# CLASSIFICATION OF THE UPLAND SOILS OF KERALA

BY

BINDU KUMARI A.

THESIS

Submitted in partial fulfilment of the
requirement for the degree

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture
Kerala Agricultural University

Department of Soil Science and Agricultural Chemistry
COLLEGE OF AGRICULTURE
Vellayani - Thiruvananthapuram

1993

# DECLARATION

I hereby declare that this thesis entitled "Classification of Upland Soils of Kerala" is a bonafied record of research work done by me during the course of research and this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title; of any other University or Society.

8/4/1993
Vellayani.

(BINDUKUMARI. A)

## CERTIFICATE

Certified that this thesis entitled "Classification of the Upland Soils of Kerala" is a bonafied record of research work done independently by Bindukumari A, under my guidance and supervision and that it has no previously formed the basis for the award of any degree, fellowship or associateship to him.

M. Subramonia

Dr. M.SUBRAMONIA IYER
Chairman
Advisory Committe,
Assoc Professor
Department of Soil Science and Agrl. Chemistry

8/7/93

8/7/1993
Vellayani.

APPROVED BY

Chairman : Dr. M SUBRAMONIA IYER

Members : Dr. (Mrs) P.PADMAJA

: Dr. (Mrs) S. PUSHKALA

: Dr. V. MURALEEDHARAN NAIR

EXTERNAL EXAMINER

Dr. S. Kabeerathumma
Scientist C.T.C.R.I
Sreekaryam

## ACKNOWLEDGEMENT

I wish to acknolowledge with deep sense of gratitude and indebtedness to:-

Dr. M.Subramoniya Iyer, Associate Professor of the Department of Soil Science and Agricultural Chemistry, (Chairman of Advisory Committee) for suggesting the problem and for his sustained help, inspiring guidance and valuable suggestions at every stage of this investigation and in preparation of the thesis.

Dr. R.S.Aiyer, Retd. Professor and former Head of the Department of Soil Science and Agricultural Chemistry (Advisory Committee Member) for his kind valuable help, facilities and encouragement given at every stage of the investigation as well as in the preparation of the thesis.

Dr. (Mrs) P..Padmaja, Associate Professor and Head of the Department of Soil Science and Agricultural Chemistry (Advisory Committee Member) for her valuable help for the compilation of the thesis.

Dr. S.Pushkala, Associated Professor, Department of Agricultural Chemistry and Soil Science (Advisory Committee Member) for the help and advice given during the course of investigation.

Dr. V. Muraleedharan Nair, Professor of Agronomy Department of Agronomy (Advisory Committee Member) for his valuable advice given during the course of investigation.

All members of the staff of the Department of Soil Science and Agricultural Chemistry, College of Agriculture, Vellayani for the kind help rendered.

The Members of the Staff of the various Research Stations of Kerala Agricultural University for their sincere co-operation and help in collection of Soil Samples.

Staff of Aiswarya Computers, Trivandrum for their sincere co-operation and endurance in printing the thesis.

Bindhu

BINDU KUMARI A

CONTENTS

## LIST OF TABLES

# LIST OF FIGURES

## LIST OF PLATES

# INTRODUCTION

## INTRODUCTION

Soil classification is a vehicle for technology transfer for agricultural development. The purpose of soil survey and classification is to organise observation and knowledge of soil to remember the significant characteristic of soils, establish environment and associated relationship and develop principles and guiddines for management. The Soil Survey Staff of United State Department of Agriculture developed a comprehensive system of soil classificat. ion that was adopted in United States during Ninteen sixty five and is used to at least some degree by scientists in thirty one other countries. This system is called the Soil Taxonomy (Soil Survey Staff 1975). The Principle practical application of soil classification lies in soil survey and its interpretations. Soil survey interpretations enable predictions about the behaviour of a soil under stated conditions, especially the system of soil use and method of manipulation, which may indicate resonable alternatives and expected results. Soil productivity is that quality of the soil that summarizes its potential for the production of plants or cropping sequence under defined sets of management practices. Reliable interpretations are possible only if there is thorough knowledge of the behaviour of soils to various agronomic and cultural practices. Smith (1965) rightly contented that soil classification used as a useful tool in the agrotechnology transfer "should be a multi categoric system with a large number of taxa in the lower categories". In the U.S Soil Taxonomy "soil families" are differentiated in a given soil subgroup. On the

basis of soil properties important to plant growth and indicative of soil, water, root relatioships soils classified in the same soil families should therefore have nearly the same management and similar potentials of crop production.

Isolated attempts of soil classification as per Soil Taxonomy have been made since ninteen sixty's in different states of India. In Kerala a tentative soil classification have been attempted at great group and sub group level as a part of post graduate thesis of the Department of Soil Science and Agricultural Chemistry and by the soil survey wing of the state Department of Agriculture. Soil Survey Staff, (1978); Venugopal (1980); Thomas Varghese (1981); and Subramonia Iyer, (1989).

The soils in the upland situations of the agricultural research stations of the Kerala Agricultural University will come under the broader category of laterite and lateritic soils. They vary in agroclimate, slope and land-use pattern. Kerala Agricultural University have perfected many soil water crop management modules. Soil classification as per the Soil Taxonomy (USDA, 1975), of the soils under different locations and land use will enable practical interpretations. It will also enable the prediction of soil and management suitability of Research Stations of the University for production, research of different suitable crops and cropping systems. In the agrotechnology transfer from Kerala Agricultural University to the global scientific community the background information of the Soil Taxonomy of the locations lead to wider appreciation and application.

# REVIEW OF LITERATURE

## Review of literature

Purpose of soil survey and classification is to organise observation and knowledge of soils, establish environment and associated relationship and to develop principles and guidelines for management. It is imperative that approach to soil survey should be both scientific and practical.

### 1.0 Use of soil classification

Principle of the practical application of soil classification lies at soil survey and its interpretation. Soil survey interpretations provide predictions about the behaviour of a "defined kind of soil" under stated conditions especially systems of soil use and methods of manipulation which indicate reasonable alternatives and the expert results (kellogg 1961).

Beinroth (1978) reported that soil classification system most widely used in the tropical areas are the FAO/UNESCO LEGEND, the French soil classification, the classification of Brazilean soils and the U.S Soil Taxonomy. On the basis of Taxonomic classification one can group soils according to the likelihood and degree of nutrient deficiency under specific assumptions of past management and their probable response to fertilizers.

Soil classification is a must for agrotechnology transfer and that the soil classification used should be a multicategorical

system with a large number of taxa in the lower categories. Smith, (1965).

Soilmoistire and soiltemperature regime plays an important role in agriculture. Aquic soils with warm temperature are better suited for paddy cultivation then other soils. In Hawaii under non irrigation management ustic soils can be used efficiently for pineapple but not for sugarcane. The isothermic soils are better suited for coffee as well as for any vegatable such as cabage ans celery then the isohyperthermic soils. The isohyperthermic soil have better suited for macadamea and pineapple then the isothermic and isomesic soils. The management techniques transfered to other areas of the world having similar soil are expected to give similar response. Ikawa, (1978).

Soil genesis is the result of influence of soil climate. Hence at the suborder level of Soil Taxonomy climatic regimes are used for differentiation. Great group of tropical varities are recogonized in several orders on the basis of isotemperature regime. Oxic subgroups provide intergrades to strongly weathered soils in many great groups. Van Wambeke, (1986).

### 1.1 Morphology

Mollisol developed under grasslands are dark and have high base status. Nimlos and Tomer, (1982).

Ultisols of hill districts of Assam are very deep well structured soil which exhibit moderate to well developed argillic horizon, Chakravarthy and Barua, (1983).

Singh et al. (1989) classified certain soils of Varanasi District of Uttar Pradesh as Entisol Inceptisol and Alfisol, due to the presence of argillic horizon and medium to coarse structure.

Oxisols of Northern plateau of Orissa are well defined and had no mottles in the matrix. The texture is finer down the depth with more than twenty percent gravel in all the horizon. Soil is clayey throughout the profile but there is no evidence of clay cutans. Sahu et al., (1990).

Dominent hill soils of Nilgiri classified as Inceptisols are deep red in color, clayey in texture and granular to blocky structure. Presence of a lithic contact within forty centimeters of soil depth, classifies the Guheda series as lithic Eutrochrepts. Sannigrahi et al., (1990).

### 1.1.1 Epipedon

Inceptisol of Tirap district of Arunachal Pradesh is classified as ochrept owing to the presence of ochric epipedon. Walia and Chamuah (1990).

Moderately well drained soils of mackenzie valley is classified as pergelic cryochrept owing to the presence of ochric

epipedon with a light brown mineral surface horizon formed from the accumulation and decomposition of shrubs and herbs. Walmsley and Lavkulich (1975).

The dryland forested areas of South Western Montana has got a Mollic epipedon instead of a light, base poor, ochric epipedon Nimlos and Tomer, (1982).

Typic paleudults, Tropeptic Haplorthox and "Plinthic" Udoxic Dystochrepts of Sierra Leone soils have got a characteristic ochric epipedon while orthoxic palehumults and Tropeptic Haplorthox has got an umbric epipedon Sutton et al ; (1989).

Amara soil series of Varanasi district of Uttar Pradesh has an ochric epipedon underlain by a cambic horizon. They are classified as Inceptisol. Singh et al, (1989).

The red and alluvial soils of Nilgiri hills classified as Inceptisol has got a comparatively higher organic carbon content, 1.1 to 1.39 percentage in the surface soil but these epipedon qualify an ochric and not as mollic or umbric. Sannigahi et al, (1990).

1.1.2 Diagnostic horizon

Studies conducted in certain Ultisols of spain revealed that its horizons contain a higher amount of clay fraction, and consist of grey argillan which are similar to argillans of secondary or hydromorphic illuviation together with argillans of

primary illuviation. Barragan and Iniguez,(1981).

Soils of Sao Paulo are classified as Ultic Haplorthox and Epiaguic Hapludult due to the presence of the an argillic horizon underlying an oxic horizon. Tie-bi-youan,(1983).

Sierra leone soils classified as Oxisols, Ultisols and Inceptisol had an oxic or kandic horizon or a cambic subsurface horizon. Sutton et al. (1981).

To distingush Alfisol and Ultisol a new diagnostic horizon the Kandic horizon was introduced (Moorman and Buol 1981). A kandic horizon is subsurface horizon with a higher percentage of clay than the overlying horizon or horizons and that has ECEC$\leq$ 12 meq/100g clay and or CEC of $\leq$ 16 meq/100g clay.

Soils of foot hill slopes of Arunachal Pradesh are characterized by argillic horizon and low base saturation and therefore keyout as Ultisol while Inceptisols of these region show developemt of a cambic horizon. Walia and Chamuah,(1990).

The Kandic horizon was introduced in 1987 to the diagnostic criteria used in Soil Taxonomy to over come the deficiencies of the system when applied to low activity clay soils of the tropics. On the basis of available soil information "Kandi" soils are persumed to be widespread in some parts of India were laterite and lateritic soils exist. The "Kandi" soils were applied to the classification of some bench mark soils of India. The resulting classification showed changes at sub group, great

group and order level for Tyamagondulu, Vijayapura and Kunnamangalam series respectively. Easwaran. et al, (1992).

Oxisols of Northern plateau of Orissa has got an oxic horizon, weakly developed argillic horizon and has less than 10% weatherable mineral in 50-200μm fraction Sahu et al,(1990)

1.1.3 Soil Family

Upland soils of Sierra leone are members of clayey skeletal Kaolinitic family of Typic paleudults and orthoxic palehumults and soils of colluvial foot slopes and upper river tributary terraces belong to fine loamy silicous families of Typic paleudults and plinthic udoxic Dystropepts respectively. Sutton et al, (1989).

Ultisols of citrus growing belts of Assam are members of fine mixed thermic family of Typic Haplohumults and Typic paleudults. Chakravarthy and Barua, (1983).

The soils of foot hill slopes of Arunachal Pradesh are classified at the subgroup and family level as fine loamy mixed hyperthermic Typic Hapludults, Fine loamy mixed hyperthermic Andic Dystrochept, Fine mixed hyperthermic Dystric Fluventic Eutrochrept. Wal'ia and Chamuah, (1990).

Joshipur pedon of Northern plateau zone of Orissa is classified under the family fine clayey kaolinitic hyperthermic family under the order Inceptisol. Sahu et al, (1990).

Some upland soils of British Honduras are classified as clayey mixed isohyperthermic oxumbric plinthic Albaqualts and better drained upland soil to a less extent as clayey mixed isohyperthermic plinthic paleudults as well as fine loamy silicious and coarse loamy silicious isohyperthermic families of plinthic and plinthaquic paleudults. Lietzke and Whiteside (1981).

1.1.3.1 **Mineralogical properties**

Fersiallitic soils of Tungo plateau (New Chaledonia) have vermicullite, illite as clay minerals and the amount of fine silt in the B horizon suggest that soils are rich in weatherable minerals. Dennis, (1988).

In some Belize soils (Typic Tropudults) iron has been tranlocated as dense nodules in the upper B horizon. Iron plasma is most abundant in these areas. Thin section show a sedimentary structural alignment. Channel argillan show parallel extinction indicate pedogenetic processes at work in lower B horizon. The B horizon of the Umbric tropaqult also had thin channel and thin ped face argillans indicating that these soils are with rapidly forming plinthite. Lietzke and Whiteside (1981).

Sierra Leone soils classified as Oxisol had an oxidic mineralogy. Oxidic materials contain less than 90 percent quartz or other weathering resistant minerals and less than 40 percent of mica in 0.02 to 2mm fraction. The dominant clay

mineral in the total and fine clay was kaolinite which was less ordered in the fine clay. Clay mineralogy of the iron stone gravels was similar to that of fine earth fractions of the gravelly profiles. Micaceous flakes in the medium and fine sand fractions of the segbwena and Timbo series were mainly inter-layered illite, Chlorite and Kaolinite with some gibbsite and Goethite. Sutton et al, (1989).

Alluvial soils of Varanasi district of Uttar Pradesh identified as Vertic Ustochrepts has got illite as the most dominant mineral constituting over 57 percent but in two soils smectite was also found in considerable amounts. The clay mineral smectite, chlorite and vermicullite along with several mixed intergrade minerals are found. Some of the soil also contained a little kaolinite. Singh et al, (1989).

Mineralogical composition of sand fraction of Jodhpur pedon (Orissa) classified under the order Inceptisol is as follows - Quartz - 94 percent, orthoclase feldspar - 30.5 percent, Ilmenite - 1.5 percent limonite - 1.5 percent and biotite - 1.5 percent. The rock constitute mostly quartzite, Pyroxenes, granite, with inclusion of iron ore group rocks. Because of higher percentage of quartzite and other quartz bearing resistant minerals in the rocks indicate intense weathering in hot and humid climate. The easily weatherable minerals are of negligable quantities because of intense weathering. Soil clays are dominated by kaolinite along with illite in appreciable amounts together with

appreciable amounts of quartz, goethite and gibbsite. Sahu et al, (1990).

Quan (1983) had reported that kaolinite and gibbsite are extensively distributed in soil of subtropics and tropics and their content is closely related to temperature, rainfall and parent material.

Studies conducted in certain Ultisol of Indonesia revealed that they contained an appreciable amount of 2:1 mineral and these soils were nearly monomineralitic mainly consisting of quartz indicating severe weathering and poverty of potential nutrient resources. Supriyo et al, (1992).

Mineralogical studies of clays in the B horizon of Kandiustults developed from metamorphosed granitic in South Korea showed that while feldspars were partly weathered, Chlorite under a well drained acid humid temperate to semitropical environment was completley weathered to halloysite, haemetite goethite gibbsite and chlorite - vermicullite inter grade probably hydroxy - inter layered vermicullite. Some dioctahedral mica appeared to be resistant in the soil. Cho and Hermut, (1992).

1.1.3.2 Micromorphology

Tropical and subtropical soils of united states, clagsified as plinthic paleudults contain extensive amounts of iron glabules. Gallaber et al,(1974).

Thin section of argillic horizon in certain Entisol Inceptisol and Alfisol of Varanasi district of Uttar pradesh reflected varying degree of plasma segregation. Singh et al,(1989).

1.1.4 Soil Series.

The differentiating characteristics of a soil series are kind and arrangement of horizons, colour, texture structure and reaction of horizons. Chemical and mineralogical properties of the horizon. Buol et al, (1980).

1.1.5 Soil moisture and temperature regime

Studies on some Sierra leone soils revealed that the moisture regime of the sierra leone since 1982 except in east of Kennema have been recogonised as predominantly ustic instead of udic. The soils of upland of highly weathered materials were Oxisol (Soil survey staff 1987) in ustic and udic moisture regime, ustox or udox. Those of the steep hill slopes were an Inceptisol with low activity clays, a Tropept or an Ultisol with udic moisture regime, an Udult. The soils of the colluvial foot slopes and tributary terraces were also Ultisol an Ustult and an Udult and those of the alluvial terraces and flood plain were Inceptisols with low activity clays - Tropepts. Sutton et al, (1989).

Ultic Haplorthox and Epiaquic Hapludult of Sao Paulo have developed under similar physiographic conditions of relief, per - udic climate and forest natural vegatation. Tie - bi-youan et al, (1983).

Ultisol in the citrus growing belts of Hill districts of Assam have developed under subtropical hyperthermic and thermic climate. Chakravarthy and Barua. (1983).

Soils of foot hill slopes of Tirap district of Arunachal Pradesh classified as Hapludults at great group level due to udic moisture regime and absence of fragipan, duripan and other characteristics and soils of Piedmont plain as aquept due to aquic moisture regime. Both these soils are formed under hyperthermic climate. Wal ia and Chamuah. (1990).

Amara and phoolwaria soils in the Varanasi district of Uttar Pradesh are classified as Ustrochrepts under the great group level as they have an ustic moisture regime. Singh et al, (1989).

It is reported that udic soils having thick, continuous and strongly oriented argillans, have low effective clay mobility and ustic soils where clay cutans are either not observed or are weakly oriented have moderate to high clay mobility. The potentially mobile that is dispersible clay is highest in ustic soils and lowest in udic soils having optimum condition for clay translocation suggesting that the highly birefringent argillans in the udic soils are not definite proof for the present clay illuviation but could be taken to include the past illuviation process. Sehgal et al, (1976).

## 2.0 Physical properties

Studies on Brazilean red subtropical soils, classified as mainly as Oxisol, Ultisol, Alfisol and Mollisol present in their natural conditionpossadequate physical properties for crop production expressed by the presence of water stable aggregates, adequate aeration, porosity, low resistance to root penetration, high water infiltration rate. Klamt et al, (1986).

## 3.0 Chemical Properties

Studies have shown that desaturated ferrsialltic soils of new chalcedonia have high free iron to total iron ratio (>80%) and the $Sio_2/Al_2O_3$ ratio greater than two Dennis, (1988).

The criterion, sum of exchangeable cations x100/ clay percent </= 12 meq does not alone separate the Oxic and kandic horizon from other diagnostic horizon. Sutton et al, (1989).

Red sub tropical soils belonging to the order Oxisol Ultisol. Alfisol and Mollisol present in general phosphorous deficiency high acidity and exchangeable aluminium. Klamt et al,(1986).

It is reported that some Ultisol of spain has a base saturation less than 35 percent organic carbon content greater than 0.9 percent and fragipan properties. Barragan, (1981).

Orthoxic Tropohumult, Typic Paleudult and Typic haplorthox has low CEC, pH and base saturation, free mobile iron and less Aluminium. Suharta and Hendro (1988).

Oxisols of some pine forest soils of Meghalaya are strongly acidic, and have high organic matter at the surface which decreased with depth. CEC ranged from 11 to 14.9 cmol ($p^+$) $kg^{-1}$ and decreased with depth. The PBS was also higher at the surface soil as compared to subsurface horizon possibly because of plant recycling. Nair et al, (1988).

Dystic Eutrochrepts of Nilgiri hills have a highly base saturated subsurfaces layer with no carbonate present. While Typic Eutrochrepts have little carbonates in the cambic horizon. Low CEC despite higher clay and silt content suggest a possible dominance of kaolinite and illite as mixed type clay minerals in these soils. Sannigrahi et al, (1990).

Studies conducted in the Alfisol, Ultisol and Oxisol of Savanna soil revealed that extractable P was highest in surface horizon but values were below 10mg/kg except in one sample. The organic carobon was generally below 1 percent. The CEC values were less than 10 meq per 100g. Moberg and Esu (1992).

The red and yellow podzolic soils (Ultisols) were strongly and with only a small amount of exchangable bases (<0.5meq/100g) but with considerable amount of KCl extractable Al (3-5 meq/100g). The CEC values were small (<8 meq/100gm) due to

low clay content and kaolinite clay mineralogy. Supriyo et al; (1992).

Studies conducted in Typic paleudults and Typic hapludults under a lowland dipterocarp forest in East Kalimantan revealed that the total carbon, nitrogen and phosphorus content decreased abruptly within the upper 15-20cm. The contents were directly related to clay content in each horizon. The greater carbon nitrogen and phosphorus content in the finer soils were considered to be associated with stabilization of organic matter by clay particles and with the higher mobility of organic matter in the finer soils. Ohta and Effendl (1992).

Oxisols of Orissa has an apparent CEC (pH-7) $NH_4OAC$ of 18.2 cmol $(P^+)$ $kg^{-1}$ in 22-60 cm layer which is supposed to be less than 16.0 cmol $(p^+)$ $kg^{-1}$ at 2.0 depth. Sahu et al; (1990).

# MATERIALS AND METHODS

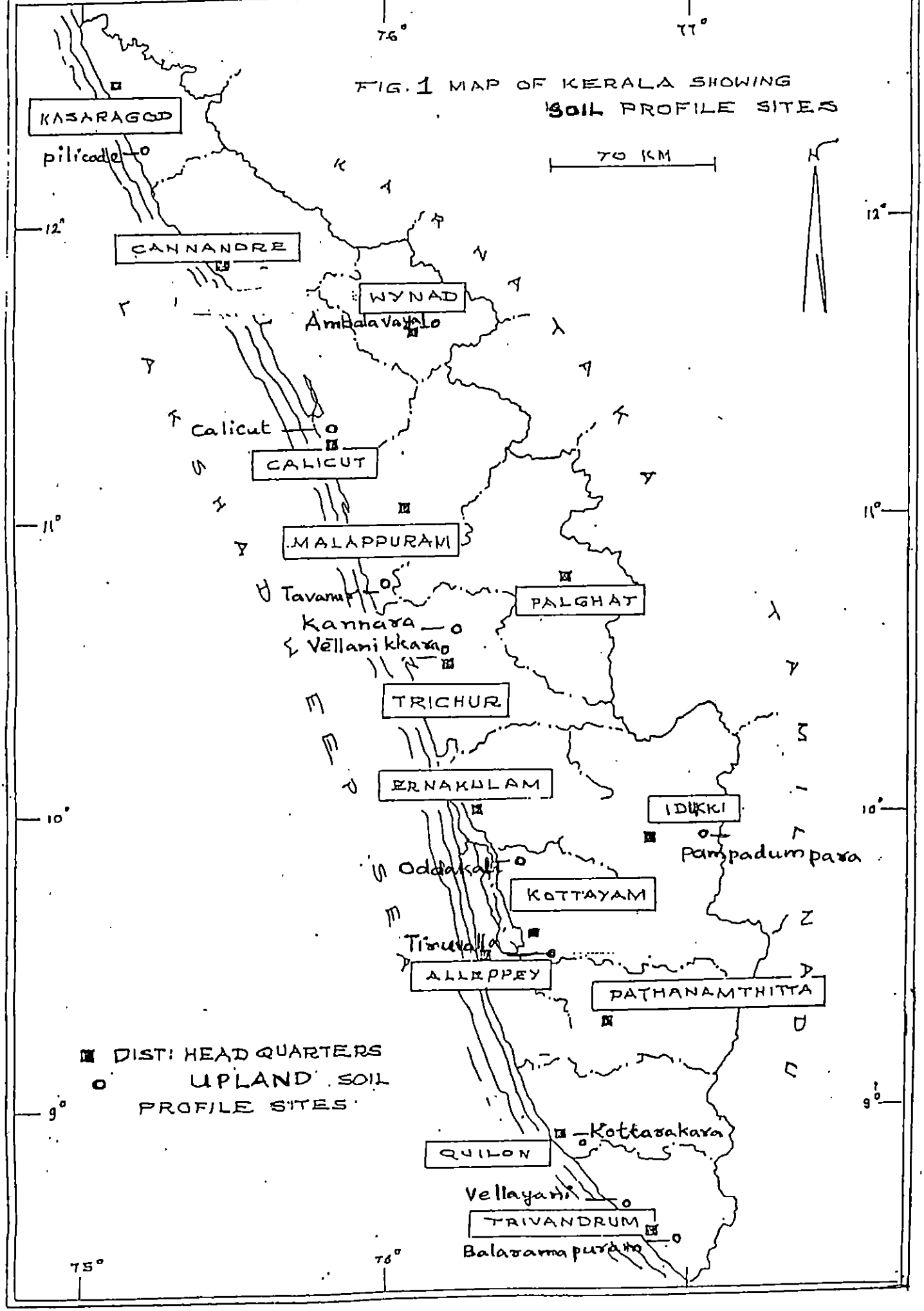



FIG. 1 MAP OF KERALA SHOWING SOIL PROFILE SITES

## Materials and Methods

Inorder to classify upland soils of the research stations under Kerala Agricultural University and to enable wider appre c iations, application and correlation of soil crop management modules to the global scientific community, one representative soil profile from each of the following research stations were selected and classified as per Soil Taxonomy (USDA, 1975).

