CLASSIFICATION OF WET LAND SOILS OF KERALA FOR PLACEMENT IN SOIL TAXONOMY

By

UNNIKRISHNAN, S.

THESIS
submitted in partial fulfilment of the requirement
for the degree of
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 Wet land Soils of Kerala for Placement in Soil Taxonomy, is bonafide record of research work done by me during the course of research and that the thesis has not formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellayani

UNNIKRISHNAN.S.

CERTIFICATE

Certified that this thesis entitled, **Classification of Wet land Soils of Kerala for Placement in Soil Taxonomy**, is a record of research work done independently by Sri.Unnikrishnan.S. under my guidence and supervision and that it has not previously formed the basis for the award of any degree, fellowhip or associateship to him.

Vellayani

Dr.THOMAS VARGHESE
Chairman
Advisory Committee
Professor of Soil Science
College of Agriculture
Vellayani.

Approved By

1. Dr. Thomas Varghese — Chairman, Advisory committee.

2. Dr. P. Padmaja — Member.

3. Dr. V. Muaraleedharan Nair — Member.

4. Sri. K. Babukkutty — Member.

18/9/93

External Examiner

ACKNOWLEDGEMENTS

With a deep sense of gratitude, I put down the following remembrances.

The original and unstinted pursuit of knowledge of Dr.Thomas Varghese, Professor of Soil Science and Chairman of Advisory Committee, has generated this research problem. His far reaching connections have helped me right from soil sample collection to the final preparation of this thesis. But for the timely interventions and critical pieces of advice of Dr.Thomas Varghese, I could not have completed this work successfully. Moreover, he has always been a guiding spirit throughout my post graduate research programme.

Dr.P.Padmaja, Professor and Head, Department of Soil Science and Agricultural Chemistry and member of Advisory Committee has provided valuable and expert suggestions for this research work. Assistance provided by her during the final preparation of the thesis work is sincerely acknowledged.

Sri.K.Babukkutty, Associate Professor, Department of Soil Science and Agricultural Chemistry and member of

Advisory Committee has contributed much to the successful completion of this thesis with his genuine interest and valued opinions.

Thanks are due to Dr.V.Muraleedharan Nair, Professor of Agronomy for his contributions to make this thesis in its entireness.

Dr.R.S.Aiyer, Professor and Head (Retd.), Department of Soil Science and Agricultural Chemistry, the then member of Advisory Committee is also remembered here for his keen interest in the subject and masterly advice.

I express my heart felt thankfulness to Dr. Hari Eswaran, National leader, World Soil Resources Programme, USDA, Washington,D.C. for his valuable suggestions in classifying the soils according to Soil Taxonomy.

Assistance provided by ISRIC lab, Wageningen, The Netherlands, for conducting clay mineralogical studies (XRDA) is also acknowledged duly.

Support rendered by CESS authorities, Akkulam, for sand mineralogy studies and the service done by Mr.Praveen and Miss.Anitha have been of immense help in completion of this thesis.

Staff members of the Department of Soil Science and Agricultural Chemistry,College of Agriculture, Vellayani, especially Dr.N.Saifudeen, Dr.P.Rajendran and

Smt.P.B.Usha have helped me a lot in the laboratory analysis. I will always keep this in mind with praise.

Accommodation and co-operation provided by my classmates and friends especially M/s Sanjeev, Moosa, Louis, Ajith, Ramesh and Narayanan will always be a pleasent memory for me.

But for the prayers and wellwishes of my wife Sangeetha I am sure that I could not have fulfilled this arduous task.

The part played by my parents and other family members in completion of this work is too precious for words. I am confident that it is their ardent wishes and blessings that helped me to reach this goal.

Timely help and sincere cooperation provided by M/S N.C. Computers, N.C. complex, Thycadu, Trivandrum 14., in preparing the thesis neatly is remembered with gratitude.

Junior Fellowship provided by the Indian Council of Agricultural Research during my post graduate research programme is also acknowledged here.

And to end the assistance and co-operation provided by number of farmers in the wet land rice fields throughout the State needs a worthy mention here.

With these words I remain...

UNNIKRISHNAN.S.

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INTRODUCTION

INTRODUCTION

The natural landscape is a self regulating complex system wherein pedologic, abiotic and biotic sub-systems of different types manifest themselves as components. Wet lands in the natural landscape form a unique system by itself. However, through human activity artifical geo-systems are also created apart from the aforesaid natural systems. Thus we have natural wetlands and man made wetlands, which are made use of to fulfil several human requirements of which aqua culture and agriculture stand supreme.

Wet land soils acclaim much importance because of their varied uses in agriculture, especially offering sustenance for paddy, the staple food grain for majority of the World population. These soils are extensive except in major deserts and occupy about ten to twelve percent of the total earth's surface. In India, it is estimated that there are about four million hectares of wetlands which can be grouped into fresh water, marine, brackish and unclassified, out of which the brackish wet lands constitute the largest group.

Kerala has 1,05,000 ha of natural wet lands and 75,000 ha of man made wet lands. A unique feature of the natural wet lands of Kerala is their nearness to the coast line and periodical or permanent inundation with salt water.

Wet land soils are transitional between aquatic and terrestrial systems where the water table is usually at or near the surface of the land or the land is covered by shallow water. The processes operating in the wet land soils are specific and depend on the unique hydromorphic conditions to which they are subjected. These soils are subjected to changes as a result of cultivation, which are generally permanent. The key attributes of such soils are hydrology or degree of flooding, specific vegetation and hydric soils.

Early attempts to classify these soils have now lead to the recognition of two broad groups namely natural and manmade wet lands. The former are those which are formed by changing season, vegetaion, course of rivers and also by sedimentation and fluviation. Disturbed drainage pattern or sea level changes in the coastal area may also give rise to natural wet lands. Man made wet lands originate mainly due to the excavation and digging of uplands by man; these areas later get flooded with water and gradually become wet lands. Man made wet lands may also include those wet lands brought under cultivation by man.

Wet land soils of Kerala vary widely with respect to their genesis,morphology,physico-chemical characteristics, microbiological attributes and production potential. Depending on their geomorphology, hydrology, general characteristics and constraints of production, the wet land soils of Kerala have been indigenously classified into Kayal lands (lakes) Kari lands (acid peats), Karappadam (acid riverine alluvium), Pokkali and Kaipad lands (saline acid), Kole lands (acid hydromorphic) and Ela lands (lateritic alluvium). These soils mainly sustain rice and cultivation is done for one or two seasons in an year adopting local management practices. In certain areas during off-season remunerative prawn/fish culture is also practised. Such water logged rice soils occupy an area of 1.13 lakh ha out of the total 6 lakh ha of rice soils of Kerala State.

Soil research in Kerala has a history of more than 60 years and much data have been collected on the fertility aspects of the rice soils. However, a comprehensive evaluation of the wet land soils of the State to fit them in an International Classification System is yet to be carried out. Hence the present study was initiated to characterise and classify the natural and man made wet lands of Kerala according to Soil Taxonomy to serve as a basis for agrotechnology transfer and a guide for future soil research.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Studies on the wet land soils of Kerala was started way back in 1920's. Iyer (1926) of the erstwhile Department of Agriculture of Travancore made some preliminary investigations on the Kari soils of Kuttanad.

Subsequently several workers had attempted a detailed study of these peculiar soils. Many of these studies were based on the feritlity aspects and reclamation of the wet land problem soils. Money (1949, 1956, and 1961 a & b), Nambiar (1961), Susheeladevi (1965), Pisharody (1965), Kabeerathumma (1969), Nair (1970), Varghese et al (1970), Koshy and Varghese (1971), Biswas and Goswamy (1973), Kurup and Aiyer (1973), Alice Abraham (1984), Marykutty (1986), Nair et al (1988), Harikumar (1989), and Iyer (1989).

However, a systematic investigation on the genesis, morphology and classification of these soils is still lacking. A review of the studies already conducted is furnished below.

1. ...esis and distribution

Genesis

Dent (1980) was of the view that the genesis of acid sulphate wet lands was due to clay accumulation along with supply of organic matter from swamp vegetation. Very high acidity of these soils was found to cause poor structure and texture.

Bhargava & Arbol (1984) reported that the release of salts through alkaline hydrolysis during the weathering of alumino silicate minerals has resulted in the accumulation of amorphous silica, alumina, potassium and iron salts in the small depressions leading to the genesis of Indo-Gangetic alluvial plains.

Pons and Van Breemen (1982) suggested that limited areas of marshy inland valleys of acid sulphate wet soils may be formed by sulphide rich water stagnation. Tidal flats, salty marshes and mangrove swamps may also be formed by saline water inundation.

Bhargava and Abrol (1984) have indicated that acid sulphate wet lands of Malabar coast of S. India were developed under a humid tropical climate on alluvium, derived mainly from laterite and lateritic soils. They occupy lagoons and similar low lying geomorphic situations. Dent (1986) suggested the role of mangrove vegetations in the development of wet land acid sulphate soils.

Liu (1987) pointed out that weak eluviation and illuviation were observed in gleyed paddy soil development. Human activity and cultivation also affect the formation and fertility of soils.

Yin et al. (1987) reported the activity of iron as the main process of wet land soil formation. He pointed out that there existed a correlation between relative clay movement and type of paddy soils.

According to Liu et al . (1988) soil parent material has a significant influence on the chemical properties of paddy soils. No influence from the different water regimes was observed on the soils from the same parent material.

Manickam (1989) reported that alluvial soils of S. India were developed from the deposition of silts over time by large rivers such as the Godavari, Cauvery, Krishna, Noyyal and Bharathappuzha. These soils were characterised by alluival deposits of relatively recent origin. Such soils were found to be deep and range from bright reddish brown and yellowish brown to grey in colour.

The development of a plough pan or dasyk pan in wet soils was reported by Eswaran (1989). Puddling destroys the soil structure and reduces hydraulic conductivity. Repeated processes of puddling and reworking the surface soils with same impliments, resulted in a compacted layer at the base of the puddled layer.

1. 2 Distribution

Moorman (1976) reviewed the distribution and classification of wet lands of the world. He observed that large areas of Aquepts and Histosols dominated the nontropical wet lands of India. More than half of the 14 million of the tropical wet lands of the United States is seen near the Atlantic and Gulf coastal plains. Northern and middle latitudes of China occupy large areas of wet land soils where Aquepts and Aquents are extensive. In Southern Hemisphere, Argentina has the principal areas of wet lands dominated by Albolls. In the tropics Tropaquepts and Tropaquents are common in Central Africa. Amazon basins of South America is predominant in Tropaquents and Plinthaqults (Osborne, 1953).

Coastal areas of northern South America is having more distribution of Paleaqults, Paleudults, Plinthaqults and Tropaqents (Eden, 1970).

Paramananthan (1978) observed that major wet lands of Malaysia are found in marine or alluvial sediments and they are mainly Aquepts and Aquents.

Guthrie (1985) reported that Indonesian wet lands are dominated by Aquepts and were distributed along the Java coast. Aquepts and Aquents were dominating in alluvial and coastal plains of Philippines, Cambodia, Laos, Vietnam and Thailand.

Kyuma (1989) suggested that the unique combination of two factors of physiography and monsoon determine the distribution of wetlands in Asia.

Oborn (1989) reported that the wet land acid sulphate soils of Sweden cover an area of 140000 ha.

Varshney (1978) reported that in India about 3.9 million ha of wet lands are present. These can be grouped into fresh water, marine, brackish water and unclassified wet lands.

Murthy (1978) observed that in India, West Bengal has a predominance of Ochraqualfs, Haplaquepts, and Haplaquents.

Varghese *et al* (1970) reported that *Pokkali* saline acid soils of Kerala occupy an area of 26400 ha. and are located mainly in the coastal part of Ernakulam district. Money and Sukumaran (1973) reported that wet land acid sulfate soils of Kuttanad, Kerala occupy an area of 875 km^2. Occurrence of saline acid sulphate wet land soils along the Malabar Coast was reported by Bhargava *et al*. (1982).

Bloomfield (1973) quoted Varghese *et al*. (1970) describing Pokkali soils of Kerala having pH of 3.1 and considerable quantities of sulphate. Kari soils with pH<3.5 are referred to by Nambiar *et al*. (1961). He recorded soils of Kerala with pH values of 2.1 completely uncultivated, except for rice, grown in the mounds of the fringes of the swamp.

Manickam (1989) reported that the river deltas and coastal areas are the main rice growing wet lands of Kerala.

1. 3 Soil development

Zhang Xiao (1981) reported that in the process of gleysation of rice soil a large part of free iron oxides in the clay fraction got reduced and leached with a resulting formation of greyish blue or grey gley horizon.

Brammer (1971) reported that clay coatings or argillans in the field, result from the natural clay illuviation process but they can also be the result of irrigation and localised alteration of clay minerals.

Ali *et al*. (1983) studied the genesis of a few low land soils of Bihar and reported that the *Karya* soils had an irregular texture showing that the soil has developed on different sedimentary materials over a long period. Soils having a regular texture originated from sedimentary materials were found to be of uniform nature.

Yin *et al*. (1987) based on their studies on the genesis and classification of paddy soils, observed the activation of Fe as the main process of paddy soil formation. They observed that there was some relation between relative mobility of clay and paddy soil formation.

Slager *et al*. (1987) reported that during geo-genesis, stratified sediments were formed, above which sediments with slightly disturbed stratification with or without matrix or feacal pellets. Brackish water phase of sedimentation, caused pyrite accumulation in various amounts and mass eluviation. Part of the pyrite get oxidised to goethite. Pyrite oxidation also lead to the formation of jarosite, gypsum, silica and ferric hydroxides.

2. Morphology

The earliest reports of the morphology of wet land soils of Kerala were given by Money and Sukumaran (1973). According to these reports, *Kari* and *Karappadam* soils were light grey in colour. Large amounts of partially decomposed plant materials present in the soil are mainly responsible for their black colour. Lime shell deposits of lacustrine origin were commonly observed in the surface and sub surface layers of Kayal soils. Yellow brown spots, mottlings, streaks and encrustations were found in almost all the layers of Kari and Karappadam soils. Clayey texture of Kari and Karappadam soils accounted for their poor drainage while the silty clay loam texture of the Kayal soils offered good drainage. Irregular variations of chemical composition and clay contents suggested that these soils were transported. Many of these soils especially Kayal and Karappadam soils were neutral in reaction when moist becoming severely acid when drained.

Van Breemen et al (1973) was of opinion that the micro morphology and profile development of a wet land soil was correlated with a chrono sequence. He suggested that in young soils, the pyrite distribution reflects the condition of muds at its original form. As the soils grow old and better drained, the horizons of pyrite accumulation and mottling occured at greater depth. Schilchting (1973) pointed out that wet land soils can be classified according to fundamental difference in the arrangement of their hydromorphic feature as subhydric, ground water and surface water soils.

USDA Anon, (1975) reported that the temporary and permanent wetting of soils will lead to a gley phenomenon in wet land soils.

Veneman et al. (1976) made an important contribution on the evolution of sesquioxides in a soil sequence with increasing duration of water saturation. He also described systematically the change in micro fabrics of the sesquioxides in a soil sequence with increasing hydromorphic characters.

Vepraskas and Bouma (1976) suggested that in saturated soil cores, the colour of the matrix remain unchanged and coatings of manganese developed on ped surfaces corroborating the field observations. The beginning of gley formation was illustrated in this manner.

According to Dobrolovsky et al. (1977) constantly wet soil horizons usually lack the well developed compact ferruginous Segregations with distinct boundaries. These were generally found in the zone where oxidation and reduction alternate. Extremely developed gley soils subjected to flooding may contain high amount of diatomic algae.

Experimental studies of Narokova and Yarilova (1983) showed that no change in composition of parent material was seen, but the material showed an increase in compaction and general bleaching. Clay accumulation indicated a mobility for micro mass.

Ali *et al*. (1983) reported that the morphogenic features of five low land soils of Bihar showed an irregular texture indicating that these soils were developed from stratified materials over a long period. Clay content was found to increase with depth.

While describing the morphology of acid sulphate wet soils of Malabar coast of South India, Bhargava & Abrol (1984) reported that these soils were generally high in decaying plant residues. A great deal of heterogenity existed with regard to the soil colour and mottling, indicating varying degrees of gleying, reduction and mottling.

Stoops and Eswaran (1985) reported that the best micro morphological indicator of hydromorphism was the presence of typic sesquioxide features, manganese seggregations (mainly coatings and hypo coatings) and lower chroma in the peds. They have also noted that in a strongly hydromorphic soil, low chroma dominate and Fe hypo and quasi coatings may occur around larger voids.

Kyuma (1985) suggested that wet land soils are totally immature or only weakly developed as they have poorly developed morphology.

Eswaran (1989) conceptualised a hydric epipedon for wet land soils which is a surface horizon with induced wetness due to the activity of man or due to the presence of a shallow impermeable layer.

3. Physical characteristics

Texturally the Kari soils of Kuttanad wet lands were classed by Money (1956) as clay or clay loam, with more sand percentage in the upper horizons. Pillai (1964) and Venugopal (1969) reported lowest bulk density for these soils. Koshy and Varghese (1971) reported that the Kari soils are characterised by deep black colour, heavy texture, high contents of organic matter and strong acidity. Varghese (1973) reported a particle density of 2.08 - 2.76 g cc^{-1}, a bulk density of 0.96 - 1.62 g cc^{-1} and a pore space of 31.58 - 62.53 percent for Kari soil profiles.

Soil Survey Staff (1975) reported that Kayal soils of Kuttanad were clay loam throughout the profile, while Karappadam soils were clay loam in the surface and silty loam in lower layers. Kari soils were silty clay with sub surface texture of clay.

