Chapter 3.

**METHODOLOGY**

Many approaches have been adopted earlier to study the land resource of a region; however the approaches were biased towards one discipline like soil science, Economics, Geography and Socio Economics. The latest emphasis on land use planning as a multidisciplinary study has stressed the need for adopting a holistic study in land resource and land use planning studies.

Accordingly the present study has been advocated and a holistic approach has been initiated. The study was divided into the following four phases:

1) Field Work

2) Collection of data

3) Compilation and analysis of data.

4) Preparation of final maps and documentation of the entire study.

During the first phase, the landform and soil resources and their spatial variations were identified mapped and described in the form of a landform/soil/landuse mapping legend. In the second phase data relating to the land resources were collected from Government departments and literature. Also data was collected from farmers within the study area about cultivation of crops, Cultivation costs, availability and quantum inputs applied and particulars about borewells, and motor used. In the next phase the data collected were tabulated systematically and analysed manually and also with the aid of computers. Finally the final maps and other statistical diagrams were prepared and the whole work was systematically documented.
The study has been arranged logistically in 4 parts, in the first part the status of various natural resource parameters and their potential for land use has been studied, in the next part land evaluation using various standard methods have been adopted and in the third part the past, present and emerging trends especially in the agriculture scenario and socio economic factors have been studied. Based on the first three parts, the recommendations for optimum land resource management has been evaluated in the final part.

3.1 STUDY OF LAND RESOURCES

The study of land resources included a detailed study of the physical component, landform, soils, vegetation, relief, climate hydrology and water. While the landform and soils were directly studied and mapped in the field; the study of other factors such as climate, vegetation and water resources were limited to collection of data from different sources to assess its distribution, quantification, consistency and potential for influencing land use especially with reference to crop cultivation. The procedures adopted are described hereunder.

3.2 STUDY OF LANDFORM AND SOIL RESOURCES

Systematic survey was conducted in the study area to study, identify and map the landform types, physiographic units, soil types and landuse. The mapping was carried out in 1:50,000 scale following the standard procedure outlined by IARI (1970), soil survey staff (1951), Sehgal, (1986) and Dent and Young (1981). The first step was to collect all reference materials of the study area such as Topo sheets (1:50,000 Scale) of the survey of India, Landsat imageries (1:50,000) Aerial photographs (1:60,000) geology maps and reports of earlier works done on various topics in the study area. The reference
materials were studied and assembled systematically to serve as a comprehensive data base for the study.

A field base map of the study area was traced from relevant topo sheets to form one contiguous sheet to facilitate the mapping and the study.

With the help of the topo sheet, thematic maps (geology maps etc) and other references collected earlier, broad physiographic or landform delineations were made on the imagery. Further aided by a magnifying glass, sub divisions were made within the broad landform units based on the colour, tone, texture and patterns observed on the imagery. In the bigger units where further sub division was not possible and wherever necessary, to confirm the delineated units, aerial photo interpretation was carried out by using a stereo-scope and by following systematic physiographic approach (Vink, 1963). The delineations were transferred to the topo base and a preliminary physiography map with legend was prepared for the study area. The preliminary physio-graph map information was checked with ground truth in the study area and after making necessary alterations, the actual physiography map and legend were finalized. The physiography map formed the base for the study of soils in the field.

After a rapid traverse of the study area, transects were selected on various physiographic units like uplands, low lands, ayacuts, flood plains and marine plain and its sub divisions. Soil profile pits upto 200 cms or to parent material or to water table in all the transects at regular intervals were studied over the entire area for morphological characterization. Random observations, depending on the variability of the soils were taken wherever necessary. Observations were also made with the help of soil augers and natural cuttings. The soil morphological descriptions were entered in standard profile study formats and arranged unitwise. The soil composition of all the physiographic units were analysed in detail and after establishing the relationship between the soil composition and physiographic units the preliminary soil map and mapping legend was established. After repeated field checks and testing the soil composition for individual units, final soil map and legend were finalised.
The soil was mapped on soil association basis comprising of not more than two soils per unit. The individual soil was identified a soil series and were represented symbolically as VRP, VRP, RFP, OP, MN, etc. The soils were indicated in the legend by a soil - land use mapping unit. (Eg.)

\[ VRP, S, B \]

G, M - R, Where VRP, refers to the soil series S refers to sandy texture and B refers to slope per cent (1,2,3 per cent). G and M represent the landuse groundnut and millets and R1 refers to rainfed agriculture.

