

Gross cropped area (GCA)

The total cropped area including area sown more than once

Net sown area (NSA)

It implies the actual area under cultivation
**Gross area irrigated (GAI)**

Total area irrigated in cultivation of crops including area under cultivation irrigated more than once.

**Net area irrigated (NAI)**

It represents the actual area under cultivation that has been irrigated.

**TOOLS OF ANALYSIS**

The data collected were subjected to following statistical analysis.

6.1. **Tabular analysis**

The technique of tabular presentation was followed for presenting land holding, consumption pattern, nutrient-wise and district-wise consumption of chemical fertilizers, to draw meaningful inferences. Various dimensions were compared and contrasted with the help of frequency, average and percentage.

6.2. **Growth Rate analysis**

In order to analyze the growth of fertilizer consumption, exponential growth rate, kinked exponential model for growth rate estimation and annual growth rate were carried out.

i) **Exponential growth rate**

To find out how the selected variables have grown over the years, the exponential function of the form

\[ Y = a \cdot b^T \]

Where

- \( Y \) = Selected economic variable
- \( T \) = Time period and Growth Rate = \((\text{Antilog } b-1) \cdot 100\) was used.
ii) **Kinked exponential model for growth rate estimation**

To estimate the growth rate of fertilizer consumption, an exponential model of the type $Y_t = a e^{bt}$ ($\ln Y_t = \log a + bt$) has been fitted, using Ordinary Least square (OLS) technique. Decade wise growth rates have been estimated by fitting Kinked Exponential Function. In the function, imposing linear restrictions had eliminated the discontinuity between segments of a piecewise regression.

Discontinuous growth rates for three sub-periods were given by the following equation:

$$\ln Y_t = a_i |D_i| + a_2 D_2 + a_3 D_3 + (b_i D_i + b_2 D_2 + b_3 D_3) t + U_t$$

Where $Y_t$ is the relevant trade indicator, $U_t$ is the error term and $D_j$ ($j=1,2,3,$) is a dummy variable which takes the values 1 in the $j^{th}$ sub period and 0 otherwise. In order to estimate continuous growth rates of the four sub periods, from the above equation, three Kinked Exponential Model is derived by imposing linear restriction such that the sub- period trend lines meet $k_{iand}k_2$.

$$a_i + b_i = a_2 + b_2 k_2$$

$$+ b_2 k_2 = a_3 + b_3 k_2$$

Substituting for $a_2$ & $a_3$ and taking $a_i |D_i| + a_i D_2 + a_i |D_3|=a_i$ We get the exponential model with two kinks:

$$\ln Y_t = a_i + b_i (D_i + D_2 K_i + D_3 K_i) + b_2 (D_2 t - D_2 K_i - D_3 K_i + D_3 K_2) + b_3 (D_3 - K_2 D_3 t) + U_t$$

Where,

$$a_i = a_i D + a_i D_2 + a_i D_3.$$  

OLS estimate of the respective coefficients, $b_i$, $b_2$, and $b_3$ gives the exponential growth rate in the three sub- periods.

Where

- $A = \text{Intercept}$
- $B = \text{Regression co-efficient}$
P = Fertilizer Data
X = Time series (years)
N = Number of Years

Exponential Trend Equation is
\[ Y = AB^t \]
Taking log on both sides to convert into linear form we get
\[ \log y = \log a + t \cdot \log b \]

Where,
- \( Y = \log Y \)
- \( A = \log a \) (Constant)
- \( B = \log b \) (Trend (slope) of the line)
- \( t = \) years

After solving for \( A \) and \( B \), the CAGR is calculated as,
\[ \text{CAGR} = (\text{antilog } (B-1)) \times 100 \], expressed in terms of percentage.

ii) Relative Cyclical Variation

The relative cyclical residual indicates how the actual trend values are either short of or in excess of the estimated values. Relative Cyclical residuals for the variables were calculated as follows:
\[ \text{Relative Cyclical residuals} = \frac{Y-y}{y} \times 100 \]

Where
- \( Y = \) Actual Values
- \( y = \) Estimated values

iii) Future Prediction by using Trend Analysis

To find out the future prediction of fertilizer consumption, the Exponential Trend analysis and Compounded annual growth rate was used.

iv) Spearman’s Rank Correlation Coefficient
The Rank correlation Co-efficient was also estimated to find out the trend and pattern of fertilizer consumption, in the ranking of different districts by using the following formula
Where,

\[ r_s = \text{Spearman's rank correction Co-efficient} \]
\[ N = \text{Number of paired observations} \]
\[ \Sigma = \text{Notation meaning "the sum of"} \]
\[ d = \text{Different between the rank for each pair of observation.} \]

v) **Variation and Instability analysis**

In order to estimate instability, the co-efficient of variations and instability index was used.