1 Agricultural Research Station - Balaramapuram
2 College of Agriculture - Vellayani
3 N A R P Special Station - Kottarakara
4 Sugarcane Research Station - Thiruvalla
5 Cardomon Research Station - Pampadumpara
6 Aromatic and Medicinal plants Research Station - Odakkali
7 Banana Research Station - Kannara
8 College of Horticulture - Vellanikkara
9 Kelappaji College of Agricultural Engineering and Technology - Thavanoor
10 Centre for Water Resources Development and Management - Calicut
11 Horticultural Research Station _ Ambalavayal
12 Regional Agricultural Research Station - Pilicode

All the sites were located in between Trivandrum and Kasargod districts of the state and they lie within latitude 8° 5′and longitude 75° 77′.

Field soil sample collection and description of soil profile.

At each location soil profile pit was dug. Profile feature and insitue observation were recorded as per FAO guide lines (1978). Identified the epipedons, the diagnostic horizon and tentatively classified as per keys to Soil Taxonomy (U.S.D.A 1987) Soil samples were collected from individual horizon from 12 profile pits.

1.1.0 Soil analysis

A total of 53 horizon samples were collected air dried and sieved through a 2mm serve.

1.1.1 Gravel Content

The gravel content retained in 2mm sieve was weighed and expressed as percentage.

1.1.2 Physical Properties

1.1.2.1 Mechanical analysis-

The mechanical composition of the soil was determined by Robinson's International pipette method. (Piper, 1967).

1.1.2.2 Single value constants

Bulk density, particle density , water holding capacity, volume expansion and pore space were determined as per the proceedings outlined by Dakshinamurthi and Gupta (1968).

### 1.1.3.0 Chemical properties

#### 1.1.3.1 Soil reaction

Soil $P^H$ was determined in distilled water and N potassium chloride solution in the ratio of 1:1, using a Perkin Elmer $P^H$ meter.

#### 1.1.3.2 Electrical Conductivity

Electrical conductivity was measured in 1:2.5 soil and water suspension (1:1) using conductivity bridge.

#### 1.1.3.3 Organic carbon

Organic carbon was determined by walkey and Black's method (Jackson 1973).

#### 1.1.3.4 Available nitrogen

Available nitrogen was determined using alkaline permanganate method by subbiah and Asija (1956).

#### 1.1.3.5 Available phosphorous.

The available phosphorous was extracted using Bray No.1 and estimated by Dickman and Bray's molybdenum blue colour method (Jackson 1973).

1.1.3.6 Available Potassium –

Available potassium was extracted using Neutral Normal ammonium acetate and read in Atomic absorption spectro photometer.

1.1.3.7 Citrate Bicarbonate Dithionate extractable iron.

The iron was extracted by citrate bicarbonate dithionate extraction method.(Mehra and Jackson,1960).

1.1.3.8 KCl extractable aluminium

KCl extractable aluminium was determined using fluoridetitration (Jackson, 1973).

1.1.4.1 Mineralogical analysis of fine sand fraction

The fine sand fraction of soil obtained by mechanical analysis were treated for the removal of organic matter and iron. Then thoroughly washed in alcohol followed by distilled water, dried and the heavy and light fractions were separated by using bromoform as per the method outlined by Carver (1971). They were mounted on microscopic slides using canada balsam and examined using a petrological microscope. Photographs of these slides were taken.

1.1.4.2 Mineralogical analysis of clay fraction

The clay fraction was separated by the method of Jackson (1972). The samples were freed from soluble

salts, organic matter and iron oxide by the method of Mehra and Jackson(1960). The clay samples were thoroughly washed with distilled water followed by ethanol. The X-ray diffraction was carried out in a Phillips P.W 1011- X-ray diffractometer using Copper $K_{\alpha}$ radiation.

### 1.1.4.3 Micromorphology

Selected soil chips of the argillic horizon were impregnated with canada balsam (refractive index 1.5), ground and polished by different grades of Carborandum powder and Aluminium oxide powder, thin section were prepared and described following the procedures outlined by Brewer (1976).

### 1.1.5.1 Interpretation and classification.

With the data gathered on soil profiles, the epipedons, diagnostic horizons, physical, chemical mineralogical and soil climatological properties, classification as per Soil Taxonomy (U S D A, 1975, 1987, 1990, 1992) were attempted and interpreted.

# RESULTS

Table 1.0

GRANULOMETRIC COMPOSITION AND TEXTURAL RATIOS OF SOIL PROFILES

| Serial No | Location of Profile Site | Depth in cm | Gravel (%) | Percentage on ovendry basis | | | | Textural Classes | Textural Ratios | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coarse sand 2.0-0.2mm | Fine sand 0.2-.02mm | Silt 0.02-0.002mm | Clay <0.002mm | | Fine sand / Coarse sand | Silt / Clay | clay ratio |
| I | RARS Balaramapuram | 0 - 15.5 | 1.9 | 30.0 | 13.0 | 13.5 | 40.0 | Sandy clay | 0.43 | 0.338 | 1.41 |
| | | 15.5- 71.5 + | 2.7 | 22.0 | 16.6 | 15.0 | 45.3 | Clayey (v fine) | 0.76 | 0.332 | 1.19 |
| | | 71.5- 145 + | 0.11 | 22.0 | 15.8 | 12.5 | 47.5 | Clayey | 0.72 | 0.26 | 1.057 |
| II | College of Agriculture Vellayani | 0 - 3 | 23.89 | 34.4 | 8.2 | 19.5 | 35.5 | Clayey (fine) | 0.24 | 0.55 | 1.749 |
| | | 3 - 8 | 17.69 | 30.0 | 9.0 | 8.1 | 52.5 | Clayey (fine) | 0.3 | 0.15 | 0.897 |
| | | 8 - 28 | 18.9 | 28.9 | 7.1 | 5.5 | 56.25 | Clayey (fine) | 0.25 | 0.1 | 0.737 |
| | | 28 - 143 | 16.7 | 22.8 | 8.9 | 27.1 | 42.75 | Clayey (fine) | 0.39 | 0.63 | 1.38 |
| II (1) | College of Agriculture Vellayani | 0 - 4 | 54.4 | 40.5 | 9.8 | 22.5 | 24.9 | Sandy clay loam | 0.2 | 0.9 | 1.3 |
| | | 4 - 27 + | 56.7 | 39.0 | 10.5 | 16.5 | 29.8 | Sandy clay loam | 0.27 | 0.55 | 2.4 |
| | | 27 - 150 + | 49.9 | 16.0 | 12.6 | 17 | 30.5 | Sandy clay loam | 0.788 | 0.413 | 0.97 |
| III | NARP Special Station Kottarakara | 0 - 21 | 66.4 | 36 | 16.5 | 10.3 | 35.00 | Clay loam | 0.46 | 0.29 | 1.79 |
| | | 21 - 52 | 71.1 | 40.7 | 11.5 | 10.0 | 40.75 | Clayey | 0.28 | 0.25 | 1.53 |
| | | 52 - 152 + | 66.9 | 38.07 | 11.98 | 10.5 | 41.00 | Clayey | 0.32 | 0.26 | 1.48 |
| | | 152- 215 + | 80.12 | 30.2 | 11.12 | 11 | 40.00 | Clayey | 0.37 | 0.28 | 1.31 |
| IV | Sugarcane Research Station Thiruvalla | 0 - 11 | 22.27 | 7.5 | 32.5 | 20.05 | 39.5 | Clayey | 4.3 | 0.48 | 1.52 |
| | | 11 - 18 | 40.63 | 11.5 | 14.5 | 19.0 | 42.0 | Clayey | 1.76 | 0.45 | 0.96 |
| | | 18 - 67 + | 66.87 | 8.7 | 14.25 | 23.0 | 49.5 | Clayey | 1.64 | 0.46 | 0.93 |
| | | 67 - 121 + | 40.18 | 12.5 | 22.75 | 22.0 | 40.5 | Clayey | 1.82 | 0.54 | 1.41 |
| V | Cardamom Research Station Pampadumpara | 0 - 7 | 48.70 | 33.55 | 10.0 | 20.5 | 26.50 | Sandy clay loam | 0.30 | 0.77 | 2.42 |
| | | 7 - 27 | 65.5 | 30.55 | 18.25 | 10.25 | 42.50 | Clayey | 0.60 | 0.24 | 1.39 |
| | | 27 - 65 + | 46.5 | 28.4 | 12.00 | 35.0 | 22.55 | Loamy | 0.42 | 0.35 | 1.28 |
| | | 65 - 147 + | 43.9 | 25.9 | 20.00 | 27.1 | 39.50 | Clayey | 0.80 | 0.33 | 1.25 |
| VI | Aromatic and Medicinal plants Research Station Odakkali | 0 - 19 | 21.16 | 52.5 | 14.25 | 17.5 | 20.00 | Sandy Clay loam (f) | 0.17 | 0.88 | 6.21 |
| | | 19 - 38 + | 22.75 | 32.2 | 11.00 | 10.5 | 35.00 | Loamy | 0.34 | 0.30 | 1.53 |
| | | 38 - 100 + | 27.3 | 30.0 | 15.22 | 22.5 | 23.00 | Loam | 0.51 | 0.98 | 2.94 |

Table 1.0

GRANULOMETRIC COMPOSITION AND TEXTURAL RATIOS OF SOIL PROFILES

(contd)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VII | Banana Research Station Kannara | 0 - 15 | 14.8 | 40.3 | 0.7 | 37.5 | 12.0 | loam | 0.27 | 3.0 | 6.54 |
| | | 15 - 71 | 13.9 | 25.85 | 17.17 | 30.0 | 20.0 | loamy | 0.66 | 1.5 | 3.65 |
| | | 71 - 140 | 21.8 | 25.5 | 9.3 | 5.0 | 57.5 | Clayey | 0.37 | 0.09 | 0.69 |
| | | 140 - 150+ | 30.4 | 30.0 | 9.8 | 20.0 | 40.0 | Clay loam | 0.33 | 0.5 | 1.50 |
| VIII | College of Horticulture Vellanikkara | 0 - 24 | 39.26 | 42.7 | 10.93 | 9.0 | 24.30 | Sandy clay loam | 0.56 | 0.37 | 2.58 |
| | | 24 - 90 | 42.9 | 36.9 | 14.6 | 17.3 | 22.50 | Sandy clay loam (f) | 0.61 | 0.77 | 3.06 |
| | | 90 - 151 | 58.5 | 37.50 | 10.8 | 17.5 | 21.25 | Coarse loamy | 0.40 | 1.6 | 3.10 |
| | | 151+ | 41.3 | 30.11 | 10.1 | 15.0 | 34.25 | Clay loam | 0.34 | 1.05 | 1.61 |
| IX | Kelappaji College of Agricultural Engineering Tavanur | 0 - 32 | 50.85 | 39.0 | 10.5 | 16.5 | 29.8 | loam | 0.27 | 0.55 | 2.21 |
| | | 32 - 72 | 50.10 | 26.0 | 11.5 | 20.15 | 30.5 | Clayloam | 0.44 | 0.66 | 1.89 |
| | | 72 - 130+ | 50.48 | 26.0 | 12.6 | 27.0 | 30.5 | loamy | 0.79 | 0.56 | 2.15 |
| X | CWRDM Calicut | 0 - 18 | 47.17 | 35.0 | 10.03 | 8.15 | 32.5 | Sandy clay loam | 0.28 | 0.25 | 1.64 |
| | | 18 - 52 | 45.9 | 20.0 | 11.6 | 10.0 | 52.5 | Sandy clay loam | 0.58 | 0.19 | 0.79 |
| | | 52 - 116 | 63.48 | 16.0 | 6.60 | 12.5 | 62.5 | Clayey | 0.41 | 0.20 | 0.56 |
| | | 116 - 143+ | 33.9 | 10.0 | 6.10 | 21.0 | 60.5 | Clayey | 0.61 | 0.35 | 0.61 |
| XI | Horticultural Research Station Ambalavayal | 0 - 12 | 30.50 | 24.10 | 19.7 | 12.5 | 40.0 | Clayey | 0.82 | 0.31 | 1.41 |
| | | 12 - 34 | 36.30 | 20.80 | 21.5 | 11.0 | 43.75 | Clayey | 1.03 | 0.25 | 1.22 |
| | | 34 - 79 | 12.70 | 18.70 | 18.98 | 12.5 | 45.0 | Clayey | 1.016 | 0.28 | 1.12 |
| | | 79 - 142+ | 33.0 | 19.25 | 21.0 | 25.0 | 30.0 | Clayey | 1.09 | 0.83 | 2.18 |
| XII | Coconut Research Station Pilicode | 0 - 9 | 70.1 | 31.85 | 9.59 | 17.5 | 36.0 | Clay loam | 0.30 | 0.49 | 1.64 |
| | | 9 - 41 | 68.4 | 21.0 | 20.5 | 22.0 | 30.5 | Sandy clay loam | 0.98 | 0.72 | 2.08 |
| | | 41 - 114 | 70.6 | 33.8 | 11.0 | 12.0 | 35.5 | Clayloam | 0.33 | 0.34 | 1.60 |
| | | 114- 147 | 69.6 | 33.0 | 12.5 | 17.0 | 30.0 | Clayloam | 0.38 | 0.57 | 2.08 |

SINGLE VALUE CONSTANTS OF SOIL PROFILES

Table 2.0

| Serial No | Location of Profile Site | Depth in cm | Apparent Specific gravity | Absolute specific gravity | Maximum water holding capacity percentage | percentage pore space | Volume expansion of 100 gm soil |
|---|---|---|---|---|---|---|---|
| I | RARS Balaramapuram | 0 -155 | 1.044 | 1.72 | 46.80 | 47.138 | 11.83 |
| | | 155 -71.5 | 1.300 | 1.96 | 28.89 | 40.4 | 8.224 |
| | | 171.5 - 145+ | 1.400 | 2.50 | 31.30 | 52.19 | 5.83 |
| II | College of Agriculture Vellayani | 0 - 3 | 1.031 | 1.82 | 47.5 | 46.70 | 8.23 |
| | | 3 - 8 | 1.681 | 2.00 | 43.50 | 50.80 | 6.296 |
| | | 8 - 28 | 1.02 | 2.00 | 52.91 | 47.13 | 5.46 |
| | | 28 - 143 | 1.04 | 2.00 | 54.5 | 50.12 | 5.2 |
| II (1) | College of Agriculture Vellayani | 0 - 4 | 1.08 | 1.8 | 37.9 | 39.64 | 4.60 |
| | | 4 - 27 | 1.04 | 1.84 | 46.40 | 40.67 | 3.20 |
| | | 27 - 150+ | 1.04 | 1.99 | 50.0 | 49.23 | 4.40 |
| III | NSP Special Station Kottarakara | 0 - 21 | 1.00 | 1.89 | 48.7 | 47.70 | 1.6 |
| | | 21 - 52 | 1.05 | 2.1 | 47.6 | 53.00 | 4.9 |
| | | 52 -152 | 0.987 | 1.78 | 52.8 | 45.40 | 4.6 |
| | | 152 -215+ | 0.965 | 1.72 | 51.4 | 46.60 | 4.8 |
| IV | Sugarcane Research Station Thiruvalla | 0 - 11 | 1.0 | 1.40 | 37.20 | 33.89 | 5.40 |
| | | 11 - 18 | 0.90 | 2.0 | 43.70 | 56.717 | 3.80 |
| | | 18 - 67 | 0.90 | 1.80 | 65.60 | 57.81 | 2.80 |
| | | 67 - 121+ | 0.99 | 1.30 | 46.20 | 46.21 | 4.70 |
| V | Cardamom Research Station Pampadumpara | 0 - 7 | 1.20 | 1.921 | 25.10 | 47.41 | 8.3 |
| | | 7 - 27 | 0.985 | 1.29 | 31.144 | 28.26 | 7.6 |
| | | 27 - 63 | 0.976 | 1.65 | 51.60 | 52.40 | 9.7 |
| | | 63 - 147+ | 0.95 | 1.696 | 46.45 | 52.19 | 4.3 |
| VI | Aromatic and Medicinal Plants Research Station Oddaktali | 0 - 19 | 1.124 | 2.44 | 38.8 | 53.6 | 2.86 |
| | | 19 - 38 | 0.819 | 1.52 | 57.3 | 53.8 | 4.84 |
| | | 38 - 109+ | 0.79 | 2.00 | 84.5 | 58 | 2.6 |

SINGLE VALUE CONSTANTS OF SOIL PROFILES

Table 2.0

(contd)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VII | Banana Research Station Kannara | 0 - 15 | 1.204 | 2.04 | 34.98 | 43.5 | 2.77 |
| | | 15 - 71 | 1.160 | 1.807 | 33.69 | 39.9 | 2.13 |
| | | 71 -140 | 1.092 | 2.036 | 46.94 | 47.32 | 3.26 |
| | | 140 -150+ | 1.078 | 1.621 | 43.87 | 34.167 | 12.93 |
| VIII | College of Horticulture Vellanikara | 0 - 24 | 0.985 | 1.619 | 42.5 | 38.5 | 1.52 |
| | | 25 - 90 | 0.713 | 2.24 | 80.83 | 61.86 | 2.855 |
| | | 90 - 151 | 1.008 | 1.703 | 48.89 | 42.42 | 7.01 |
| | | - 151+ | 0.9714 | 1.622 | 45.44 | 46.96 | 4.18 |
| IX | Kelappaji College of Agricultural Engineering Tavanur | 0 - 32 | 1.4 | 1.7 | 29.9 | 42.3 | 8.32 |
| | | 32 - 72 | 0.8 | 2.35 | 32.8 | 45.6 | 5.61 |
| | | 72 - 130+ | 1.25 | 2.11 | 30.9 | 44 | 10.9 |
| X | CARDA Calicut | 0 - 18 | 0.91 | 1.53 | 49.8 | 45.74 | 3.23 |
| | | 18 - 52 | 1.1 | 2.25 | 44.8 | 57.75 | 6.57 |
| | | 52 - 116 | 0.76 | 1.11 | 49.02 | 33.53 | 5.107 |
| | | 116 - 143+ | 0.92 | 1.72 | 54.26 | 49.07 | 3.13 |
| XI | Horticultural Research Station Ambalavayal | 0 - 12 | 0.96 | 1.7 | 50.20 | 47.7 | 5.23 |
| | | 12 - 34 | 0.96 | 1.65 | 52.43 | 37.67 | 5.40 |
| | | 34 - 79 | 0.96 | 1.88 | 53.03 | 47.9 | 5.89 |
| | | 79 - 142+ | 0.857 | 1.65 | 58.40 | 51.6 | 1.85 |
| XII | Coconut Research Station Pilicode | 0 - 9 | 0.95 | 1.85 | 49.01 | 57.5 | 4.8 |
| | | 9 - 41 | 0.90 | 1.69 | 56.2 | 46.3 | 4.4 |
| | | 41 - 114 | 0.94 | 1.66 | 49.37 | 46.4 | 4.2 |
| | | 114 - 147+ | 0.943 | 1.6998 | 49.8 | 45.9 | 2.6 |

Table3.0

CHEMICAL PROPERTIES OF SOIL PROFILES

| Serial No: | Location of the Profile | Depth (Cm) | Soil PH 1:1 Water | 1:1 KCl | PH | Soil Ec dSm$^{-2}$ | Organic Carbon (%) | Exchangeable bases cmol(p$^+$)Kg$^{-1}$ Potassium | Sodium | Magnesium | Calcium | CEC cmol(p$^+$)Kg$^{-1}$ | PBS (%) | Extractable Iron (%) | Aluminium cmol(p$^+$)Kg$^{-1}$ | Available (Kg/ha) Nitrogen | Phospho-rous | Potassium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | Coconut Research Station, Balarasapuram | 0-15.5 | 4.8 | 3.7 | -1.1 | 0.0303 | 0.25 | 2.79 | 2.76 | 13.11 | 15.09 | 2.6 | 22.12 | 2.44 | 1.8 | 276 | 62.72 | 24.4 |
| | | 15.5-715 | 4.9 | 3.7 | -1.2 | 0.0303 | 0.141 | 3.68 | 10.45 | 46.81 | 80.3 | 3.0 | 47.68 | 2.43 | 0.446 | 273 | 22.4 | 32.16 |
| | | 71.5-145 | 4.9 | 4.0 | -0.9 | 0.0202 | 0.141 | 2.34 | 8.05 | 25.34 | 63.35 | 3.8 | 26.66 | 1.21 | 0.66 | 271 | 27.1 | 20.47 |
| II | College of Agriculture Vellayani | 0-3 | 4.7 | 3.9 | -0.8 | 0.0505 | 0.17 | 0.069 | 4.95 | 19.45 | 80.8 | 6.5 | 12.43 | 2.52 | 0.22 | 298 | 79.5 | 0.61 |
| | | 3-8 | 4.0 | 3.3 | -0.7 | 0.0606 | 1.044 | 6.78 | 8.33 | 5.12 | 24.1 | 5.2 | 8.53 | 1.51 | 1.526 | 269 | 42.6 | 59.3 |
| | | 8-28 | 4.4 | 3.4 | -1.0 | 0.0606 | 0.268 | 0.17 | 3.12 | 18.52 | 86.6 | 4.7 | 20.9 | 2.55 | 0.438 | 280 | 26.9 | 1.48 |
| | | 28-143 | 4.4 | 3.8 | -0.6 | 0.0707 | 0.141 | 2.18 | 3.12 | 13.52 | 56.6 | 3.4 | 22.23 | 1.17 | 0.654 | 282 | 15.7 | 19.08 |
| III | College of Agriculture Vellayani | 0-4 | 4.6 | 3.9 | -0.7 | 0.0505 | 0.223 | 5.63 | 7.06 | 24.72 | 123.2 | 5.3 | 28.97 | 1.86 | 0.572 | 367 | 45.9 | 49.2 |
| | | 4-27 | 4.4 | 3.2 | -1.2 | 0.101 | 0.057 | 2.22 | 7.29 | 8.54 | 59.3 | 4.1 | 18.87 | 2.48 | 1.308 | 269 | 33.7 | 2.06 |
| | | 27-150 | 4.4 | 3.5 | -0.9 | 0.0606 | 1.212 | 2.52 | 4.47 | 4.5 | 36.05 | 2.6 | 18.29 | 2.17 | 1.064 | 217 | 33.8 | 2.364 |
| IV | NARP Soecial Station Kotarakara | 0-21 | 4.7 | 3.7 | -1.0 | 0.0404 | 0.918 | 0.7 | 5.56 | 1.80 | 12.5 | 3.9 | 5.27 | 0.24 | 1.971 | 280 | 16.8 | 6.13 |
| | | 21-52 | 4.5 | 3.4 | -1.1 | 0.0303 | 0.99 | 0.41 | 2.62 | 1.86 | 6.5 | 4.3 | 2.55 | 0.19 | 2.91 | 278 | 16.8 | 3.58 |
| | | 52-152 | 4.4 | 3.6 | -0.8 | 0.0404 | 1.107 | 0.75 | 2.37 | 1.20 | 5.0 | 4.4 | 2.37 | 0.53 | 0.218 | 298 | 11.2 | 6.50 |
| | | 152-215 | 4.8 | 3.9 | -0.9 | 0.0202 | 0.309 | 1.38 | 4.05 | 11.68 | 17.4 | 4.1 | 7.84 | 0.22 | 1.10 | 291 | 16.8 | 12.03 |
| V | Sugar cane Research Station Thiruvalla | 0-11 | 4.9 | 4.2 | -0.7 | 0.0404 | 0.055 | 11.62 | 4.16 | 20.89 | 115.85 | 11.4 | 13.38 | 2.8 | 1.744 | 291 | 59.1 | 100.8 |
| | | 11-18 | 4.9 | 4.1 | -0.8 | 0.0505 | 0.883 | 5.42 | 3.31 | 14.59 | 117.1 | 12.2 | 11.51 | 2.86 | 0.33 | 253 | 58.3 | 47.04 |
| | | 18-67 | 5.3 | 4.5 | -0.8 | 0.0101 | 0.34 | 2.7 | 3.01 | 25.7 | 185.5 | 9.7 | 22.36 | 3.46 | 1.09 | 199.4 | 40.3 | 23.58 |
| | | 67-121 | 6.0 | 5.2 | -1.2 | 0.0101 | 0.05 | 1.06 | 4.67 | 50.25 | 216.15 | 8.4 | 32.41 | 1.86 | 1.53 | 269 | 33.72 | 9.27 |
| VI | Cardamom Research Station Pampadumpara | 0-7 | 6.0 | 4.4 | -1.6 | 0.101 | 1.338 | 24.59 | 5.78 | 64.75 | 306.2 | 16.7 | 24.013 | 0.25 | 0.436 | 285 | 58.2 | 214.6 |
| | | 7-27 | 6.2 | 5.3 | -0.9 | 0.202 | 1.22 | 24.35 | 5.02 | 63.2 | 310.75 | 15 | 26.89 | 0.19 | 0.436 | 309 | 58.2 | 212.8 |
| | | 27-63 | 6.0 | 5.4 | -0.6 | 0.0909 | 1.455 | 19.9 | 2.48 | 52.75 | 221.45 | 14.8 | 31.71 | 0.17 | 0.216 | 199 | 40.3 | 174.7 |
| | | 63-127 | 6.0 | 5.4 | -0.6 | 0.0909 | 0.55 | 23.75 | 2.36 | 39.3 | 136.5 | 10.4 | 21.22 | 0.28 | 1.526 | 269 | 33.71 | 206.8 |
| VII | Aromatic and Medicinal Plants Research Station Odakkali | 0-19 | 4.9 | 4.1 | -0.8 | 0.0101 | 1.71 | 3.33 | 5.98 | 45.9 | 187.1 | 7.2 | 30.88 | 1.995 | 1.56 | 282 | 26.9 | 29.12 |
| | | 19-38 | 4.8 | 3.8 | -1.0 | 0.0202 | 1.52 | 1.31 | 4.82 | 4.15 | 51.2 | 7.8 | 6.60 | 2.79 | 1.744 | 280 | 25.8 | 11.5 |
| | | 38-100 | 4.4 | 3.9 | -0.5 | 0.0101 | 0.75 | 0.84 | 4.38 | 7.01 | 52.9 | 7.3 | 8.92 | 1.8 | 0.218 | 170 | 22.4 | 7.39 |
| VIII | Banana Research station Kannara | 0-15 | 5.0 | 3.9 | -1.1 | 0.0404 | 0.54 | 12.78 | 3.42 | 24.5 | 139.45 | 6.0 | 29.98 | 1.775 | 0.218 | 196 | 154.6 | 111.6 |
| | | 15-71 | 4.9 | 3.6 | -1.3 | 0.0404 | 0.225 | 9.21 | 2.6 | 12.5 | 120.3 | 6.0 | 24.09 | 2.09 | 1.308 | 200.48 | 179 | 89.4 |
| | | 71-140 | 5.1 | 4.0 | -1.1 | 0.0404 | 0.267 | 10.12 | 2.86 | 40.7 | 200.85 | 6.5 | 39.16 | 1.54 | 0.218 | 262 | 49 | 88.48 |
| | | 140-150 | 5.2 | 4.4 | -0.8 | 0.0404 | 0.225 | 8.78 | 6.9 | 49.5 | 204.8 | 6.9 | 39.12 | 1.49 | 0.309 | 264 | 44 | 76.16 |
| IX | College of Horticulture Vellanikkara | 0-24 | 4.9 | 3.5 | -1.4 | 0.0404 | 1.296 | 3.82 | 4.08 | 15.4 | 86.6 | 7.2 | 14.7 | 3.10 | 0.76 | 296 | 79.5 | 33.6 |
| | | 24-90 | 5.0 | 3.8 | -1.2 | 0.0303 | 0.709 | 3.49 | 4.4 | 17.5 | 128.9 | 5.0 | 39.23 | 2.97 | 0.109 | 293 | 61.6 | 30.5 |
| | | 90-151 | 5.4 | 3.9 | -1.5 | 0.0101 | 0.264 | 6.76 | 7.02 | 44.0 | 178.5 | 7.4 | 31.91 | 0.205 | 0.109 | 296 | 56.0 | 59.02 |
| | | -151 | 5.5 | 4.6 | -1.9 | 0.0303 | 0.246 | 3.38 | 6.3 | 45.9 | 168.6 | 6.2 | 35.85 | 0.155 | 0.159 | 259 | 45.9 | 29.5 |