Similarly each soil units was described illustrating the texture, slope and landuse on that soil and cultivation under rainfed/irrigated condition. The soil series identified were correlated with the soil series of Pondicherry region established by the NBSS and LUP and the Department of Agriculture (1991). The description and physico-chemical properties of the typifying pedon described in the earlier study was utilised for further interpretations and study in the present work.

3.3 STUDY OF SURFACE SOIL PROPERTIES

After studying and mapping the different soils with relation to the landforms in the study area, separate study was also conducted on surface soil properties mainly with reference to soil pH, electrical conductivity, available nitrogen, phosphorous and potassium. For this purpose regular sample points were established in the study area and soil samples were collected only on the sample points. The procedure followed are described hereunder.

3.3.1 SELECTION OF SAMPLE POINTS

The base map of the study area was divided into square grids representing 1Km. x 1Km. (2x2cm on 1:50,000 scales). Every intersection
point was considered as a sample point which was used as bench mark for
collection of surface soil samples for evaluating the soil fertility. The sample
points were also considered for predicting the optimal crop described in
chapter 3.7.4.

In case the sampling points fell on the water bodies or sites unfit for
sampling a further point towards north about 50mts was considered. The
sampling point grid map was superimposed over the soil map and the soil type
(Series) for each point was recorded for further evaluations.

3.3.2 STUDY OF SOIL FERTILITY

The sampling was numbered serially on the map and at each
corresponding site in the study area surface, soil samples were collected by
making a "V" shaped cut and scraping the soils from the sides of "V" cut. The
soil was well mixed and about 400-500 grams of the samples were collected in
the serially numbered polythene bags. The soil samples were later dried,
pounded with wooden hammer and sieved in 2mm sieves, repacked and stored
for further laboratory analysis. The soil samples were analysed for soil pH,
(to indicate soil alkalinity) electrical conductivity (to indicate soil salinity),
available nitrogen, phosphorous and potash using the standard procedures
followed in the soil testing laboratory, Department of Agriculture.

_Determination of soil reaction (pH):_

The determination of soil reaction (pH) by a pH meter is based on
measurement of the electromotive force of a pH cell with a reference buffer
and then with a test solution. The pH cell consists of two electrodes, the
measuring electrode is of glass and the reference is of calomel electrode. Most
digital pH meters have single (combined) electrode assembly. The instrument
being a potentiometer, the pH scale has to be calibrated before use with buffer
solution of known pH values. Since the dissociation/ionic activity increases
with temperature the pH scale of 0 to 14 is valid only for a particular temperature (25°C). Thus all instruments are provided with temperature setting/correction knob which must be made use of.

**Procedure:**

About 20gm of the prepared soil sample was taken in a 100ml beaker to which 40ml of distilled water was added (1:2). The suspension was stirred at regular intervals for 30 minutes and the pH was recorded. The suspension must be stirred well just before the electrodes are immersed and readings are taken.

**Measurement of Electrical conductivity:**

Electrical conductivity is a measure of the ability of a salt solution to carry electric current by the migration of ions under the influence of an electric field. Thus the measurement of Ec can be directly related to the soluble salts concentration of the soil at any particular temperature.

The apparatus for measuring electrical conductivity consists of an AC salt bridge or electrical resistance bridge and conductivity cell having electrodes coated with platinum black. The instrument is also available as an already calibrated assembly (sodu bridge) for giving directly the conductivity of solution in millimhos per cm at 25°C. The electrodes are immersed in the test solution, the bridge is balanced and the reading is recorded at 25°C using the knob provided for this purpose.

**Estimation of available nitrogen:**

The estimation of available nitrogen was carried out following the procedure alkaline permanganate method (Subbiah and Asija, 1956). The procedure involves distilling the soil with excess of alkaline permanganate
solution and determining the ammonia released which serves as an index of available/mineralizable nitrogen level (or) status.