vi) **Co-efficient of variation**

The coefficient of variation is given as:

\[ \text{Co-efficient of variation} = \frac{\sigma_X}{X} \times 100 \]

Where
\[ \sigma = \text{standard deviation of } X \]
\[ X = \text{mean of } X \]

vii) **Instability index**

Ray (1983) observed that measure of instability based on exponential time trend can be readily used for cross comparisons. To study the instability of fertilizer consumption, the following instability index was used.

\[ x = \frac{I}{n-k} \]

Where
\[ n = \text{number of observations} \]
\[ K = \text{number of parameters estimated} \]
\[ e_i = \text{residuals} \]

The residual \( e_i \) will be obtained from the exponential trend equation.
6.4. Analysis of determinants

i) Multiple Regression model

The determinants of fertilizer use were examined using multiple regression model. The identification of explanatory variables was based on the empirical evidences made by the early writers (Mohanam, 1989, Parthasarathy and China Rao, 1986, Ramesh and Anand, 2007).

To determine the various factors influencing the fertilizer use in Tamil Nadu variables viz: net irrigated area, rainfall, price of fertilizer, area of HYVP crops and gross cropped area were considered. To study the simultaneous impact of net irrigated area, rainfall, price of fertilizer, area of HYVP crops and gross cropped area, on fertilizer use a multiple linear regression model was used.

\[ Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e_i \]

Where, \( Y \) = Consumption of fertilizer in kg/ha
\( X_1 \) = Net irrigated area
\( X_2 \) = Annual rainfall (millimeters)
\( X_3 \) = Price of fertilizer in Rs. per Kg
\( X_4 \) = Area of HYVP crops
\( X_5 \) = Gross cropped area
\( b_1, b_2, b_3, b_4, b_5 \) - partial regression coefficient

To find out the determinants of fertilizer consumption in Thondamuthur block the following model was used:

\[ Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + e_i \]

Where, \( Y \) = Consumption of fertilizer in kg. per acre
\( X_1 \) = Price of fertilizer in Rs. per Kg
\( X_2 \) = Cost of irrigation in Rs. per acre
\( X_3 \) = Cost of Ploughing in Rs. per acre
\( X_4 \) = Cost of labour in Rs. per acre
\( X_5 \) = Farm Size
\( X_6 \) = Income from crop production
\( b_1, b_2, b_3, b_4, b_5, b_6 \) - partial regression coefficient
ii) Factor analysis

Factor analysis was adopted to identify and analyze the important factors influencing fertilizer consumption. The perceptions of farmers on a set of 7 statements about factors which determine the fertilizer consumption and 8 statements about factor which determine the selected suppliers were subjected to factor analysis. These statements were measured on a Likert's five point Scale (from 'strongly agree' to 'strongly disagree') regarding the perceptions of the farmers about the factors which determine their fertilizer consumption. Each variable is expressed as a linear combination of underlying factors. The amount of variance, a variable shares with all other variables included in the analysis is referred to as communality. The co-variation among the variables is described in terms of a small number of common factors plus a unique factor for each variable. These factors are not over observed. If the variables are standardized, the factor model may be represented as:

\[ X_i = A_{ij}F_1 + A_{i2}F_2 + A_{i3}F_3 + \ldots \ldots + A_{im}F_m + V_i U_i \]

Where,

\( X_i = \text{ith standardized variable} \)

\( A_{ij} = \text{Standardized multiple regression co-efficient of variables } i \text{ on common factor } j \)

\( F = \text{Common factor} \)

\( V_i = \text{Standardized regression co-efficient of variable } i \text{ on unique factor } i \)

\( U_i = \text{The unique factor for variable } i \)

\( m = \text{Number of common factors.} \)

The unique factors are unconnected with each other and with the common factors. The common factors themselves can be expressed as linear combinations of the observed variables.
\[ F_i = W_{i1}X_1 + W_{i2}X_2 + W_{i3}X_3 + \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots W_{ik}X_k \]

Where,

- \( F_i \) = Estimate of \( i^{th} \) factor
- \( W_i \) = Weight or factor score co-efficient
- \( K \) = Number of variables

It is possible to select weights or factor score co-efficient, so that the first factor explains the largest portion of the total variance. Then, a second set of weight can be selected, so that the second factor accounts for most of the residual variance, subject to being uncorrelated with the first factor. This same principle could be applied for selecting additional weights for the additional factors. Thus, the factors can be estimated so that their factor scores, unlike the value of the original variables are not correlated. Furthermore, the first factor accounts for the highest variance in the data, the second factor the second highest and so on.