Sreedevi et al. (1975) observed that clay was the dominating particle size fraction in the natural wet lands of Kerala. Karappadam soils were dominated by silt and clay fractions, Kole soils had the highest percentage of clay.

Kawaguchi and Kyuma (1977) observed that physical proprties of wet land soils were generally poor because of their high clay contents and low organic matter. Soil texture was generally fine in the tropical wet land soils containing more than 45 percent clay. This was true for about 46 percent of the wet lands studied by them.

Xu Qui et al. (1980) reported that according to a Chinese classification of wet land soils in relation to clay content and premeability, these soils can be grouped as permeable, side bleaching, stagnating, water logged or percolated.

Kyuma (1981) suggested that physical properties of wet land soils become only of secondary importance when there is copious water for crop production.

Ali et al. (1983) reported that for the wet land soils of Ranchi District of Bihar, the textural changes were irregular with depth, indicating that these soils were developed over different sedimentary (stratified) parent materials over a long period. Clay content and water holding capacity increased with depth whereas specific graivity and apparent density decreased.

Jackson (1984) investigated the physical properties of wet land soils and found out that in most profiles there was a very large variation of physical properties and content of organic matter with depth.

Wilding & Rehage (1985) suggested that many soils with aquic moisture regimes had strong textural differentiation between surface and sub-surface horizons. This was mainly due to illuviation of clay into finer textured sub soils. Sedimentary discontinuities, ferrolysis, insitu weathering of primary minerals and lithorelics, neo-formation and differential transport of eroded sediments had also been observed.

Raju (1988) reported that the predominant textural class of Kuttanad soils was clay to clay loam. Sandy pockets were common in Kari soils of Kuttanad. The bulk density of these soils were lower due to organic matter content.

4. Chemical characteristics

4. 1 Soil Acidity

Money (1949) reported that the high acidity of Kuttanad soils on drying was due to the oxidation of sulphur compounds to sulphuric acid.

Kayal and Karappadam soils of Kuttanad were reported to be less acidic than Kari soils (Kabeerathumma, 1969 and Ghosh, et al. 1973).

Coult (1969) reported that an appreciable amount of permanent negative charge of acid soils was encountered by aluminum and hydrogen ions which were generally known as exchange acidity.

Ponnamperuma (1972) studied in detail about the pH values of submerged soils and sediments. According to him irrespective of initial pH, soils on wetting and continuous submergence attained a near neutral pH.

Ponnamperuma et al. (1973) reported that the main disorder of the acid sulphate wet lands was soil acidity.

Sanchez (1976) recommended that percentage aluminium be calculated on the basis of effective CEC as a measure of soil acidity.

Kawaguchi & Kyuma (1977) collected 410 soil samples of wet land soils from Tropical Asia. The mean pH reported was 6.0. They observed that soils with exceptionally low pH (below 4.5) were either peaty or brackish sedimentary in origin. These soils were frequent in South East Asia and possess serious problems to rice production.

Alice (1984) reported exchangeable aluminium as the main constituent of soil acidity in the wet land rice soils of Kerala.

Bhargava & Abrol (1984) reported that a wide variation of characteristics existed for the acid sulphate wet lands of the Malabar coast. Electrical conductivity varied form 2.9 - 44.4 dSm^{-1} for epipedons, and 1.5 - 74.6 dSm^{-1} for subsurface soils. A pH range of 3.4 - 7.5 was reported between endopedons and epipedons. Heterogenity in acidity was reported to be due to the differential distribution of pyrites.

More et al. (1988) reported that the salt affected wet lands of Maharashtra were having Ec values ranging from 0.8 - 19.0 dSm^{-1}.

Nair (1988) reported that the pH of wet land soils of Kerala varied from 3.6 - 6.5 and drying of these soils resulted in the decrease of pH, believed to be due to oxidation of Fe^{2+} to Fe^{3+}.

4. 2 Soil Fertility

Iyer (1926) reported that the infertility of Kari soils of Kerala was due to the enormous amounts of water soluble salts in them.

Nair (1945) showed that no such correlation can be worked out.

Varghese (1973) reported the occurrence of saline acid wet lands in Kerala which are very poor in their fertility.

Total nitrogen content of the acid sulphate wet lands of Kerala was reported to be high due to high organic matter. Available nitrogen content of 140-590 ppm was reported for the Kari soils of Kerala (Pillai, 1964).

Kyuma (1985) reported that of the 410 samples of tropical Asian wet lands, about 78 percent samples contained only < 0.15 percent total nitrogen. Overall mean was reported to be as low as 0.13 percent. C:N ratio of tropical wet lands ranged between 10-12. Indian wet lands were reported to be low in their organic matter due probably to a drier climate. The N status of wet lands were found to be better than that of uplands.

Raju (1988) reported mean values of available nitrogen contents of 238, 227 and 240 ppm for *Kari*, *Kayal* and *Karappadam* soils of Kerala.

Venugopal (1969), Varghese *et al*. (1973) and Ghosh *et al*. (1976) reported low available P_2O_5 contents in the acid sulphate wet lands of Kerala.

Kyuma (1985) reported that 50 percent of the tropical Asian wet lands were having only 6.6 ppm available phosphorus. High phosphorus sorption capacity and low absolute phosphorus content may be attributed to this result. Total P_2O_5 content was reported to be less than 400 ppm.

Pillai (1964) reported exchangeable potassium levels of 60 - 77 ppm in *Kari* soils.

Kabeerathumma (1969) and Varghese (1973) reported comparitively low values of exchangeable potassium in *Kari* soils, compared to *Karappadam* and *Kayal* soils.

Ghosh *et al*. (1976) reported exchangeable potassium in the range of 0.14 - 0.20, 0.17 - 0.30 and 0.20 - 0.40 me. 100 g^{-1} in *Kari*, *Karappadam* and *Kayal* soils.

Kyuma (1985) reported that about 30 percent of the tropical Asian wet lands were having an exchangeable potassium of less than 0.15 cmol(+) Kg^{-1}. The mean value for exchangeable potassium for these soils was 0.4 cmol(+)Kg^{-1}. Other basic cations like calcium and magnesium were also being reported to show the same status.

Raju (1988) reported 124, 135 and 120 ppm of mean values of exchangeable potassium for Kari, Kayal and Karappadam soils of Kerala.

Money and Sukumaran (1973) reported that the Kari, Karappadam and Kayal soils of Kerala recorded values of CEC in the range of 15.4 - 40.7, 16.4 -37.8 and 12.8 -17.0 cmol(+)kg^{-1} respectively.

Venugopal and Koshy (1976) found that the exchangeable base status of different wet land soils of Kerala was in the order of Ca > Mg > K > Na.

Sanchez (1976) suggested a CEC of at least 4 cmol(+)Kg^{-1} to retain most cations against leaching.

Hassan (1980) reported a comparatively low value of CEC, exchangeable cations, organic matter and total and available nutrients in the ribbon valley laterite wet lands of Kerala.

Kyuma (1985) from a study of tropical Asian wet lands observed the over all mean of CEC as 18.6 cmol(+)Kg^{-1}.

Marykutty (1986) reported that the CEC of *Kole* soils ranged from 14.2 - 24.5 cmol(+)Kg^{-1}. The values obtained for *Kari*, *Karappadam* and *Kayal* soils were 20.7 - 43.6, 11.1 - 20.4 and 10.8 - 12.3. *Pokkali* soils were reported to have a CEC range of 16.0 - 29.0 cmol(+)Kg^{-1}. According to her, CEC was postively correlated to total CaO, MgO, silt + clay and clay percent of the soil and negatively correlated to base saturation.

Iyer (1989) reported a mean CEC of 11.15 - 46.6 cmol(+) Kg^{-1} for wet lands of Kerala. CEC varied significantly between soils. Range of mean ECEC values reported by him for the same soils were 8.8 - 22.0 cmol (+) Kg^{-1}. ECEC values were found to be correlated with CEC, total CaO, total MgO, silt+clay and clay.

Marykutty (1986) reported that base saturation was positively correlated with toal CaO and MgO and negatively correlated with silt + clay and clay of soil. Base saturation varied from 13.0 - 35.9 percent for *Kole*, 5.6 - 13.6 percent for *Kari*, 17.9 - 32.6 percent for *Karappadam* and 41 - 50.5 percent for *Kayal* wet lands of Kerala.

4. 3 Organic carbon/Organic matter.

Money and Sukumaran (1973) reported that the wet land soils of *Kuttanad* contained fairly large amounts of organic matter. Kari and Karappadam soils were found to have high organic matter compared to Kayal soils.

Bhargava et al. (1984) observed that there existed a wide variation in the organic matter content of the wet lands of Malabar coast, South India (0.5 - 40.5 percent). He suggested that organic matter, soil acidity and associated characters help to qualify them to be classified as Tropaquents (saline slightly acid), Sulfohemists (saline acid sulfate) and Sulfaquents (non-saline acids).

According to Neue (1985) soil organic matter had an important role in soil formation. He reported an organic carbon range of 0.1 - 40 per cent for wet land rice soils of the World in general. Most wet land rice soils of Asia were reported to have only upto 3 percent organic matter.

Marykutty (1986) reported that organic carbon percentage of Kole soils of Kerala ranged from 0.46 - 2.79, Kari soils recorded 2.57 - 10.02 Karappadam 1.69 - 4.00, Kayal 0.19 - 7.28 and Pokkali soil 3.17 - 6.13 percent.

Iyer (1989) reported a mean organic carbon of 0.50 - 10.35% for the acid sulphate wet lands of Kerala.

4. 4 Iron

Brinkman (1970) suggested that displacement or loss of bases by Fe^{2+} causes acidification or ferrolysis. This was suggested to be the major soil forming process of acid sulphate wet lands.

Money and Sukumaran (1973) reported that the water soluble iron content of wet land soils of Kerala ranged form 40 - 140 ppm.

Bhargava <u>et</u> <u>al</u>. (1981) suggested that the differences in pH associated with the wet land soils can be ascribed to the heterogenity in the distribution of pyritous clays in the alluvium.

Marykutty (1986) reported that Fe_2O_3 status of <u>Kole</u> soils ranged from 3.39 - 7.87 percent, that of <u>Kari</u> from 6.26 - 10.29, that of <u>Karappadam</u> from 7.14 - 8.89 and that of <u>Kayal</u> soils of <u>Kuttanad</u> from 6.19 - 7.82. <u>Pokkali</u> soils were reported to have an Fe_2O_3 content of 3.17 - 6.13 percent. Positive correlation with Al_2O_3 and sesquioxide status of the soil and negative correlation with ECEC, CEC, total CaO, MgO, silt + clay percent were reported by her.

According to Yin <u>et</u> <u>al</u>. (1987) to aid classification of paddy soils Fe_d/Fe_o ratio was effective. Their reports highlighted the activation of Fe as the main process of paddy soil formation.

Iyer (1989) reported that the mean Fe_2O_3 content was the highest in Pokkali soils and lowest in Kari soils.

4. 6 Sulphides

According to Moorman (1973) accumulation of sulphides, in particular pyrite is quite common in marine and estuarine deposits all over the world.

Ponnamperuma (1965) observed that acid sulphate wet lands were derived mainly from marine and estuarine sediments with high sulfide contents.

Pillai (1964) reported that the sulphate sulphur content of Kari soils of Kerala range from 1.2-4.3 percent. Sulphuric acid was formed in these soils by the oxidation of sulphur compunds in wood fossils.

Money and Sukumaran (1973) observed that the sulphate sulphur was found in the upper exposed layers and sulphide sulphur in lower layers which varied with the layers of the profile.

Iyer (1989) reported that the total sulphur of wet land soils of Kerala ranged between 0.04 and 0.34 percent.

4. 7 Aluminium

Schoefield (1949) observed that aluminium was the main constituent of soil acidity.

Kanivets (1973) suggested the accumulation of exchangeable aluminium in acid gleyed soils was caused by the decomposition of alumino silicate minerals and aluminium hydroxide by H^+ and H_3O^+.

Sanchez (1976) considered soil acidity on the basis of percentage aluminium saturation of the ECEC. Marykutty (1986) reported exchangeable aluminium values of 5.02 - 9.5 me 100 g^{-1} for Kole, 7.4 - 19.25 for Kari, 4.5 - 5.84 for Karappadam, 3.5 - 4.6 for Kayal and 3.44 - 6.55 for Pokkali soils. A positive correlation was reported with aluminium saturation of total CEC and ECEC, Eh, organic carbon, silt + clay and clay percent.

Iyer (1989) observed a range of 4.35 - 12.5 percent for total Al_2O_3 in wet land soils of Kerala. Mean exchangeable Al varied from 3.4 - 18.5 cmol (+) kg^{-1}.

5. Sand and clay minerology of wet land soils

Gopalaswamy (1961)observed the clays of Moncompu (Karappadam) profile showed an appreciable amount of alumina. Calcium oxide existed in traces in the clay fraction of most of these soils. The percentage MgO and K_2O were also appreciable. Clays of most of these soils were found to have illitic or montmorillonitic minerals.

Brinkman (1970) described the term ferrolysis. This is chloritisation under a reduced environment. Yoshida and Itoh (1974)postulated the possibility of Aluminium interlayering of expanding 2:1 type clays, leading to lowering of CEC.

Van Breemen (1976) identified haematite in the red mottles occurring in certain acid sulphate soils of Thailand. He ascribed its occurrence partly to the dehydrating terrain conditions and partly to strong acidity.

Ghosh et al. (1976) in their studies on the acid sulphate soils of Kerala, pointed out that the occurrence of kaolinite and halloysite (18-32 percent) in association with smectite (18-32 percent), illite (6-12 percent) and chlorite (4-11 percent). In addition gibbsite up to 4 percent and traces of amphibole together with quartz and feldspars were detected.

Hatori (1978) reported that acid sulphate soils derived from brackish alluvial sediments had considerable amounts of aluminium interlayered minerals. Riverine allivial sediments were reported to contain 2:1 type of minerals of vermicullite nature; 10A° minerals and minerals without the dominance of species.

Bhargava et al. (1981) indicated that the sodic soils of Indo-Gangetic alluvium were dominated by the accumulation of silica and alumina, potassium and iron salts. Weathering of alumino silicate was believed to be the soil genesis process.

Pombo et al. (1982)reported the occurrence of maghaemattite in the coarse clay fractions of both Ap and B2 horizons of wet Latosols.

Watasuki et al. (1984) observed that prolonged paddy cultivation brought about a modification in the clay mineralogy of Ap horizons. Characteristic changes resulted in the formation of 18-25A° minerals, composed of intralamellar humus-smectite complexes and inter stratified minerals.

Huang et al. (1987)reported that the clay mineralogy of low land soils of China varied from kaolinite to illite and montmorillonite depending on parent material.

Shamsuddin et al. (1987) reported that acid sulphate wet lands of Malaysia had yellowish mottles of jarrosite and or natrojarrosite. The other minerals present were kaolinite,mica, mica smectite and smectite. Xing et al. (1988)pointed out that aluminium substitution in geothite was decreased by water logging and was indicative of the degree of development of paddy soils.

6 Classification of Wet lands

Boul et al. (1980) observed that earlier classifications of wet lands were mainly based on geological origin or lithological composition of parent materials. These systems of classification were prepared for specific purpose or objective and using factors or characteristics, not properties of the soils themselves as differentiating characters.

Perkins and Hutchins (1980) related the soil reaction as a criterion in classifying entisols. 122 pedons of alluvial entisols from 8 geological regions were studied for their soil reaction values in water and 0.1 M $CaCl_2$. According to him geologic formation may be used to predict the soil reaction class at the family level when the formation is relatively uniform, the clay content in these horizons did not show a sharp change as compared with horizons just above or beneath it.

FAO - UNESCO system (1974) distinguished acid sulphate wet lands as Thionic Fluvisols with a sulphuric horizon or sulfidic material or both within 125 cm depth.

Van Breemen and Pons (1978) reported that eventhough the clay organic matter is high in acid sulphate wet lands the unbuffered CEC is normally low, (10-25 cmol (+)Kg^{-1}) due to low pH and chloritisation of swelling clay minerals. Sulfaquents were reported to have a pH of 3.5 - 6.5 for surface soils, Sulfaquepts were reported to have pH range of 3-4 and 4-5 and in Sulfidic Tropaquepts pH below 3 is exceptional.

Soil Taxonomy (1975) suggested that pH of potentially acid wet lands soils drops below 3.5 on drying. Simple air drying of the soils in the shade gave non-conclusive results because microbially induced pyrite oxidation is hampered once the soil is dried.

Paramananthan & Gopinathan (1982) defined Cat clay soils as those with a pH of about 3.3 or less on the air dried soil and a sulphur content> 0.1 percent. The presence of sulphidic materials without a sulphuric horizon, within 50-100 cm could be considered as a criteria for classification of Tropaquepts. Soils with sulphidic material within 50 cm but overlain by a well developed cambic and/or sulphuric horizon would fall into Sulfidic Tropaquepts and Typic Sulfaquepts respectively.

Smith (1981) defined Soil Taxonomy and its place in Soil survey. He reported the place of soil climate (moisture and temperature regimes) in Soil Taxonomy and its estimation. The limitations and usefulness of the system were also discussed.

FAO-UNESCO (1974) grouped the Wet land soils of the World based on their distribution and agricultutral potential.

Soil Taxonomy (1975) defined the potential and actual acid sulphate wet lands based on the occurrence of a sulphuric horizon or sulphidic material. Accordingly a sulphuric horizon is composed of mineral or organic soil material with a pH < 3.5 and yelllow jarrosite mottles. Sulphidic materials are water logged mineral or organic materials with > 0.75 percent sulphur and <3 times as much carbonate ($CaCO_3$ equivalent) as sulphide sulphur.