In a 800ml dry Kjeldahl flask, 20gm of soil was taken. To this 20ml of water is added followed by 100 ml each of 0.32per cent KMnO4 and 2.5per cent NaOH solution. The frothing during boiling is prevented by liquid paraffin (1ml) and by adding a few glass beads. The contents was distilled in a kjeldahl assembly at a steady rate and the liberated ammonia was collected in a conical flask (250 ml) containing 20 ml of boric acid solution (with mixed indicator). With the adsorption of ammonia the pinkish colour turns to green. Nearly 100 ml of distillate is to be collected in about 30 minutes which is titrated with 0.02NH₂SO₄ to the original shade (pink). Blank correction (without soil) is to be made for the final calculation.

Mineralizable N(Kg/ha) = R x 0.02 x 1/20 x 0.014 x 2.24 x 10⁶ = R x 31.36

Where R=Volume of 0.02 NH₂SO₄ required for titration.

Estimation of available Phosphorous

The extracting reagent for Olsen’s P is 0.5 molar sodium bicarbonate (pH 8.5) prepared by dissolving 42.0 gm of Na HCO₃ in distilled water to give one litre of the solution. The pH is adjusted to 8.5 with small quantities of 10per cent NaOH. The method has been found widely applicable in slightly neutral and calcareous soils.

To 2.5gm of soil in 100 ml conical flask a little of Darco G 6.0 or equivalent grade of activated carbon (free of phosphorous) was added followed by 50 ml of Olsens reagent. A blank is to be run without soil. The flasks are shaken for 30 minutes on a platform type shaker and the contents filtered immediately through dry filter paper (Whatman No 1) into clean and dry beakers or vial. In the filtrate phosphorous is estimated calorimetrically by ascorbic acid method (Watanabe and Olsen 1965) described as follows.
Reagents

1) 12 gm of ammonium molybdate (AR) is dissolved in 250 ml of distilled water. In 100 ml of distilled water a solution of 0.291 gm of antimony potassium tartrate was prepared separately. Both these solutions are added to 1000 ml of approx. 5 N H$_2$SO$_4$ (140 ml conc. H$_2$SO$_4$ in one litre), mixed thoroughly and made to two litres with distilled water.

2) Ascorbic acid solution: 1.056 gm of ascorbic acid (LR) was dissolved in 200 ml of reagent (i) and mixed well. This should be prepared fresh as and when required.

About 5 ml of the Olsen extract was pipetted into a 25 ml volumetric flask. Carefully acidified with 5 N H$_2$SO$_4$ to pH 5.0 On adjustment of the pH it is diluted to 20 ml with distilled water and 4 ml of reagent (2) added. The volume is made up to mark and the contents shaken well. After 10 minutes, the intensity of the blue colour is read in a photo electric calorimeter using 6.60mu filter. A blank was also run without soil simultaneously.

Standard curve for phosphorous:

Analytical grade potassium dihydrogen orthophosphate (K$_2$H$_2$PO$_4$) is dried in air oven at 60 C for 1 hour and after cooling exactly 0.439 gm is dissolved in about half a litre of distilled water. To this 25 ml of N H$_2$SO$_4$ (approx.) is added and made up to one litre with distilled water. This gives a 100 ppm stock solution of P (100 ug P per ml). From this a 2 ppm P solution is made (50 times dilution). For preparation of the standard curve different concentration of P (1,2,3,4,5 and 10 ml of 2 ppm P solution) are taken in 25 ml volumetric flasks. To these 5 ml of extracting agent is added and the colour is developed. The calorimeter reading is taken against 660 mu (red) filter just after 10 minutes. The curve is plotted taking the colorimeter reading on the vertical axis and the amount of P (in 1 ug) in the horizontal one.
Total volume of extractant 2.24 x 10^6

Available P/Kg/ac = \( \frac{R \times \text{Aliquot wt-of-soil}}{10^6} \) (Where R - ug P in the aliquot (seen from standard curve)).

**Estimation of available Potassium**:

The potassium ions in the exchange sites are replaced with NH\(_4^+\) and K\(^+\) is released. The concentration of K ions in the solution is determined using flame photometer.

**Reagents**:

1) Neutral ammonium acetate:

About 77 gms of ammonium acetate was dissolved in 900 ml of distilled water, shaken well and pH adjusted to 7.0 with either liquid ammonia or acetic acid and then made up to one litre with distilled water and pH was again checked.