The principal component analysis was used for extracting factors and the numbers of factors to be retained were based on Latent Root Criterion, i.e. variables having Eigen values greater than 1. The factors having loadings greater than 0.50 are considered very significant while factors having loadings greater than 0.40 are considered important and factors with loadings greater than or equal to 0.30 are considered significant.

A factor loading represents the correlation between an orthogonal variable and its factor. The signs are interpreted just like any other correlation co-efficient. On each factor 'like signs' of factor loading means factor loading and factors are positively correlated and 'opposite signs' of factor loadings means that factor loadings and factors are negatively correlated. One of the final outcomes of a factor analysis is called 'Rotated Factor Matrix' a table of co-efficient that express the ratios between the variable and the factor that have been prepared.
iii) Attitude scale

Since the attitude of the farmers is an abstract concept it cannot be measured directly in quantitative terms. However, it can be measured indirectly with the help of an appropriate scaling technique. An attitude scale’ was developed by giving scores to measure the level of attitude. The response of the respondents to each statement was elicited with the help of likert five point scales. The selected farmer were asked to rate the identified statement on a five point scale namely' Strongly Agree', Agree', Neutral', Disagree', Stronglydisagree', the marks assigned to the above said scales are 5, 4, 3, 2 and 1 respectively. It reveals that the higher scores indicate the better attitudes towards the statement and vice versa. The attitude scale was used in the following analysis:

- Satisfaction level of fertilizer usage of the respondents
- Estimation towards satisfaction level of suppliers

iv) Weighted Average method

Weighted average method was used to identify the satisfaction level towards fertilizer suppliers and factors influencing fertilizer consumption. If all quantities are weighed equally or contribute equally, while calculating the average, it is equal to the arithmetic mean. It comes handy when you have to combine the averages of two different sets of values and get an overall average value.

The general formula is Weighted Average = (\( x_i \cdot w_i + x_2 \cdot w_2 + \ldots + x_n \cdot w_n \)) / (\( w_1 + w_2 + \ldots + w_n \)) = \( \frac{\sum_{i=1}^{n} (x_i \cdot W_j)}{\sum_{h=1}^{n} W_j} \)

Here 'Xj' are values of the quantity whose average is being calculated, while 'Wj' are the values of the corresponding weights. So, for calculating weighted average, you must multiply values of the quantity, with their corresponding weights, add them up and divide them by the sum of the weights.
v) Chi- square test

The Chi-square test was used to determine, if there is any association between satisfaction level of different factors in fertilizer usage and farming experience of the farmers. The Chi- square ($x^2$) value was calculated from the formula:

$$X^2 = \frac{\sum E_{ij}}{E} = \frac{(Rt*CT)}{N}$$

Where

'0' is observed frequency in each category and $J$ denotes number of groups. The obtained value is compared with the theoretical value at the given degrees of freedom to draw interference about the sample.

vi) Garrett's ranking technique

Garrett's ranking technique was used to rank the different factors influencing the problems of fertilizer usage by farmers. The farmers were asked to rank the different attributes. The orders of merits were converted into ranks by using the following formula:

$$\text{Percent} = \frac{100(R_y-0.5)}{N}$$

Where $R_y$ Rank given for $i^{th}$ individual $N_j$ number of factors ranked by $j^{th}$ individual by referring the Garret's scores table, the per cent position estimated were converted into scores. Then for each factors, the scores of various respondents were added and the mean was calculated. The mean values were arranged in descending order. The variables with the highest mean score was considered to be the most important one.
7. **SCOPE OF THE STUDY**

The present study intends primarily to be of use to the planners and policy makers of Tamil Nadu state, to identify the priority areas in developmental efforts. More specifically, the study would present the objectives of the inter-regional and inter-temporal difference in fertilizer usage and to study various factors influencing the consumption pattern. This would be shown to draw the attention of the planners and policy makers for a selective policy approach in planning. The results of the study will help to formulating suitable policy measures to ensure uniform fertilizer consumption pattern.

8. **LIMITATIONS OF THE STUDY**

- The respondents were not able to remember accurately, the amount of fertilizer that they used before and the profit they obtained out of it hence the bias of the respondents is a limitation of the study.
- The primary data is confined to only one block of Coimbatore district, therefore generalization based on result of the study should be done very carefully.