Table3.0

CHEMICAL PROPERTIES OF SOIL PROFILES

| Serial No | Location of the Profile | Depth (Cm) | Soil PH 1:1 Water | 1:1 KCl | PH | Soil Ec dSm$^{-2}$ | Organic Carbon (%) | Exchangeable bases Potassium | Sodium | Magnesium | Calcium | CEC | PBS (%) | Extractable Iron (%) | Aluminium | Available Nitrogen (Kg/ha) | Phosphorous | Potassium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | Kelappaji college of Agrl Engineering Tavnur | 0 - 32 | 5.1 | 4.8 | -0.3 | 0.05058 | 0.561 | 2.69 | 4.97 | 39.4 | 127.3 | 3.7 | 47.2 | 0.543 | 0.872 | 259 | 140 | 47.86 |
| | | 32 - 72 | 5.1 | 5.2 | -0.1 | 0.0303 | 0.309 | 8.4 | 5.9 | 25.8 | 94.65 | 2.0 | 31.7 | 0.645 | 0.218 | 269 | 56 | 23.6 |
| | | 72 - 130 | 5.0 | 4.5 | -0.5 | 0.0505 | 0.666 | 6.43 | 6.68 | 44.65 | 59.1 | 5.7 | 49.0 | 0.383 | 1.09 | 269 | 38 | 9.27 |
| XI | CWRDM Calicut | 0-18 | 4.8 | 4.2 | -0.6 | 0.0101 | 0.281 | 1.96 | 4.44 | 54.1 | 24.85 | 5.8 | 14.72 | 1.58 | 0.218 | 311 | 32.5 | 102.14 |
| | | 18-52 | 4.9 | 3.8 | -1.0 | 0.0101 | 1.254 | 15.41 | 27.07 | 54.2 | 67.95 | 7.9 | 20.84 | 1.77 | 4.32 | 197 | 24.6 | 17.02 |
| | | 52-166 | 5.0 | 3.9 | -1.1 | 0.0101 | 1.467 | 1.70 | 4.11 | 13.2 | 93.3 | 7.7 | 9.39 | 1.72 | 1.09 | 273 | 33.6 | 134.60 |
| | | 116-143 | 5.2 | 4.4 | -0.8 | 0.0101 | 0.33 | 15.62 | 31.1 | 58.6 | 51.1 | 6.0 | 28.07 | 3.07 | 1.866 | 262 | 26.9 | 14.82 |
| XII | Horticultural Research Station Ambalavayal | 0-12 | 4.2 | 3.5 | -0.7 | 0.0606 | 1.1 | 5.1 | 2.95 | 5.7 | 57 | 7.5 | 10.28 | 1.1 | 1.32 | 280 | 23.1 | 44.55 |
| | | 12-34 | 4.2 | 3.5 | -0.7 | 0.0606 | 0.6 | 2.32 | 1.67 | 8.3 | 55.7 | 8.3 | 7.86 | 1.1 | 0.872 | 300 | 20.1 | 20.25 |
| | | 34-79 | 4.8 | 3.8 | -1.0 | 0.0404 | 0.1 | 2.23 | 3.015 | 38.4 | 38.45 | 7.1 | 11.96 | 1.5 | 0.872 | 271 | 39.2 | 19.48 |
| | | 79-142 | 4.9 | 3.8 | -1.1 | 0.0505 | 0.33 | 11.69 | 26.73 | 9.05 | 65.05 | 6.4 | 21.41 | 1.30 | 0.23 | 257 | 95.2 | 102.14 |
| XIII | Coconut Research Station Rlicode | 0-91 | 5.0 | 4.0 | -1.0 | 0.0303 | 2.43 | 3.46 | 4.67 | 26.48 | 121.5 | 9.3 | 16.87 | 6.01 | 1.09 | 298 | 23.5 | 30.40 |
| | | 9-41 | 4.9 | 4.1 | -0.8 | 0.0101 | 1.674 | 1.96 | 4.59 | 4.67 | 74.55 | 8.2 | 15.4 | 6.51 | 0.436 | 291 | 22.4 | 17.14 |
| | | 41-114 | 5.0 | 3.9 | -1.1 | 0.0404 | 0.477 | 1.97 | 4.68 | 15.24 | 71.6 | 5.6 | 16.7 | 5.66 | 0.872 | 224 | 26.8 | 17.24 |
| | | 114-147 | 5.4 | 4.1 | -1.3 | 0.0101 | 0.06 | 0.74 | 4.97 | 11.45 | 35.6 | 2.8 | 18.84 | 4.203 | 1.09 | 174 | 22.4 | 6.50 |

## Profile No. I

| | |
|---|---|
| Location | A Block ARS Balaramapuram |
| Parent Material | Lateritic alluvium |
| Physiography | Alluvial basil |
| Relief | Nearly flat |
| Slope | 1-2 percent |
| Elevation | More than 50m MSL |
| Drainage | Moderately well drained |
| Climate | Humid tropical, Mean annual rainfall 1646.92 mm, Mean annual temperature 27.5°C |
| Vegatation | Coconut |
| Limitations effecting plant growth if any | Low fertility, Low water holding capacity |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 15.5 | Red(2.5YR 3/6); sandy loam; weak Coarse granular; Structure slightly sticky, slightly plastic; many fine to medium roots; pH 5.5; gradual-smooth boundary. |
| AB | 15.5- 71.5 | Red(2.5YR 3/6); sandy loam to sandy clay loam; many moderate granular and few weak subangular blocky structure; slightly hard, slightly sticky, slightly plastic; many coarse coconut roots; pH 5.0; gradual smooth boundary. |
| B | 71.5-145$^{+}$ | Red(2.5YR 3/6); clay loam; medium moderate subangular blocky structure; moderately hard; slightly sticky, slightly plastic, many coarse purplish red and few red coconut roots; pH 5.0. |

Plate No. 1 Soil profile site at Balaramapuram

Plate No. 2 Balaramapuram Soil profile

## Profile No. II

| | |
|---|---|
| Location | College of Agriculture, Vellayani, Rubber garden |
| Parent Material | Lateritic alluvium, residual material derived from coarse acid igneous rock. |
| Physiography | Levelled experimental land |
| Relief | Gently slopy |
| Slope | 1-3 percent |
| Elevation | 50m above MSL |
| Drainage | Moderately well drained |
| Climate | Humid tropical, Mean annual rainfall 1646.1 mm, Mean annual temperature 27.5°C |
| Vegatation | Rubber |
| Limitations effecting plant growth if any | Low fertility, Low water holding capacity |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 3 | Dark red(2.5YR 3/6); sandy loam; Common-many; Crumby structure; very friable; slightly sticky, plastic; coarse to fine rubber roots; pH 5.0; gradual- wavy boundary. |
| Ap | 3 - 8 | Dark red(2.5YR 3/6); sandy clay loam; Common- many; medium granular structure; very friable; slightly sticky, plastic; many coarse to fine rubber roots; pH 4.5; gradual- smooth boundary. |
| AB | 8 - 28 | Dark red(10R 3/6);clay loam; many medium granular structure; loose;very friable; slightly sticky; plastic; few to many fine rubber roots; pH 4.9;gradual- smooth boundary. |
| B | 28 -143$^{+}$ | Dark red(2.5YR 3/6); clay loam; many medium granular structure; loose friable; slightly .sticky, plastic; common, fine rubber root hairs; pH 4.9; gradual-smooth boundary |

Plate No. 3 Soil profile site at Vellayani

Plate No. 4 Vellayani I Soil profile

Plate No. 5 Vellayani II Soil profile

## Profile No. II (1)

| | |
|---|---|
| Location | College of Agriculture, Vellayani, Building cut behind rest house. |
| Parent Material | Lateritic alluvium; residual material derived from coarse acid igneous rock. |
| Physiography | Levelled experimental land |
| Relief | Gently slopy |
| Slope | 1-3 percent |
| Elevation | 60m above MSL |
| Drainage | Moderately well drained |
| Climate | Humid tropical, Mean annual rainfall 1646.9 mm, Mean annual temperature 27.5°C |
| Vegatation | Nil, waste land |
| Limitations effecting plant growth if any | Low fertility, Low water holding capacity Less effective soil |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 4 | Dark Brown (7.5YR 4/4); strong coarse granular structure, loose, slightly sticky, slightly plastic; few to common fine roots; pH 5.0; abrupt to wavy boundary. |
| AB/E | 4 - 27 | Strong brown (7.5YR 5/8); sandy loam; strong coarse granular structure; loose; slightly sticky, plastic; few to common fine roots; pH 4.8; abrupt to wavy boundary. |
| B/BC | 27 -150$^{+}$ | Strong brown(7.5YR 5/8); sandy clay loam; Strong coarse granular structure; Hard; loose; sticky, plastic, few to many coarse roots; pH 4.8; abrupt to wavy boundary. |

## Profile No III

| | |
|---|---|
| **Location** | Terraced land of NARP Special Station, Sadananthapuram, Vettikavala, Kottarakkara, Quilon |
| **Parent Material** | Lateritic alluvium on biotite gneiss and charnokite |
| **Physiography** | Mid slope of a middle level laterite hill |
| **Relief** | Gently slopy towards West |
| **Slope** | 2-4 percent |
| **Elevation** | 600m above MSL |
| **Drainage** | Moderately well drained |
| **Climate** | Humid tropical climate Mean annual rainfall-2500mm, Mean annual temperature-24°C |
| **Vegatation** | Mango garden with few grasses. |
| **Limitation affecting plant growth if any** | Moderate water holding capacity, Erosion |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0-12 | Dark brown (7.5 YR 4/4); clay loam texture; weak medium granular to crumby structure; moist slightly firm, slightly sticky, slightly plastic; many fine to few medium roots; Crotovinas and clay pockets; pH 5.0; gradual smooth boundary. |
| BA | 12-34 | Dark brown(7.5YR 4/4); clay loam texture; crumby structure; moist slightly firm, slightly sticky, slightly plastic; few fine roots; pH 5.0; gradual smooth boundary. |
| $Bw_1$ | 34- 79 | Yellowish red(5YR 4/6); clay loam; medium weak subangular blocky structure; moist firm; slightly sticky; slightly plastic; roots nil; quartz stone layer forming in the lower boundary; pH 5.0; abrupt wavy boundary. |
| $Bw_2$/BC | 79-142$^+$ | Yellowish red(5YR 4/6); clay loam texture; medium subangular blocky structure; moist firm; sticky and plastic; Many red and yellow discontinuous patchy cutans present; pH 5.5. |

Plate No. 6 Soil profile site at Kottarakkara

Plate No. 7 Kottarakkara Soil profile

## Profile No. IV

| | |
|---|---|
| **Location** | Experimental plot of Sugarcane Research Station, Thiruvalla |
| **Parent Material** | Alluvium |
| **Physiography** | Toe slope of a hill levelled |
| **Relief** | Gently Slopy |
| **Slope** | 1-2 percent |
| **Elevation** | 20m above MSL |
| **Drainage** | Moderately well drained to well drained |
| **Climate** | Humid tropical climate Mean annual rainfall- 2500mm, Mean annual temperature - 27°C |
| **Vegatation** | Sugarcane experimental plot |
| **Limitation affecting plant growth** | Low fertility, Low water holding capacity |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| 1 | 0-11 | Dark yellowish brown 10YR 3/4; weak coarse crumby structure; sandy loam; Moist friable; Dry slightly hard, Slightly sticky; Gravels nil ; Many medium roots. pH - 5.5; gradual smooth boundary. |
| $Ap_2$ | 11-18 | Dark yellowish brown (10YR 3/4); Sandy loam to loam ; Medium to fine moderate sub angular blocky structure; Moist firm, dry slightly hard, slightly plastic; few fine to medium roots; pH 5.5; gradual smooth boundary. |
| $E/Bw_1$ | 18-67 | Dark yellowish brown (10YR 3/4); loamy sand; medium coarse subangular blocky structure; moist firm, dry hard; slightly sticky, slightly plastic; roots nil; pH 5.5; gradual smooth boundary. |
| $Bw_2$ | 67-121 | Dark yellowish brown (10YR 4/4); loamy; Coarse medium sub angular blocky structure; moist firm, dry hard; slightly sticky, slightly plastic; roots nil; few clay pockets of translocated clay; pH 8.0 |

Plate No. 8 Soil profile site at Thiruvalla

Plate No. 9 Thiruvalla Soil Profile

## Profile No V

| | |
|---|---|
| **Location** | Cardamom Germplasm collection plot of ARS Pampadumpara. Idukki, Kerala. |
| **Parent Material** | Laterite alluvium |
| **Physiography** | Toe slope of a hillock |
| **Relief** | Slopy |
| **slope** | 15-30 percent |
| **Elevation** | 520 m above MSL |
| **Drainage** | Well drained |
| **Climate** | Humid tropical climate,Mean annual rainfall 3000mm, Mean annual temperature 24°C |
| **Vegetation** | Cardamom germplasm cultivated. |
| **Limitations affecting plant growth if any** | Erosion |

| Horizon | Depth(cm) | Horizon description |
|---|---|---|
| Ap | 0-7 | Black (10YR 2/1); fine loamy; weak to medium crumbs;moist loose,dry friable;slightly sticky slightly plastic;common fine to medium roots; few coarse gravels;partially decomposed forest litter and cardamom leaf fragments; pH 6.0; gradual wavy boundary. |
| AB | 7-27 | Dark reddish brown (5YR 2/2)fine loamy crumby; moist loose; dry friable; slightly sticky and plastic;few partially decomposed litter fragments;gravels nil;few fine to medium roots;pH6.0 |
| $Bw_1/E$ | 7-63 | Dark reddish brown (5YR 2/2);clay loam; weak medium subangular blocky; moist firm; dry slightly hard; slightly sticky and slightly plastic; many coarse and medium roots; many discontinuous grey, red patchy cutans; few medium to fine gravels pH 5.5; gradual smooth boundary. |
| $Bw_2/BC$ | 63-147 | Dark reddish brown (5YR 2/2);clay loam; weak medium subangular blocky; moist firm; dry slightly hard; slightly sticky and slightly plastic; many coarse and medium roots; many discontinuous grey, red patchy cutans; few medium to fine gravels; 50 to 60cm sized weathered gneissic boulders present; more reddish mottlings present pH 5.5; gradual smooth boundary. |

Plate No.10 Soil profile site at Pampadumpara

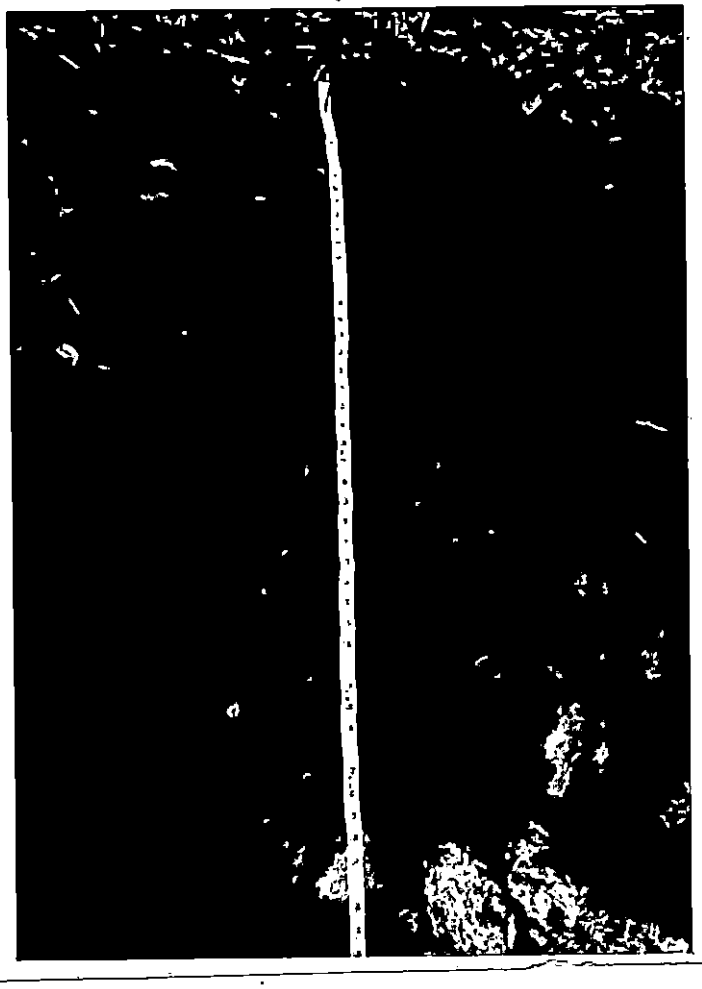


Plate No.11 Pampadumpara Soil profile

## Profile No. VI

| | |
|---|---|
| **Location** | Aromatic and Medicinal plants Research Station, Odakkali. Lemon grass cultivated experimental land behind the office building |
| **Parent Material** | Lateritic alluvium over residual laterite. |
| **Physiography** | Side slope of a low laterite mount. |
| **Relief** | Gently slopy |
| **Slope** | 3-5 percent |
| **Elevation** | 50m above MSL |
| **Drainage** | Moderately well drained |
| **Climate** | Humid tropical, Mean annual rainfall 2300 mm, Mean annual temperature 27°C |
| **Vegatation** | Lemon grasscultivated experimental plot |
| **Limitations effecting plant growth if any** | Medium fertility, Low water holding capacity, less effective soil volume. |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 14 | Dark brown (7.5YR 3/4); sandy loam; weak granular to moderate subangular blocky structure; moist friable; slightly sticky, slightly plastic; many medium to fine roots; pH 5.0; abrupt wavy boundary. |
| BA | 14 - 38 | Dark brown(7.5YR 3/4); clay loam ; sandy clay; moderate medium; subangular blocky structure; moist friable; slightly sticky; slightly plastic; few fine roots; many continuous red yellow grey medium to fine cutans present; pH 5.0; abrupt wavy boundary. |
| BC/CR | 38 -100$^{+}$ | Dark brown (7.5YR 4/4); clay loam; medium moderate subangular blocky; moist firm; slightly sticky and plastic, roots nil; weathered, leached boulders with red grey and white continuous; coarse to medium; cutans; pH 5.0. |

Plate No.12 Soil profile site at Odakali

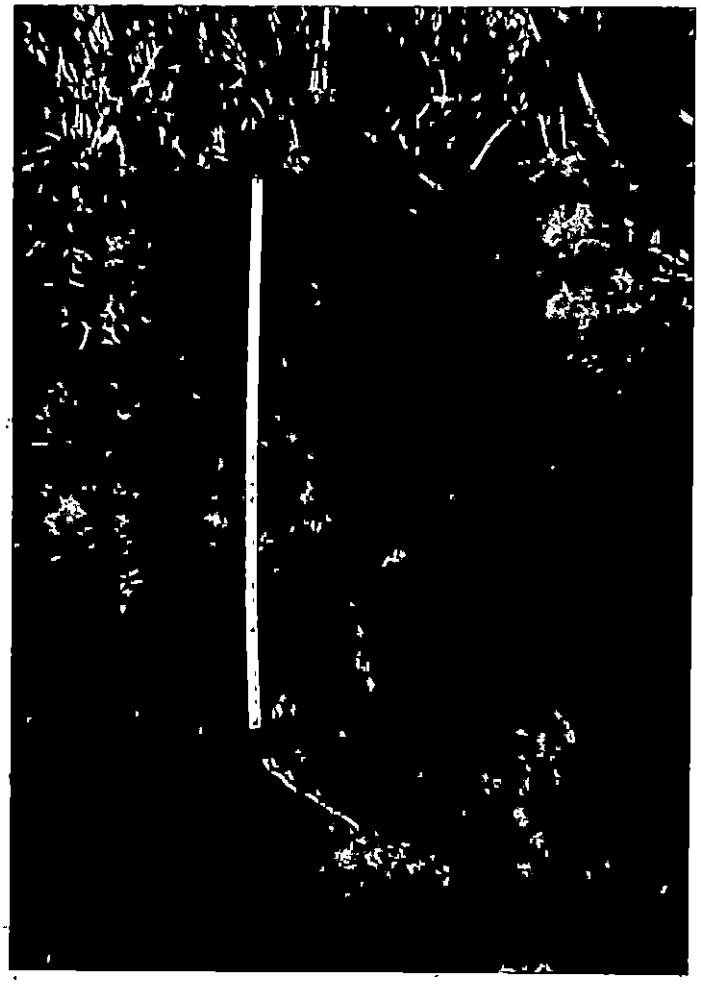


Plate No.13 Odakkali Soil pofile

## Profile No. VII

| | |
|---|---|
| Location | Banana Research Station, Kannara |
| Parent Material | Biolite gneiss |
| Physiography | Rolling midland |
| Relief | Gently slopy |
| Slope | 2-3 percent |
| Elevation | 150m above MSL |
| Drainage | Well drained |
| Climate | Humid tropical, Mean annual rainfall 2800 mm, Mean annual temperature 28°C |
| Vegatation | Banana cultivated |
| Limitations effecting plant growth if any | Low-medium fertility, Low water holding capacity, partial reduction during post rainy season. |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 15 | Dark Yellowish brown(10YR 3/4); clay loam to sandy clay loam; Granular to crumby structure; slightly sticky, slightly plastic; many fine to medium roots; pH 5.5; gradual-smooth boundary. |
| E | 15 - 71 | Dark yellowish brown(10YR 3/4); clay loam; weak medium subangular blocky structure; slightly sticky, slightly plastic; few fine to medium roots; gravels and concration nil; pH 5.5; upper wavy boundary. |
| Bg/Bw | 71 -140 | Dark Yellowish brown(10YR 4/4); clay loam; coarse weak subangular blocky structure; friable, sticky, slightly plastic; roots nil; crotovinas and charcoal spots present; reduced and gleyed; pH 5.5; abrupt wavy boundry. |
| Bg | 140 -150 | Dark brown(7.5YR 4/4); clay loam; coarse weak subangular blocky structure; friable; sticky; slightly plastic; roots nil; crotovinas and charcoal spots present; Reduced and gleyed; pH5.5. |