2) Potassium chloride solution:

A stock solution of 1000 ug K/ml was made by dissolving 1.908 gm of AR grade potassium chloride (dried at 60 C for 1 Hr) in distilled water and volume made to 1 litre.

**Procedure**:

About 5 gm of soil sample was shaken with 25 ml of neutral normal ammonium acetate (ph7) for 5 minutes and filtered immediately through a dry filter paper (What No. 1). First few ml was rejected. The potassium
concentration in the extract was determined in the flame photometer after necessary setting and calibration of the instrument.

**Standard curve**

From the stock solution, measured aliquots are diluted (in 50 or 100 ml vol. flasks) with the ammonium acetate solution to give 10 to 40 ppm and K. After making necessary adjustments the photometer reading was set zero for the blank (ammonium acetate) and at 100 for 40 ppm K. The curve was obtained by plotting the readings against the concentration (10, 12, 20, 25, 30, 40 ppm) of K.

**Available K kg/ha**

\[
\text{Available K kg/ha} = \frac{\text{volume of extract}}{\text{weight of soil taken}} \times \frac{2.24 \times 10^6}{10}
\]

Where R = ppm of K in the extract (obtained from standard curve)

\[
= \text{ppm of K} \times 11.2
\]

3.4 STUDY OF CLIMATE RESOURCES

In the study area a rich source of climatic data base has already been established and therefore the study was restricted only to collection, compilation and analysis of the available data. Earlier works in analysis of climatology of Pondicherry and its environs have been carried out by Meher Homji (1966) and Blasco and Legris (1973). The works have been described and in some cases even combined and updated to the period 1990. The analysis and interpretation undertaken for the study area was focussed mainly on the following objectives.
a) The variation in the total annual rainfall, north east monsoon, south west monsoon and post monsoon for the period 1911-1990.

b) Comparative study on the quantity and distribution of the annual rainfall for the period 1911 to 1990.

c) Frequency of the years in different rainfall classes during the period 1911 to 1990

d) Month wise frequency and quantity of rainfall received during the period 1911 to 1990.

e) To study the relationship between the atmosphere and the soil-plant system through water balance studies according to Thornwaite and Mathur (1957) for a period of nine decades from 1911 to 1990.

The relationship between the atmosphere and the soil-plant system is a complex one which can be simplified and generalised in water balance studies. The water balance equation is of the general form:

\[ P - Q - E - S = 0 \]

where P is precipitation, Q is stream flow, E is evapotranspiration and S represents changes in groundwater and soil moisture storage. Assumptions and simplifications are adopted in water balance computations. It is assumed that all precipitation infiltrates and therefore there is no surface run off until the moisture storage capacity is exceeded. Also it is assumed that the rate of actual evapotranspiration as a function of potential evapotranspiration if the available soil moisture level in the soil is known. Evapotranspiration occurs at the potential rate only when the soil is at field capacity or evapotranspiration occurs at the potential rate until a certain proportion of soil moisture has been transferred or evaporated. In the present study the field capacity is 100 and this value is calculated with rainfall and potential evapotranspiration. In the present study water balance is applied only to assess the suitability of an area for a given crop through analysis of growing season. (Jackson, 1977).
The results and along with the interpretation of the climatic parameters on crops in the study area are presented in chapter 4.3.

3.5 STUDY OF WATER RESOURCES

Due to the coastal location of the study area and the over exploitation of groundwater, the danger of reversal of hydraulic gradients leading to salt water displacement of fresh water and the aquifer turning saltish is always possible. This scenario gains particular importance in the present context in the study area where due to the spurt in population, industrial and other allied growth the demand for ground water is ever increasing.