Soil Taxonomy (1975) classified potential acid sulphate soils either as Sulfaquents (Aquents with sulphidic material within 50 cm of the mineral soil surface), Sulfic Fluvaquents (Fluvaquents with sulphidic material within 50 and 100 cm depth).

In majority of cases acid sulphate paddy soils can be classified as Sulfaquepts, (Aquepts with a sulphuric horizon that has its upper boundary within 50 cm of the soil surface). Sulfic Tropaquepts, (Tropaquepts with jarrosite mottles and a p^H 3.5 - 4 somewhere between 50-150 cm depth), or sulfic Haplaquepts, (similar to Tropaquepts but under more temperate climate).

ORSTOM classification identified acid sulphate wet lands as a class of saline soils,(Segalen 1979). Two sub classes were distinguished as Thiosols, (with a reduced Thion within 60 cm of the surface. 'Thion' has > 0.75 percent oxidisable sulphur and becomes acid when dried), and Sulfosols (with jarrosite mottles within 60 cm of the surface having > 0.75 percent sulphur and a pH <3.5). These definitions corresponded to potential and actual acid sulphate soils.

In the ILRI system of nomenclature for acid sulphate wet lands a distinction into peat and non-peat had been made. Grouping as sandy and clayey, raw and ripe acid sulphate soils and acid aluminium soils was done according to this system (Dent, 1986). Categorisation according to climate was effected by adopting different diagnostic depth limits according to potential soils water deficit.

Bhargava and Abrol (1984) classified the acid sulphate wet lands of Kerala as Tropaquents because the mean summer (March, April, May) and mean winter (Nov., Dec.) temperatures at 50 cm differed by < 5°C. Sulfohemists soils were identified near Calicut where the upper boundary of sulphuric horizon was within 50 cm of the surface. Pokkali soils of Ernakulam were classed as Hemistic Aquents (Aquents with hemic material underneath). Kari soils of Ambalappuzha were grouped as Sulfaquents (Aquents with surfidic material that has its upper boundary within 50 cm).

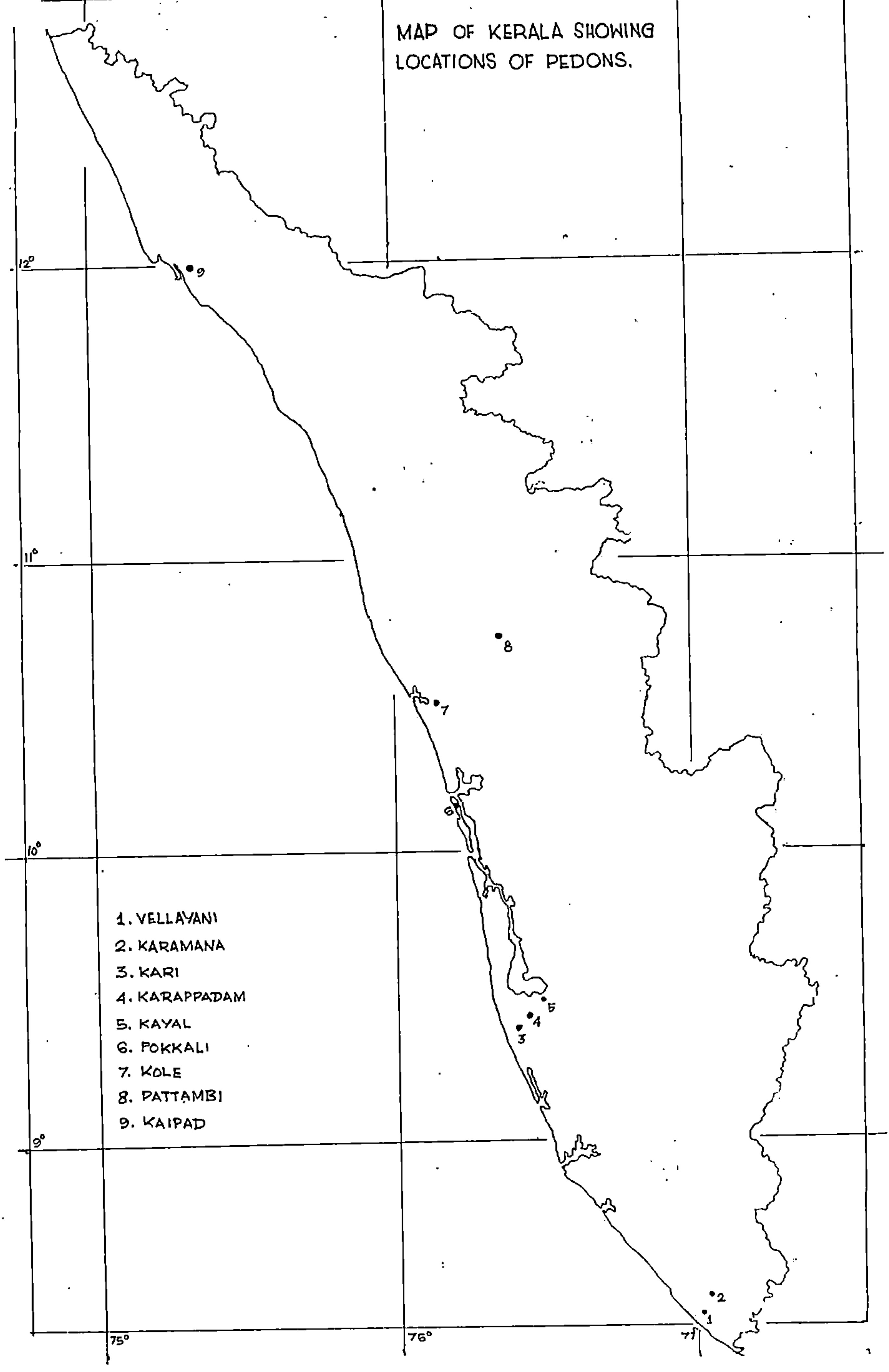
MATERIALS AND METHODS

MATERIALS AND METHODS

In order to study the morphology and characteristics and to classify the wet land soils of Kerala, nine specific locations representing the manmade and natural wet lands were selected. The selection of locations were based on the occurrence of natural wet lands which had been reclaimed for cultivation and which have a natural water table at or near their surface and manmade wet lands which had been brought under cultivation by man for rice culture in the recent past. Care was taken to select those soils which are known by local terminology or by common scientific names, representing major agricultural tracts of the State.

The profiles were dug at the following representative sites.

No.	Site	Nature	Common name of soil type
1.	Vellayani	Natural/freshwater *Kayal*	Acid Hydromorphic
2.	Karamana	Manmade/Valley bottom	Brown hydromorphic
3.	Thakazhi	Natural/*Kari*	Acid sulphate
4.	Nedumudi	Natural/*Karapadam*	Acid hydromorphic
5.	D-Block	Natural/*Kayal*	Saline hydromorphic
6.	Njarackal	Natural/*Pokkali*	Saline acid
7.	Anthikkad	Natural/*Kole*	Saline acid
8.	Pattambi	Manmade/Valley bottom	Brown hydromorphic
9.	Pazhayangadi	Natural/*Kaipad*	Saline acid


MAP OF KERALA SHOWING LOCATIONS OF PEDONS.
12°
11°
10°
9°
75°
76°
77°
1. VELLAYANI
2. KARAMANA
3. KARI
4. KARAPPADAM
5. KAYAL
6. POKKALI
7. KOLE
8. PATTAMBI
9. KAIPAD
1
2
3
4
5
6
7
8
9

Profile pits were dug in the above 9 locations upto a depth > 150 cm. Information on the site, general information on the soil and profile description were made as per the guide lines suggested by Soil Survey Staff (1975). A total number of 62 samples were collected from each horizon of different profiles for physico-chemical analysis in the laboratory. Climatological data regarding mean monthly temperature and mean annual rainfall were collected from the research stations viz. Karamana and Pattambi for the man made wet lands and from Soil Moisture and Temperature Regimes of S.India (1990) for other locations.

Laboratory investigations

The wet land soil samples were air dried, powdered and sieved through a 2 mm IS sieve and stored in air tight bottles. These sieved soil material was subjected to physical, chemical and mineralogical evaluations. A portion of fresh soil sample from each horizon was kept separately in wet condition for specific determinations.

I Physical Analysis

(a) Mechanical analysis

The mechanical composition of the soil samples was determined by International Pipette method (Jackson, 1973).

The percent contents of various size fractions were determined and the fine sand fraction was used for identification of sand mineralogy. After the determination of granulometric compostion, the textural classification of the soils was done using USDA textural diagram (Soil Survey Staff, 1975).

(b) Single value constants

The single value physical constants viz; bulk density, particle density, porosity, water holding capacity and volume expansion were determined using Keen- Raczkowski Box as described by Piper (1950).

II <u>Chemical Analysis</u>

(a)pH of the fresh and air dried soil samples were determined in water (1:1 soil and water and 1:2.5 soil and water), I M KCl (1:2.5 soil and KCl) and $CaCl_2$ 0.01 M (1:2 soil and $CaCl_2$) using 'Perkin Elmer' pH meter (Jackson, 1973, USDA - SCS Anon, 1984).

(b) Electrical conductivity of the 1:2.5 soil water extract was read using an 'Elico' conductivity bridge, Jackson (1973).

(c) Organic carbon and organic matter were determined by modified Walkley and Black wet digestion method, (Jackson, 1973).

(d) Total nitrogen, phosphorus, potassium, calcium, magnesium and iron were determined by standard procedures described by Jackson (1973).

(e) Cation exchange capacity was determined by Neutral 1N NH_4OAC leachate method as described by Jackson (1973). Effective CEC was derived by adding sum of bases (CEC) and KCl extractable Al. (USDA-SCS Anon, 1984).

(f) Exchangeable hydrogen and aluminium were estimated in the 1M KCl extract (Black, 1965).

(g) Base saturation was calculated on the basis of total CEC as suggested by Jackson (1973).

(h) Total sulphur was determined by turbidimetric determination of available sulphate, described by Chesnin and Yien (1951).

III Mineralogy

Identification of minerals in the fine sand and clay fraction of the surface samples of 9 profiles was done using petrological microscope. (Parfenova and Yarilova, 1965).

RESULTS

RESULTS

Pedon: 1

Location: Vellayani, Thiruvananthapuram, Kerala.

La :8^{o} 26′ 3" N and Lo :76^{o} 59′ 5" E.

Information on the site: Below 0.1 Metre MSL-Valley bottom Kayal lands, flat or almost flat, rice fields, isohyperthermic temperature and aquic moisture regimes.

Information on the soil: Recent lagoonal clays and sediments, very poorly drained, water logged, wet throughout the profile,artificially drained, brought under cultivation with rice (single crop) for the past 50 years. Natural vegetation: marsh land grasses, numerous wood foosils seen embedded on lower horizons.

Profile description : Ap1; 0-11cm; Light olive brown 2.5 Y 5/6 moist and pale yellow 2.5 Y 7/4 dry; sandy clay loam; moderate granular; weakly cemented; many fine medium continuous pores; fine to medium rice and weed roots; gradual wavy boundary. pH 4.5. (wet), 4.2 (dry).

Ap2; 11-16 cm; Greyish brown 2.5 Y 5/2 moist and light grey 2.5 Y 7/2 dry; sandy clay loam; moderate granular; sticky; weakly cemented; many fine medium continuous and discontinuous pores; clear smooth boundary. p^{H} 4.6.(wet), 4.4 (dry).

A2g; 16-28 cm; Light yellowish brown 2.5 Y 6/4 moist and light grey 2.5 Y 7/0 dry; clay loam; moderate fine granular; sticky; plastic; many continuous and discontinuous pores; gradual smooth boundary. pH 4.9 (wet), 4.4 (dry).

AC; 28-40 cm; Light olive brown 2.5 Y 5/4 moist and very pale brown 10 YR 8/3 dry; clay; massive; sticky; plastic; many, fine, continuous pores; gradual smooth boundary. pH 5.2 (wet), 4.7 (dry).

C1 40-56 cm; Light brownish grey 2.5 Y 6/2 moist and pale yellow 2.5 Y 7/4 dry; clay; massive sticky; plastic; strong; roots nil; fine many continuous pores; diffuse smooth boundary; wood fossils and remains of earlier mangrove vegetation. pH 5.6 (wet), 4.9 (dry).

C2; 56-82 cm; Very dark greyish brown 2.5 Y 3/2 moist and light grey 2.5 Y 7/2 dry; clay; massive; blocky; sticky; plastic;roots nil; fine many continuous pores; diffuse smooth boundary; wood fossils and remains of earlier mangrove vegetation. pH 5.6 (wet), 4.9 (dry).

C3; 82 - 150 cm; Very dark greyish brown 2.5 Y 3/2 moist and light grey 2.5 Y 7/2 dry; clay; massive; blocky; strong; sticky; plastic; roots nil; many fine continuous pores; diffuse boundary. pH 5.7 (wet), 4.8 (dry).

C4 150 -172 cm; Very dark greyish brown 2.5 Y 3/2 moist and grey 2.5 Y N/6 dry; clay; massive; strong; sticky; plastic; roots nil; fine many continuous pores; and diffuse wavy boundary; remains of mangrove vegetation. pH 6.0. (wet), 5.0 (dry).

C5 172 - 200 cm; Very dark greyish brown 2.5 Y 3/2 moist and grey 2.5 Y N/6 dry; clay; fine granular; plastic; sticky; roots nil;. pH 6.1 (wet), (4.9 dry).

I.Physical characteristics

Symbol	AP1	AP2	A2g	Ac	C1	C2	C3	C4	C5
Texture	Sandy Clay loam	Sandy Clay loam	Clay loam	Clay	Clay	Clay	Clay	Clay	Clay
Bulk density g.cc^{-1}	1.16	0.95	1.27	1.25	1.19	0.96	1.16	1.19	1.48
Particle density g.cc^{-1}	1.99	1.98	2.14	2.14	2.04	1.99	2.26	1.97	2.49
Pore space: %	45.99	45.09	45.71	44.44	46.22	35.49	55.84	46.14	49.69
Maximum water holding capacity %	40.95	40.12	38.62	40.26	40.78	36.07	40.66	53.85	38.36
OCx BD x THICKNESS. / 10	1.59	0.43	0.83	0.09	0.79	1.90	2.80	1.75	4.8

II.Chemical Characteristics.

Symbol	AP1	AP2	A2g	Ac	C1	C2	C3	C4	C5
pH 1:1 (wet)	4.5	4.6	4.9	5.2	5.6	5.6	5.7	6.0	6.1
pH 1:1 (dry)	4.2	4.4	4.4	4.7	4.9	4.9	4.8	5.0	4.9
pH KCl (1:1)	3.9	4.1	3.7	4.1	4.1	4.2	4.3	4.6	4.7
Ec.(dS.m^{-1})	0.20	0.30	0.10	0.05	0.20	0.30	1.01	0.60	0.70
Organic carbon(%)	1.25	0.92	0.55	0.60	0.42	0.66	1.38	0.67	1.08
Organic matter (%)	2.16	1.58	0.95	1.03	0.73	1.13	2.37	1.17	1.86
CEC (cmol (+)Kg^{-1}	11.02	9.87	8.88	8.71	8.21	8.23	10.41	7.23	14.27
ECEC " "	6.47	6.45	6.55	6.78	5.97	5.84	4.55	5.7	5.92
Base Saturation %	41.60	46.40	46.80	48.70	43.30	40.30	41.30	57.90	38.30
Total Sulphur (ppm).	10.40	9.41	5.68	5.01	6.02	6.64	5.21	4.37	4.29
Total Fe%	10.71	10.64	10.20	10.95	10.82	10.61	10.82	10.12	10.12
Exchange-able Hydrogen me 100g^{-1}	0.32	0.45	0.32	0.38	0.40	0.36	0.39	0.47	0.49
Exchangeable Al:me 100g^{-1}	0.14	0.17	0.40	1.81	1.67	0.97	1.01	0.84	0.46
Total N (%)	0.013	0.040	0.077	0.052	0.031	0.033	0.020	0.027	0.011
Total P_2O_5(%)	0.016	0.017	0.014	0.011	0.012	0.011	0.010	0.011	0.010
Total K_2O(%)	0.421	0.312	0.233	0.241	0.211	0.197	0.186	0.154	0.125
Total Ca(%)	0.401	0.391	0.367	0.343	0.347	0.341	0.326	0.319	0.311
Total Mg(%)	0.056	0.050	0.025	0.025	0.027	0.023	0.038	0.035	0.040
Total Na(%)	0.062	0.051	0.051	0.052	0.061	0.068	0.072	0.074	0.073
Exchangeable K me 100g^{-1}	0.19	0.21	0.17	0.24	0.21	0.22	0.20	0.28	0.19
Exchangeable Ca me 100g^{-1}	1.93	1.57	2.01	2.12	1.91	1.73	1.79	1.54	1.59
Exchangeable Mg. me 100g^{-1}	1.73	2.14	2.14	2.03	1.99	1.79	1.83	1.76	1.87
Exchangeable Na me 100g^{-1}	0.31	0.42	0.36	0.47	0.22	0.29	0.31	0.21	0.23

Pedon :2

Location: Karamana, Thiruvananthapuram, Kerala,

La: 8^{0} 28′ 3" N. and Lo: 76^{0} 57′ 50"E.

Information on the site : Above 7 metres MSL. Valley bottom, man made, flat or almost flat, rice fields, isohyperthermic temperature and aquic moisture regimes.