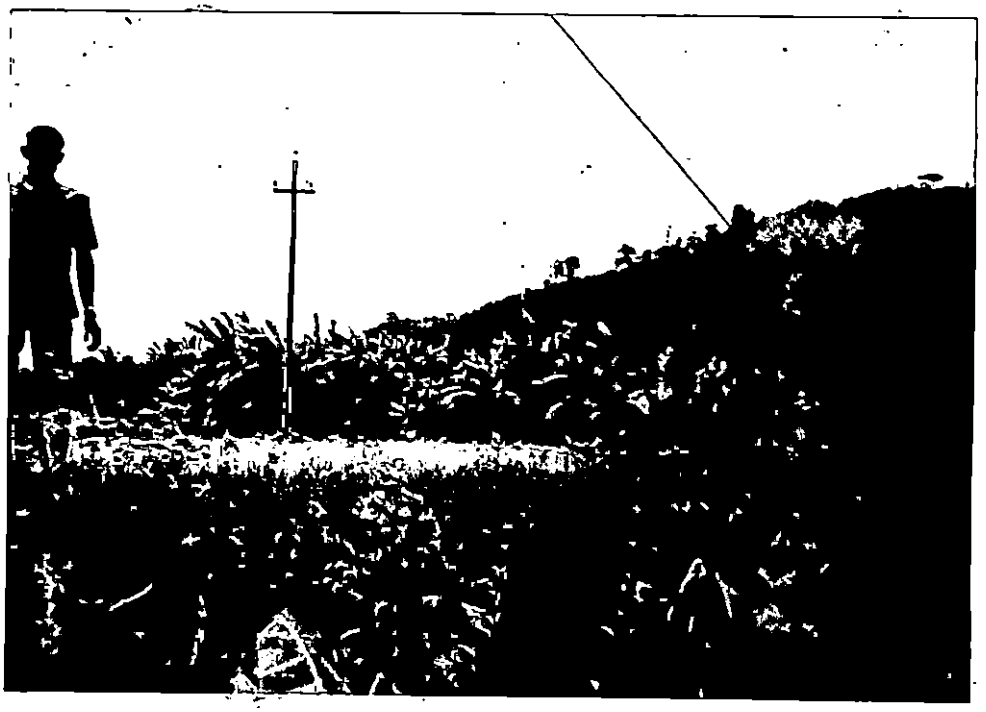


Plate No.15 Kannara Soil profile

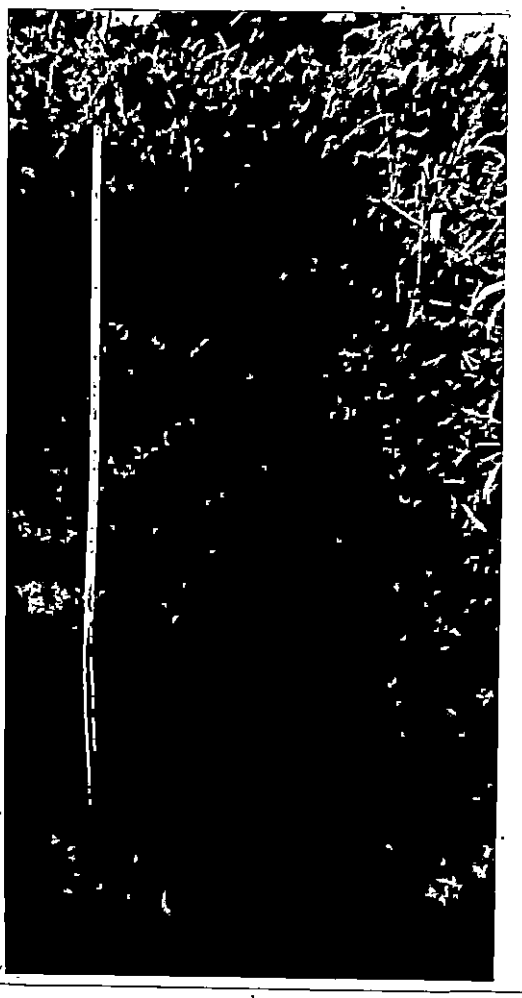


Plate No.14 Soil profile site at Kannara

## Profile No VIII

| | |
|---|---|
| Location | Terraced land near playground of College of Horticulture, Vellanikkara. Kerala Agricultural University. |
| Parent Material | Biotite gneiss |
| Physiography | Rolling midland |
| Relief | Gently Slopy |
| slope | 2-3 percent |
| Elevation | 150 m above MSL |
| Drainage | Well drained |
| Climate | Humid tropical climate, Mean annual rainfall 2800mm, Mean annual temperature 28°C |
| Vegetation | Barren land with few grasses. |
| Limitations affecting plant growth if any | Low effective soil volume, low fertility medium water holding capacity, erosion. |

| Horizon | Depth(cm) | Horizon description |
|---|---|---|
| A | 0-24 | Dark brown (7.5YR 4/2); Sandy loamy to loamy sand; weak granular structure to medium moderate subangular blocky; dry friable, slightly sticky and non plastic; many fine to medium roots; fine to medium gravels; many medium sized iron concretions pH 5.5; clear wavy boundary. |
| E | 25-90 | Dark reddish brown (5YR 3/4) Gravelly; sandy clay loam; coarse moderate subangular blocky structure; friable slightly sticky and slightly plastic; few medium to fine roots; fine to medium gravels pH 5.5; clear wavy boundary. |
| B | 90-151 | Reddish brown (25YR 4/4); clay loam; coarse weak subangular blocky structure; friable sticky and slightly plastic; few fine and coarse roots; evidence of laterisation pH 5.5; gradual wavy boundary. |
| Bc | $151^{+}$ | Yellowish red (5YR 4/6);clayey;coarse weak subangular blocky structure;friable;sticky and slightly plastic roots absent; highly laterised; pH 5.5. |

Plate No.16 Soil profile site at Vellanikkara

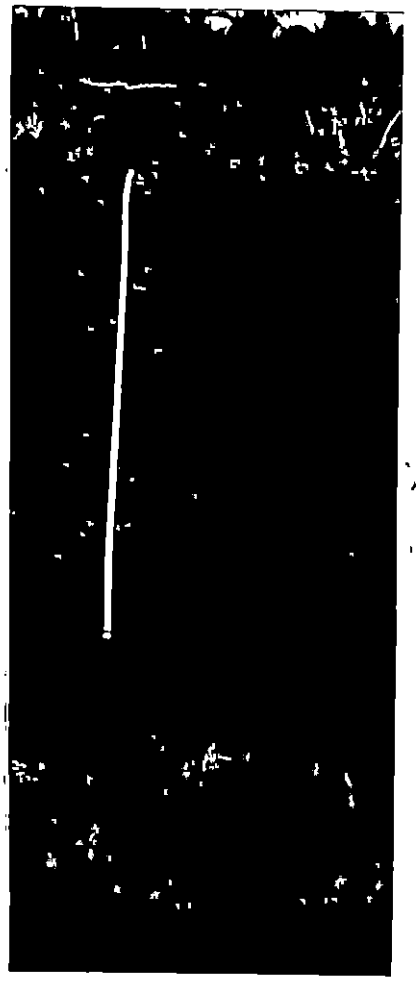


Plate No.17 Vellanikkara Soil profile

## Profile No. IX

| | |
|---|---|
| Location | Dissected cut of a hill crest on the side of Instructional farm of Kellappaji college of Agricultural Engineering and Technology Tavanoor, Malappuram. (Petroferric Contact) |
| Parent Material | Biotitic/gneiss |
| Physiography | Petroferric hill crest |
| Relief | Slopy |
| Slope | 2-5 percent |
| Elevation | 80m above MSL |
| Drainage | Ill drained |
| Climate | Humid tropical climate, Mean annual rainfall-2800mm, Mean annual temperature-27.5°C |
| Vegatation | Nil with few grasses. |
| Limitation affecting plant growth if any | Shallow soil and hard petroferric contact |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| BC | 0-32 | Yellowish red (5 YR 4/6); clayey; very hard angular blocky surface of Petroferric contact with soft loose Red Yellow and Purple continuous or patchy molttings many; pH 5.0; gradual smooth boundary. |
| | 32-72 | Dark red (2.5 YR 3/6); clayey angular blocky; Hard and very firm; Petroferric contact Red Yellow Purple and White continuous mottlings many; pH 5.7. |
| | 72-130+ | Dark red (7.5 YR 3/6); clayey angular blocky; Hard and very firm; Petroferric contact Red Yellow Purple and White continuous mottlings many; pH 5.5. |

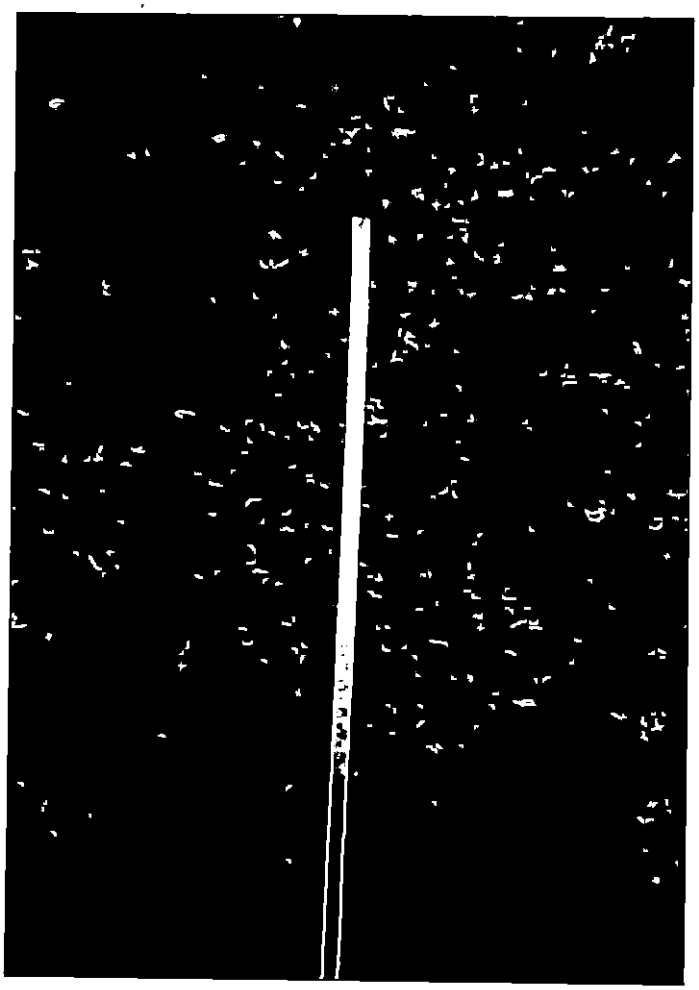


Plate No.18 Tavanur Soil profile

## Profile No X

| | |
|---|---|
| **Location** | CWRDM Calicut. Terraced forest patch behind the main office cum laboratory building of CWRDM , Kunnamangalam Calicut |
| **Parent Material** | Lateritic alluvium |
| **Physiography** | Side slope of a lateritic mount |
| **Relief** | Slopy |
| **Slope** | 10-12 percent |
| **Elevation** | 80m above MSL |
| **Drainage** | Moderately well drained |
| **Climate** | Humid tropical climate Mean annual rainfall-2960mm,Mean annual temperature-27°C |
| **Vegatation** | Grasses shrubs and trees |
| **Limitation affecting plant growth** | Low fertility, Low water holding capacity less effective soil volume. |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| AB | 0-18 | Dark red (2.5 YR 3/6); gravelly sandy loam ; weak coarse granular structure; moist firm, dry slightly hard; slightly sticky, slightly plastic; many medium and few fine roots ; many gravels and few iron nodules present, pH 5.0; gradual wavy boundary. |
| $Bw_1$ | 18-52 | Dark red(2.5YR 3/6);Gravelly sandyloam to sandy clay loam;crumby structure; medium weak subangular blocky structure; moist firm; Many medium gravels present;pH 5.5; gradual smooth to diffused boundary. |
| $Bw_2$ | 52-116 | Dark red(10 YR 3/6); Gravelly sandy loam to sandy clay loam; crumby structure; medium weak subangular blocky structure; moist firm; Many medium gravels present; pH 5.5; gradual smooth to diffused boundary. |
| $Bw_3$ | 116-143$^+$ | Dark red(2.5YR 3/6);Gravelly sandyloam to sandy clay loam; medium subangular blocky structure; moist firm; slightly sticky; slightly plastic; Many medium gravels present; pH 5.5; gradual wavy boundary. |

Plate No.20 Calicut Soil profile

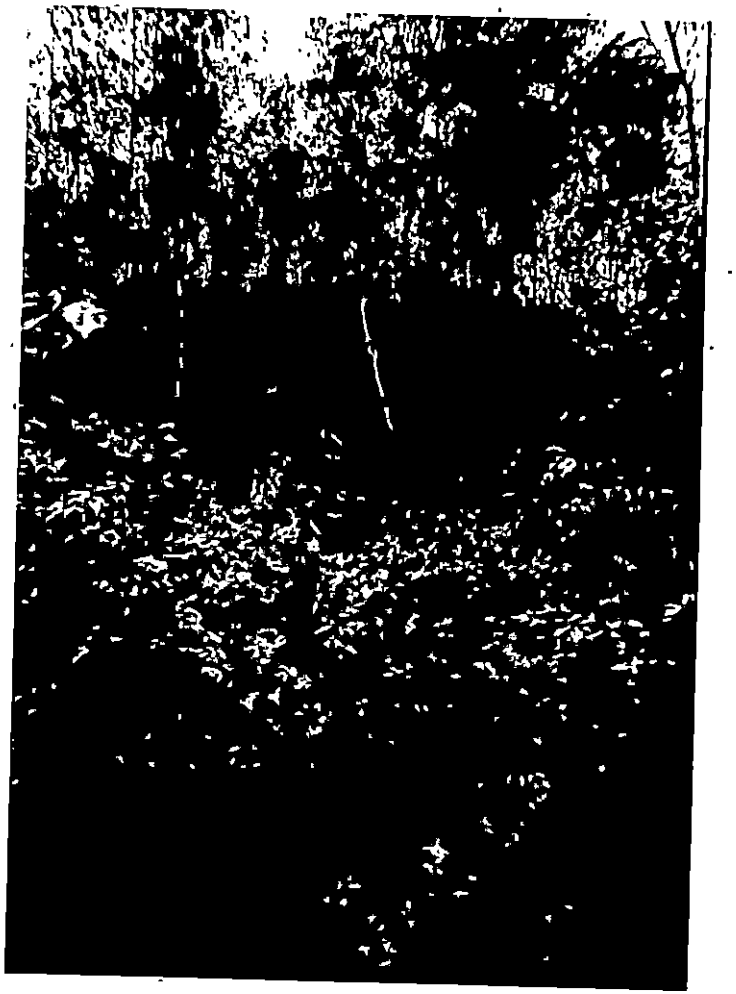


Plate No.19 Soil profile at Calicut

## Profile No XI

| | |
|---|---|
| **Location** | Mango garden RARS Ambalavayal , Wynad |
| **Parent Material** | Lateritic alluvium on residual weathered quartizitic gneiss |
| **Physiography** | Summit of a hill |
| **Relief** | Gently slopy towards West |
| **Slope** | 2-4 percent |
| **Elevation** | 600m above MSL |
| **Drainage** | Moderately well drained |
| **Climate** | Humid tropical climate Mean annual rainfall-2500mm,Mean annual temperature-24°C |
| **Vegatation** | Mango garden with few grasses. |
| **Limitation affecting plant growth if any** | Moderate water holding capacity, Erosion |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0-12 | Dark brown (7.5 YR 4/4); clay loam texture; weak medium granular to crumby structure; moist slightly firm, slightly sticky, slightly plastic; many fine to few medium roots; Crotovinas and clay pockets; pH 5.0; gradual smooth boundary. |
| BA | 12-34 | Dark brown(7.5YR 4/4); clay loam texture; crumby structure; moist slightly firm, slightly sticky,slightly plastic;few fine roots;pH 5.0; gradual smooth boundary. |
| $Bw_1$ | 34- 79 | Yellowish red(5YR 4/6); clay loam; medium weak subangular blocky structure;moist firm; slightly sticky; slightly plastic; roots nil; quartz stone layer forming in the lower boundary;pH 5.0; acrupt wavy boundary. |
| $Bw_2$/BC | 79-142$^+$ | Yellowish red(5YR 4/6);clay loam texture; medium subangular blocky structure; moist firm; sticky and plastic; Many red and yellow discontinuous patchy cutans present; pH 5.5. |

Plate No.22 Ambalavayal Soil profile

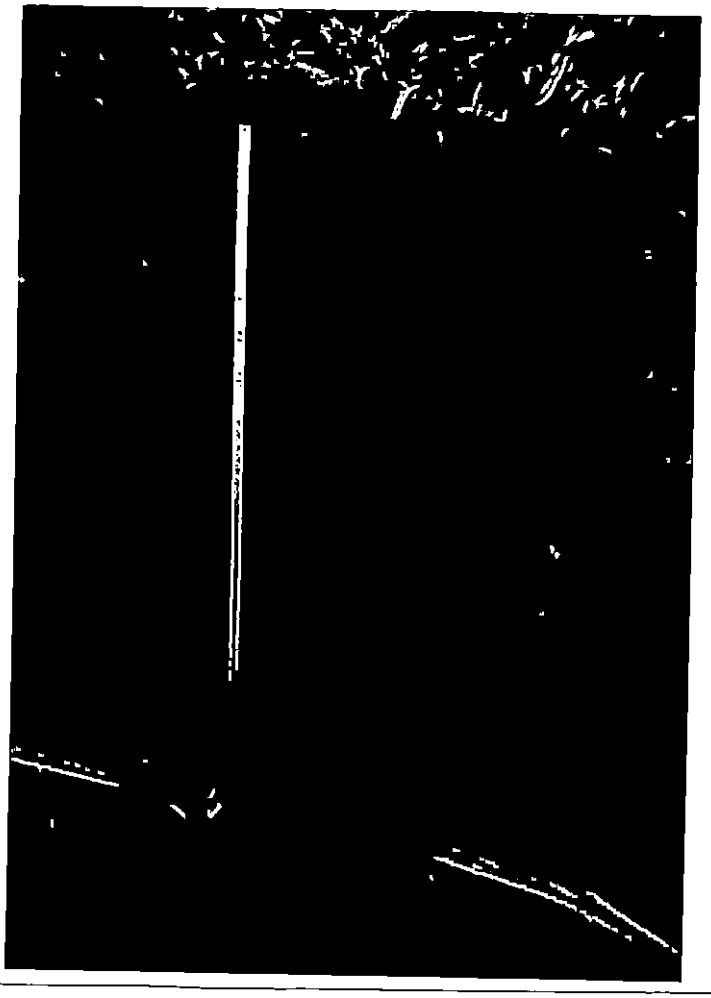


Plate No.21 Soil profile site at Ambalavayal

## Profile No. XII

| | |
|---|---|
| Location | New land with cashew acquired by RARS, Pilicode. |
| Parent Material | Lateritic alluvium on residual laterite |
| Physiography | Low laterite mount |
| Relief | Slopy |
| Slope | 5-10 percent |
| Elevation | 100m above MSL |
| Drainage | Moderately well drained |
| Climate | Humid tropical, Mean annual rainfall 2900 mm, Mean annual temperature 27°C. |
| Vegatation | Cashew, Coconut. |
| Limitations effecting plant growth if any | Low fertility, Low water holding capacity Less effective soil volume. |

| Horizon | Depth (cm) | Horizon description |
|---|---|---|
| Ap | 0 - 9 | Dark reddish brown(2.5YR 3/4); gravelly, clay, loam; medium weak; subangular blocky structure; Friable; non-sticky; non-plastic; many fine to medium roots; medium fine to grevels;pH 5.5; abrupt wavy boundary. |
| AB | 9 - 41 | Dark reddish(2.5YR 3/4); gravelly clay loam; moderate subangular blocky structure; friable to slightly hard, SS and S plastic, many fine to medium roots; many medium to fine gravels; pH 5.0; gradual wavy boundary. |
| B $w_1$ | 41 -114 | Dark red(10R 3/6); gravelly clay loam; subangular blocky structure; Moist firm; slightly sticky, plastic, few fine roots; many reddish brown medium to fine gravels; pH 5.5; gradual wavy boundary. |
| B $w_2$/BC | 114-147$^+$ | Red (10R 3/6); gravelly clayey, subangular blocky structure, moist firm; sticky and plastic; very few fine roots; reddish brown medium to fine gravels; roots-nil; pH 6.0. |

Plate No.23 Soil profile at Pilicode

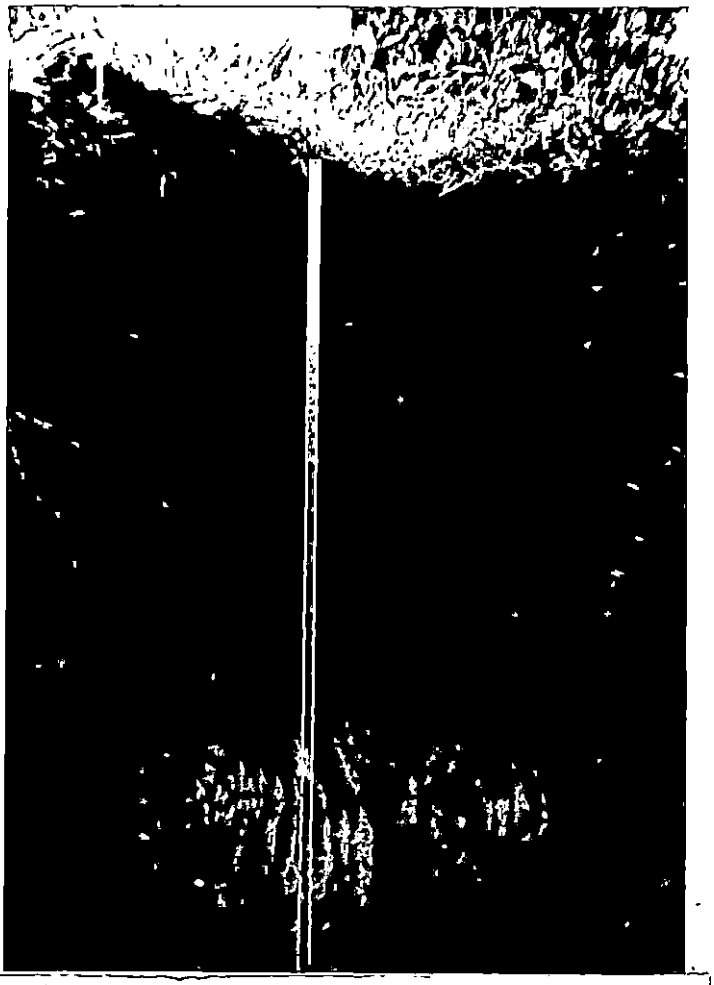


Plate No.24 Pilicode Soil profile

## Results

In order to classify the upland soils of Research stations under Kerala Agricultural University as per Soil Taxonomy (USDA 1975). One representative profiles each were dug, described, profile sample analysed for physical, chemical and mineralogical properties. The detailed results of the field and laboratory work are presented below:

### 1.0 Morphology

Comparatively the soil colour of the twelve profiles studied varies from red, yellowish red, yellowish brown, dark brown to black. The content of gravel is nil in the Balaramapuram profile and is maximum in the Kottarakara profile. Kottarakara, Pilicode, Vellayani II, Odakkali and Vellanikkara profiles were gravelly. The Thiruvalla profile was more sandy than other profiles. The Kannara profile and Pampadumpara profile were comparatively finer. The Kannara profile is comparatively more siltier. All the other profiles are comparatively clayey in texture with maximum in the Calicut profile and least in the Odakali Profile. The profile is moderate in Pampadumpara and well drained at Thiruvalla. Comparatively profile permeability is maximum at Balaramapuram and minimum or least in Odakkali. General comparison of the profile features reveal at the expanding clay minerals will be more in the Kannara profile While the non expanding Kaolinitic minerals will be more at Vellanikkara. The gravelly less

effective soil volume profile at Kottarakara is a profile with active leaching while the leaching is least at Kannara, Pambadumpara and Ambalavayal.

The diagnostic epipedon observed in all the profiles except Tavanur, Pampadumpara are ochric epipedon. It is thin dry with high colour value little organic matter. It include elluvial horizon near the surface and extend to sub surface diagnostic endopedons. In the cultivated profiles that is except at Calicut it is in Ap horizon. In all these profiles these horizons do not have any rock structure and finely stratified fresh sediments. At Tavanur the surface is itself a petroferric cap while at Pambadumpara it is cambic horizon. The cambic diagnostic horizon is deep at Pambadumpara. This horizon is followed by a developing argillic horizon. The diagnostic sub surface horizon is argillic in all the profiles which are in different stages of development except Tavanur where the profile as a whole is a petroferric contact extending 3-5m from the surface.

## 2.0 Mineralogy

The fine sand Mineralogy of all the profiles are constituted predominently by quartz which ranges between 80 to 95 percent irrespective of the profiles. The other minerals present with the increasing order are Haemetite, Silimenite, Leucosene, Illmenite, Zircon and few feldspars. Another mineral though rare present is Kyanite.