The objective of the present study can be listed as follows.

a) To study the source and potential of the water resources both surface and ground water in the study area.

b) To study the status and potential of the different groundwater aquifer and its discharge, recharge potential, depth and fluctuation.

c) To study the relationship between rainfall and water table depths by simple regression analysis. The procedures adopted is detailed hereunder;

An attempt was made to detect more directly any tendency of over extraction ie: rate of extracting water is greater than the rate of replenishment by recharge process. In order to diagnose this tendency the changing relationships between rainfall and water table have examined graphically. The required data for the proposed study has been obtained from the mean levels of rainfall in Pondicherry for the years of 1986 and 1990. Also the water level from four stations (observation wells) monitored by the State Ground Water Unit of the Department of Agriculture were utilised for this study. The station considered are representatives of the alluvium, tertiary and cretaceous
The depth of water level from the surface (in metres) is taken as a dependent variable (Y-axis) while the monthly rainfall deviation is taken as independent variable (X-axis). This exercise was carried out for all the representative stations and in each graph we have trends in particular regions for two different years. Instead of using actual monthly rainfall and corresponding depth of water table; cumulative departure from the mean rainfall was plotted against the depth of water table in the succeeding month; because of the use of the latter parameter a better regression was obtained. The method was adopted from Madduma (1980).

d) To prepare a map delineating the approximate source of the different aquifer in the study region along with relevant information like discharge capacity, water level etc.

The methodology comprised of preparation of base map using survey of India toposheets and delineating broad land form units as done earlier for land form/soil studies. Lithological data of borewells at several locations were collected from the State Ground Water unit, Govt. of Pondicherry and were plotted on the base map. Based on the lithological data, the aquifer zones having homogenous geology were spatially delineated and additional informations like discharge capacity, water level etc were gathered to supplement the informations for the different acquifer zones delineated earlier. For areas other than Pondicherry region the delineations were extrapololated after making necessary ground truth checks in the study area.

Monthwise date on water levels of observation wells within the Pondicherry region maintained by the State ground water unit were utilized for studying the fluctuations of water levels and the recharge relationship with the rainfall. Similarly based on old records on ground water studies and various reports of the Central ground water board and the State ground water units all
the required information were collected and utilized for assessing the ground water potential of the study area.

Apart from the collection of information/data from earlier works, field traverses were also made and data were collected from farmers directly about the water availability to them for irrigation both from surface and ground water source. Information regarding depth of bore well, type of bore well and motor horse power of motor and history of his old well or irrigation were collected at the sampling point.

The study of surface water was limited only to collection of data from the Public Works Department and interpretation of the same for assessing the status, potential and scope for further development. Also during the field study the actual condition of the tanks and the supply canals were inspected to observe the encroachments within the tanks and the level of maintenance and utilization of the irrigation tanks. The observation, results and discussion have been presented in chapter 4.4.

3.6 STUDY OF CULTURAL FACTORS AFFECTING LAND USE, LAND UTILISATION PATTERNS AND DYNAMICS OF GENERAL LAND USE.

The study envisages a detailed analysis of the human resources, land utilisation pattern, agriculture, cropping pattern, irrigation, capital resources and the emerging trends in land utilisation. The objective of the study is summarized as follows:

a) To study the human resources and its influence on land use.

b) To analyse the land use pattern, the changing trends with special emphasis on the increase in land area under non-agricultural uses.
c) To study and describe the agriculture practises and analyse the cropping pattern; trends in cropping pattern, agricultural growth and food production trends over the years.

d) To study the irrigation pattern and their influence on agriculture.

As mentioned earlier, the land use studies were restricted to only the entire Pondicherry region in the study area as the villages belonging to Tamil Nadu State were not continuous within the extent of the study area and also data for these regions were either not available or were discontinuous.

The Pondicherry region comprises of 6 communes with 179 numbers of villages. The data relating to population, land use, agriculture and irrigation were collected from the season and crop report (annually) and Abstract of Statistics published periodically by the Directorate of Economics and Statistics, Government of Pondicherry. Information pertaining to population were also collected from the Census of India 1961, 1971, 1981 and 1991 published by the Directorate of Census operations, Pondicherry and various reports published by the Department of Agriculture, Public Works Department and other technical reports prepared by various Government agencies, sponsored by Government of Pondicherry.

The field work was only limited to collection of relevant data from farmers in the sample points. Various statistical techniques were adopted for analysis, representation and interpretation of data. Since most of the data available were secondary data from authenticated Government of Pondicherry departments the field work involved in collection of data were minimised and were restricted only to collection of data, compilation in the required format for further analysis and interpretation.
3.7 LAND EVALUATION STUDIES

There are many kinds of evaluation systems out of which the most widely adopted of land evaluation methods are USDA land capability classification, USBR irrigation suitability system, parametric methods and the F.A.O. framework for land evaluation.