Information on the Soil : Recent and sub recent sediments moderately drained, surface soil at field capacity, high water table, wet throughout the profile, artificially drained, brought under cultivation with rice for the past 60 years. Natural vegetation: rice and grassy weeds, fossil woods nil.

Profile description: AP1; 0 - 17 cm; Olive brown 2.5 Y 4/4 moist and pale yellow 2.5 Y 7/4 dry; sandy clay loam; moderate fine granules; slightly sticky; slightly plastic; many fine vesicular and tubular pores; many fine roots concentrated in the first 5 cm. diffuse smooth boundary. pH 6.0 (wet), 4.5 (dry).

Ap_2; 17 - 32 cm; Light olive brown 2.5 Y 5/6 moist and light yellowish brown 2.5 Y 6/4 dry; sandy clay; moderate fine granular; slightly sticky slightly plastic; common vesicular and tubular pores; diffuse smooth boundary. pH 5.5 (wet), 4.9 (dry).

Ac; 32 - 56 cm; Light olive brown 2.5 Y 5/6 moist and light yellowish brown 2.5 Y 6/4 dry; clay; massive; sticky; plastic; common fine imped pores; diffuse smooth boundary. pH 6.2 (wet), 4.9 (dry).

C_1g; 56-90 cm; Olive brown 2.5 Y 4/4 moist and dark greyish brown 2.5 Y 4/2 dry; massive;plastic;fine irregular pores;diffuse smooth boundary ;pH 6.0(wet), 5.2 (dry).

C_2; 90 - 111 cm; Dark grey 2.5 Y N/4 moist and dark greyish brown 2.5 Y 4/2 dry; clay; massive; sticky, plastic; fine irregular pores; diffuse smooth boundary. pH 6.0 (wet), 4.9 (dry).

C_3; 111 - 140 cm; Olive brown 2.5 Y 4/4 moist and light grey 2.5 Y 7/2 dry; clay; massive; sticky; plastic; fine irregular pores; diffuse smooth boundary. pH 6.0 (wet), 4.9 (dry).

C_4; 140 - 210 cm; Dark grey 2.5 Y N/4 moist and brownish grey 2.5 Y 6/2 dry; clay; massive; sticky; plastic; fine irregular pores; diffuse smooth boundary. pH 6.1 (wet), 4.8 (dry).

I. Physical Characteristics

Symbol	Ap1	Ap2	AC	Cg	C2	C3	C4
Texture	Sandy	Sandy	Clay	Clay	Clay	Clay	Clay
Bulk density $g.cc^{-1}$.	1.27	1.01	0.91	0.94	0.97	0.99	1.20
Particle density $g.cc^{-1}$.	2.09	2.24	2.32	2.43	2.44	2.67	1.91
Pore space(%)	52.3	55.32	60.12	61.20	61.20	54.2	56.1
Maximum water holding capacity (%).	41.2	54.30	49.90	57.30	57.20	53.21	43.20
$\frac{\text{OC x BD x Thickness}}{10}$	2.91	1.72	0.58	0.86	0.18	0.34	0.51

II Chemical Characteristics:

pH(1:1) wet	6.0	5.5	6.2	6.0	6.0	6.0	6.1
pH(1:1) dry	4.5	4.9	4.9	5.2	4.9	4.9	4.8
pH KCl (1:1)	3.9	4.1	4.5	4.1	4.0	4.0	3.8
E.C dSm^{-1}	0.10	0.20	0.30	0.09	0.10	0.10	0.05
Organic Carbon %	1.20	1.17	0.27	0.27	0.12	0.12	0.06
Organic matter %	2.06	2.01	0.46	0.46	0.20	0.20	0.10
CEC (cmol (+) Kg^{-1})	11.0	11.20	9.21	9.69	6.10	6.01	8.56
ECEC "	5.04	4.99	5.00	3.43	4.98	4.11	4.66
Base Saturation %	29.5	30.6	31.9	34.9	38.8	27.2	33.50
Total Sulphur ppm	6.53	6.20	1.44	2.84	2.32	1.56	1.48
Total Fe %	10.50	10.63	10.63	9.56	8.49	9.24	9.17
Exchangeable Hydrogen me $100g^{-1}$	0.18	0.14	0.10	0.22	0.19	0.18	0.18
Exchangeable Al Me $100g^{-1}$	0.34	0.21	0.26	0.10	0.14	0.19	0.17
Total N %	0.142	0.097	0.092	0.087	0.073	0.063	0.041
Total P_2O_5%	0.019	0.013	0.016	0.015	0.010	0.004	0.009
Total K_2O%	0.310	0.231	0.187	0.164	0.113	0.102	0.276
Total Ca%	0.313	0.297	0.280	0.273	0.280	0.276	0.271
Total Mg %	0.048	0.035	0.037	0.038	0.036	0.038	0.036
Total Na%	0.025	0.028	0.083	0.019	0.020	0.023	0.018
Exchangeable K.me $100g^{-1}$	0.19	0.14	0.28	0.61	0.13	0.27	0.16
Exchangeable Ca me $100g^{-1}$	1.32	1.27	1.30	1.43	1.78	1.14	1.36
Exchangeable Mg me $100g^{-1}$	1.29	1.32	1.82	1.07	1.83	1.20	1.42
Exchangeable Na me $100g^{-1}$	0.48	0.63	0.49	0.38	0.14	0.21	0.41

Pedon:3.

Location : Thakazhi, Kuttanad, Alapuzha,Kerala.

La :9^{0} 20′ 27′′ N and Lo :76^{0}25′30′′ E.

Information on the Site: Below 1metre MSL, natural coastal marsh, flat, rice fields, isohyperthermic temperture and aquic moisture regimes.

Information on the Soil: Recent riverine clay and peat sediments on marine sands,poorly drained,water logged, artifically drained subject to occasional salt water intrusion, brought under cultivation with rice for the past 50 years and coconut on the bunds of drainage channels. Natural vegetation: marsh land grasses and mangroves, numerous fossil woods.

Profile Description:Ap1; 0-12 cm; Olive brown 2.5 Y 4/4 moist and light olive brown 2.5Y 5/4 dry; sandy clay loam; moderate fine granular; slightly sticky and slightly plastic; many fine roots inside the peds; many fine tubular pores; gradual smooth boundary. pH 3.9 (wet), 3.4 (dry).

Ap2; 12-18 cm; Very dark greyish brown 2.5 Y 3/2 moist and greyish brown 2.5 Y 5/2 dry; sandy clay; moderate fine granular; slightly sticky and slightly plastic; few roots; many fine tubular pores; gradual smooth boundary; few fossil woods well mixed. pH 4.0 (wet), 3.9 (dry).

Ag; 18-30 cm; Very dark grayish buown 2.5 Y 3/2 moist and dark grayish brown 2.5 Y 4/2 dry; sandy clay; moderate coarse granular; sticky and plastic; roots nil; fine irregular pores; gradual smooth boundary; few fossil woods. pH 4.4 (wet), 3,3 (dry).

C1; 30-54 cm; Very dark gray 2.5 Y 3/N moist and very dark grayish brown 2.5 Y 3/2 dry, clay; coarse granular, sticky and plastic; roots nil;many fine tubular pores; diffused smooth boundary; numerous soft fossil woods. pH 5.5 (wet), 3.2 (dry).

C2; 5 4-140 cm; Black 2.5 Y N/2 moist and very dark grayish brown 2.5 Y 3/2 dry ; clay; massive; sticky and plastic; roots nil; many tubular pores; few soft fossil woods; pH 5.9 (wet), 3.0 (dry).

I. Physical Characteristics

Symbol	Ap1	Ap2	Ag	C1	C2
Texture	Sandy Clay loam	Sandy clay	Sandy clay	clay	clay
Bulk density $g.cc^{-1}$	1.11	1.03	0.94	0.97	1.13
Particle density $g.cc^{-1}$	1.73	1.86	1.51	1.29	1.76
Pore space (%)	49.69	50.69	50.99	33.25	54.77
Maximum water holding capacity (%)	44.26	48.50	47.35	32.48	44.66
$\frac{\text{OC x BD x Thickness}}{10}$	4.19	1.55	5.75	1.1	13.72

II. Chemical Characteristics

	Ap1	Ap2	Ag	C1	C2
pH (1:1) wet	3.9	4.0	4.4	5.5	5.9
pH (1:1) dry	3.4	3.9	3.3	3.2	3.0
pH Kcl (1:1)	3.0	3.0	2.9	2.5	2.5
E.C. ($dS\ m^{-1}$)	1.9	8.3	4.8	5.5	5.5
Organic carbon (%)	3.15	2.52	5.10	0.51	2.64
Organic matter (%)	5.40	4.30	8.70	0.80	4.50
C.E.C ($cmol\ (^+)\ Kg^{-1}$)	15.4	24.2	22.0	24.3	25.3
E.C.E.C. "	14.2	12.3	10.5	15.3	16.6
Base Saturation (%)	20.5	21.7	21.9	21.8	22.9
Total Sulphur (ppm)	29	125	130	7623	7024
Total Fe (%)	10.3	11.2	11.7	10.9	11.6
Exchangeable Hydrogen me $100\ g^{-1}$	3.90	41.30	38.70	32.80	43.30
Exchangeable Al me $100g^{-1}$	0.90	4.70	7.30	14.80	5.90
Total N %	.120	.109	.090	.010	.071
Total P_2O_5 %	.017	.011	.012	.009	.010
Total K_2O %	.219	0.208	0.112	0.118	0.110
Total ca %	0.420	0.410	0.360	0.310	0.320
Total Mg %	0.157	0.118	0.166	0.101	0.102
Total Na %	0.101	0.097	0.098	0.091	0.093
Exchangable K me $100g^{-1}$	0.16	0.18	0.17	0.19	0.20
Exchangable Ca me $100g^{-1}$	0.93	0.97	0.99	0.89	0.91
Exchangeable Mg me $100g^{-1}$	0.84	0.86	0.89	0.97	0.96
Exchangeable Na me $100g^{-1}$	0.12	0.16	0.14	0.13	0.19

Pedon: 4

Location : Nedumudi, Kuttanad, Alapuzha, Kerala.

La : 9^{o} 24′, 57" N. and Lo:76^{o} 25′ 13" E.

Information On the Site: Below 0.75 metre MSL, Natural flood plains, flat, rice field, isohyperthermic temperature and aquic moisture regimes.

Information on the Soil: Recent riverine clay and peat sediments poorly drained, water logged, artificially drained, brought under cultivation with rice for the past 50 years. Natural vegetation: rice and grassy weeds, fossil woods present in the lower strata of the profile.

Profile Description : Ap1; 0-16 cm; Olive brown 2.5 Y 4/4 moist light olive brown 2.5 Y 5/4 dry; sandy clay; coarse granular; many fine roots inside peds; many fine tubular pores; smooth diffuse boundary. pH 5.0 (wet), 4.1 (dry).

Ap2; 16-24 cm; Greyish brown 2.5 Y 5/2 moist and light olive brown 2.5 Y 5/4 dry; clay; moderate fine granular; sticky; slightly plastic; roots few; fine irregular pores; gradual smooth boundary. pH 5.0 (wet), 4.6 (dry).

B2 24 - 34 cm; Dark greyish brown 2.5 Y 4/2 moist and olive brown 2.5 Y 5/4 dry; few fine distinct dark reddish brown mottles; clay; massive; sticky; plastic; strong; roots nil; fine irregular pores; gradual smooth boundary, pH 5.6 (wet), 5.2 (dry).

2C1g; 34 - 52 cm; Dark greyish brown 2.5 Y 5/2 moist and dark grey 2.5 Y N/4 dry; few fine distinct dark reddish-brown mottles; clay; massive; sticky; plastic; strong; roots nil; fine irregular pores; diffuse smooth boundary. pH 5.8 (wet), 5.4 (dry).

2C2g; 52 - 69 cm; Very dark brown 2.5 Y 3/2 moist and dark grey 2.5 Y N/4 dry; few fine faint reddish-brown mottles; clay; massive; very sticky; plastic; strong; roots nil; fine irregular pores; diffuse smooth boundary; remains of mangrove vegetation. pH 6.2 (wet), 5.4 (dry).

2C3g; 69 - 164 cm; Very dark greyish brown 2.5 Y 3/2 moist and dark grey 2.5 Y N/4 dry; clay; massive; very sticky; plastic; strong; roots nil; fine irregular pores; diffuse smooth boundary. pH 6.8 (wet), 6.1 (dry).

I. Physical Characteristics

Symbol	Ap1	Ap2	B2	2C1g	2C2g	2C3g
Texture	Sandy clay	Clay	Clay	Clay	Clay	Clay
Bulk density g. cc^{-1}	1.18	1.20	1.27	1.26	1.20	0.90
Particle density g.cc^{-1}	2.14	2.02	2.13	2.05	1.71	1.70
Pore space (%)	52.49	47.64	50.16	49.78	52.15	48.65
Maximum water holding capacity (%)	49.51	43.04	45.03	45.46	49.16.	40.75
$\frac{\text{OC x BD x Thickness}}{10}$	3.34	1.04	1.29	5.40	5.32	7.0

II.Chemical Characteristics

pH(1:1) wet	4.6	5.0	5.6	5.8	6.2	6.8
pH (1:1) dry	4.1	4.6	5.2	5.4	5.4	5.1
pH Kcl (1:1)	3.1	3.9	4.2	4.5	4.6	4.6
Ec (dSm^{-1})	0.20	0.60	0.50	5.05	5.05	5.05
Organic carbon %	1.77	1.08	1.02	2.40	2.61	2.52
Organic matter (%)	3.05	1.86	1.75	4.13	4.49	4.34
CEC (cmol (+) kg^{-1}	16.21	10.94	9.73	16.21	15.23	14.28
ECEC "	5.78	6.42	5.65	5.99	5.85	5.59
Base Saturation %	25.70	30.10	27.20	28.70	28.60	29.90
Total Sulphur (ppm)	12.04	11.28	9.24	8.12	118.72	213.08
Total Fe (%)	9.74	8.83	8.42	8.83	6.40	6.78
Exchangeable Hydrogen me $100g^{-1}$	2.01	1.99	2.00	10.10	10.91	12.31
Exchangeable aluminum me $100g^{-1}$	0.39	0.41	0.70	6.09	6.10	7.40
Total N (%)	0.027	0.029	0.093	0.098	0.097	0.085
Total P_2O5 (%)	0.024	0.016	0.013	0.012	0.013	0.011
Total K_2O (%)	0.476	0.320	0.234	0.210	0.179	0.183
Total Ca (%)	0.409	0.421	0.403	0.413	0.419	0.417
Total Mg (%)	0.215	0.203	0.227	0.228	0.252	0.249
Total Na (%)	0.079	0.076	0.079	0.088	0.086	0.084
Exchangeable K me 100g	0.14	0.16	0.17	0.16	0.19	0.29
Exchangeable Ca. me $100g^{-1}$	1.01	1.24	1.12	1.22	1.17	1.03
Exchaneable Mg me $100g^{-1}$	1.23	1.34	1.29	1.28	1.32	1.30
Exchangeable Na. me $100g^{-1}$	0.19	0.11	0.14	0.21	0.18	0.23

Pedon : 5.

Location : D-Block North-6000, Kuttanad, Alapuzha, Kerala
(South of R Block; 200 M)
La : 9^{0} 31′ 2" N and Lo : 76^{0} 24′ 45" E.

Information on the Site: Below 1 metre MSL, tidal marsh, reclaimed Kayal land, flat flood plains, rice fields, isohyperthermic temperature and aquic moisture regime.

Information on the Soil: Recent lagoonal clays and marine sediments, poorly drained, water logged, artificially drained and brought under cultivation with rice for the past 50 years. Natural Vegetation: marsh land grasses and mangroves, fossil woods present.

Profile Description Ap1; 0 -10 cm; Dark greyish brown 2.5 Y 4/2 moist and light olive brown 2.5 Y 5/6 dry; sandy clay; moderate granular; many fine roots; many fine pores; gradual smooth boundary; pH 5.5 (wet),4.1 (dry).

Ap2: 10 -18 cm ; Dark greyish brown 2.5 Y 4/2 moist and light olive brown 2.5 Y 5/4 dry; clay; moderate granular. weak; slightly plastic; slightly sticky; roots few; many fine tubular pores; gradual smooth bounday. pH 5.6 (wet), 4.7 (dry).

C1g ; 18 -22 cm ; Olive brown 2.5 Y4/4 moist and dark greyish brown 2.5 Y 4/2 dry; few fine faint mottles; clay; massive; fossillified wood; many fine tubular pores; clear smooth boundary; lime shell accumulation about 5% by weight pH 6.9 (wet), 6.5 (dry).

C2g; 22 -33 cm; Olive brown 2.5 Y 4/4 moist and olive brown 2.5 Y 5/2 dry; clay; massive; sticky; plastic; strong; many fine irregular, pores; gradual smooth boundary; lime shell accumulation about 10% by weight; pH 6.2 (wet) , 6.0 (dry).

C3g; 33 -41 cm ; Very dark greyish brown 2.5 Y 3/2 moist and black 2.5 Y N/2 dry; fine distinct reddish and yellowish mottles; clay; massive;sticky;plastic; strong; many fine irregular pores; gradual boundary. pH 6.7 (wet), 4.0 (dry).

C4g ; 41 -97 cm; Black 2.5 Y N/2 moist and very dark grey 2.5 Y N/3 dry; few fine distinct mottles; clay; massive; sticky; plastic; strong; fine irregular pores; smooth boundary; peat wood occasional. pH 6.9 (wet) , 3.0 (dry).