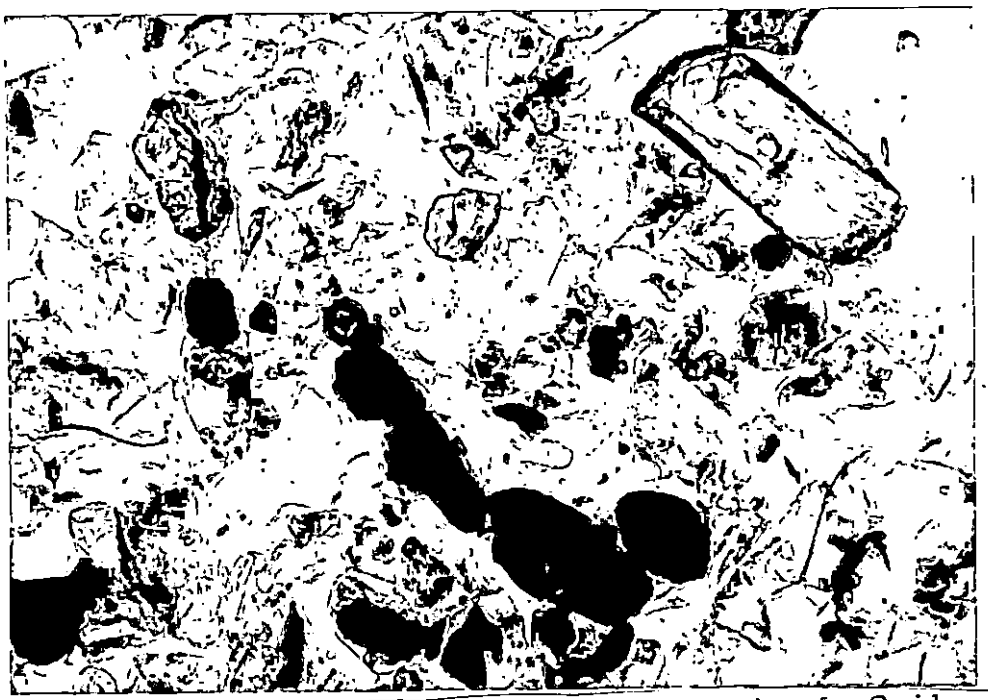


Plate No.25 Fine sand mineralogy Photomicrograph of Soil of Balaramapuram profile in transmitted light mgf100x

Plate No.26 Fine Sand mineralogy photomicrograph of Vellayani Soil profile in transmitted light mgf 100x

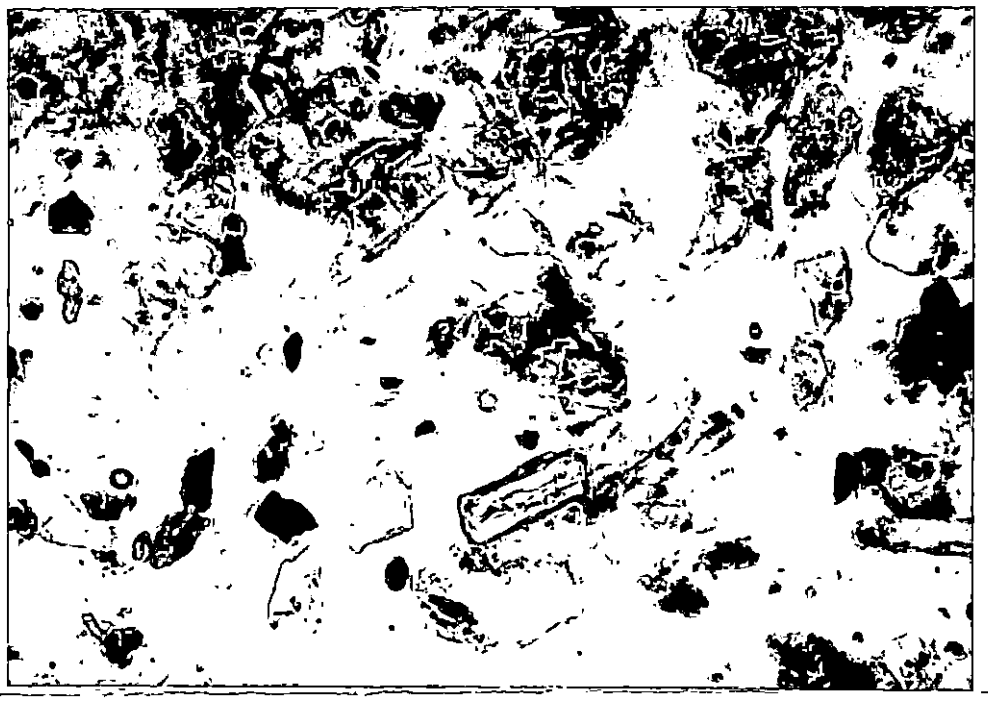
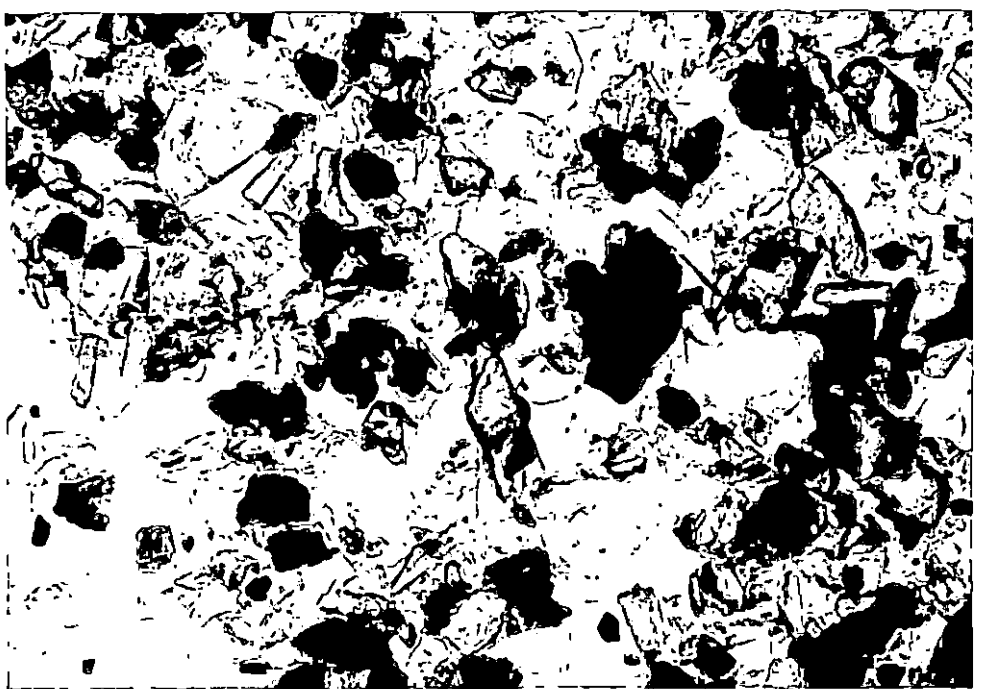


Plate No.27 Fine Sand mineralogy photomicrograph of Kottarakkara Soil profile in transmitted light mgf 100x.



No 28 Fine sand mineralogy photomicrograph of Thiruvalla soil profile in transmitted light mgf 100x.

Plate No 29 Fine sand mineralogy photomicrograph of Pampadumpara soil profile in transmitted light mgf 100x.

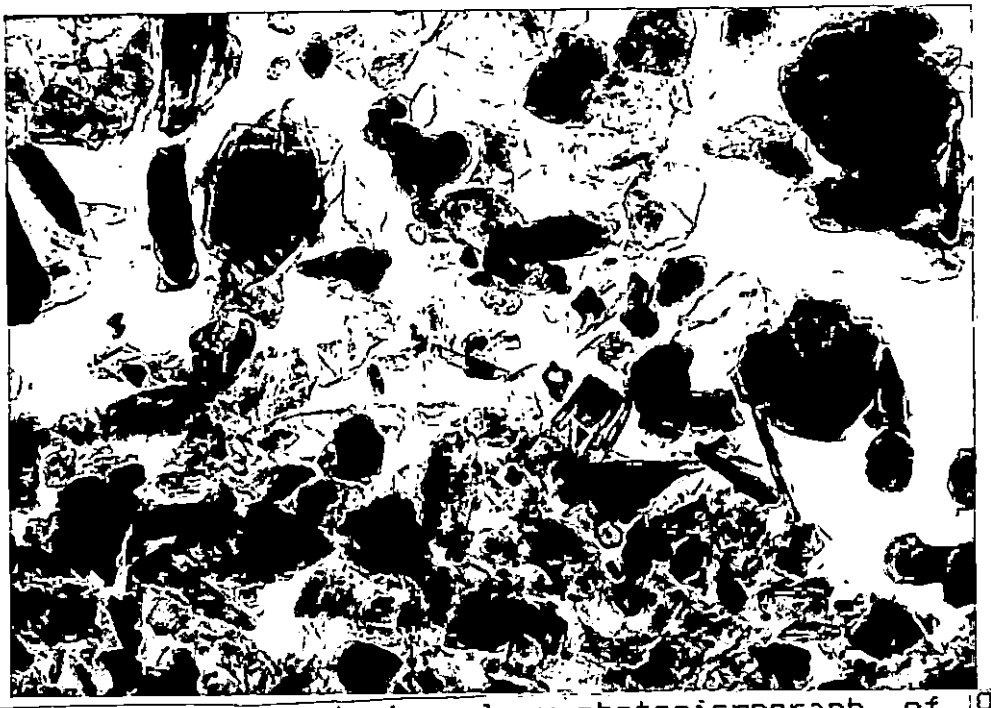


Plate No 30 Fine sand mineralogy photomicrograph of Odakkali soil profile in transmitted light mgf 100x.

Plate No 31 Fine sand mineralogy photomicrograph of Kannara ~~a~~ soil profile in transmitted light mgf 100x.

Plate No 32 Fine sand mineralogy photomicrograph of Vellanikkara soil profile in Transmitted light mgf 100x.

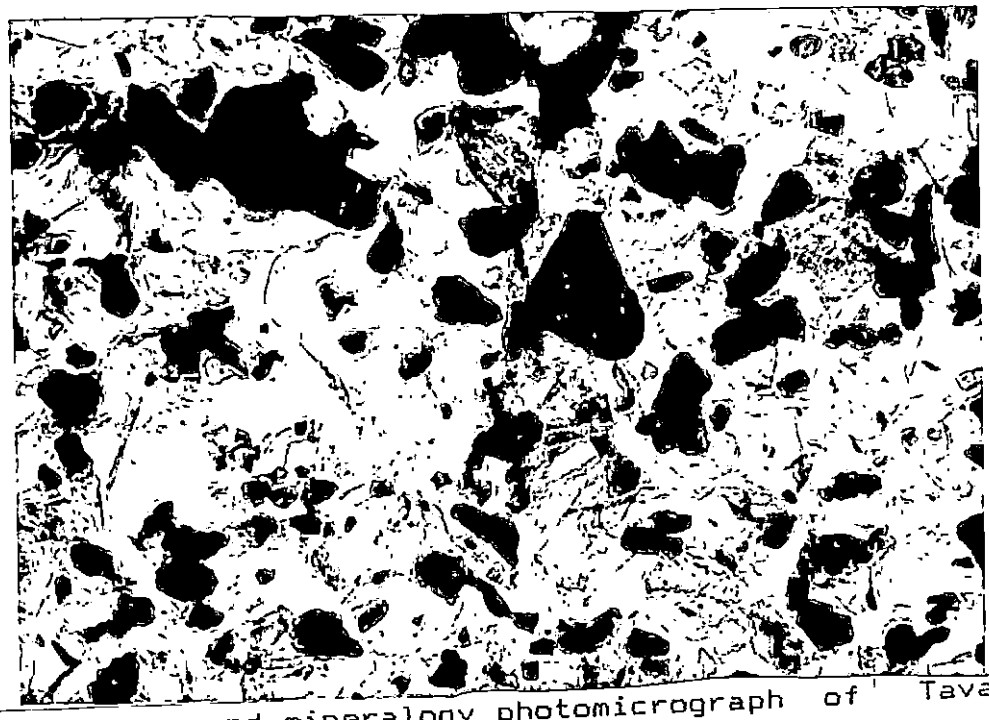


Plate No 33 Fine sand mineralogy photomicrograph of Tavanur soil profile in transmitted light mgf 100x.

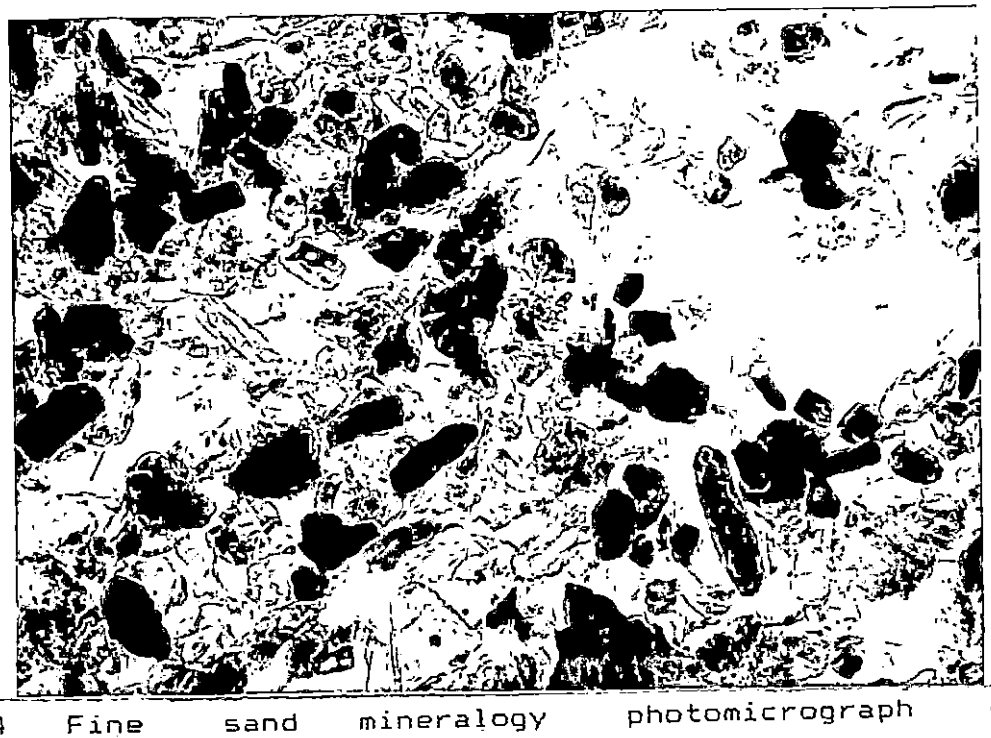


Plate No 34 Fine sand mineralogy photomicrograph of Calicut soil profile in transmitted light mgf

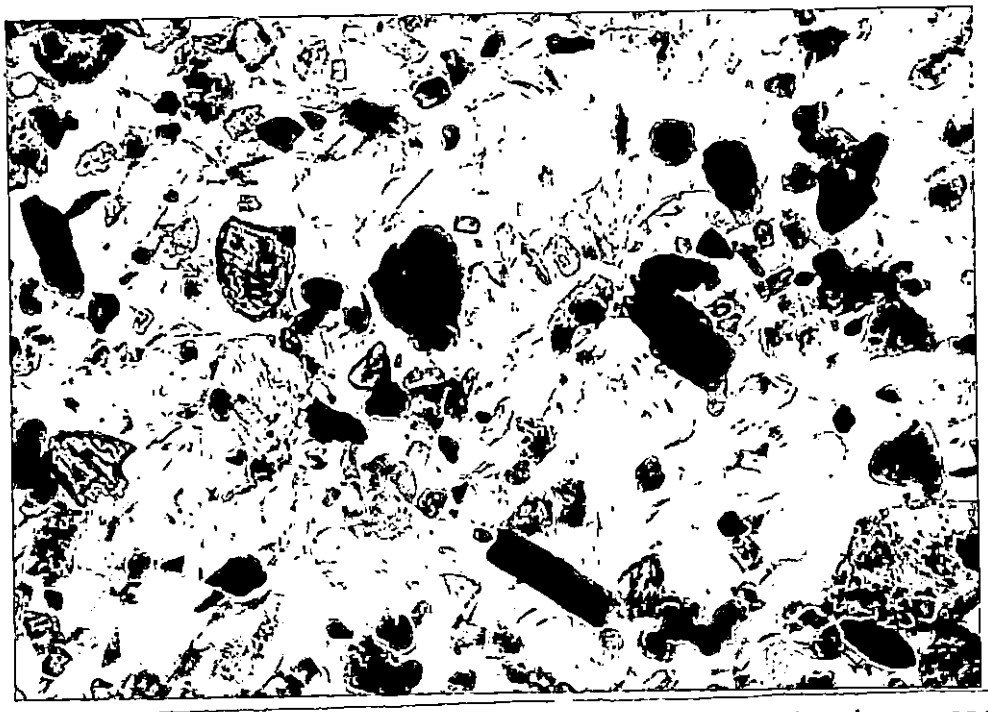


Plate No 34 Fine sand mineralogy photomicrograph of Ambalavayal soil profile in transmitted light mgf 100x.

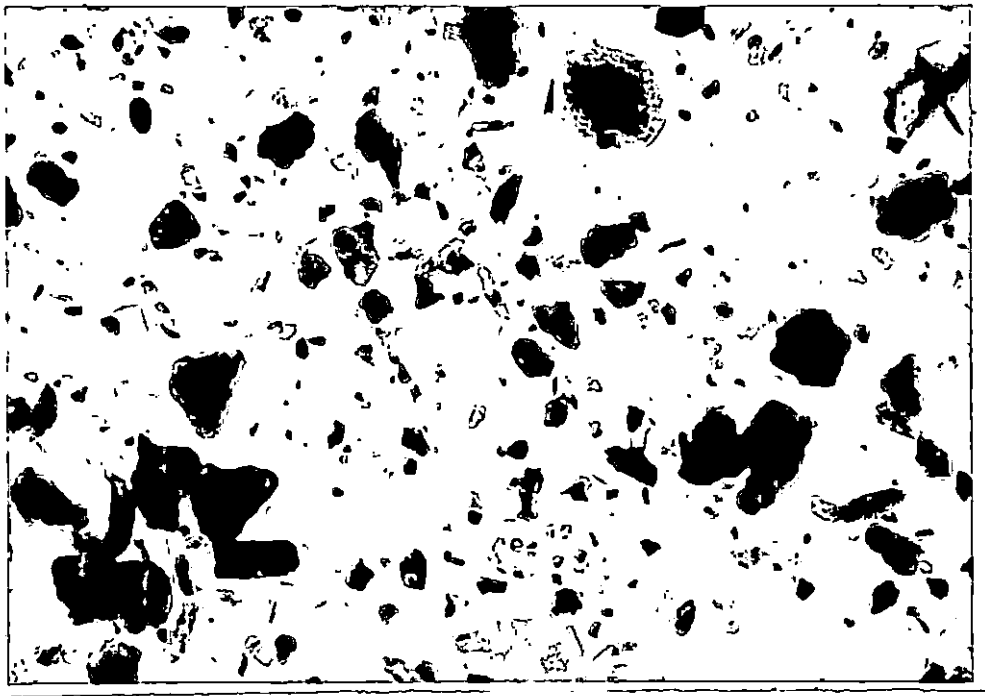
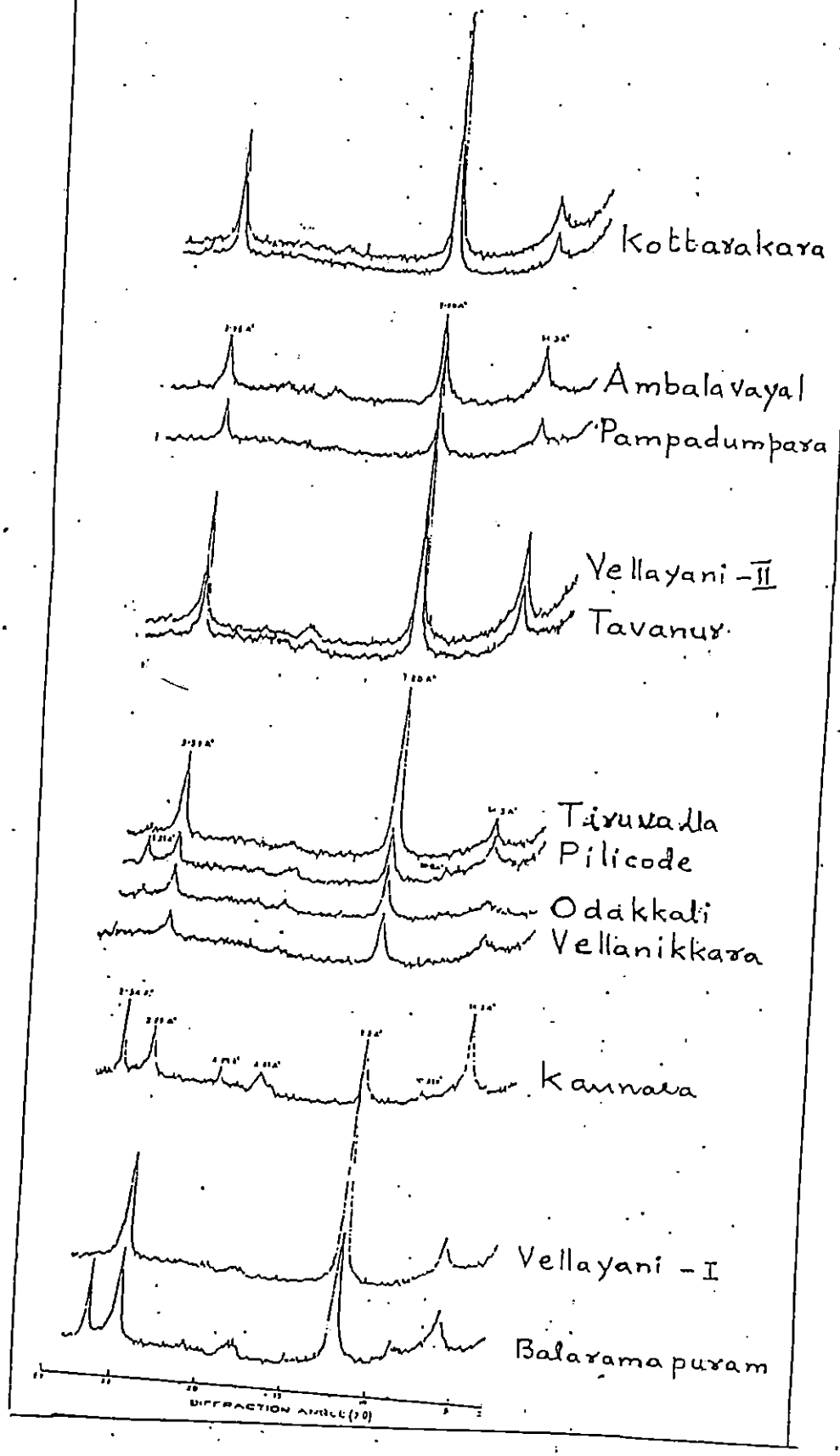


Plate No 35 Fine sand mineralogy photomicrograph of Pilicode soil profile in transmitted light mgf 100x.

FIG. 2. X-RAY DIFFRACTOGRAMS OF UNTREATED CLAY FRACTION OF SOIL PROFILES (0-100 cm)



The x-ray diffraction analysis of representative untreated clay samples from 0 to 100cm depth in predominently kaolinitic ranging from 50-80 percent. At Kannara, Pampadumpara and Ambalavayal this is followed by more 2:1 type of minerals. Chlorite mica quartz are the other important clay minerals identified.

**Classification**

As per the Soil Taxonomy (1975) the Balaramapuram profile keys out to be a member of fine loamy, kaolinitic isohyperthermic family of kandic Haplustalf.

Vellayani I profile comes under fine loamy kaolinitic isohyperthermic family of Typic Kandiustults.

Vellayani II profile is also a member of the same family of the same subgroup of Kandiustults.

The Thiruvalla profile can be fitted within fine loamy mixed isohyperthermic family of Tropustults. the Odakkali profile also accommodated similarly. The profile at Kottarakara and Vellanikkara is best accommodated in the clayey skeletal Kaolinitic isohyperthermic family of Typic Kandiustults. the Pilicode profile can also be accommodated similarly.

The profile at Pampadumpara with cambic horizon is a member of fine loamy mixed, hyperthermic family of Haplustalfs. The Ambalavayal profile also can be accommodated similarly.

The profile at Calicut keys in to be a member of clayey skeletal Kaolinitic isohyperthermic family of Kandiudults.

The profile at Tavanur is a member of fine clayey kaolinitic isohyperthermic family under unique subgroup namely petroferric Dystropepts.

The results on the physicochemical analysis of individual is presented below.

## I BALARAMAPURAM PROFILE

### 1.0 Physical properties

Granulometric composition and textural ratios of the soil profiles are presented in table 1.0. In the Balaramapuram profile gravel is less in this profile, coarse sand content ranges between 22.00 and 30 percent, it decreases with depths. In the case of fine sand content it exhibitted a profile pattern of increase with depths. Its content varies between 13 and 16.6 percent. Among the fine fractions silt content ranges between 12.5 and 15 percent and clay ranges between 40 and 47.5 percent within the profile. Silt exhibitted a profile pattern of alternate increase and decrease while the clay increases down the profile. Finesand/coarse sand, silt/ clay and clay ratios of the profile lies between 0.43 and 0.76, 0.26 and 0.338 and 1.057 and 1.41 respectively. Among the textural ratio fine sand/coarse sand increased down the profile. Both silt/clay and clay ratio decreased down the profile.