Land evaluation studies were conducted in the study area using only the USDA land capability classification, parametric method of Riquier et al. (1970) and F.A.O. framework for land evaluation. Apart from these standard land evaluation models, a statistical model using multiple quadratic regression was utilized to predict the optimal crop based on profit in the study area depending on the soil properties.

Further the changing trends in profitability of the crops due to assumed increase in price of inputs were also calculated simultaneously thereby giving a readymade package for land users and administration to aid them in policy decisions. The procedure adopted for land evaluation are summarised below:

3.7.1 LAND CAPABILITY CLASSIFICATION

The USDA Land capability classification (Klingebiel and Montgomery, 1961) is one of the earliest system for land evaluation. This system groups soil mapping units according to their capability for producing fieldcrops, pastures and forests on a sustained basis. It is an interpretative grouping of soils based on the factors that limit the land use for agriculture. The factors taken into consideration for land capability classification are inherent soil characters, external land features and environmental factors. The system evaluates soils on susceptibility to erosion, drainage problems and other soil characteristics that would affect and limit the sustained production of agricultural crops.
The land capability classification has three levels of classification. They are 1. capability class, 2. capability sub class and 3. capability unit. The soil mapping units are classified according to their capability for use without causing unacceptable levels of soil erosion. Further they are divided into sub class based on their main limitations. The sub class may further be divided based on specific soil management requirements into land capability units. The capability class are indicated by Roman letters I to VIII. The numerals indicated progressively greater limitations and narrower choices for practical uses. The sub classes are indicated by alphabet e,w,s and c which refers to limitation due to erosion, wetness, root zone limitations and climatic limitations respectively. Capability units condenses soil information for planning field by field and furnish information, kind of conservation problems and the management practices needed. The soil under capability classification I to IV are considered to be arable while from V to VIII the soils are considered non-arable.

Although the system is simple and widely adopted, its shortcomings are that the classification is based on permanent limitations and no consideration is given to land characteristics, like soil nutrients and impeded drainage, that can be improved by the farmer.

The land characteristics of the study area have been examined and classified to give a first hand information about its suitability and specifying its other limitations for crop cultivation.

3.7.2 LAND EVALUATION ADOPTING RIQUIER ET AL SYSTEM (1970)

The Riquier et al (1970) system is a parametric method with the underlying principle that the productivity can be expressed with reference to the intrinsic soil characteristics(depth,moisture, base status, texture etc.). The soils are classified according to the indices of "Productivity" and "Potential productivity". The ratio of these two indices gives. "Co-efficient of improvement".
The evaluation involves choosing of nine selected intrinsic soil properties namely moisture, drainage, effective depth texture/structure, base saturation, soluble salt concentration, organic matter content, exchange capacity, nature of clay and mineral reserves. Each of these properties are rated on a scale of 0-100, the actual percentages are multiplied by each other to arrive at the productivity also lying between 0 and 100. Which is set against a scale placing the soil in one or other of the five productivity classes (Excellent, good, average, poor and extremely poor to nil). Based on the appropriate management measures and the characters that can be improved which are determined with the help of prescribed tables, the potential productivity can be calculated. The ratio of the indices productivity and potential productivity will give the co-efficient of improvement which will reveal the amount of improvement possible in quantitative terms. However parametric systems are suitable only for the local areas for which they are developed and tested.

All the soils present in the study area were evaluated using this procedure and the ratings of the different soils were calculated and reached for enabling recommendation of suitable land use planning.

3.7.3 LAND EVALUATION - THE FAO FRAMEWORK

The evaluation of land for its suitability for specific crops was done by adopting the procedures outlined in the framework for land evaluation (FAO, 1976) as indicated by Sys (1985).

In the early system of land evaluation grade the land was classified as best to worst irrespective of the kind of land use and level of management, whereas, the FAO framework provides a method to make a choice between alternatives applying specific management to particular parcel of land. The advantage of FAO framework is that it provides only a set of principles and concepts from which land evaluation can be established to suit any conditions. The basic principle of the framework provides a comparison between land use
and land benefits yielded and inputs needed, between alternative land use. Also, it is a multi disciplinary approach relevant to local conditions.