C5g; 97 -103 cm; Black 2.5 Y N/2 moist and very ark grey 2.5 Y N/3 dry; clay; massive; plastic; strong;

fine irregular pores; clear smooth boundary; occasional lime shells. pH 7.2 (wet) , 5.3 (dry).

C6g; 103 -151 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry ; clay; massive; sticky; plastic; strong; fine irregular pores; diffuse smooth boundary; occassional peats. pH 7.4 (wet), 6.5 (dry).

I Physical Characteristics

Symbols	Ap1	Ap2	C1g	C2g	C3g	C4g	C5g	C6g
Texture	Sandy Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Bulk density $g.cc^{-1}$	1.08	1.02	1.13	1.29	1.09	1.10	0.96	1.13
Particle density gcc^{-1}	2.32	2.26	2.12	2.27	1.97	1.91	2.11	1.99
Pore space (%)	46.03	48.67	53.50	49.98	48.45	56.48	59.99	59.54
Maximum Water holding Capacity %	43.11	47.90	43.33	44.11	38.04	45.07	49.82	49.59
$\frac{OC \times BD \times Thickness}{10}$	2.11	0.84	0.49	0.59	1.76	26.4	1.99	17.9

II. Chemical Characteristics

	Ap1	Ap2	C1g	C2g	C3g	C4g	C5g	C6g
pH (1:1) wet	5.5	5.6	6.9	6.2	6.7	6.9	7.2	7.4
pH (1:1) dry	4.1	4.7	6.5	6.0	4.0	3.0	5.3	6.5
pH (1:1) Kcl	3.9	4.6	5.4	5.2	3.6	3.7	5.2	6.1
E C. ($dS\ m^{-1}$)	1.21	0.90	1.01	0.10	0.40	0.05	0.60	0.70
Organic Carbon (%)	1.96	0.78	1.09	0.42	2.02	4.30	3.40	3.46
Organic matter (%)	3.39	1.34	1.89	0.72	3.49	7.42	5.87	5.97
C.E.C ($cmol(+)Kg^{-1}$)	13.94	8.04	9.10	14.11	12.86	19.21	16.47	17.90
E.C.E.C "	6.77	6.05	6.53	8.33	6.95	6.70	13.42	14.99
Base Saturation (%)	47.6	50.5	53.4	59.2	51.4	49.1	49.2	49.9
Total Sulphur (ppm)	9.8	8.4	25.4	29.2	82.52	74.26	20.37	21.12
Total Fc (%)	4.92	5.56	4.74	8.41	8.78	7.86	6.06	7.62
Exchangeable Hydrogen me $100g^{-1}$	2.10	10.41	8.21	7.29	11.51	12.37	14.61	14.93
Exchangeable Al me $100g^{-1}$	0.37	6.29	4.20	3.91	6.19	6.21	8.00	8.10
Total N (%)	0.148	0.126	0.121	0.120	0.111	0.109	0.083	0.073
Total P_2 05 (%)	0.031	0.024	0.021	0.024	0.011	0.012	0.010	0.009
Total K_2O (%)	0.400	0.321	0.307	0.312	0.281	0.203	0.173	0.141
Total Ca (%)	0.693	1.124	2.346	2.987	0.934	0.976	0.832	0.630
Total Mg (%)	0.143	0.138	0.194	0.141	0.312	0.382	0.462	0.420
Total Na (%)	0.091	0.080	0.089	0.089	0.093	0.091	0.90	0.091
Exchangeable K me 100 g^{-1}	0.19	0.20	0.23	0.26	0.18	0.19	0.17	0.10
Exchangeable Ca me 100^{-1}	2.10	3.46	3.71	3.00	2.41	2.26	2.20	2.21
Exchangeable Mg me $100g^{-1}$	2.27	2.19	1.22	2.14	2.32	2.24	2.31	2.37
Exchangeabe Na me $100g^{-1}$	0.29	0.20	0.18	0.24	0.23	0.27	0.24	0.25

Pedon : 6

Location : Njarackkal, Kanayannur, Ernakulam, Kerala,
La : 10° 3' EN and Lo: 76° 13' 22'' E.

Information on the site : Below 1 metre MSL, natural tidal marsh. flat, rice fields, iso hyperthermic temperature and aquic moisture regimes.

Information on the soil: Recent lagoonal clays and marine sediments, very poorly drained, water-logged throughout, artificially drained, subject to tidal ingress of salt water periodically, brought under cultivation using salt resistant local rice varieties for the past 75 years, during offseason prawn culture is practiced; Natural vegetation: halophytic mangroves, no fossil woods.

Profile Description : Ap1 ; 0-8 cm; Very dark gray 2.5 Y N/3 moist and very dark greyish brown 2.5 Y 4/2 dry; sandy clay; weak fine granular; slightly sticky and slightly plastic; weak many fine tubular pores; gradual smooth boundary; few fine roots. pH 4.4 (wet), 3.5 (dry).

Ap2 ; 8-20 cm; Black 2.5 Y N/2 moist and very dark brown 2.5 Y 3/2 dry; sandy clay; weak fine granular; slightly sticky and slightly plastic; many fine tubular pores; gradual smooth boundary; few fine roots, pH 4.4 (wet), 3.5 (dry).

B2; 20-35 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 4/2 dry; sandy clay; massive; sticky and plastic; strong many fine irregular pores; diffuse smooth boundary; roots nil. pH 4.9 (wet), 3.5 (dry).

Cg; 35-75 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry; clay; massive; highly sticky and plastic; strong irregular pores; diffuse wavy boundary; roots nil. pH 4.3 (wet), 3.4 (dry).

C2g; 75-110 cm, Black 2.5 Y N/2 moist and very dark grayish brown 2.5 Y 3/2 dry; clay; massive; highly sticky and plastic; strong irregular fine pores, diffuse wavy boundary; roots nil. pH 4.6 (wet), 3.6 (dry).

C3g; 110-140 cm; Black 2.5 Y N/2 moist and very dark grayish brown 2.5 Y 3/2 dry; clay; massive; highly sticky and plastic; strong irregular fine pores; roots nil. pH 4.7 (wet), 3.6 (dry). .rm70

I Physical Characteristics

Symbol	Ap1	Ap2	B2	Cg	C2g	C3g
Texture	Clay	Clay	Clay	Clay	Clay	Clay
Bulk density $g\ cc^{-1}$	1.09	0.91	0.89	1.01	1.11	1.07
Particle density $g\ cc^{-1}$	2.40	2.41	2.30	2.60	2.51	2.48
Pore Space %	58.03	62.30	63.36	64.11	56.20	57.20
Maximum water holding capacity.	49.20	49.90	50.30	51.80	50.90	51.20
$\frac{OC \times BD \times Thickness}{10}$	0.21	1.9	2.3	5.45	3.90	3.04

II. Chemical Characteristics

pH (1:1) wet	4.2	4.4	4.9	4.3	4.6	4.7
pH (1:1) dry	3.7	3.5	3.5	3.4	3.6	3.6
pH (1:1) Kcl	3.0	3.1	3.1	2.9	2.9	3.8
EC ($dS\ m^{-1}$)	15.0	10.0	10.7	6.1	6.5	6.5
Organic carbon %	2.41	1.77	1.74	1.35	1.01	0.95
Organic matter %	4.1	3.1	3.0	2.3	1.7	1.6
CEC ($cmol(+)Kg^{-1}$)	13.41	13.6	12.9	10.8	7.2	8.4
E C E C "	7.2	7.1	7.1	7.2	6.8	6.7
Base Saturation %	48.9	49.5	51.4	51.6	50.6	49.6
Total S (ppm)	39	33	659	64596	6893	653
Total Fe (%)	2.8	3.2	3.8	4.2	4.6	3.2
Exchangeable Hydrogen me 100 g^{-1}	6.29	4.91	7.10	6.21	7.09	6.84
Exchangeable Al me $100g^{-1}$	2.21	1.51	3.20	2.12	2.20	2.10
Total N%	0.112	0.107	0.100	0.099	0.083	0.79
Total P_2O_5 %	0.020	0.017	0.011	0.010	0.009	0.009
Total K_2O %	0.326	0.301	0.312	0.293	0.284	0.263
Total Ca %	0.270	0.230	0.210	0.220	0.180	0.190
Total Mg%	0.410	0.245	0.204	0.201	0.193	0.186
Total Na%	0.260	0.340	0.330	0.410	0.290	0.290
Exchangeable K me $100g^{-1}$	1.980	2.120	2.200	2.100	2.290	1.930
Exchangeable Ca me $100g^{-1}$	2.130	2.010	2.270	2.190	2.020	2.140
Exchangeable Mg me $100g^{-1}$	0.520	0.480	0.340	0.460	0.400	0.410
Exchangeable Na me $100g^{-1}$	2.031	2.594	2.246	1.983	1.246	1.172

Pedon :7

Location Anthikkadu (Centre of <u>Kole</u> lands),Thrissur,Kerala.

La: 10 ^{o} 26'44" N. and Lo:76^{o}8'52"E.

Information on the Site: Below 1 metre MSL, natural flood plains, flat or almost flat, rice fields, isohyperthemic temperature and aquic moisture regimes.

Information on the soil: Recent riverine and marine sediments imperfectly drained, water logged, wet throughout the profile, subject to occassional salt water inundation, brought under cultivation with rice for the past 50 years. Natural vegetation : marsh land grasses and mangroves, fossil woods present.

Profile Description: Ap1 : 0 -10 cm; Olive brown 2.5 Y 4/4 moist and pale yellow 2.5 Y 7/4 dry; sandy clay loam; medium granular; sticky; plastic; weak; many fine roots; fine tubular pores; gradual smooth boundary. pH 4.4 (wet), 4.0 (dry).

AP2; 10-20 cm; Olive brown 2.5 Y 4/4 moist and pale yellow 2.5 Y 7/4 dry; sandy clay; moderate fine granular; slightly sticky; plastic; weak; roots nil; many tubular pores; smooth gradual boundary. pH 4.5 (wet), 4.1 (dry).

B1; 20 - 30 cm; Dark greyish brown 2.5 Y 4/2 moist and olive brown 2.5 Y 4/4 dry; sandy; fine granular; sticky; plastic; strong; roots nil; medium tubular pores; gradual smooth boundary. pH 4.5 (wet), 4.2 (dry).

B2 ; 30-40cm; Dark greyish 2.5 Y 4/2 moist and olive brown 2.5 Y 4/4 dry; clay; massive; sticky; slightly plastic; roots nil; medium tubular pores; gradual smooth boundary; pH 4.6 (wet), 4.2 (dry).

C1; 40-50 cm; Very dark grey 2.5 Y N/3 moist and dark grey 2.5 Y N/4 dry; clay; moderate; massive; slightly plastic; non-sticky; roots nil; tubular pores; gradual smooth boundary. pH 4.8 (wet); 4.3 (dry).

C2; 50-60 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry; clay; massive; sticky; plastic; strong; roots nil; tubular pores; gradual smooth boundary pH 4.9 (wet), 4.0 (dry).

C3; 60-70 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry; clay; massive; sticky; plastic; strong; roots nil; fine tubular pores; gradual smooth boundary pH 4.9 (wet), 4.0 (dry).

C4 : 70-80; Black 2.5 Y N/2 moist and very dark brown 10 Y 3/3 dry; clay; massive; sticky; plastic; strong; roots nil; fine tubular pores; gradual smooth boundary; pH 4.9 (wet), 3.9 (dry).

I. Physical Characteristics

Symbols	Ap1	Ap2	B1	B2	C1	C2	C3	C4
Texture	Sandy clayloam	Sandy clay	Sandy clay	Clay	Clay	Clay	Clay	Clay
Bulk density gcc^{-1}	1.30	1.26	1.27	1.22	1.30	1.11	1.03	1.21
Partiale density $g.cc^{-1}$	2.11	2.05	2.01	1.86	2.31	2.66	2.19	2.24
Pore space %	54.70	52.90	52.00	49.70	51.30	53.40	51.20	49.20
Maximum water holding capacity %	47.30	52.40	46.20	43.40	45.20	48.50	47.90	46.20
$\frac{OC \times BD \times Thickness}{10}$	1.75	0.69	0.63	0.61	0.58	0.45	1.21	8.78

II. Chemical Characteristics

pH (1:1)wet	4.4	4.5	4.5	4.6	4.8	4.9	4.9	4.9
pH (1:1) dry	4.0	4.1	4.2	4.2	4.3	4.0	4.0	3.9
pH(1:1) Kcl	3.3	3.5	3.6	3.8	4.0	3.6	4.0	4.1
Ec (dS M^{-1})	0.20	0.10	0.10	0.05	0.10	0.10	0.05	0.80
Organic Carbon (%)	1.35	0.53	0.50	0.50	0.45	0.41	1.20	2.42
Organic matter (%)	2.32	0.96	0.86	0.86	0.77	0.71	2.07	4.17
CEC. cmol $(+)kg^{-1}$	11.14	16.89	15.44	13.21	14.03	14.29	10.43	16.48
E.CEC. "	4.14	7.31	4.19	5.16	4.34	4.00	4.97	4.52
Base Saturation(%)	20.4	19.9	20.6	20.4	20.4	19.9	20.8	20.9
Total Sulphur (ppm)	25.82	17.76	14.27	19.31	64.28	675.12	642.31	72.23
Total Fe %	12.10	12.73	11.63	13.42	13.45	13.44	13.93	11.28
Exchangeable Hydrogen me $100g^{-1}$	2.15	1.33	0.95	0.53	1.27	1.51	1.79	1.23
Exchangeable Aluminium me $100g^{-1}$	0.20	0.91	1.21	1.63	0.81	0.49	0.21	0.69
Total N %	0.100	0.193	0.087	0.090	0.089	0.072	0.70	0.058
Total P_2O_5 %	0.012	0.010	0.010	0.008	0.009	0.009	0.010	0.007
Total K_2O %	0.242	0.183	0.179	0.168	0.159	0.153	0.146	0.139
Total Ca %	0.310	0.310	0.200	0.260	0.210	0.190	0.180	0.130
Total Mg %	0.107	0.097	0.057	0.055	0.051	0.056	0.050	0.049
Total Na %	0.100	0.090	0.140	0.140	0.080	0.100	0.130	0.080
Exchangeable K me $100g^{-1}$	0.91	0.87	0.86	0.81	0.79	0.84	0.92	0.89
Exchangeable Ca me $100g^{-1}$	0.89	0.92	0.97	0.99	1.61	0.92	0.89	0.97
Exchangeable Mg me $100g^{-1}$	0.14	0.11	0.09	0.10	0.16	0.13	0.14	0.15
Exchangeable Na me $100g^{-1}$	2.10	2.73	2.63	3.42	3.45	2.44	1.39	1.28

Pedon : 8

Location : Pattambi, Rice Research Station, Palakkad, Kerala

La: 10^{o} 48′ 57" N and Lo: 76^{o} 11′ 35" E.

Information on the Site: Above 40 metres MSL, narrow valley bottoms, undulating lateritic hillock; flat or almost flat, isohyperthermic temperature and aquic moisture regimes.

Information on the Soil : Recent and subrecent laterite sediments originated from crystalline and metamorphic rocks; well drained, brought under cultivation with rice for the past 60 years.

Profile Description AP ; 0 -20 cm; Olive brown 2.5 Y 4/4 moist and light yellowish brown 2.5 Y 6/4; Clay loam; weak; fine granular; non sticky; lightly plastic; many micro discontinuous vertical pores; many fibrous roots; clear smooth boundary. pH 5.7 (wet), 5.4 (dry).

B1 ; 20 - 30 cm; Light olive brown 2.5 Y 5/4 moist and olive yellow 2.5 Y 6/6 dry; clay; massive; slightly sticky; plastic; cemented with iron oxides; micro continuous vertical pores; medium roots; gradual smooth boundary. pH 5.3 (wet), 5.4 (dry).

B2 ; 30 - 46 cm; Olive brown 2.5 Y 4/4 moist and olive yellow 2.5 Y 6/6 dry; clay; subangular blocky;

slightly sticky; non-plastic; weakly cemented; vertical pores; roots absent; gradual smooth boundary; pH 5.1 (wet), 5.4 (dry).

C2; 56 - 89 cm; Olive brown 2.5 Y 4/4 moist and light yellowish brown 2.5 6/4 dry; clay; massive; non-sticky; non-plastic; weakly cemented; vertical pores; roots absent; diffuse smooth boundary. pH 5.3 (wet), 5.4 (dry).

C3 ; 89 cm and below Olive brown 2.5 Y 4/4 moist and light yellowish brown 2.5 6/4 dry; clay; massive; non-sticky; non-plastic; weakly cemented; vertical irregular pores; roots absent; pH 5.3 (wet), 5.6 (dry).