### 1.1 Single Value Constants

Single value constants are presented in table 2.0. The single value constants of the profile namely Apparent specific gravity, absolute specific gravity, maximum waterholding capacity, percentage pore space, volume expansion varies from 1.044 to 1.4[illegible], 1.72, to 2.5[illegible] 28.89 to 46.80 percent, 40.4 to 52.19 percent and 5.83 to 11.83 percent respectively. Both specific gravity determination exhibited a profile pattern of increase with depth. In the case of maximum water holding capacity and pore space an alternate decrease and increase is observed. Volume expansion decreases with depth.

### 1.2 Chemical properties

The chemical properties of the soil profile are presented in Table 3.0.

#### 1.2.1 Soil reaction

The soil $p^{H}$ ranges from 4.8 to 4.9 $p^{H}$KCl ranges between 3.7 to 4. The observed shift in $P^{H}$($\Delta p^{H}$) ranges between -0.9 to -1.2. Among the three parameter of soil reation $P^{H}$w remain almost steady through out the profile while $P^{H}$ KCl increase with depth with a relative drop in $\Delta p^{H}$.

#### 1.2.2 Electrical Conductivity

The soluble salt concentration expressed as electrical conductivity in less than 0.3dSm$^{-1}$ throughout the profile with little variation.

### 1.2.3 Organic Carbon

Organic carbon content in the surface horizon is 0.25 percent while it is 0.141 percent in the second and third horizon.

### 1.2.4 Cation exchange capacity

Cation exchange capacity of the Balaramapuram profile in below 3.8 cmol ($p^+$) $kg^{-1}$. It ranges between 2.6 and 3.8 cmol ($p^+$) $kg^{-1}$ and increasing with depth.

### 1.2.5 Exchangeable bases.

The exchangeable potassium, sodium, magnesium and calcium content of the profile ranges between 2.34 to 3.68 cmol ($p^+$) $kg^{-1}$ 2.76 to 10.45 cmol ($p^+$) $kg^{-1}$, 13.11 to 46.81 cmol ($p^+$) $kg^{-1}$ and 15.09 to 80.3 cmol ($p^+$) $kg^{-1}$ respectively. All the above exchangeables exhibited an alternate increase and decrease profile pattern. Considering the variation in horizon, surface,soil are less rich in exchangeables.

### 1.2.6 Extractable iron:-

The citrate dithionate bicarbonate extractable iron in the surface horizons ranges from 1.21 to 2.44 percent. It showed a decreasing trend with depth.

increase with depth in case of laterite profile. The silt contents were 19.5, 8.1, 5.5 and 27.1 percent in red loam profile and 22.5 16.5 and 17 percent in laterite profile. In both the cases silt content decreased with depth, clay content was 35.5, 52.5, 56.35 and 42.75 percent and 24.9, 29.8, 30.5 percent in the red loam and laterite profile respectively.

Among the textural ratios namely Fine sand/coarse sand, Silt/clay, and clay ratios, fine sand/coarse sand showed an alternate increase-decrease pattern in red loam soil while in laterite profile it increased with depth. While $\frac{\text{silt}}{\text{clay}}$ and clay ratios decreased with depth in both the profiles. The respective values for fine sand/coarse sand in red loam soil are 0.24, 0.3, 0.25 and 0.39 and the values for the same in laterite soil were 0.2, 0.27 and 0.788. The silt/clay ratio ranges from 0.1 to 0.65 in red loam soil and 0.413 to 0.9 in laterite soil. Clay ratio showed a decreasing profile pattern with values ranging from 0.737 to 1.749 and 0.97 to 2.4 in red loam and laterite profile respectively.

## 2.1 Single value Constants

Single value constant are presented in Table 2.0.

The single value constants namely apparent specific gravity in red loam profile are 1.031, 1.081, 1.02 and 1.04 in the four horizons respectively while absolute specific gravity is 1.82, 2, 2, and 2.0 in the four horizons.

Both absolute specific gravity and apparent specific gravity did not show much variation with depth. Maximum water holding capacity ranges from 43.5 to 52.91 percent. It showed a decrease-increase profile pattern. The values for percentage pore space varied from 46.7 and 50.8 percent and that for volume expansion for 100gm soil ranges from 5.2,to 8.23 percent respectively.

In laterite profile apparent specific gravity were constant through out the profile. The values for apparent specific gravity was 1.08, 1.04 and 1.04 respectively and that of absolute specific gravity was 1.8, 1.84 and 1.99 throughout the profile. Maximum water holding capacity and percentage pore space showed a similar profile pattern. They showed an increase with depth. The respective values for maximum water holding capacity was 39.9, 46.40, 50.01, percent and for percentage pore space it was 39.64,40.67 and 49.23 percent respectively volume expansion of 100gm soil showed a decrease - increase profile pattern. Respective values for this was 4.6, 3.2 and 4.4 percent.

## 2.2 Chemical Properties

The chemical properties of the soil profiles are presented in table 3.0.

2.2.1Soil Reaction:-

The $pH_w$ of Red loam profile varies from 4.0 to 4.7 while $pH_{KCl}$ varies from 3.3 to 3.9 pH showed a decrease - increase profile pattern.

2.2.2 **Electrical conductivity**

The soluble salt concentaion expressed as electrical conductivity in less than 0.3 $dSm^{-1}$ throughout the profile, with little profile variation in both red loam profile as well as laterite profile.

2.2.3 **Organic Carbon**

Organic carbon showed a increase - decrease profile pattern in red loam profile while it showed a decrease increase profile pattern in laterite profile. The respective values for organic carbon in red loam profile were 0.17, 1.044, 0.288 and 0.14 percent while in laterite profile it showed a decrease increase profile pattern. The respective value for organic carbon in this profile in 0.223, 0.057 and 1.212 percent.

2.2.4 **Cation Exchange capacity**

The cation exchange capacity of Vellayani profile ranges from 2.6 to 6.5 cmol $(p^+)$ $kg^{-1}$, in laterite soil it is 2.6-5.3 and 3.4 to 6.5 in red loam soil. In both profiles it showed a decreasing trend with depth. However cation exchange capacity was higher in red loam profile.

### 2.2.5 Percentage Base Saturation (PBS)

Percentage base saturation showed a decrease - increase profile pattern in red loam soil and decreasing trend in laterite profile. In Red loam soil the values recorded in the four horizon were 12.43, 8.53, 20.9 and 22.23 percent respectively while the values for laterite profile 28.97, 18.87 and 18.29 percent respectively.

### 2.2.6 Extractable iron

Citrate bicarbonate dithionate extractable iron showed a decrease-increase profile pattern in red loam soil while in laterite soil it showed a increasing profile pattern. In red loam soil the corresponding values were 2.52, 1.51, 2.65 and 1.17 percent while that for laterite soil was 1.86,2.48 and 2.17 percent.

### 2.2.7 Extractable aluminium

In both red loam soil and laterite soil it showed a increase- decrease profile pattern. In the first profile the KCl extractable Aluminium content was 0.22, 1.526, 0.436, 0.654 cmol $(p^+)$ $kg^{-1}$ and in the laterite profile the content of Aluminium was 0.872, 1.308 and 1.084 cmol $(p^+)$ $kg^{-1}$.

### 2.2.8 Available nitrogen phosphorous and potassium

In the red loam profile nitrogen content varied from 269 to

298 $kgha^{-1}$ and the content of phosphorous varied from 15.7 to 79.5 $kgha^{-1}$. The content of potassium ranges from 1.48 to 59.3 $kgha^{-1}$.

In laterite profile the content of nitrogen was 307, 269 and 217 $kgha^{-1}$ while that of phosphorous was 45.9, 33.7 and 33.8 $kgha^{-1}$. The content of potassium varies from 2.4 to 49.2 $kgha^{-1}$.

## III KOTTARAKARA

### 3.0 Physical properties:-

In Kottarakara profile the soil was highly gravelly. The gravel content showed a increase - decrease profile pattern. The gravel content in the four horizon identified were 66.4, 71.1, 66.9 and 80.12 percent. The coarse sand content range from 36.0 to 40.7 percent and fine sand content ranges from 11.5 to 16.5 percent. Among the fine fractions silt content ranges from 10 to 11 percent while clay content ranges from 35 to 41 percent. The silt content was almost constant throughout the profile while clay content showed a increasing trend with depth. Among the textural ratios the fine sand/ coarse sand ranges from 0.32 to 0.46 and silt/clay ranges from 0.25 to 0.29 and clay ratio ranges from 1.3 to 1.79. The fine sand/coarse sand ratio showed a decrease - increase profile pattern while silt/clay ratio was almost constant and clay ratio showed a decreasing trend with depth.

### 3.1 Single value constant

The single value constants of this profile is presented in table 2.0. Apparent specific gravity ranges from 0.965 to 1.05 and Absolute specific gravity ranges from 1.72 to 2.1. The apparent specific gravity showed almost a constant trend while absolute specific gravity showed a alternate increase-decrease profile pattern. Maximum water holding capacity exhibitted the following values in the four horizon that is 48.7, 47.6, 52.8 and 51.36 percent. It showed a alternate decrease-increase profile pattern. Percentage pore space showed a alternate increase -decrease pattern, with the following respective values ie 47.7, 53.0, 45.4 and 46.60 percent. While volume expansion showed a continuously increasing trend with values ranging from 1.6, 4.9, 4.6 and 4.8 percent respectively.

### 3.2 Chemical properties:-

Chemical properties of this soil profile is presented in table 3.0

#### 3.2.1 Soil reaction:-

The $p^{H}w$ ranges from 4.4 to 4.8 and $p^{H}KCl$ ranges from 3.4 to 3.9 Both $p^{H}w$ and $p^{H}KCl$ showed a decreasing trend with a relative shift in $\Delta p^{H}$ ranging from -0.8 to -1.1.

### 3.2.2 Electrical conductivity

The soluble salt concentration expressed as electrical conductivity is less than 0.3dSm$^{-1}$ throughout the profile with little profile variation.

### 3.2.3 Organic carbon

Organic carbon content ranges between 0.309 to 1.107 percent. In the surface horizon it is 0.918 percent. While in the next two horizon it increase to 0.99 and 1.107 percent respectively. In the fourth horizon it decreased to 0.309 percent.

### 3.2.4 Cation exchange capacity

The cation exchange capacity of Kottarakara profile is below 4.4 cmol ($p^+$) kg$^{-1}$. The corresponding values for the four horizon are 3.9, 4.3, 4.4, 4.1 cmol ($p^+$) kg$^{-1}$. The profile pattern exhibitted by it is an increasing one. Cation exchange capacity increases with depth.

### 3.2.5 Exchangable bases

The percentage base saturation was very low in this profile. It ranges from 2.37 to 7.84. Among the exchangeable bases the surface soil showed a high content of calcium followed by sodium magnesium and potassium.

### 3.2.6 Extractable iron

The citrate dithionate extractable iron of Kottarakara profile are 0.24, 0.19, 0.53,and 0.22 percent respectively. It showed an alternate decrease increase profile pattern .

### 3.2.7 Extractable Aluminium

The content of KCl extractable Aluminium in this profile was 1.971, 2.91, 0.218 and 1.10 cmol ($p^+$) $kg^{-1}$. It showed an alternate increase - decrease profile pattern.

### 3.2.8 Available Nitrogen phosphorous and potassium.

The content of Nitrogen in this profile was 280, 278, 298,291kg$ha^{-1}$ and that of phosphorous it is 16.8, 16.8, 11.2 and 16.8 respectively. In case of potassium it ranges from 3.58 to 12.03 kg $ha^{-1}$.

## IV THIRUVALLA

### 4.0 The physical properties

The granulometric composition and textural ratios of the Thiruvalla profile were presented in table 1.0.

In the Thiruvalla profile the soil was gravelly with the percentage of gravel content showing an increasing profile pattern. The gravel percentage in this profile ranges from 22.27 to 66.89 percent. The coarse sand content ranges from 7.5 to 11.5

percent with an alternate increase-decrease profile pattern. The fine sand content were 32.5, 14.5.14.25 and 22.75 percent. It showed a decreasing profile pattern. Among the fine fractions silt content ranges from 19 to 23 percent and clay content ranges from 39.5 to 49.5 percent. The clay and silt content showed an increasing profile pattern. Textural ratios of this profile such as fine sand/coarse sand ranges from 1.64 to 4.3, and silt/clay ratio ranges from 0.45 to 0.54. The values for clay ratio was 1.52 , 0.96, 0.93 and 1.41 respectively.

### 4.1 Single value constants

Single value constants of the Thiruvalla profile is presented in table 2.0. The absolute specifice gravity, apparent specific gravity, maximum water holding capacity, percentage pore space and volume expansion of 100gm soil ranges from 1.4 to 2 , 0.9 to 1.0 , 37.2 to 65.6 percent 33.8 to 57.8 percent and 2.8 to 5.4 percent respectively.

### 4.2 Chemical properties

Chemical properties of the Thiruvalla profile is presented in table 3.0.

#### 4.2.1 Soil reaction

pHw and pHKCl ranges from 4.9 to 6 and 4.1 to 5.2 respectively ^pH ranges from -0.7 to -1.2. The ^pH showed an increasing trend with depth.

### 4.2.2 Electrical Conductivity

The soluble salt concentration expressed as electrical conductivity ranges from 0.010 to 0.0505 $dSm^{-1}$. In second and third horizon it exhibitted a high value namely 0.05 $dSm^{-1}$ and 0.04 $dSm^{-1}$ respectively.

### 4.2.3 Organic Carbon

The organic carbon content ranges from 0.055 to 0.683 percentage. It showed a increase-decrease profile pattern with depth.

### 4.2.4 Cation exchange capacity

The cation exchange capacity showed a slight increase at first with depth then decreased continuously through out the profile. It is less than 16cmol $(p^+)$ $kg^{-1}$. The corresponding values in the four horizons is 11.4, 12.2, 9.7 and 8.4 cmol $(p^+)$ $kg^{-1}$.

### 4.2.5 Percentage base saturation

Percentage base saturation ranges from 11.51 to 32.41 percent. The lowest value of 11.51 percent was noted in the second horizon while the highest value of 32.41 percent was noted in the last horizon.

### 4.2.6 Exchangeable bases

Exchangeable bases namely potassium, sodium, magnesium calcium ranges from 1.06 to 11.62, 3.01 to 4.67, 14.59 to 50.25 and 115.85 to 216.15cmol ($p^+$) $kg^{-1}$.

### 4.2.7 Extractable Aluminium

KCl extractable aluminium varies from 0.33 to 1.744 cmol ($p^+$) $kg^{-1}$. This showed an alternate decrease - increase profiles pattern through out the profile.

### 4.2.8 Extractable iron

The iron content in this profile ranges from 2.8, 2.86, 3.46 and 1.86 percentage respectively. It showed an alternate decrease-increase profile pattern.

### 4.2.9 Available Nitrogen Phosphorus and Potassium

The available Nitrogen in Thiruvalla profile varies from 199.4 to 291 $kgha^{-1}$. It showed a decreasing trend with profile. Available phosphorous content varies from 33.71 to 59.2 $kgha^{-1}$ while available potassium ranges from 9.27 to 100.8 kg $ha^{-1}$.

## V PAMPADUMPARA

### 5.0 Physical Propertice

The granulometric composition and textural ratios of Pampadumpara soil profile is presented in table 1.0.

The gravel content of this profile is above 40 percent through out the profile. The percentage content of gravel varies from 43.9 to 65.5 percent. It showed an alternate increase-decrease profile pattern. Coarse sand content ranges between 25.9 and 33.55percent. A decrease in content of coarse sand was noted through out the profile while fine sand content ranges from 10 to 20 percent exhibiting a profile pattern of alternate increase-decrease. Clay content ranges from 22.5 to 42.5 percent with an alternate increase -decrease profile pattern while silt content ranges from 10.25 to 35 percent showing an alternate decrease-increase profile pattern. Textural ratios such fine sand/ coarse sand, silt/clay and clay ratio ranges from 0.3 to 0.8, 0.24 to 0.77 and 1.39 to 2.42 respectively. Coarse sand showed an alternate increase-decrease profile pattern while silt/clay ratio and clay ratio showed an alternate decrease-increase profile pattern.

## 5.1 Single value constants

The single value constants of Pampadumpara profile was shown in table 2.0.

The apparent specific gravity ranges from 0.95 to 1.2 [illegible]. It was almost constant through out the profile. The absolute specific gravity ranges from 1.29 to 1.921 [illegible]. It showed an alternate increase-decrease profile pattern. Maximum water holding capacity ranges from 25.0 to 51.6 percent. It

showed an increase in the second and third horizon and in the last horizon it showed a decrease.

The percentage pore space showed the respective values in the four horizon that is 49.4, 26.26, 52.4 and 52.19 respectively. It showed an alternate decrease-increase profile pattern. Volume expansion per 100gm soil also showed an alternate decrease-increase profile pattern, with values ranging from 4.3 to 9.7 percent.

## 5.2 Chemical properties

The chemical properties of Pampadumpara profile is given in table 3.0.

### 5.2.1 Soil reaction

The pHw varies from 6 to 6.2 while pH(KCl) ranges between 4.4 to 5.4. The observed shift in pH(^pH) ranges between -0.6 to -1.6. Among the three parameters of soil reaction pHw remain almost steady throughout the profile. While pH (KCl) increase with depth.

### 5.2.2 Electrical conductivity

The soluble salt concentration expressed as electrical conductivity of this profile ranges from 0.08 to 0.2 $dSm^{-1}$.

### 5.2.3 Organic Carbon

The percentage of organic carbon in this profile was 1.338, 1.22, 1.055 and 0.55 percent respectively. A decrease in percentage of organic carbon was noted through out the profile.

### 5.2.4 Cation exchange capacity

The cation exchange capacity of Pampadumpara profile was quite high with values ranging from 10.4 to 16.7 cmol $(p^+)$ $kg^{-1}$. The profile for pattern exhibitted in this profile for this property is a decreasing trend with depth.

### 5.2.5 Exchangeable bases

The exchangeable potassium sodium magnesium and calcium content of the profile ranges. between 19.9 to 24.59 cmol $(p^+)$ $kg^{-1}$, 2.36 to 5.78 cmol $(p^+)$ $kg^{-1}$, 39.3 to 64.75cmol $(p^+)$ $kg^{-1}$ and 136.5 to 310.7 cmol $(p^+)$ $kg^{-1}$. All the above exchangeable except calcium showed a decreasing profile pattern. Calcium showed a slight increase at first then decreased continuously. Considering the variation in horizon, surface soils are rich in exchangeables.

### 5.2.6 Percentage base saturation

Percentage base saturation ranges from 21.22 to 31.71 percent. The same profile trend as exchangeables is strengthened by the distribution of percentage base saturation.

### 5.2.7 Extractable iron

The citrate dithionate bicarbonate extractable iron ranges from 0.17 to 0.28 percent. Compared to the second and third horizon a higher content of iron was noticed in the first and last horizon.

### 5.2.8 Extractable Aluminium

The KCl extractable Aluminium ranges from 0.216 to 1.524 cmol ($p^+$) $kg^{-1}$. It showed a decrease - increase profile pattern.

### 5.2.9 Available Nitrogen phosphorous and potassium

The Nitrogen content in this soil showed an increase-decrease profile pattern. The respective values for the four horizon are 285,309,199 and 269kgha$^{-1}$.

In the case of phosphorous the content of phosphorous decrease with depth. The content of phosphorous ranged from 33.7 to 58.2kgha$^{-1}$ while potassium showed a decrease in trend. Its value ranges fron 174.7 to 214.6 kgha$^{-1}$.

## VI ODAKKALI

### 6.0 Physical properties

Granulometric composition and textural ratios of odakkali profile are presented in table 1.0.

In this profile the percentage of gravel was comparatively low. The gravel percentage ranges from 21.16 to 27.3 percent. It showed a profile pattern of increase with depth while the percentage of coarse sand showed a decreasing trend with depth. The respective values for coarse sand contant in this profile was 52.5, 32.2 and 30 percent. Fine sand and silt showed a profile pattern of alternate range and increase with depth. The percentage of fine sand ranges from 11 to 15.22 percent while the silt content ranges from 10.5 to 22.5 percent. The clay content showed in alternate increase and decrease with depth. The percentage of clay ranges from 20 to 35 percent. Among the textural ratios fine sand/coarse sand increases down the profile with a values ranging from 0.17 to 0.51 while the silt/clay and the clay ratio showed an alternate decrease and increase profile pattern. The silt/clay ranges from 0.3 to 0.9% and the clay ratio ranges from 1.53 to 4.21.

## 6.1 Single value constants

The single value constant of this profile is shown in table 2.0. The single value constants namely apparent specific gravity absolute specific gravity, maximum water holding capacity, percentage pore space and volume expansion varies from 1.124 to 0.818, 1.52 to 2.44 [illegible] 38.8 to 84.5 percent, 53.6 to 58 percent and 2.6 to 4.84 percent respectively. The apparent specific gravity showed a increase and decrease pattern while the volume expansion showed an alternate increase-decrease profile

pattern. Absolute specific gravity showed an opposite trend. Maximum water holding capacity and percentage pore space increase with depth.

## 6.2 Chemical properties

The chemical properties of this profile is shown in table 3.0.

### 6.2.1 Soil reaction

The pHw varies from 4.4 to 4.9 while pH(KCl) ranges between 3.8 to 4.1. The observed shift in pH (^pH) ranges between 0.5 to -1.

Among the three parameters of soil reaction the pHw showed decrease in trend while pH (KCl) and ^pH showed an alternate decrease - increase profile pattern.

### 6.2.2 Electrical conductivity

The salt concentration expressed as electrical conductivity is less than 0.3 $dSm^{-1}$ through out the profile.

### 6.2.3 Organic carbon

The organic carbon content in the surface horizon is 1.71 percent while in the second and third horizon it decrease to 1.52 and 0.75 percent respectively.

### 6.2.4 Cation Exchange Capacity

The cation exchange capacity of this profile is above 7 cmol $(p^+)$ $kg^{-1}$. It ranges between 7.2 to 7.8 cmol $(p^+)$ $kg^{-1}$, showing an alternate increase-decrease profile pattern.

### 6.2.5 Percentage Base Saturation

It ranges from 6.6 to 30.88 percent. The highest CEC of 30.88 is recorded by surface horizon and much lower values are recorded with lower horizon.

### 6.2.6 Exchangeable bases

The exchangeable potassium sodium magnesium and calcium content of this profile ranges 0.84 to 3.33 cmol $(p^+)$ $kg^{-1}$, 4.38 to 5.98 cmol $(p^+)$ $kg^{-1}$, 4.15 to 45.9 cmol $(p^+)$ $kg^{-1}$ and 51.2 to 167.1 cmol $(p^+)$ $kg^{-1}$ respectively. Compared to the underlying horizons the surface soil is rich in exchangeable bases.

### 6.2.7 Extractable iron

The citrate dithionate:- bicarbonate extractable iron ranges from 1.8 to 2.79 percent. It showed a profile of alternate increasing -decreasing one.

### 6.2.8 Exchangeable Aluminium

The KCl extractable Aluminium is 0.218 to 1.744 cmol $(p^+)$ $kg^{-1}$. Unlike the iron content the Aluminium content showed an alternate increase-decrease profile pattern.

### 6.2.8 Available Nitrogen Phosphorous and Potassium.

The available nitrogen and phosphorous showed a similar profile pattern of decreasing trend with depth. The available Nitrogen ranges from 170 to 282kg $ha^{-1}$ and available phosphorous content ranges from 22.4 to 26.9 kg $ha^{-1}$ while the profile pattern exhibitted by potassium is dreceasing trend. Its value ranges fom 7.38 to 28.12 $kgha^{-1}$.

## VII KANNARA

### 7.0 Physical properties

The granulometric composition and textural ratios of Kannara soil profile is presented in table 1.0.

Among the physical properties the gravel percentage of this profile was comparatively less. The gravel content ranges from 13.9 to 30.4 percent. The percentage of coarse sand ranges from 25.5 to 40.3 percent. The percentage of coarse sand was high in the surface soil. The fine sand content ranges from 0.7 to 17.17 percent. The values for percentage of clay in this profile is 12.0, 20, 57.5 and 40 percent. The silt content ranges from 5 to 37.5 percent. Among the textural ratio the fine sand/coarse sand and silt/clay showed an alternate increase-decrease profile pattern. The fine sand/coarse sand ranges from 0.33 to 0.66 while silt/clay ratio ranges from 0.09 to 3.0. The clay ratio decreases with depth. Its value ranges from 0.69 to 6.54.

## 7.1 Single value constants

The single value constant of this profile is shown in table 2.0. The apparent specific gravity, the absolute specific gravity showed the following values 1.1 to 1.2 and 1.621 to 2.04, respectively. The apparent specific gravity was almost constant throughout the profile while the absolute specific gravity showed an alternate decrease -increase profile pattern. The maximum water holding capacity ranges from 34 to 46.94percent and the percentage pore space ranges from 34.167to 47.32 percent. The volume expansion showed an alternate decrease-increase profile pattern with the values ranging from 2.13to 12.93percent.