The FAO framework is a four category system with orders, classes, subclasses and units. There are two orders ("S" for suitable and "N" for unsuitable land) which reflect kinds of suitability. There are 3 classes (S₁, S₂S₃) under the orders S and 2 classes (N₁ and N₂) under the order N reflecting degrees of suitability within the order. The appraisal of the classes, within an order is done according to evaluation of land limitations. The sub classes reflect the kinds of limitations or the main kind of improvement measures required within classes. The limitation are climatic (C), topographic (t), wetness (w), salinity(n), soil fertility (f), physical influencing soil/water relationship and management.

The first step in the approach for land suitability classification according to FAO (1976) is to define land utilisation types, followed by establishing the land requirements of each land utilisation type (LUT). Relevant data necessary to the LUT are gathered and then matched with the land requirements by comparing both the parameters. Finally the resultant deduction (initial land suitability classification) is subjected to economic, social and environmental impact analysis.

The evaluation of land for its suitability for specific crops was done by and adoption of the framework for land evaluation (FAO, 1976) as indicated by Sys (1985). For grouping of land soil mapping units according to their suitability for growing rice, sugarcane, groundnut, cotton etc. sets of land quality criteria were developed from published literature on land requirements for each of the crop and the mapping units were rated according to the criteria. The rating of land for suitability of crops is based on the nature, degree and number of limitations of the land for cultivation of the crops.
3.7.4 LAND EVALUATION BY PREDICTION OF OPTIMAL CROP USING A STATISTICAL MODEL

The present study aims at establishing the relationship between the yield of the identified principal crops grown in the study area with the basic soil parameters which are further divided into surface soil parameter and sub surface soil parameters for predicting the optimal crop in respect of the particular point.

Details of soil parameters chosen:
I) Surface soil parameter were available nitrogen, available phosphorous, available potash, pH and electrical conductivity.
II) Sub surface soil parameters were pH, etc. exchanges bases (Ca, Mg, Na and K) cation exchange capacity, organic carbon and calcium carbonate combination.

The data generated by analysis of samples drawn from surface soils of the sample points as detailed in chapters 3.3.1 and 3.3.2 and the data available for the corresponding sub surface soils from the established soil series were taken into consideration. All the sample points distributed over the study area were considered constant in respect of all other variable factors. Paddy, Sugarcane, Cotton, Groundnut and Tapioca were subjected to evaluation. The relationship equation between the yield of crops and basic soil parameters were obtained using the non linear multiple quadratic equation as shown below

\[ Y_i = a_{11} x_1 + a_{12} x_1^2 + a_{13} x_2 + a_{14} x_2^2 + \ldots \ldots + a_{1n} x_n + a_{1n+1} x_n^2 + \mu \]

where \( Y_i \) = yield of the crop

\( x_1, \ldots, x_n \) are independent variable (pH ec, N,P,K,Ca,Mg,CEC etc). \( a_{11}, a_{12}, \ldots, a_{1n}, a_{1n+1} \) are fitted regression coefficients, \( \mu \) is a constant.

This relationship equation derived was used for arriving at the yield of the principle crop for each sample point. Taking into consideration the calculated yield obtained for different crops in the sample points, their cost of cultivation and sale proceedd of both main and bye products, the gross income
and net income were derived and compared for the maximum profit. The crop which yielded maximum profit was considered as the optimal crop for that particular sample point. The calculated yield, profitability of the crops were tabulated for each sample point and the optimal crop was identified. The optimal crop in relation to the trend of changes in the variable cost like input prices were calculated for each sample point. The results were analysed for their trends of profitability of crops with reference to soil properties, profit ration and changes in profitability due to increase in price structure (assumed).

The entire process of this evaluation technique can be summarised as follows:

1) Calculation of multiple regression for crop yield with soil properties as independent variables and yield as dependant variables.

2) Using the co-efficient (x) to predict the yield of each crop at the sample points using the soil parameters at that point.

3) Convert yield into gross income (multiply selling price) and subtract input cost for each crop.

4) The crop which gives maximum income is the optimum crop.

5) Calculate the optimum crop when input cost increases or decreases.