I. Physical Characterisitcs

Symbols	Ap	B1	B2t	C1	C2	C3
Texture	Clay	Clay	Clay	Clay	Clay	Clay
Bulk density $g.cc^{-1}$.	1.26	1.24	1.20	1.19	1.18	1.23
Particle density $g.cc^{-1}$.	2.11	2.20	2.24	2.10	2.10	2.16
Pore Space (%)	46.34	45.28	48.00	44.10	46.20	44.29
Maximum Water holding cacpacity.(%)	43.20	42.10	40.90	37.60	36.10	44.29

II. Chemical Characteristics

Symbols	Ap	B1	B2t	C1	C2	C3
pH (1:1) wet	5.3	5.3	5.2	5.1	5.3	5.3
pH (1:1) dry	5.4	5.3	5.3	5.4	5.4	5.6
pH(1:1) Kcl	4.9	5.0	5.1	5.0	5.1	5.3
E.C.(dS M^{-1})	0.05	0.60	0.01	0.05	0.10	0.10
Organic carbon %	1.12	0.81	0.50	0.21	0.20	0.10
Organic matter (%)	1.93	1.39	0.86	0.36	0.34	0.17
CEC (cmol (+) Kg^{-1})	9.47	8.96	7.32	5.21	5.0	4.33
E.C.E.C "	8.59	6.86	6.86	3.41	2.49	1.30
Base Saturation (%)	43.8	38.3	46.0	38.8	36.2	36.3
Total Sulphur (ppm)	12.88	9.12	9.76	9.88	8.31	7.27
Total Fe (%)	8.48	8.93	8.01	6.11	6.20	6.43
Exchangeable Hydrogen me $100g^{-1}$.	0.69	0.47	0.29	0.49	0.67	0.53
Exchangeable Al Me $100g^{-1}$.	0.21	0.41	0.40	0.91	1.21	1.11
Total N%	0.142	0.100	0.061	0.026	0.028	0.017
Total P_2O_5%	0.028	0.030	0.029	0.027	0.020	0.019
Total K_2O %	0.192	0.173	0.152	0.141	0.140	0.132
Total Ca %	0.190	0.210	0.160	0.170	0.180	0.150
Total Mg %	0.042	0.033	0.030	0.031	0.027	0.029
Total Na %	0.160	0.190	0.230	0.210	0.200	0.210
Exchangeable K me $100g^{-1}$	1.81	2.34	2.12	2.27	2.11	2.02
Exchangeable Ca me $100g^{-1}$.	1.93	1.94	1.57	1.07	1.01	1.12
Exchangeable Mg me $100g^{-1}$	0.48	0.36	0.39	0.33	0.30	0.28
Exchangeable Na me $100g^{-1}$	0.48	0.93	0.01	0.11	0.20	0.43

Pedon: 9.

Location : Pazhayangadi (Thayam) Kannoor,Kerala.

La : 12^{o} 43" N and Lo : 75^{o} 17' 2" E.

Information on the site : " Below 1 metre MSL, natural coastal marsh, flat or almost flat, rice fields, isohyperthermic temperature and aquic moisture regimes.

Information of the soil : Recent riverine clay and marine sediments, very poorly drained, waterlogged, artificially drained, subject to periodical salt water inundation from backwat--rs or sea, brought under cultivation with rice fo the past 50 years. Natural vegetation: marsh land grases and mangroves.

Profile description : AP ; 0 - 9 cm ; Dark greyish brown 2.5 Y 4/2 moist and dark greyish brown 2.5 Y 3/2 dry; sandy clay; moderate granular; slightly sticky; slightly plastic; weak; many fine roots; tubular pores; gradual smooth boundary. pH 4.4 (wet), 4.6 (dry).

Ap2; 9 - 17 cm; Dark greyish brown 2.5 Y 4/2 moist greyish brown 2.5 Y 5/2 dry; clay; fine granular; sticky; plastic; weak; fine roots; tubular pores; gradual smooth boundary. pH 6.4 (wet), 5.9 (dry).

Cg1 ; 17 - 26 cm; Dark grey, 2.5 Y 4/6 moist very. dark greyish brown 2.5 Y 3/2 dry; few fine reddish and yellowish mottles; clay; massive slightly sticky; slightly plastic; weak; roots nil, fine tubular pores; gradual smooth boundary. pH 6.5 (wet), 6.1 (dry).

Cg2 ; 26 - 45 cm; Dark grey 2.5 Y 4/6 moist dark grey 2.5 Y 3/0 dry; few fine distinct mottles; clay; massive; sticky; plastic; strong; roots nil; irregular pores, diffuse wavy boundary; pH 7.1 (wet),6.9 (dry).

C3 ; 45 - 59 cm; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry; clay; massive; sticky; plastic; strong; roots nil; fine irregular pores; diffuse smooth boundary pH 7.1 (wet), 6.9 (dry).

C4 ; 59 - 84 ; Black 2.5 Y N/2 moist and very dark greyish brown 2.5 Y 3/2 dry; clay; massive; sticky; plastic; strong' roots nil; fine irregular pores; diffuse smooth boundary. pH 7.3 (wet), 7.2 (dry).

C5 ; 84 - 126 cm; Black 2.5 Y N/2 moist and very dark grey brown 2.5 Y 3/2 dry; clay; massive; sticky; plastic; strong; roots nil; fine irregular pores, diffuse smooth boundary. pH 7.4 (wet), 7.4 (dry).

I. Physical characteristics.

Symbol	Ap1	Ap2	Cg1	Cg2	C3	C4	C5
Texture	Sandy Clay	Clay	Clay	Clay	Clay	Clay	Clay
Bulk Density $g.cc^{-1}$	1.08	1.11	1.20	1.09	0.99	0.98	0.81
Particle density $g.cc^{-1}$	2.23	2.46	2.53	2.51	2.40	2.33	2.11
Pore space %	53.21	54.60	51.89	58.01	58.91	58.20	58.20
Maximum water holding capacity %	42.60	44.10	43.50	47.90	44.20	50.30	51.40
OC x BD x Thickness / 10	0.68	0.47	0.35	0.62	0.22	0.80	1.1

II. Chemical Characteristics.

	Ap1	Ap2	Cg1	Cg2	C3	C4	C5
pH (1:1) wet	4.4	6.4	6.5	7.1	7.1	7.3	7.3
pH (1:1) dry	4.6	5.9	6.1	7.1	6.9	7.2	7.4
pH (1:1) Kcl	4.2	5.4	5.7	6.4	6.4	6.0	6.5
Ec (dSm^{-1})	10.60	5.85	4.54	4.24	4.04	5.95	6.66
Organic carbon %	0.70	0.53	0.33	0.30	0.16	0.33	0.50
Organic matter %	1.21	0.92	0.57	0.52	0.28	0.57	0.86
C.E.C ($cmol(+)kg^{-1}$)	17.23	17.01	18.33	14.08	14.21	16.09	17.19
E.C.E.C "	12.2	9.74	10.11	8.94	9.68	7.94	7.63
Base Saturation (%)	35.7	35.7	36.1	37.7	33.7	33.1	34.2
Total Sulphur (ppm)	74.8	67.93	42.36	49.21	53.63	183.21	174.64
Total Fe %	11.75	11.64	11.44	11.17	11.14	11.21	11.19
Exchangeable Hydrogen me $100g^{-1}$	0.90	0.89	3.81	4.27	3.24	10.69	3.10
Exchangeable Al me $100g^{-1}$	0.39	0.21	2.00	2.10	4.10	6.17	8.19
Total N %	0.082	0.080	0.073	0.071	0.52	0.051	0.049
Total P_2O_5 %	0.011	0.010	0.010	0.006	0.007	0.006	0.008
Total K_2O %	0.347	0.283	0.232	0.201	0.204	0.193	0.190
Total Ca %	0.460	0.420	0.390	0.380	0.360	0.310	0.300
Total Mg %	0.302	0.230	0.338	0.226	0.296	0.287	0.290
Total Na %	0.190	0.210	0.230	0.260	0.160	0.130	0.140
Exchangeable K me 100^{-1}	1.02	1.16	1.21	1.30	0.97	1.31	1.19
Exchangeable Ca me 100^{-1}	2.04	1.91	1.83	1.94	1.98	1.74	1.86
Exchangeable Mg me $100g^{-1}$	0.32	0.29	0.34	0.27	0.36	0.31	0.23
Exchangeable Na me 100g	1.75	1.64	1.44	1.17	1.14	1.21	1.19

DISCUSSION

DISCUSSION

The generic term "wet land" readily conveys the notion of an excess of water on the land during part or all of the year. Wet land soils can thus be defined as soils whose development and properties are strongly influenced by temporary or permanent saturation in the upper part of the horizon.

Classification of wet land soils, though attempted by many early workers varies widely with respect to the criteria used for categorising them. While some workers place much stress on the genetic nature of these soils, some others relied on the morphological and hydrological parameters. In the case of acid wet land soils, it was customary to lay much emphasis on the chemical and electrochemical nature of the soils. However, such systems of classification were able to satisfy only the specific purpose or objective for which such soils were classified.

According to U.S. Soil Taxonomy, (1975) present day characteristics or properties of the soils themselves are used as differentiating parameters to place them under different categories. Though, this system is said to be free from genetic bias, due to the young nature of the wet land soils, the characteristics and composition of the parent material have a profound influence on the differentiating characters.

Soil Taxonomy recognises wet land soils as those with an aquic moisture regime and uses this property to categorise the soils at the suborder level.

The majority of the natural wet land soils of the World fall in the soil orders Entisols, Inceptisols and Histosols. As per Soil Taxonomy, in order to use the aquic moisture regime at the higher categories of classification the whole soil must be saturated,which implies a reducing regime that is virtually free of dissolved oxygen; in the sub groups only the lower horizons may be saturated. The soil is said to be saturated if water is stagnating in an unlined borehole at such a shallow depth that the capillary fringe reaches the soil surface except in non capillary pores and the water in the borehole is stagnant which remains coloured if a dye is placed in the water. It has been pointed out that the taxonomic definition is sometimes ambiguous, since distinction is made between soils that are saturated and reducing throughout (ground water gley soils and soils in which only the upper horizons are temporarily water saturated). While refinement in Soil Taxonomy with respect to delination of aquic moisture regimes is underway by the International Committee on Aquic Moisture regimes (ICOMAQ),Fanning et al (1991),the concept used in this study to characterise and categorise the wet land soils is the one in the present version of Soil Taxonomy.

In Kerala State 180000 ha. of the geographical area qualify them to be grouped under wet land soils ie. soils with an aquic moisture rigime. The present study is the first of its kind to classify the natural and manmade wet lands of the State according to U.S. Soil Taxonomy. While identifying the soil individuals for this study the indigenous classification of the wet land rice soils was taken into consideration and nine major wet land soils have been recognised and detailed studies on each pedon with respect to soil morphology, physico-chemical characteristics and mineralogy have been conducted and the results already presented. On the basis of differentiating criteria suggested by Soil Taxonomy (1975), each soil type has been classified and presented hereunder.

Pedon 1. Vellayani, Natural fresh water <u>Kayal</u> wet lands, Acid Hydromorphic.

This pedon was located in the <u>Kayal</u> lands which forms a valley bottom surrounded by red soil hillocks(Oxisols).

Morphology of the pedon with respect to soil colour showed a gradual decrease in value and chroma of the horizons with depth thus indicating dark coulr formation in the lower horizons.

This pedon exhibited cracking when dried and these cracks were not permanent. These soil samples showed shrinkage sufficient enough to have a COLE of more than 0.09. Lithic or paralithic contact could not be identified within the 200 cm. Mean summer and winter soil temperature at 50 cm depth exhibited a variation of only 1°C. The soil was having a reducing regime that was virtually free of oxygen, because it was saturated by ground water. Mean annual soil temperature was 27°C.

Mechanical analysis of the soil samples showed a gradual increase in clay content with depth. The clay content was more than 30 percent in the horizons that were more than 50cm in thickness. Mean value for clay content was 42.5 percent.

Bulk density of the horizons showed a mean value of 1.17 gcc^{-1} and particle density mean was 2.1gcc^{-1}. Horizons of the pedon had a mean water holding capacity of 41.07 percent while mean pore space was 46.06 percent.

Wet pH (1:1) of the soil horizon in general showed a gradual increase with depth.(from 4.5–6.1). The lowering of pH in any of the horizons was not drastic enough to qualify the horizons to be sulphidic. Except in the two lower horizons where organic matter accumulation in the form of fossilified woods occured, organic carbon and organic matter content of the horizons showed a gradual decrease with depth in the horizons, except where accumulation of fossil wood was prominant (C_3 and C_5 horizons). CEC also showed a similar pattern of variation. Mean base saturation of the horizons were 43.8 percent. Mean value of total sulphur contents of the horizons was 6.33 (ppm). Total Fe content of the horizons showed uniformity with respect to distribution in the horizons. Mean total Fe content was 10.5%. Neither mean exchangeable hydrogen 0.45 me.$100g^{-1}$ nor mean exchangeable aluminium 0.83 me.$100g^{-1}$ reveal high acidity for these soils.

Classification

The characteristic features of the pedon indicate their very recent origin on fluvial sedimentary materials in a lagoon which is naturally water logged resulting in the formation of a wet land marsh. Cultivation is possible only by artificial drainage. There is no evidence of classical profile development or any characteristic diagnostic surface or subsurface horizon. Hence this soil was well placed under the **SOIL ORDER: Entisol.**

The pedon was permanently saturated with water at some time of the year or are artificially drained and had within 50cm of the surface, dominant colour (moist) in the matrix as follows. In horizons that had texture finer than loamy fine sand in some or all horizons, there was no mottling, value was less than 4 and chroma was less than 1. In horizons that had texture of loamy fine sand or coarser hue is bluer than 10Y, and hence the soil came under **SUB ORDER:Aquent.**

Pedon has an organic carbon content that decreased irregularly with depth and it remained above 0.2 percent to a depth of 125 cm. The texture was finer than loamy fine sand in A2g horizon (16-25cm). Within 100 cm a paralithic contact could not be established. Hence the pedon qualified to be placed in the **GREAT GROUP: Fluvaquent.**

Mean summer and winter soil temperatures at a depth of 50cm differed only by $1^{o}C$ .Identified **SUB GROUP** was Tropic Fluvaquent.

Pedon fell under the temperature regime isohyperthermic and had predominant clay mineral identified as kaolinite and the dominant texture was clay(35-59 per cent in some horizons). FAMILY: Fine, Kaolinitic, Isohyperthermic, Tropic Fluvaquent.

The pedon was classified according to U.S. Soil Taxonomy as **FINE,KAOLINITIC,ISOHYPERTHERMIC, TROPIC FLUVAQUENT.**

Pedon: 2. Karamana, manmade wet land,Brown Hydromorphic

Karamana Pedon was identified in the manmade rice fields of cropping systems research station of KAU. This pedon was located in a valley bottom surrounded by laterite hillocks.

Morphological analysis of the pedon with respect to soil colour showed no particular trend with depth. In the lower horizons (C1g - C4) an alteration of dark and light colours was seen to exist. Mean summer and winter soil temperatures at 50 cm depth exhibited a variation of 1.3^{o}C. Mean annual soil temperature was 27^{o}. The pedon was permanently saturated with water for some time of the year and was artificially drained for rice cultivation.

Mechanical analysis of the soil samples from different horizons showed a gradual increase in clay content with depth. Mean clay content was 49.5 percent. Mean value for bulk density was 1.0 gcc^{-1} and that of particle density was 2.3 gcc^{-1}. Maximum water holding capacity mean for the horizons was 50.9 percent and pore space mean was 57.2 percent.

Wet pH (1:1) of the soil horizons in general did not show any marked variation with depth; mean value being 5.9. The lowering of pH with drying was the most in the lowest horizon (the difference in wet and dry pH being 2.3). The distribution of organic carbon and the variation in CEC showed similar trend,with the highest value for the upper most horizon . The organic carbon content and CEC values decreased with depth. Mean organic carbon content was 0.45 percent and mean CEC value was 8.5 cmol(+) Kg^{-1}.

Base saturation varied irregularly in the pedon and it showed a mean value of 32.3 percent. Mean value of total sulphur content of the horizons was 3.2 ppm. Total Fe content had a mean value of 9.74 percent. The mean exchangeable hydrogen 0.17 $me.100g^{-1}$ and mean exchangeable aluminium 0.30 $me100g^{-1}$ values indicated that the pedon was not highly acidic.

Classification.

The differentiating features of the pedon gave an indication of very recent origin of these soils on recent and subrecent sediments. These soils remained water logged for some period of the year and was artificially drained for rice cultivation. The pedon did not exhibit any features of natural wetness or marshy lagoons. Absence of a classical profile development and characteristic horizonation indicated that this soil could very well be placed in the SOIL ORDER: Entisol.

The pedon was saturated with water at some time of the year. It was artificially drained and had within 50 cm of the surface , dominant colour in the matrix was bluer than 10Y. (In horizons that had texture of loamy fine sand or coarser). For horizons that had texture finer than loamy fine sand there was no mottling and the value was more than 4 and chroma less than 1. These diagnostic features qualify the pedon to be grouped under **SUB ORDER: Aquent.**

The pedon had an isohyperthermic temperature (mean summer & winter soil temperatures differ only by 1^{o}C) regime, and had an organic carbon content that decreased regularly with depth below 25 cm and reached a level of 0.12 percent within a depth of 125 cm. These features satisfied the requirements for the **GREAT GROUP:Tropaquent.**

None of diagnostic criteria for sub group classification was met within the pedon and as such the pedon was placed in **SUB GROUP: Typic Tropaquent.**

The pedon came under isohyperthermic temperature regime and had the predominance of Kaolinite as clay mineral. Texture was clay (with content of clay ranging from 35-59 per cent) and hence the FAMILY name provided was: Fine Kaolinitic, Isohyperthermic, Typic Tropaquent.

U.S.Soil Taxonomy identified this pedon as FINE, KAOLINITIC, ISOHYPERTHERMIC, TYPIC, TROPAQUENT.

Pedon: 3. Thakazhi, Kuttanad, Natural Kari, Acid Sulphate

Location of this pedon was done in the typical Kari rice fields of Kuttanad, originally designated as acid sulphate peaty soils. Pedon was located in a natural coastal marsh, brought under cultivation with rice after artificial drainage. This pedon was subject to marine influence and salt water ingress.