## 7.2 Chemical properties

The chemical properties of the Kannara profile is shown in Table 3.0.

### 7.2.1 The soil reaction

The pHw ranges from 4.9 to 5.2 while pH(KCl) ranges from 3.6 to 4.4. The observed shift in pH(^pH) ranges from -0.8 to -1.3.

### 7.2.2 Electrical conductivity

The soluble salt concentration expressed as electrical conductivity is below $0.3dSm^{-1}$.

### 7.2.3 Organic Carbon

The organic carbon content ranges from 0.25to 0.54percentage. In this profile the surface soil is rich organic carbon compared to the underlying horizons.

### 7.2.4 The Cation Exchange Capacity

The cation exchange capacity of the Kannara profile is comparatively higher with the values ranging from 6 to 8.9 cmol $(p^+)$ $kg^{-1}$. The profile pattern exhibited by this property is an increasing trend with depth.

### 7.2.5 Exchangeable Bases

The exchangeable potassium, sodium, magnesium and calcium showed almost similar profile pattern of alternate decrease-increase with depth. The Exchangeable potassium ranges from 8.78 to 12.78 cmol $(p^+)$ $kg^{-1}$. The exchangeable sodium and magnesium ranges from 2.6 to 6.9 cmol $(p^+)$ $kg^{-1}$ and 12.5 to 49.5 cmol $(p^+)$ $kg^{-1}$ respectively. The content of calcium is comparatively higher with values ranging from 120.3 to 204.8 cmol $(p^+)$ $kg^{-1}$.

### 7.2.6 Percentage Base Saturation

The percentage base saturation range from 24.09 to 39.16 percent It showed a similar profile pattern as that of the exchangeable bases.

### 7.2.7 Extractable iron

The citrate dithionate-bicarbonate extractable iron ranges from 1.54 to 2.09 percent. It showed a profile pattern of alternate increase-decrease with depth.

### 7.2.8 Extractable Aluminium

The extractable aluminium also showed a similar profile pattern as that of extractable iron. The aluminium content ranges from 0.218 to 1.308 cmol $(p^+)$ $kg^{-1}$.

### 7.2.9 Available Nitrogen, Phosphorous and potassium

Available nitrogen content ranges from 196 to 264 $kgha^{-1}$. The content nitrogen increase with depth. Available phosphorous ranges from 44 to 179 $kgha^{-1}$. It showed alternate increase - decrease profile pattern while the available potassium content ranges from 76.16 to 111.6 $kgha^{-1}$.

## VIII VELLANIKARA

### 8.0 Physical properties

The granulometric composition and textural ratios of Vellanikkara profile is presented in table 1.0.

In this profile the gravel content was comparatively high and showed a profile pattern of increasing trend with depth. The gravel percentage ranges from 39.30 to 58.5 percent. The

coarse sand content showed a alternate decrease - increase profile pattern. The content of coarse sand varies from 30.11 to 42.7 percent. The fine sand content showed an alternate increase-decrease profile pattern. It ranges form 10.1 to 14.6 percent. Among the finer fractions the silt content increases continuously with depth. while the clay content showed a decrease in the second and third horizon but increase in the fourth horizon. The silt and clay content ranges from 9 to 17.5 percent and 21.25 to 34.25 percent respectively. Among the textural ratios the fine sand/coarse sand showed an increase - decrease profile pattern with values ranging from 0.34 to 0.61. The silt /clay and the clay ratio increased with depth. The silt/clay ranges from 0.37 to 1.6 and the clay ratio ranges from 2.58 to 3.10.

## 8.1 Single value constants

The single value constants of Vellanikkara profile is presented in table 2.0. The apparent specific gravity showed a decrease - increase profile pattern with values ranging from 0.713 to 1.008 $gm^{-3}$. The absolute specific gravity showed a increase in the second horizon and then decreased continuously with depth. The absolute specific gravity ranges from 1.619 to 2.24 $gm^{-3}$. The maximum water holding capacity and the percentage pore space showed similar trend of increase in the second horizon and then decrease in the following horizon. The maximum water holding capacity ranges from 42.5 to 80.83 percent. The percentage pore space ranges from 38.5 to 61.86 percent. The

volume expansion of this soil increase continuously with depth with values ranging from 1.52 to 7.01 percent.

## 8.2 Chemical Properties

The chemical properties of Vellanikkara profile is presented in Table 3.0.

### 8.2.1 Soil Reaction

The $pH_W$ and pH(KCl) increased continuously with depth. The respective values for $pH_W$ and pH(KCl) are 4.9, 5.6, 5.4, 5.5 and 3.5, 3.8, 3.9, 4.6 respectively. The observed shift in pH (^pH) ranges from -1.2 to -1.9.

### 8.2.2 Electrical Conductivity

The electrical conductivity of this soil is below $0.3 dSm^{-1}$.

### 8.2.3 Organic Carbon

The organic carbon content decreased continuously with depth. The surface horizon recorded a carbon content of 1.296 percent while in the lower horizon it ranges from 0.246 to 0.708 percent.

### 8.2.4 Cation Exchange Capacity

The respective values of Cation exchange capacity for the soil profile are 7.2, 5, 7.4 and 6.2 cmol $(p^+)$ $kg^{-1}$. It showed an alternate decrease-increase profile pattern.

### 8.2.5 Exchangeable Bases

Among the exchangeable bases Potassium showed an alternate decrease-increase profile pattern while exchangeable Sodium, Magnesium and Calcium increased continuously with depth. Considering the variations in horizons the surface soil are less rich in exchangeables. The exchangeable Potassium ranges from 3.38 to 6.76 cmol $(p^+)$ $kg^{-1}$ while exchangeable Sodium, Magnesium and Calcium ranges from 4.08 to 7.02, 15.4 to 44.0 and 86.6 to 178.5 cmol $(p^+)$ $kg^{-1}$ respectively.

### 8.2.6 Percentage Base Saturation

The percentage base saturation of the soil ranges from 14.7 to 39.2 percent. The profile pattern exhibitted by this parameter is that of an alternate increase-decrease one.

### 8.2.7 Extractable Iron

The citrate dithionate - bicarbonate extractable iron ranges from 0.205 to 3.1 percent. The content of iron decreased continuously with depth.

### 8.2.8 Extractable Aluminium

The KCl extractable aluminium in the surface soil was 0.76 cmol $(p^+)$ $kg^{-1}$ while in the lower horizon it showed a constant value of 0.109 cmol $(p^+)$ $kg^{-1}$.

### 8.2.9 Available Nitrogen, Phosphorous and Potassium

The available Nitrogen content showed an alternate decrease-increase profile pattern. Its content ranges from 269 to 296kgha$^{-1}$. The Phosphorous content decrease continuously with depth. The content of Phosphorous ranges from 45.9 to 79.5kgha$^{-1}$. The Potassium content showed a value of 33.6, 30.5, 59.02 and 29.5kgha$^{-1}$.

## IX THAVANUR

### 9.0 The physical properties

The granulometric composition and textural ratio of Tavanur soil profile is presented in table 1.0.

This soil profile was highly gravelly with 50 percent and more of gravel content. The coarse sand content decreased continuously with depth. The percentage of coarse sand in this profile are 39.0, 26.0 and 26 respectively. The fine sand content, silt content and clay increased continuously with depth. The respective values for fine sand, silt and clay are 10.5, 11.5, 12.6 and 16.5, 20.15, 27 and 29.8, 30.5, 30.5 respectively.

The fine sand/coarse sand content ranges from 0.27 to 0.79 It showed an increasing trend with depth. The silt/clay ratio showed an alternate decrease - increase profile pattern. Its value ranges from 0.55 to 0.66. The clay ratio decreases with depth with values ranging from 1.89 to 2.21.

## 9.1 Single value constants

The single value constants of Tavanur profile is shown in table 2.0. The apparent specific gravity, the absolute specific gravity, the maximum water holding capacity, the percentage pore space ranges from 0.8 to 1.4 [illegible], 1.70 to 2.35 [illegible], 29.9 to 32.8, 42.3 to 45.6 and 5.61 to 10.9 percent respectively.

## 9.2 Chemical Properties

The chemical properties of this soil is presented in table 3.0.

### 9.2.1 The soil reaction

The $pH_W$ and pH(KCl) ranges from 5.0 to 5.1 and 4.5 to 5.2 respectively.The observed shift in pH(^pH)ranges from-0.1 to -0.5

### 9.2.2 Electrical Conductivity

The soluble salt concentration is below 0.3 $dSm^{-1}$

### 9.2.3 Organic Carbon

The content of organic carbon was high in the surface horizon It ranges from 0.308 to 0.666 percent respectively.

### 9.2.4 Cation Exchange Capacity

The cation exchange capacity was high in the surface horizon and in the fourth horizon . The respective values for this

parameter in this soil were 3.7, 2.0 and 5.7 cmol ($p^+$) $kg^{-1}$ respectively.

### 9.2.5 The Exchangeable Bases

The exchangeable potassium and magnesium showed a similar profile pattern. They increased continuously with depth. The potassium content ranges from 2.69 to 8.4 cmol ($p^+$) $kg^{-1}$ while the magnesium content ranges from 25.8 to 44.65 cmol ($p^+$) $kg^{-1}$. The exchangeable sodium ranges from 4.97 to 6. cmol ($p^+$) $kg^{-1}$. The calcium content showed an alternate increase- decrease profile pattern with values ranging from 59.1 to 127.3 cmol ($p^+$) $kg^{-1}$.

### 9.2.6 Percentage Base saturation

The percentage base saturation ranges from 31.7 to 49 percent. It exhibitted a profile pattern of alternate increase-decrease with depth.

### 9.2.7 Extractable iron

The extractable iron showed an alternate decrease -increase profile pattern with values ranging from 0.383to 0.645percent.

### 9.2.8 Extractable Aluminium

The extractable Aluminium decreases with depth. Its content ranges from 0.218 to 1.09 cmol ($p^+$) $kg^{-1}$.

### 9.2.9 Available Nitrogen, Phosphorous and Potassium

The Available Nitrogen content and the available phosphorus content ranges from 259 to 269 and 38 to 140 $kgha^{-1}$ respectively. The available potassium ranges from 9.27 to 47.86 $kgha^{-1}$.

## X CALICUT

### 10.0 Physical properties

The granulometric composition and textural ratios of Calicut profile is presented in Table 1.0.

The percentage of gravel content in this profile was quite high in the surface soil and the last horizon. The gravel content in the four horizon were 47.2, 45.9, 63.5 and 33.9 percent. The content of coarse sand increase in the $2^{nd}$ horizon and then decreased continuously. The coarse sand content ranges from 10 to 35 percent. the fine sand content ranges from 6.1 to 11.6 percent. It showed an alternate decrease - increase profile pattern. While the finer fraction namely the silt and clay content showed a continuous increase with depth. The clay content ranges from 32.5 to 62.5 percent and silt content ranges from 8.2 to 21 percent. Among the Textural ratios the Fine sand/Coarse sand ratio showed an alternate increase- decrease with depth. While clay ratio decreased with depth. Fine sand/coarse sand ratio ranges from 0.28 to 0.61, silt/clay ratio ranges from 0.19 to 0.35, and clay ratio ranges from 0.56 to 1.64.

## 10.1 Single value constant

Among the single value constants the apparent specific gravity, absolute specific gravity and percentage pore space showed a similar profile pattern of alternate increase - decrease trend. The above parameter ranges from 0.76 to 1.1 , 1.1 to 2.3 and 33.5 to 57.8 percent respectively. Maximum water holding capacity ranges from 44.8 to 54.26 percent while volume expansion of 100gm soil ranges from 3.11 to 6.6 percent.

## 10.2 Chemical properties

The chemical properties of Calicut profile is presented in table 3.0.

### 10.2.1 Soil reaction

The $pH_w$ ranges from 4.8 to 5.2 and $pH$ KCl ranges from 3.8 to 4.4. The observed shift in $pH$ ($\Delta pH$) showed a increasing trend with depth.

### 10.2.2 Electrical Conductivity

The soluble salt concentration expressed as electrical conductivity is very low, 0.01dSm$^{-1}$ and it was constant throughout the profile.

### 10.2.3 Organic Carbon

Organic Carbon content was low in the surface soil and last horizon. While in the second and third horizon its value was high. Organic carbon content ranges from 0.33 to 1.467 percent.

### 10.2.4 Cation exchange capacity

The cation exchange capacity was above 5 cmol $(p^+)$ $kg^{-1}$ throughout the profile. It showed a decreasing trend with depth with values ranging from 5.8 to 7.9 cmol $(p^+)$ $kg^{-1}$.

### 10.2.5 Exchangeable bases

The exchangeable potassium, sodium magnesium and calcium in this soil ranges from 1.7 to 15.6, 4.1 to 31.1, 13.2 to 58.6, 24.85 to 68.0 cmol $(p^+)$ $kg^{-1}$. The exchangeable potassium sodium showed an alternate increase - decrease profile pattern. while Exchangeable calcium increased at first and then decreased continuously.

### 10.2.6 Percentage base saturation

The percentage base saturation showed an alternate increase-decrease profile pattern with values ranging from 9.39 to 26.1 percent.

### 10.2.7 Extractable iron

The citrate dithionate bicarbonate extractable iron showed an alternate increase - decrease profile pattern with values ranging from 1.58 to 3.07 percent.

### 10.2.8 Extractable Aluminium

The KCl extractable aluminium ranges from 0.218 to 4.32 cmol $(p^+)$ $kg^{-1}$. It also showed a similar trend with as extractable iron. An alternate increase-decrease profile pattern was exhibitted by aluminium also.

### 10.2.9 Available Nitrogen, phosphorous and potassium

Available nitrogen content showed an alternate decrease - increase profile pattern with values ranging from 197 to 311kgha$^{-1}$. Available phosphorous ranges from 24.6 to 36.9 kgha$^{-1}$. Available potassium ranges from 14.82 to 134.6kgha$^{-1}$.

## XI AMBALAVAYAL

### 11.0 Physical Properties

The Granulometric composition and textural ratios of Ambalavayal profile is presented in table 1.0. The content of gravel in this profile ranges from 12.7 to 36.3 percent. The gravel content showed a decrease in third horizon while in the rest of the horizon it was about 30 percent. The percentage of

coarse sand decreased continuously with depth. It ranges from 18.70 to 24.1 percent. The fine sand content showed an alternate increase decrease profile pattern with values ranging from 19.7 to 21.5 percent. The silt and clay content ranges from 11 to 25 percent and 30 to 45 percent respectively.

Among the textural ratios the Fine sand/coarse sand ratio increased with depth. With values ranging from 0.82 to 1.09. The [illegible]/clay ratio ranges from 1.1 to 2.2.

**11.1 Single value constants:-**

The single value constants are presented in table 2.0. The apparent specific gravity showed a constant value of 0.96 upto the third horizon and in the last horizon it decreased to 0.857[illegible]. The absolute specific gravity showed a value of 1.65[illegible] in all the horizon except in the third horizon where it increased to 1.88[illegible]. The maximum water holding capacity ranges from 50.2 to 58.4 percent with increase in depth. The percentage pore space and volume expansion of 100gm soil ranges from 37.7 to 51.6 percent and 1.84 to 5.8 percent respectively.

**11.2 Chemical Properties:-**

The chemical properties of this profile is shown in table 3.0.

### 11.2.1 Soil Reaction:-

The $pH_w$ and $pH$ Kcl showed an increase with depth. $pH_w$ ranges from 4.2 to 4.9 while $pH_{KCl}$ ranges from 3.5 to 3.8. The observed shift in pH(^p) ranges from -0.7 to -1.3.

### 11.2.2 Electrical conductivity:-

The soluble salt concentration measured as electrical conductivity ranges from 0.04 to 0.06 $dSm^{-1}$.

### 11.2.3 Organic Carbon

The percentage of Organic Carbon in the four horizon of this profile were 1.1, 0.6, 0.1 and 0.3 percent respectively.

### 11.2.4 Cation exchange capacity

The cation exchange capacity was high in the surface horizon, then it decreased down the profile. The cation exchange capacity in the four horizon are 7.5, 8.3, 7.1, and 6.4 cmol ($p^+$) $kg^{-1}$ respectively.

### 11.2.5 Exchangeable bases

The exchangeable potassium sodium calcium and magnesium ranges from. 2.23 to 11.69, 1.67 to 26.73, 5.7 to 38.4 and 38.5 to 65.1 cmol ($p^+$) $kg^{-1}$ respectively.

### 11.2.6 Percentage base saturation

The percentage base saturation showed an alternate decrease and increase pattern it ranges from 7.86 to 21.4 percent.

### 11.2.7 Extractable iron

The citrate dithionate bicarbonate extractable iron ranges from 1.1 to 1.5 percent. It showed an alternate decrease increase profile pattern.

### 11.2.8 Extractable Aluminium

The KCl Extractable aluminium ranges from 0.23 to 1.3% cmol $(p^+)$ $kg^{-1}$. The Extractable aluminium showed a decrease with depth.

### 11.2.9 Available Nitrogen phosphorous and potassium

Available nitrogen content of this soil ranges from 257 to 300kgha$^{-1}$ and available phosphorous ranges from 20.1 to 95.2kgha$^{-1}$. The available potassium ranges from 02.14 to 19.46 kgha$^{-1}$.

## XII PILICODE

### 12.0 Physical Properties

The granulometric composition and textural ratios of Pilicode profile is presented in Table 1.0.

The soils of this profile was gravelly with gravel percentage above 60 percentage. The content of gravel in the four horizons characterized are as follows, 70.1, 68.4, 70.6, 69.6 percent. It showed a alternate decrease-increase profile pattern. The percentage of Coarse sand ranges from 21 to 33.8 percent. The fine sand and silt content showed an alternate decrease - increase profile pattern. Their content ranges from 9.59 to 20.5 and 12 to 22 percent respectively. The clay content showed an alternate decrease - increase profile pattern. Clay content in this profile ranges from 30 to 36 percent. All the three textural ratio namely fine sand /coarse sand, silt/clay and clay ratio all showed a similar profile pattern of alternate increase - decrease one. The range values for the above ratios are 0.3 to 0.98, 0.34 to 0.72 and 1.6 to 2.08.

## 12.1 Single Value Constants

The single value constant are presented in Table 2.0. The apparent specific gravity ranges from 0.9 to 0.95 . It was almost constant through out the profile. The absolute specific gravity ranges from 1.69 to 1.85 . The maximum water holding capacity ranges from 49.01 to 56.2 percent. It showed an alternate increase - decrease profile pattern. Percentage pore space and volume expansion of 100 gm soil increase continuously with depth. Their value ranges from 45.9 to 57.5 and 2.6 to 4.8 percent respectively.

## 12.2 Chemical Properties

The Chemical properties of this profile is presented in table 3.0.

### 12.2.1 Soil Reaction

The pHw and pHKCl of Pilicode profile ranges from 4.9 to 5.4 and 3.9 to 4.1. The observed shift in pH showed an alternate increase-decrease profile pattern with values ranging from -0.8 to -1.5.

### 12.2.2 Electrical Conductivity

The soluble salt concentration expressed by electrical conductivity is below $0.03 dSm^{-1}$

### 12.2.3 Organic Carbon

The content of organic carbon in this soil ranges from 0.06 to 2.43 percent. The surface soil is rich in organic carbon content and it decreased with depth.

### 12.2.4 Cation Exchange Capacity

The respective values for Cation exchange capacity in the soil were 9.3, 8.2, 5.6 and 2.8 cmol $(p^+)$ $kg^{-1}$. It continuously decreased with depth.

### 12.2.5 Percentage base saturation

The percentage base saturation is below 50 percent throughout the profile. It ranges from 15.4 to 16.9 percent.

### 12.2.6 Exchangeable Bases

Exchangeable Potassium, Sodium, Calcium and Magnesium ranges from 0.74 to 3.46, 4.67 to 4.97, 35.6 to 121.5 and 4.67 to 26.48. percent respectively.

### 12.2.7 Extractable Iron

The citrate dithionate bicarbonate extractable iron was comparatively high in this profile with values ranging from 4.2 to 6.5 respectively.

### 12.2.8 Extractable Aluminium

The KCl extractable Aluminium ranges from 0.436 to 1.09 cmol $(p^+)$ $kg^{-1}$. It showed a decreasing trend with depth and then increased continuously.

### 12.2.9 Available Nitrogen, Phosphorous and Potassium

Available Nitrogen content decreased continuously with depth. Its value ranges from 174 to 298 $kgha^{-1}$. While available Phosphorous showed an alternate decrease - increase profile pattern. The content of phosphorous ranges from 22.4 to 26.8 $kgha^{-1}$. The content of potassium ranges from 6.50 to 30.4 $kgha^{-1}$.

# DISCUSSION

# DISCUSSION

Soil classification is the basis for agrotechnology transfer and for national and regional planning. Soil Taxonomy is one of the well accepted and popular system of soil classification through which soil informations can be communicated globally. Agricultural research station under Kerala Agricultural University and CWRDM Calicut have been located in the important representative land resource areas of the state. All these stations have valuable treasure of research results perfected by the efforts of dedicated scientists over years. These perfected modules of research are well appreciated and accepted by the farming community of the state, Nationally and to some extent globally also Soil Taxonomy of these sites are highly essential for their world wide communication appreciation, application and follow up. Hence in the present study one representative upland profile each from the 11 research station under Kerala Agricultural University and CWRDM, Calicut were examined, described, analysed for physical , chemical and mineralogical properties and classified as,per Soil Taxonomy (USDA, 1975).

All the upland profiles studied lies between the latitude 8°5′ and longitude 77° 75′ but elevations range from 20m to 600m above MSL. Mean annual rainfall ranges between 1646mm and mean annual temperature ranges between 24°C and 27°C. Micro topography is flat to mild sloping and steep sloping, Surrounding land forms are undulating and rolling. Parent materials is lateritic alluvium on

residual laterite or granitic gneiss materials of archean age. Rolling or undulating topography of the profile sites provides good drainage which is a pre requisite for laterisation (Kanter and schwertmann, (1974).

Field observation and description is a semiquantitative but a valuable indicator of important physical and chemical soil conditions.

All the soils are gravely with a component having a diameter in excess of 2mm which make considerable part of soil matrix except Balaramapuram. Presence of gravels reduces the volume of soil that can be explored by roots and consequently water that soil can supply to crops. Water shortages develops more rapidly in these gravely soils.

Red, reddish brown, reddish yellow soil colours are characteristic of intense weathering and emphasize the well aerated condition that prevails. Brown, greyish brown and black colour observed because of the humified organic matter coatings. Reddish yellow of the argillic B horizon is as a result of the process of the dehydration of iron compounds in the prevalent long dry season. Distinct iron mottling observed indicate zone of past ground water table fluctuations. At Pampadumpara the extended black colour is due to leached surface soil and humus along former root channels.

Homogeneity of the profile at Balaramapuram, Vellayani I and Thiruvalla is both due to intensity of mixing and uniformity of the material source. Uniformity can also be due to deep weathering of homogenous parent rock in stable environment and prolonged sedimentation. The latter are thus dependent on the parent material which is a geological datum. The lack of abrupt horizon boundary observed in many profiles maybe due to uniformity of soil material and biological activity. The uniform texture resulted in the root zones is related to the physical properties which in turn govern the crop production environment, coarse reddish mottles, indurated iron nodules observed in the subsurface are indications of wetness in the past.

Decrease in sand with depth observed in all profiles is due to advancing of laterisation process. Silt distribution pattern is indicative of disrupted sedimentation and non uniform weathering. The observed higher content clay with depth is due to mechanical elluviation with a higher migration of clay colloids. Silt/clay ratio is an index of weathering and as such lower values observed in all the profiles in the B horizon indicate low degree of ferralitization. Based upon this ratio the profiles can be arranged in the order of decreasing weathering degree. Calicut > Kottarakara > Balaramapuram > Vellayani I > Pampadumpara > Ambalavayal > Thiruvalla> Pilicade > Vellayani II > Tavanur > Odakkali > Vellanikara > Kannara.

Clay ratio is least at vellayani I and maximum at calicut. Critical comparison of the ratio revealed that non clay fraction is maximum at Vellanikkara and least at Balaramapuram and vellayani while at Calicut the clay fraction is higher than the non clay fractions. The observed difference is due to the difference in clay content formed by weathering from the non clay fractions.

The observed variations in bulk density, particle density pore space and water holding capacity in the profiles are expressions of physical conditions of the soil which in turn have been resulted by the laterisation process and clay migration to lower strata.

Volume expansion is due to clay bulge which is lesser in the surface horizon of Kottarakara, Vellanikkara and Calicut, due to higher content of clay fractions. Surfaces of these profile are comparatively gravely. The observed lower volume expansion at all the profiles is due to higher clay fractions rich in non expanding kaolinitic type of clay minerals.

Drop in pH KCl from pHw is a clear indication of the comparative extend of laterisation which is very low at Pampadumpara. This is due to the lower acidity ie higher aluminium ion concentration.