Soil morphology in relation to soil colour of the pedon showed a gradual decrease in value and chroma indicating dark lower horizons and light upper horizons. Mean summer and winter soil temperature showed a difference of 1.6 ^{o}C. Mean annual soil temperature was 27.3 ^{o}C. This pedon was saturated with water for some period of the year and was artificially drained for rice cultivation.

Results of mechanical analysis indicated a coarser texture for the upper three horizons and finer texture for lower ones. Mean clay content of the pedon was 34.3 percent. Bulk density of the horizons showed a mean value of 1.0 g cc^{-1}. While particle density mean was 1.6 gcc^{-1}. Mean maximum water holding capacity for the horizon was 43.4 percent and pore space mean was 38.7 percent.

Wet pH (1:1) showed a gradual increase with depth. When dry pH was noted the difference between wet and dry pH obtained was very marked in the lower horizons (1.1, 2.3 and 2.5 units for the three lower horizons). Dry KCl pH (1:1) also indicates a marked drop in pH with drying. Here also the drop in pH with drying was most prominant in the lower horizons (54-140 cm depth). Organic matter accumulation was noticed in the Ag horizon (8.70 percent). Variation in CEC showed an increasing trend with depth. Mean values for organic carbon and CEC were 2.7 percent and 22.2[illegible] cmol (+) Kg^{-1} respectively. Mean base saturation was 27.1 percent. Base saturation also showed an increasing trend with depth. Mean value of total sulphur content was 2968.2[illegible] ppm. A marked increase in the sulphur content within C1 and C2 horizons indicated accumulation of sulphidic materials and sulphidic horizon. Mean value for total iron content was

11.4 percent. Mean values of exchangeable hydrogen 32.0 me.100g^{-1} and exchangeable aluminium 6.72 me.100g^{-1} indicated that this pedon is having very high potential and exchange acidity.

Classification

The diagnostic criteria of the soil indicated that this pedon was of recent origin on fluvial sediments, lagoonal clays and peat sediments. The pedon was naturally water logged and it resulted in the formation of a wet land marsh. The pedon is the formation of a wet land marsh. The pedon was subjected to periodical marine influence and salt water inundation. Cultivation was possible only by artificial drainage. Profile development was not evident in the pedon. Absence of any of the characteristic surface or sub surface horizons suggested that this soil comes under SOIL ORDER : Entisol.

The pedon had sulphidic materials within 50 cm of the mineral soil surface and was saturated with water at sometime of year and were artificially drained for rice cultivation. In horizon that had texture finer than loamy fine sand, hue was bluer than 10 Y. These characteristics formed the basis of including this pedon in SUB ORDER: Aquent.

Presence of sulphidic materials within 50cm of the mineral soil surface qualifies the soil to be placed under GREAT GROUP: Sulfaquent. The soil did not satisfy the requirement for'n' value to be placed in any other sub groups. Hence the identified SUB GROUP is :Typic Sulfaquent.

Temperature regime was isohyperthermic, composition of clay minerals indicated a mixed nature and the dominant textural class was fine loamy. The soil can be grouped under FAMILY: Fine loamy, mixed, isohyperthermic, Typic Sulfaquent.

This soil was be classified according to U.S. Soil Taxonomy as: FINE-LOAMY, MIXED ISOHYPERTHERMIC, TYPIC SULFAQUENT.

Pedon: 4. Nedumudi, Kuttanad, Natural Karappadam, Acid Hydromorphic.

The Karappadam pedon was identified in the natural flood plains of riverine alluvium. The pedon was located in recent riverine clay and sediments and was artificially drained for rice cultivation.

Soil colour of the horizons was seen to be getting darker with depth as evidenced by a decrease in value and chroma. Mottling of the horizons was noticed

B2 (24-34 cm), 2C1g (34-53 cm) and 2 C2g (52-69 cm) horizons. Mean summer and winter soil temperatures differed by 1.6^{o}C. Mean annual soil temperature was 27.3^{o}C. Rice cultivation was practiced after artificially draining the soil; which was saturated at some period of the year.

Study of the physical characteristics showed that except in the upper most horizon, clay was the dominant particle size fraction. Mean clay content of the horizons was 48.6 percent. Horizons of the profile had a mean bulk density of 1.2 gcc^{-1} and particle density 1.9 gcc^{-1}. Mean maximum water holding capacity and pore space was 50.1 percent and 45.5 percent respectively.

pH (1:1) wet showed an increasing trend with depth, from 4.6 in the upper most horizon to a near neutral pH of 6.8 in the lower most horizon. The decrease in pH with drying was not prominant in the upper horizons. Maximum variation in pH on drying was noticed in the lowest horizon (1.7 units), while drop in pH with (1:1)KCl was the highest for Ap1 horizon (1.5 units). Distribution of organic carbon showed irregular trend with depth and the variation in CEC also followed the same pattern. Mean values of organic carbon and CEC was 1.9 percent and 13.7 cmol(+) Kg^{-1}. Mean value of base saturation was 28.3 percent. Total sulphur content showed a mean value of 62.0 ppm. Accumulation of sulphidic materials was not found in any of the horizons. Mean total Fe content was 8.1 percent. Mean values for exchangeable hydrogen 6.55 me.100g^{-1} and exchangeable aluminium 3.15 me.100g^{-1} indicated that the soil is not very highly acidic.

Classification

Karappadam pedon was situated in the natural flood plains of riverine alluvium. The pedon was found to be developed on recent riverine clay and sediments. The pedon did not show accumulation of sulphidic materials within 50 cm. Presence of an altered horizon with light colour, lesser organic matter content, and a structure not definitive of a histic, mollic or an umbric epipedon was noticed. A clay texture in almost all the horizons, CEC values of 16 cmol(+) Kg^{-1} in some horizons and an evidence of alteration in the following forms (a) aquic moisture regime and artificial drainage (b) presence of mottling and a chroma of 2 or less and (c) a regular decrease of organic carbon with depth up to 50 cm was noticed. And the above features along with absence of an argillic, kandic, or spodic horizon and cementation or induration and brittle consistence when moist indicated that the pedon was having a cambic horizon. The pedon meets the 'n' value requirement of less than 0.7 in the 20-50 cm depth. These diagnostic features indicated that the soil belong to SOIL ORDER Inceptisol.

Presence of an aquic moisture regime and the requirement of artificial drainage help the soil to be placed under SUB ORDER:Aquepts.

The soil satisfied the condition of difference in mean summer and winter soil temperature requirement (that the difference should be less than 5^{o}C at 50 cm depth.) Hence the soil can be grouped under GREAT GROUP. Tropaquepts.

The soil had in more than 40 percent of the matrix in one or more sub horizons between the A or Ap horizons and depth of 75 cm a hue of 2.5 Y and a value of 5 or less, the chroma moist was 2 or more. These characteristics lead to the assumption that the soil belonged to SUB GROUP, Aeric Tropaquepts.

Temperature regime was isohyperthermic, clay mineralogy indicated that no constituent minerals consisted of more than 40 percent by weight and textural class identification revealed that the predominant particle size was clay (35-59 percent clay in some horizons). These diagnostic criteria pointed to FAMILY: Fine, Mixed, Isohyperthermic, Aeric, Tropaquepts.

Pedon 5. D-block, North 6000, Kuttanad; Natural Kayal, Saline Hydromorphic.

This pedon was located in reclaimed Kayal lands which included recent lagoonal clays and marine sediments. Flat flood plains where the pedon was identified was natural flood plains subject to seasonal inundation with salt water.

Morphology of the pedon in relation to soil colour indicated that lower horizons were darker than the upper ones. This was evident from the lower value and chroma which were dominant in the lower horizons. Mean summer and winter soil temperature difference was only $1.6^{\circ}C$. Mean annual soil temperature was $27.3^{\circ}C$. Pedon was saturated with water during some period of the year and was artificially drained for rice cultivation.

Analysis of physical characteristics of the soil revealed that the clay content increased up to depth of 41 cm and then decreased. Variation in clay content did not show any fixed pattern. Mean clay content was 48.3 percent. Mean values for bulk density and particle density were $1.2gcc^{-1}$ and $2.3gcc^{-1}$ respectively. The soil samples of the profile showed a mean maximum water holding capacity of 45.05 percent and pore space of 45.73 percent.

pH(1:1) wet of the samples showed an increasing trend, with depth lower horizons showing even alkaline range of pH. This may be attributed to the presence of lime shell in C1g (18-22 cm) and C2g (22-33 cm). Lowering of pH with drying did not produce any evidence of severe acidity. Percentage of organic carbon was seen to increase with depth and in the lower horizons (C4g, C5g and C6g) accumulation of organic matter in the form of fossilified woods were prominent. Mean value for organic carbon was 2.2 percent CEC of the soil samples were found to vary irregularly with depth. In the lower horizons where there had been preponderance of organic matter, CEC also showed comparatively high values. Mean value of CEC obtained was 13.9 cmol(+) Kg^{-1}. Base saturation mean was 51.2%. Total Fe mean was 6.7%. Content of total Fe was found to increase with depth. Total sulphur content also not found to increase with depth. Mean value of total sulphur was 33.8 ppm. Total sulphur percent of any of the horizons was not high enough to qualify the soil to have sulphidic materials. Mean values of exchangeable hydrogen 10.1 me $100g^{-1}$ and exchangeable aluminium 5.40 me $100g^{-1}$ showed that these pedon was not potentially or actively acidic.

Classification

Diagnostic criteria for classifying the pedon indicated that this soil was of recent or subrecent origin; developed on lagoonal clays and sediments. Absence of any characteristic surface or sub surface horizons and a well developed horizonation, indicated that this pedon can well be grouped under recently developed soils. This pedon was permanently wet for some period of the year and it required drainage for the soil to be brought under cultivation. These criteria revealed that this pedon comes under **SOIL ORDER** : Entisol.

During seasonal wetting of the pedon, it was saturated with water and was artificially drained. Mottles were present in the C3g horizon (33-41cm) and had a chroma of 2 in C3g horizon which is clay texture indicated that the soil comes under **SUB ORDER** : Aquent.

The mean clay content of horizons between C1 (18-22 cm) and C4 (41-97 cm) was 49.6 percent and the mean annual soil temperature of 27.3^{o}C qualified the soil to be placed under **GREAT GROUP** : Hydraquent.

Soil Taxonomy identified only one subgroup for all Hydraquents that is, Typic Hydraquent. The pedon was having isohyperthermic temperature regime, and mineralogy showed a mixed status (with none of the clay mineral friction occupying more than 4% content by weight)(clay percentage of 35.59 in some of the human) Textual calss is mainly fine and hence the FAMILY Name : Fine, Mixed, Iso hyperthermic, Typic Hydraquent .

Classification according to US Soil Taxonomy. FINE, MIXED, ISOHYPERTHERMIC, TYPIC HYDRAQUENT

Pedon 6. Njarackkal; Natural Pokkali Saline Acid.

Identification of the pedon was done in a natural tidal marsh, brought under rice cultivation by artificial drainage. The pedon was water logged and subjected to salt water intrusion from backwaters or sea.

Morphological analysis of the pedon indicated that the horizon is either very dark grey or black in colour. The moist and dry colours of the horizons remained more or less uniform.

Difference between mean summer and winter soil temperature was only 1.6°C and mean annual soil temperature was 27.3°C.

Predominant textural class was clay and the mean content of clay was 52.1 percent. Mean values for bulk density and particle density were 1.0 gcc^{-1} and 2.45 gcc.

Mean values for maximum waterholding capacity and pore space was 50.5 percent and 60.2 percent respectively.

pH (1:1) wet showed an increasing trend with depth except in the Cg horizon, where there was drop in pH. Lowering in pH was not prominant with drying. But pH (1:1) KCl of dry soil samples was low enough suggesting the presence of a potentially acidic soil. Organic carbon content was found to decrease with depth. Mean organic carbon content was 1.53 percent. The distribution of CEC also showed a decreasing trend with depth. Mean CEC reported was 11.0 cmol(+) Kg^{-1}. Variations in base saturation showed an initial increase with depth reaching the highest value for Cg horizon and then decreasing. Mean value for base saturation was 50.26 percent. Total sulphur content of the pedon showed a rapid increase in its content from 659 ppm in B_2 horizon to 6459 ppm in cg1 and 6893 ppm in c_29 horizon indicating an accumulation of sulphidic materials. Total Fe content showed a mean value of 3.6 percent. Mean values of exchangeable hydrogen 6.40 me $100g^{-1}$ and aluminium 2.22 me $100g^{-1}$ showed that the soil is having very high potential acidity.

Classification

The pedon was situated in a natural tidal marsh. It was developed on recent clay and lagoonal sediments. The pedon showed an accumulation of sulphidic material within 50 cm. Presence of a sulphuric horizon whose upper boundary is within 50 cm of the soil surface was also noticed in the pedon. These considerations lead to the conclusion that the pedon belonged to **SOIL ORDER** - Inceptisol.

The pedon was having an aquic moisture regime and was artificially drained; A sulphuric horizon that had its upper boundary within 50 cm of the soil surface was also present in the pedon. These diagnostic criteria were used to place the pedon in **SUB ORDER** : Aquept.

Mean summer and winter temperatures differed by 1.6^{o}C at 50cm depth. This criteria lead to the assumption of **GREAT GROUP** : Tropaquept.

Occurance of few fine faint mottles and pH value between 3.5 & 4.0 (for 1:1 water, air dried samples) within 50-150 cm depths qualified the pedon to be grouped under **SUB GROUP** : Sulfic Tropaquept.

The Pokkali pedon was having isohyperthermic temperature regime. Predominant textural class was clay that has 35-59 percent clay in the fine earth fraction. Mineralogical investigation showed that all the minerals present were having less than 40 percent by weight. Thus the pedon was identified under **FAMILY** : Fine, Mixed, Isohyperthermic, Sulfic Tropaquept.

Soil Taxonomy identifies the pedon as, **FINE MIXED, ISO HYPERTHERMIC, SULFIC, TROPAQUEPT.**

Pedon:7 Anthikkad, natural Kole, Saline Acid

Anthikkad Kole pedon was located in a natural flood plain of recent riverine and marine sediments. This pedon also was subject to seasonal salt water ingress.

Morphological analysis of the soil showed that the soil colour gradually changed towards darker shades, with increase in soil depth. This was indicated by the lowering of chroma and value. Accumulation of organic matter was seen to be the main reason for this colour variation. Mean summer and winter soil temperatures differed only by 1.6^{o}C. Mean annual soil temperature was 27.3^{o}C.

Upper horizons of the profile showed predominance of coarser particle size fractions where as the lower horizons were clayey in texture. Mean clay content of the horizons was 42.6 percent. Mean values for bulk density and particle density were 1.2gcc^{-1} and 2.1gcc^{-1} respectively. Mean maximum water holding capacity was 47.1 percent and mean pore space was 51.8 percent.

pH of the soil samples was found to increase with depth. Decrease in soil pH with drying of soil samples was not marked in any of the horizons. Distribution of organic carbon with depth showed an irregular trend. Mean value of organic carbon was 0.92 percent. Variations in CEC with depth also did not follow any defined format. Mean CEC of the samples was 13.9 cmol(+)Kg^{-1}. Changes in base saturation with depth was uniform. The mean base saturation value was 20.4 percent. Accumulation of sulphur in the lower horizons of the profile was identified. Mean sulphur content of the soil samples was 191.4(ppm). Distribution of total Fe in the horizons was irregular and the middle to lower horizons were found to have more Fe content. Mean value of total Fe was 12.7 percent. Mean values of exchangeable hydrogen and exchangeable aluminium indicated that the soil is neither actively nor potentially acidic.

Classification

This pedon was identified in the natural flood plains of recent riverine and marine sediments. Development of the pedon was found to be from recent and sub recent clay and sediments. No sulphidic materials could be identified in the first 50 cm. Presence of a cambic horizon with an altered horizon with lighter colour, lesser organic matter content, and a structure not definitive of a histic, mollic, or umbric epipedon a loamy fine sand, or finer texture in almost all horizons, CEC values 16 Cmol(+)Kg^{-1} in some horizons of the profile, aquic moisture regime and artificial drainage, regular decrease of organic carbon with depth, absence of argillic, kandic or spodic horizons absence of cementation, induration and brittle consistance when moist was also observed in the pedon. The pedon also meets the 'n' value requirement of less than 0.7 in the 20.50 cm depth. All the above diagnostic criteria indicated that the soil belonged to **SOIL ORDER** : Inceptisol.

An aquic moisture regime and the requirement of artificial drainage help the soil to be placed under **SUB ORDER** : Aquept.

The soil met the requirements of mean summer and winter temperature difference (<5^{o}C difference). Hence the soil came under **GREAT GROUP** : Tropaquept.

The sub group requirements of the pedon indicated that the soil came under **SUB GROUP** : Typic Tropaquept.

Pedon comes under isohyperthermic temperature regime and mineralogy showed the presence of many minerals but each of which constituted <40 percent of the total mineral weights. Dominant texture class is clay (which varies from 35-59 percent) in almost all the horizons. These criteria showed that SOIL FAMILY is Fine, Mixed, Isohyperthermic, Typic, Tropaquepts. U.S.Soil Taxonomy identified the soil as **FINE, MIXED, ISOHYPERTHERMIC, TYPIC, TROPAQUEPTS.**

Pedon 8. Pattambi, manmade wet land, Brown Hydromorphic

Location of this pedon was done in the lateritic alluvial paddy fields which consisted of recent and sub recent lateritic sediments, originated from crystalline and metamorphic rocks.