Lower electrical conductivity of all the profiles and the profile pattern observed indicate intensive leaching operating in these soils. Intensive leaching coupled with acidic pH are activators of the laterisation process and kaolinite mineral formation. CEC is less than 16 $cmol(p^{+})kg^{-1}$ except at the surface of Pampadumpara and PBS is below 47 percent which is due to the

above processes. The lower CEC values is due to clay enrichment with low active clay minerals. Organic matter is found to inhibit the ferrallitisation even in the conducive laterite environment of the state. Shwertanann (1966) and Walker et al (1969) have observed a negative relationship between organic matter content and induration. Sivadasan (1989) reported a negative correlation between Fe (d) and organic matter (-0.4697). This positive correlation with clay (+0.4607) confirms that iron moves along with clay colloidal fractions down the profile. But the extent of laterisation cannot be discussed merely on the basis of the level of organic matter in the soil. The fertility status of the profiles falls in the low status with regard to the available NPK except Pampadumpara and certain surface soils.

Close examination of the type and content of minerals in the fine sand fraction of profiles (plates 26 to 36) suggest that all these soils are formed from the same parent material namely granitic gneiss. Weatherable minerals such as feldspars and micas are found at Pampadumpara, Ambalavayal and Kannara only. This suggest their comparative lesser weathering. The preponderance of quartz at the expense of feldspars and ferromagnesium minerals is indicative of highly weathered nature of these soils. The predominance of quartz is due to selective accumulation on account of its resistance to weathering. The occurrence of resistant minerals like Zircon invariably in all profiles except at Pampadumpara and Ambalavayal is suggestive of its residual accumulation.

X-ray diffraction of clay fraction showed the predominance of kaolinitic minerals in all the profiles. Presence of 2:1 minerals and chlorite was comparatively higher at Pampadumpara, Ambalavayal and Kannara. Kaolinisation develops when les ivage accelerates and the medium becomes acid (Millot 1970). Chlorite content is comparatively high at Kannara. Illite and chlorite are reported to be common minerals. Poor drainage, moderate chemical activities may be the reason for its existence at Kannara while it is vulnerable in the les ivage prevailing condition in the acidic environment of other profiles. Laterisation conducive factors of study sites are namely heavy rainfall and high temperature favour the clay mineral suite in these soils.

Except Pampadumpara all the other profiles satisfy the requirement for an Ochric epipedon. Ochric epipedon is usually encountered in a humid tropical situation where the climate and geomorphic environment accelerates intense leaching and translocation of clay, organic matter and finer fractions to the lower strata. The same process impart an extended organic matter coated layer to the subsurface at Pampadumpara. As it does not satisfy the requirements of a mollic, umbric, and plaggen epipedon, it is accommodated in the cambic horizon which is an endopedon.

Except Vellanikkara and Pilicode profile the clay translocation to the B horizon qualifies them to be a developed argillic horizon kandic horizon. At the Vellanikara and

Pilicode profiles it is partially developed. The development of the argillic horizon is seen clearly in their thin section. (Plates 24-26). The field morphology and laboratory data keys in Balaramapuram profile to the subgroup Kandic Haplustalf while at Kannara and Ambalavayal it is Haplustalf. Typic Kandiustults accommodates the profiles at Vellayani, Kottarakara, Vellanikara, Pilicode and Calicut. While the Thiruvalla and Odakkali qualifies to be members of Tropustult subgroup. The Tavanur profile is accommodated in an unique subgroup petroferric Dystropepts.

Irrespective of the profiles the soils exhibited the same family character isohyperthermic, temperature regime indicating that the mean annual temperature is more than 22°C and the difference between MAST and MAWT is less than 5°C, though the Pampadumpara and Ambalavayal profiles qualified to be hyperthermic as the difference in MAST and MAWT is above 5°C.

Other family parameters accommodating particle size and mineralogy classes, qualifies the profiles at Balaramapuram, Vellayani, Kottarakara, Pilicode, Calicut and Tavanur to be fine loamy to clayey Kaolinitic. At Kottarakara, Vellanikara, Pilicode and Calicut the skeletal nature is another family character. At Thiruvalla, Pampadumpara, Kannara and Ambalavayal the mineralogy is mixed revealed by XRD analysis (Fig.2) .

By the family level classification these profiles falls under the same category with a specific difference in their

mineralogical character. The Kaolinitic mineralogy is indicative of low fertility and warns careful management practices for increased crop production like split application of fertilizers as the clays are very low active. The crop performance and perfected research results are to be gathered and interpreted from these research stations and centres as a follow up future line of work. The present study gives a soil basis with their taxa for the global communication and appreciation of valuable research results.

Plate No 36 Photomicrograph of ferriargillan in the argillic/kandic horizon of Kannara soil profile under plane polarised light mgf 100x.

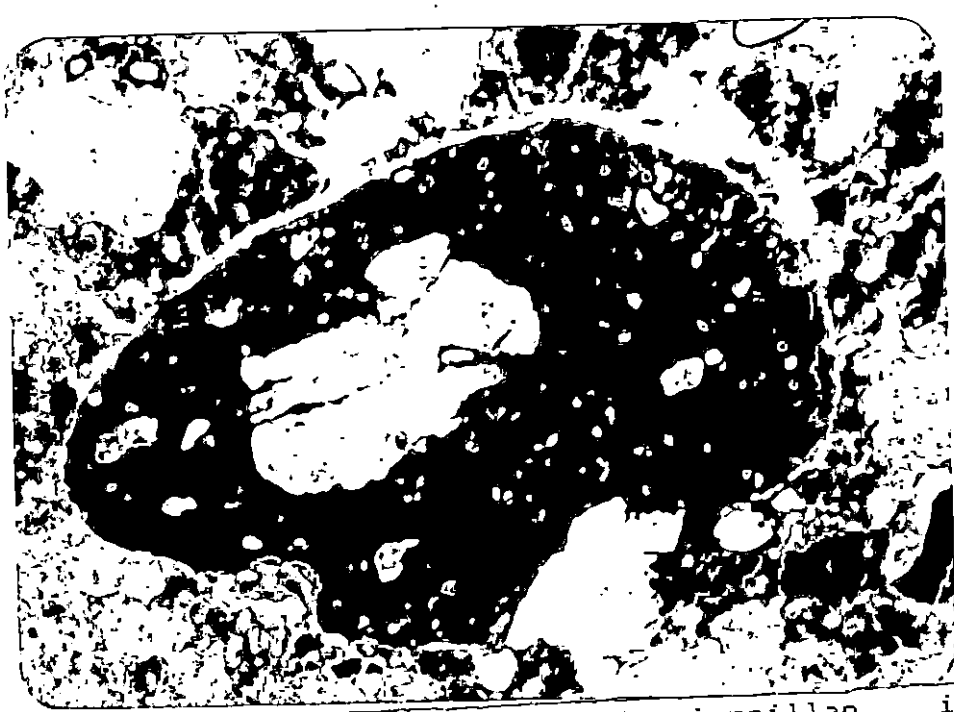


Plate No 37 Photomicrograph of ferriargillan in the argillic/kandic horizon of Calicut soil profile under plane polarised light mgf 100x.

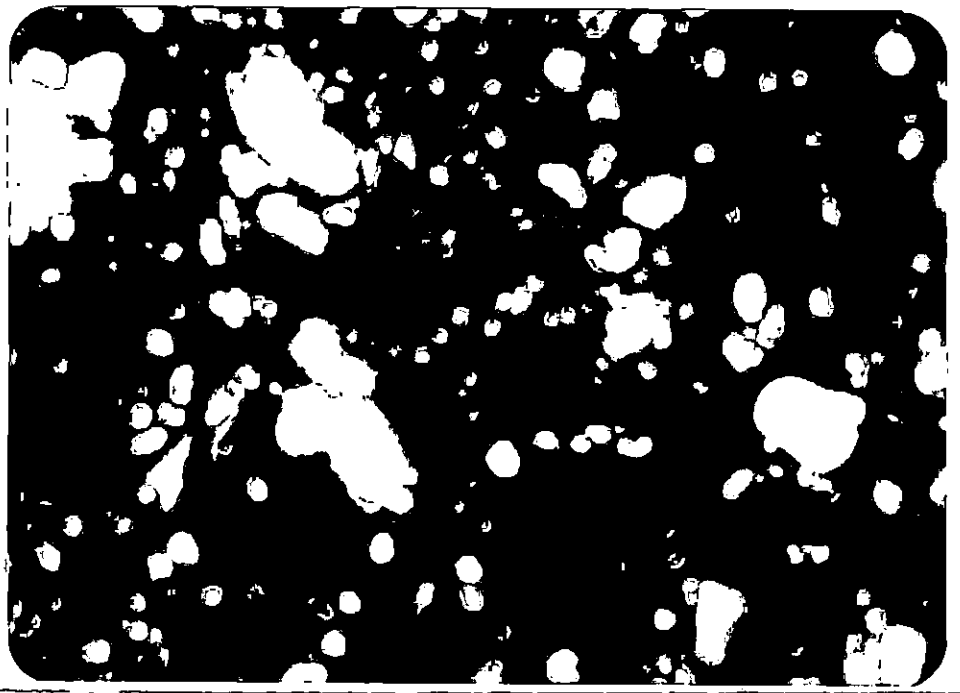


Plate No 38 Photomicrograph of ferriargillan in the argillic horizon of Odakali soil profile under plane polarised light mgf 100x.

# SUMMARY AND CONCLUSION

## SUMMARY AND CONCLUSIONS

A study was undertaken to classify the representative upland soil profiles, from the Agricultural Research Stations and from CWRDM, Calicut, One representative soil profile from each location were described infield and samples analysed for their physical, chemical and mineralogical properties.

The Salient observations from this study is presented below:-

1. Geologically all the soil profiles from 12 locations representing different land resource areas of the state are developed from the granite gneiss of Archean age. This is evident from the uniform granulometric composition, bulk density, soil colour and the types and distribution of fine sand minerals.

2. Though the soil profiles are exposed to different climates mainly due to the manifestation of altitude, all locations seem to fall within the limits with regard to geology, geomorphology and climate condusive for ferrallitisation.

3. The soil at Pampadumpara are not subject to severe movements and hence comparatively younger others are forced to be more weathered.

4. The low temperature and organic matter reduces the extend of laterisation at Pampadumpara, Ambalavayal in spite of high rainfall.

5. The proportion of gravel is higher in all profiles except Balaramapuram. Maximum nonclay fractions is found at Vellanikkara and least at Balaramapuram and Vellayani. At Calicut the clay fraction is higher than nonclay fractions.

6. Based upon the silt/clay ratio the soil profiles may be placed in order of decreasing weathering degree Calicut > kottarakara > Balaramapuram > Vellayani I > Pampadumpara > Ambalavayal > Thiruvalla > Pilicode > VellayaniII > Thanur > Odakkali > Vellanikkara > Kannara.

7. CEC of all profiles are less than 16 cmol (+) $lg^{-1}$ except at the surface of Pampadumpara.

8. Percentage of Base Saturation (PBS) is below 47 in all profiles indicating severe leaching and acidic pH which activate ferralliti s :ation.

9. Organic matter is found to inhibit the laterisation process in these profiles as is observed at Pampadumpara, Odakkali and Pilicode.

10. All the profiles are formed from same parent material namely granite gneiss, revealed by Single grain Mineralogy. All the profiles are highly weathered except at Pampadumpara, Ambalavayal and Kannara.

11. A cambic endopedon is present at Pampadumpara while all the other profiles satisfy for an ochric epipedon and argillic/Kandic endopedon.

12. Irrespective of the profiles of the soil moisture regime is ustic and temperature regimes isohyperthermic except Pampadumpara and Ambalavayal where it is with a hyperthermic temperature regime.

13. Balaramapuram, Vellayani, Kottarakara, Pilicode, Calicut and Tavanur profiles are fine loamy to clayey Kaolinitic at Kottarakara, Vellanikkara, Pilicode and Calicut the skeletal family parameters is a unique charactor.

14. The clay mineralogy at Pampadumpara, Ambalavayal and Thiruvalla is mixed with appreciable amounts of 2:1 expanding minerals.

15. Based on the available information and results of the present study, keys the profile in to the following taxa as per Soil Taxonomy (1975).

| | | |
|---|---|---|
| 1. | Balaramapuram | Fine loamy kaolinitic isohyperthermic family of kandic Haplustalf. |
| 2. | Vellayani | Fine loamy kaolinitic isohyperthermic family of Typic Kandiustults. |
| 3. | Thiruvalla | Fine loamy mixed isohyperthermic |
| 4. | Odakkali | family of Tropustults. |
| 5. | Kottarakara | Clayey skeletal kaolinitic |
| 6. | Vellanikkara | isohyperthermic family of Typic |
| 7. | Pilicode | Kandiustults. |
| 8. | Pampadumpara | Fine loamy mixed isohyperthermic family Haplustalf. |

| | | |
|---|---|---|
| 9. | Kannara | Fine loamy mixed hyperthermic |
| 10. | Ambalavayal | family of Haplustalf. |
| 11. | Calicut | Clayey skeletal kaolinitic isohyperthermic family of kandiu.lts. |
| 12. | Tavanur | Fine clayey kaolinitic isohyperthermic family of petroferric Dystropepts. |

The family charactors reveal that these soils are with less availables water capacity, low cation exchange capacity. Soil temperature is not a problem in these soils. The typic subgroup indicates lesser problems of water logging. The argillic and kandic endopedon indicates low nutrient holding capacity and presence of low active clays (LAC) warranting special soil management measures for increase crop production like split application of fertilizers. Ustic moisture regime is indicative of prevalent water stress in these profiles sites. The order Ultisol, Alfisol and even Inceptisol is indicative of highly weathered soil of varied horizon development and less fertility because of lower percentage bases saturation (PBS).

The present study gives a "soil basis" for the global communication and appreciation of the valuable research results of these research institutions .

The research results, the crop performance from all these research institution are to be gathered and critically analysed with the "soil basis" as a future line of work.

# REFERENCES

## REFERENCES


Barragan, E., and Iniguez, J., (1981) Soils of the ulzama valley (Navarra) Ultisol .I Morphology, chemical properties and classification. A review. Anale de Edafologia Y Agrobiologia 40 (3/4) 427-440:

==

Bienruth, F.H.,(1970) Some fundamentals of soil classification. In Soil Resourse Data for Agricultural Development (ed) Leslie. D. Swindale Hawai Agricultural Experiment Station. University of Hawai. pp 12-19.

Brewer, R., and Haldae (1956) optically oriented clays in thin section if soil. Cong. Inter Sci soil 6 E Paris B, 21-25.

Buol, S.W., F.D Hole and R.J MCcracken (1980) Soil genesis and classification 2nd edition. pp 180.

Buol, S.W., (1986) L.A.C Oxisol Interface In Symposium on LAC soils. Technical Monograph No 14. Soil Management Support Service.

Carver, R.E., (1971) Proceeding in Sedementary Petrology: Wiley Inter Science, New York.

Chakravarthy D.N, and Classifications of the soils of Charecterization and classification of the soils of Citrus growing be4lts of Hill districts of Assam. J. Indian soc. soil Sci. 31 237-293.

==

Cho,H.D; Mermut, A.R., (1992) Pedogenesis of two forest Soils (Kandustults) derived fropm metamorphosed granite in Korea: Soil. sci soc America 56 (2) 517-525.

==

Dakshnamoorthy, C. and Gupta, R.P, (1968). Practicals in Soil physics. IARI, New Delhi.

Dennis,B.(1988) Desaturated Fersiallitic soils of the Tungo plateau (New caledonia) Cashiers ORSTOM Pe' dologie, office de la Recherche scientificque et Technigue otri-mer 24 (1) 61-76.

Eswaran, H;Krishnan,P.K, Reddy, R.S; Reddy, P.S.A., Sarma, V.A.K (1992). Application of the `Kandi' Concept to soils of India. J. Indian Soc. Soil sci. 40 (1): 137-142.

Gallaber, R.N., Perkins, H.F., and Tan, K.H (1974) Classification, Composition and Mineralogy of iron glabules in a Southern Coastal plane Soils. Soil Science. 117 (3); 155-164.

Ikawa, H., (1978) Occurrence and Significance of Climatic Parameters in Soil Taxonomy. In soil resource data for Agricultural Development. (ed) Leslie.D. Swindate., Hawaii Agricultural Experiment Station, University of Hawaii 20-27.

Jackson, M.L., (1973). Soil Chemical Analysis Prentice Hall of India Pvt. Ltd., New Delhi.

Jawahar L Sehgal., R.Gombeer and J.D Hoore., (1976) `Clay Migration' in the formation of Argillic horizon in Soils developed under varying moisture regime. J Indian Soc Soil Sci 24 (1) 20-28.

Kellogg (1961) Soil Interpretations in Soil Survey U.S.D.A. SCS U.S Government printing office Washington.

Klamt E., J Meelniezuk and R.P Schneide (1986) `Degradation of the properties of red Brazelean Subtropical Soils by management. In proc. Intern. Symposium on red soils (ed) Li C.K Beijing, China. Science Press pp 523-542.

Lietzke D.A and E.P Whiteside (1981) `Characterization and Classification of Some Belize soils. J of Soil Sci Soc Amer.

Mehra, O.P and Jackson, M.L., (1960) Clays and clay minerals, London, Pergamon press 7th conf. , pp 317 - 327 (1960).

Millot, G. (1970) Geology of Clays. Springer - Verlag, New York. Chapman and HAll, London.

Moberg, J.P., and Esu, I.E., (1991) Characteristics and Composition of some Savanna Soils in Nigeria Geoderma 48 (1-2) 113-129.
==

Moorman F.R., S.W. Buol (1981) The Kandic horizon as a diagnostic subsurface horizon Proc. 4th Int Soil classification work shop, Rwanda.

Morrison, R.J., and Asghar, M. (1992) Soil of the laloanea farm, North Western upolu Western Samoa Pacific Science 46 (1) 35-45.
==

Nair K.M, and G.S Chamua (1988) Charecteristics and classification of some Pine forest soils of Meghalaya J of Indian Soc of Soils science. 36 (1) 142-145.
==

Nyle C Brady (1984) Nature and properties of soil. 9th edition Eurania Publishing House (p) Ltd, New Delhi.

Ohta,S.,Effend I,S.,Ultisol of Lowland Dipterocarp forest in East Kalimantan, Indonesia II Status of Carbon Nitrogen and Phosphorous Soils Science and plant nutrition 38 (2) 207-216.
==

Piper, C.S. (1967) Soil Plant Analysis. Hans Publishers, Bombay.

Sahu G.C., S.N. Patnaik and P.K. Das (1990) Morphology Genesis Minerology and classification of soils of Northern Plateau zone of Orissa. J. Indian Soc soil Sci 38 (1) 116 - 121.
==

Sannigrahi, A.K., Godse, N.G.,and Sharanappa. (1990) Characteristics and classification of Dominent hill soils of Nilgiri, J. Indian Society of Soil Science 38 345-348.
==

Schwertmann, U. (1965). Inhibitary effect of soil organic matter of the crystalisation of amorphous ferric hydroxide, Nature., 212 645-646.
===

Singh G.N., H.P.Agrawal and M. Singh (1989) Genesis and classification of soils on an alluvial pedogenic complex. J. Indian Soc Sci 37 (2) 433-354.

Singh G.N., H.P Agrawal and M. Singh (1989) Clay minerology of Alluvial soils in different physiographic position.J. Indian Soc soil Sci 39 160-163.

Sivadasan, N. (1989) Comparative morphology and physico-chemical properties some forest and deforested soils of Kerala MSc (Ag) Thesis. Kerala Agricultural University.

Smith, G.D. (1965) Lectures on soil classification. In pedologie, Special No-4 Belgian soil sci soc; Ghent.

Soil Survey Staff (1975) Soil Taxonomy U.S. Dept. Agric., Washington P.C.

Soil Survey Staff (1987) Keys to Soil Taxonomy (3rd printing) SMSS Tech. Monogr.6 Ithaca.

Subramonia Iyer, M. (1989) Studies on macro meso and micromorphology and clay minerology of the acid sulphate soils of Kerala. Ph.D Thesis Kerala Agricultural University.

Suharta N., P.N. Hendro., (1986) Characterisation of Soils developed from ganetic materials in West Kalimantan. Pemberitaan, penelitian Tanah dan Pupuk, Indonesia 6 51-60.

Sutton P.M., E.R. Whiteside and R.T. Odell (1989) 'Some Sierra leone soils; 2. Mineralogy, Micromorphology and classification Soil Sci 148 (2) 29-33.

Supriyo, H., Matsue, N.,and Yoshinaga; N., (1992) Chemistry and Minerology of some soils from Indonesia. Soil Science and Plant Nutrition 38 (2) 217-225.

Thomas Varghese, P. (1981) Studies on the genesis, morphology and physico-chemical properties of the laterite soils of Kerala Ph.D. Thesis, Kerala Agricultural University.

V.

Thomas J Nimlos and Mark Tomer (1982) Mollisol beneath Conifer forest in South Western Montana Soil Science. 134 (6).

Tie-Bi-Yoyan, Sakai E lepsch ., and I.F. Channel (1983) Charecterization and classification of soils from Pariquera Acce formation Sao Paulo, Beazet Revista Brasileira de ciencia do solo 7 (2) 183-190.

Uehara, G., (1978) Agro Technology transfer the Soil Family. In Soil Resource Data for Agricultural Development (ed.) Leslie D. Swindale Hawaii Agricultural Experiment Station, University of Hawaii pp. 204-209.

Venugopal, V.K (1980) Pedological studies on laterite catsnary sequences occurring in Kerala. Kerala Agricultural University.

Walker, J.L., Sherman, G.D and Katsura, T (1969). Iron and titanium Minerals in the titaniferrous latosols of Hawaii. Pauf. Sci., 23 291-304.

Walmsley M.E., and L.M. Lavkulich (1975) Soil genesis, Morphology and classification Soil Sci Soc Amer Proc 39 84-88.

Walia C.S. and G.S Chamuah (1990) Charecteristics classification and Sutability for land use planning of fool hill soils. J. Indian Soc soil Sci 38 286-292.

Wambeke A Van (1986). The use of soil climatic data in Soil Taxonomy with special reference to the tropics. In proceedings of the International symposium on red soils (ed) Li,cketal pp 185-196.

Xu Ji Quan (1983) 'Distribution of clay mineral in soils of China. Soil Science 135 (1).

# CLASSIFICATION OF THE UPLAND SOILS OF KERALA

BY

BINDU KUMARI A.

ABSTRACT OF THESIS

Submitted in partial fulfilment of the
requirement for the degree

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture
Kerala Agricultural University

Department of Soil Science and Agricultural Chemistry
COLLEGE OF AGRICULTURE
Vellayani - Thiruvananthapuram

1993

## ABSTRACT

Soil Taxonomy is one of the well accepted popular system of soil classification through which soil information can be communicated globaly. Inorder to have the soil Taxonomy information of the uplands of Agricultural Research Station and Centres under Kerala Agricultural University and CWRDM , Calicut one representative profiles were examined described analysed for physical chemical and mineralogical properties and with the available site and climatic parameters and from the results of the present study the soil were classified as per Soil Taxonomy (1975).

All the soils are gravelly, clay loam to clayey texture with kaolinitic to mixed mineralogy with expanding 2:1 minerals at Pampadumpara, Ambalavayal and Kannara. At Calicut the clay fraction is more than non clay fraction. Irrespective of the profiles, the profiles are with ustic moisture regime and isohyperthermic temperature regime. The temperature regime at Pampadumpara and Ambalavayal is hyperthermic. Based on the degree of weathering revealed by silt/clay ratio the profiles can be arranged with a decreasing degree of weathering Calicut> Kottarakara> Balaramapuram > Vellayani > Pampadumpara > Ambalavayal > Thiruvalla > Pillcode > Vellayani II > Tavanur > Odakkali > Vellanikkara > Kannara.

Based on the available information and results of the present study, keys the profile in to the following taxa as per Soil Taxonomy (1975).

| | | |
|---|---|---|
| 1. | Balaramapuram | Fine loamy kaolinitic isohyperthermic family of kandic Haplustalf. |
| 2. | Vellayani | Fine loamy kaolinitic isohyperthermic family of Typic Kandiustults. |
| 3. | Thiruvalla | Fine loamy mixed isohyperthermic family of Tropustults. |
| 4. | Odakkali | |
| 5. | Kottarakara | Clayey skeletal kaolinitic isohyperthermic family of Typic Kandiustults. |
| 6. | Vellanikkara | |
| 7. | Pilicode | |
| 8. | Pampadumpara | Fine loamy mixed isohyperthermic family Haplustalf. |
| 9. | Kannara | Fine loamy mixed isohyperthermic family of Haplustalf. |
| 10. | Ambalavayal | |
| 11. | Calicut | Clayey skeletal kaolinitic isohyperthermic family of kandiudlts. |
| 12. | Tavanur | Fine clayey kaolinitic isohyperthermic family of petroferric Dystropepts. |

The family charactors reveal that thesee soils are with less availables water capacity, low cation exchange capacity. Soil temperature is not a problem in these soils. The typic subgroup indicates lesser problems of water logging. The argillic and kandic endopedon indicates low nutrient holding capacity and presence of low active clays (LAC) warranting special soil management measures for increase crop production like split application of fertilizers. Ustic moisture regime is indicative of prevalent water stress in these profiles sites. The order

Ultisol , Alfisol and even Inceptisol is indicative of highly weathered soil of varied horizon development and less fertility because of lower percentage bases saturation (PBS).

The present study gives a "soil basis" for the global communication and appreciation of the valuable research results of these research institutions .

The research results, the crop performance from all these research institution are to be gathered and critically analysed with the "soil basis" as a future line of work.