Morphology of the pedon with respect to soil colour indicated that the horizons within the profile showed uniform colour variation with depth. Moist and dry soil colours remained almost uniform. Mean annual winter and summer soil temperatures varied by 1.6^{o}C and mean annual soil temperature was 27.4^{o}C.

Physical characteristics in relation to particle size distribution indicated that clay was the textural class throughout the profile. Mean clay content was 56.6 percent.

Mean values of bulk density and particle density were 1.2gcc^{-1} and 2.1gcc^{-1}. Mean maximum water holding capacity and pore space showed values of 40.6 percent and 45.7 respectively.

pH (1:1) wet of the horizons did not vary widely with depth. The drop in pH with drying was also not marked, indicating absence of any acid forming materials in the soil. Distribution of organic carbon showed a gradual decrease with depth. Mean organic carbon content was 0.50 percent. Variations in CEC also followed the pattern of organic carbon distribution. Mean CEC reported was 6.7 cmol(+) Kg^{-1}. Variations in base saturation did not follow any strict pattern, the mean value being 39.9 percent. Total sulphur content (Mean 9.5(ppm)) was not high enough to define sulphidic materials or sulphuric horizons. Total iron content of the horizons indicated a uniform distribution the mean value being 7.3 percent. Mean values of exchangeable hydrogen 0.52 me 100g^{-1} and aluminium 0.70 me 100g^{-1} indicated that the soil was not potentially or actively acidic.

Classification

This pedon which was developed on recent and sub recent lateritic sediments had an isohyperthermic temperature regime. Presence of an illuvial horizon with a CEC of 9.47 cmol(+)Kg^{-1}. Hue of the soil horizons was 2.5 and a value moist of 4 and dry of 6 at 125 cm below the upper boundary of Kandic horizon. These diagnostic criteria lead to the assumption that the soil belonged to SOIL ORDER: Ultisol.

Since the pedon was saturated with water at some time of the year and artificially drained, and had characteristics associated with wetness, the pedon had dominant hue of 2.5 Y in the matrix of the Kandic horizon with distinct and prominant mottles with isohyperthermic temperature regime. This diagnostic criteria were indicative of **SUB ORDER** : Aqult.

A CEC of 9.47 cmol (+)Kg^{-1} and an ECCE of 8.59 cmol(+)Kg^{-1} in the major part of the Kandic horizon, absence of a lithic paralithic or petroferric contact within 150 cm of the soil surface, and clay distribution which did not decrease from its maximum by as much as 20 percent within a depth of 150 cm pointed to a **GREAT GROUP** : Kandiaqult.

Presence of sub horizon which had chroma of 4 within 75 cm of the soil surface helped to identify **SUB GROUP** : Aeric Kandiaqult.

Pedon was situated in isohyperthermic temperature regime and the mineralogy identified more than half Kaolinite by weight and other 1:1 non expanding minerals or gibbsite. Percentage of clay (35-59 percent) helped to identify particle size class as fine. Hence the **FAMILY** : Fine, Kaolinitic, Isohyperthermic, Aeric, Kandiaqult.

Identification of the pedon by U.S.Soil Taxonomy was : **FINE, KAOLINITIC, ISOHYPERTHERMIC, AERIC, KANDIAQULT.**

Pedon 9. Pazhayangadi, natural <u>Kaipad</u> Saline Acid

Pazhayangadi pedon was situated on a natural coastal marsh of recent riverine clay and marine sediments. The pedon was subjected to periodical inundation with marine water.

Morphology of the pedon in relation to soil colour indicated darker lower horizons and lighter upper horizons. This was evident from the fact that value and chroma decreased with depth. Mean summer and winter soil temperatures showed a difference of only 2^{o}C. Mean annual soil temperature was 27.4^{o}C.

Mechanical analysis showed that except in the upper most horizon clay was the dominant particle fraction. Mean clay content of the horizons was 61.8 percent. Mean values of particle density and bulk density were 1.0 gcc^{-1} and 2.3gcc^{-1} respectively. Maximum water holding capacity and pore space showed mean values of 46.2 percent and 56.1 percent respectively.

pH(1:1) wet of the profile samples was found to show an increasing trend with depth. pH ranges showed a wide variation from 4.4 in the surface horizon to near alkaline pH of 7.3 in the lowest horizon. Decrease in pH with drying of soil samples and Kcl (1:1) pH did not exhibit any marked variation. Organic carbon contents were found to be low with a mean value of 0.4 percent. Variations in CEC with depth was irregular and exhibited a mean value of 16.3 $cmol(+)Kg^{-1}$. Base saturation values also showed an irregular trend in distribution. Mean value of base saturation was 35.1 percent. Mean values for total sulphur and total Fe was 92.2(ppm) and 11.36 percent. Distribution of total sulphur was found to increase with depth, while total Fe content was found to be uniform in distribution among the horizons. Mean values of exchangeable hydrogen 5.70 $me100g^{-1}$ and exchangeable aluminium 3.32 me $100g^{-1}$ able indicated that the soils are neither potentially nor actively acidic.

Classification

The differentiating features of the pedon gave an indication of very recent origin of these soils on recent and sub recent riverine clay and marine sediments. These soils remained water logged for some period of the year. The pedon exhibited features of natural wetness and marshy lagoons. Absence of a classical profile development and characteristic horizonation indicated that this soil can very well be placed under the **SOIL ORDER** : Entisol. The pedon was permanently saturated with water at sometime of the year or were artificially drained and had within 50 cm of the surface dominant colour (moist) in the matrix as follows. In horizons that have texture finer than loamy fine sand in some or all horizons where mottling was there chroma was 2 or less. In horizons that had texture of loamy fine sand or coarser there was not mottling and hue was bluer than 10 Y.These characteristics help the soils to be classified under **SUB ORDER** : Aquent.

Organic carbon content of the pedon decreased irregularly with depth and was 0.50 percent at a depth of 125 cm. Texture was clay between 25 cm and 100 cm. Hence the pedon comes under **GREAT GROUP** : Fluvaquent.

Difference in mean summer and winter soil temperatures at a depth of 50 cm was 2^{o}C. This qualified the pedon to be grouped under **SUB GROUP** : Tropic Fluvaquent.

Temperature regime in which the pedon was situated was isohyperthermic. Mineralogy indicated that all the minerals present constituted only less than 40 percent by weight. Predominant textural class was clay. Content of clay in the fine earth fraction varied between 35-59 percent. Thus the pedon was grouped under **FAMILY** : Fine, Mixed, Isohyperthermic Tropic, Fluvaquent.

Classification of the soil according to U.S. soil Taxonomy is **FINE, MIXED, ISOHYPERTHERMIC TROPIC FLUVAQUENT.**

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

A consistant classification of wet lands inorder to group these soils and to give a better understanding of their characters and factors of formation was absent hitherto in the history of soil research in Kerala, which has reached sixty years of growth. A comprehensive classification of the wet lands to include them in an International Classification system was lacking until now. Characterisation and classification of the wet land soils of the State, based on Soil Taxonomy was attempted in the present study.

The assumptions used in the present study to define wet lands was those put forward by USDA-SCS. According to this concept wet land soils are soils which are saturated at or near the soil surface with water that virtually lacks free oxygen for significant periods during the growing season.

Basic concept in classification of the wet lands was identification of two broad groups of wet lands such as natural and man made. It is very difficult to distinguish manmade and natural epiquic regimes. Changing season, vegetation types and changing course of river or sediments brought down with water course resulted in natural wet lands. Excavation and digging of uplands by man give rise to manmade wet lands.

Wet land soils of the State in general had immature soil morphology. Characteristics of the soils were mainly determined by the parent materials. Aquic moisture regimes and isohyperthermic temperature regimes were common for all the pedons studied. Absence of characteristic horizonation and diagnostic surface or sub surface horizons indicated that all the pedons are young.

The wet land soils studied in the present research project were found to fall under three soil orders namely Entisols (Vellayani, Karamana, Kari, Kayal and Kaipad pedons), Inceptisols (Karappadam, Pokkali and Kole pedons), and Ultisols. (Pattambi).

The specific hydric or hydromorphic conditions to which the wet land soils are subjected to, form the basis of the concept that the differentiating criteria in the sub order level was aquic state.

A general comparison of the results of present study in comparison with the traditional terminology attributed to the wet land soils can be summarised as follows.

Sl. No.	Pedon	Nature	Common Name/ Traditional Terminology	Proposed nomenclature According to soil Taxonomy
1.	Vellayani	Natural/<u>Kayal</u>	Acid Hydromorphic.	Fine,Kaolinitic, Isohyperthermic, Tropic, Fluvaquents
2.	Karamana	Manmade/valley bottom.	Brown hydromorphic.	Fine, Kaolinitic, Isohyperthermic, Typic, Tropaquents.
3.	Thakazhi	Natural/<u>Kari</u>	Acid Sulphate Peats.	Fine, Loamy Mixed, Isohyperthermic, Typic, Sulfaquent.
4.	Nedumudi	Natural/ <u>Karappadam</u>	Acid hydromorphic.	Fine, Mixed, Isohyperthermic, Aeric,Tropaquept.
5.	D-Block	Natural/<u>Kayal</u>	Saline hydromorphic.	Fine, Mixed, Isohyperthermic, Hydraquent.
6.	Njarakkal	Natural/<u>Pokkali</u>	Saline acid.	Fine, Mixed, Isohyperthermic, sulfic Tropoquept
7.	Anthikkad	Natural/<u>Kole</u>	Saline acid.	Fine, Mixed, Isohyperthermic Typic, Tropaquept
8.	Pattambi	Manmade/Valley bottom.	Brown hydro morphic.	Fine, Kaolinitic Isohyperthermic Aeric Kandiaqult.
9.	Pazhayangadi	Natural/<u>Kaipad.</u>	Saline acid	Fine, Mixed Isohyperthermic, Tropic Fluvaquent.

The earlier concepts of acid sulphate and saline acid soils and the traditional nomenclatures attributed to the _Kari_ and _Pokkali_ soils could be confirmed with the present study. These pedons exhibited accumulation a sulphidic materials in some part of the horizons and were identified as Sulfaquents.

The study reveals that the wet land soils of the state are variable in nature due to the various soil forming factors. In general they can be said as young soils which are in their early stages of profile differentiation.

The importance of soil classification lies in the fact that for efficient soil management and sustainable land development transfer of technology should be based on the soil units in a particular agroclimatic zone. The need of the hour is to identify, describe and catalogue the soil units through a common system of nomenclature. It is a matter of concern that such a system is not available at present on a global basis .

With the wet land soils of the State being described and classified according to an International soil classification system viz, Soil Taxonomy, the possibility of application of agrotechnology generated elsewhere to varying regions of the country will be increased tremendously.

Soil is the only medium of earth on this glob that is capable of growing the vast quantities of food that are required to feed the fast growing human population. Indian soils are generally said to be poor with regard to their productivity. This may be more true with regard to Kerala soils, where a large area of arable land comes under the problem soils. With the introduction of an International soil classification system, corrective and ameliorative measures developed elsewhere in the World can come handy for Kerala soils also.

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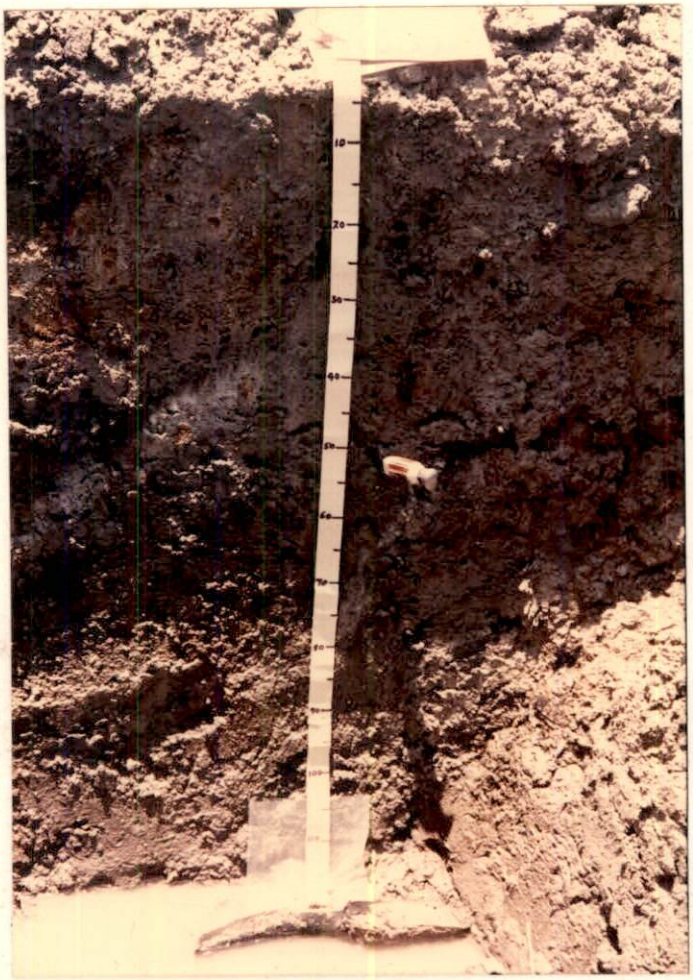
* Orginals not seen.

APPENDIX

PEDON 1. VELLAYANI

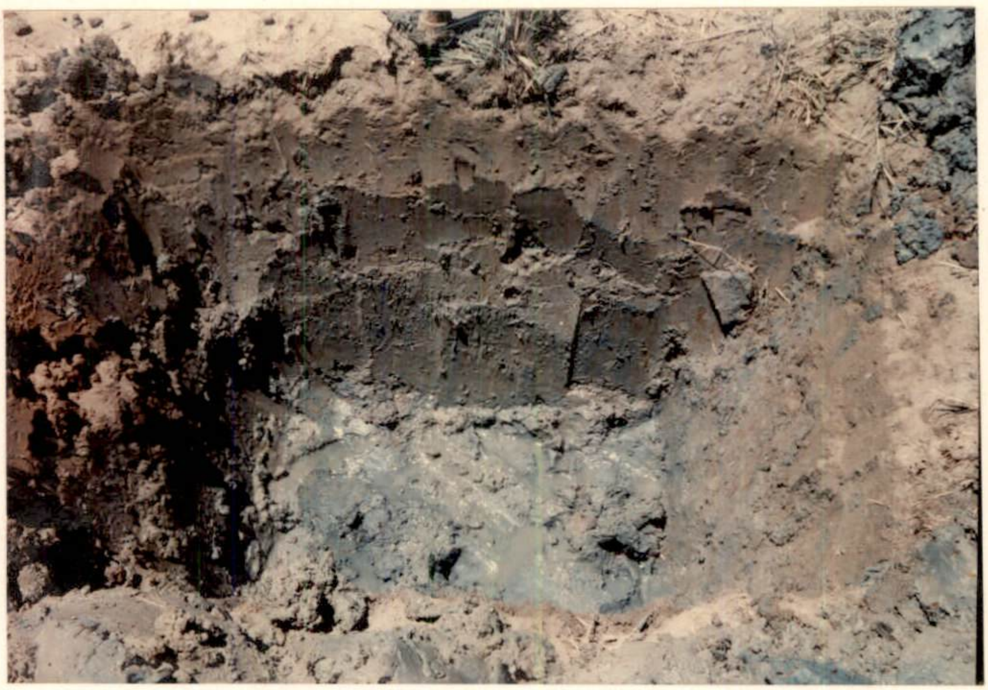
GENERAL VIEW



PROFILE

PEDON. 2. KARAMANA

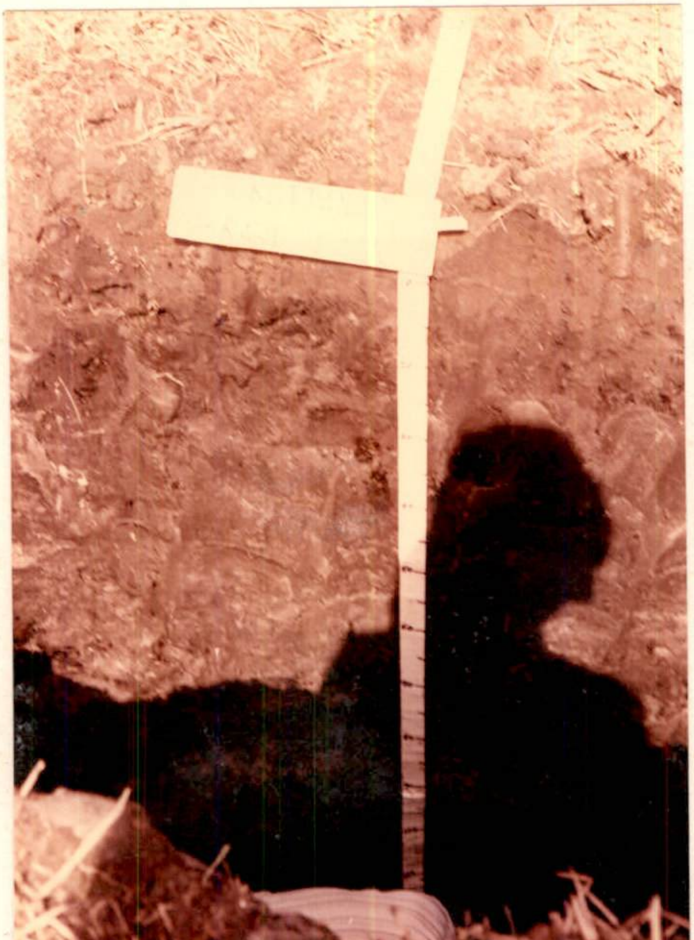
▲ GENERAL VIEW



PROFILE

PEDON 3. KARI

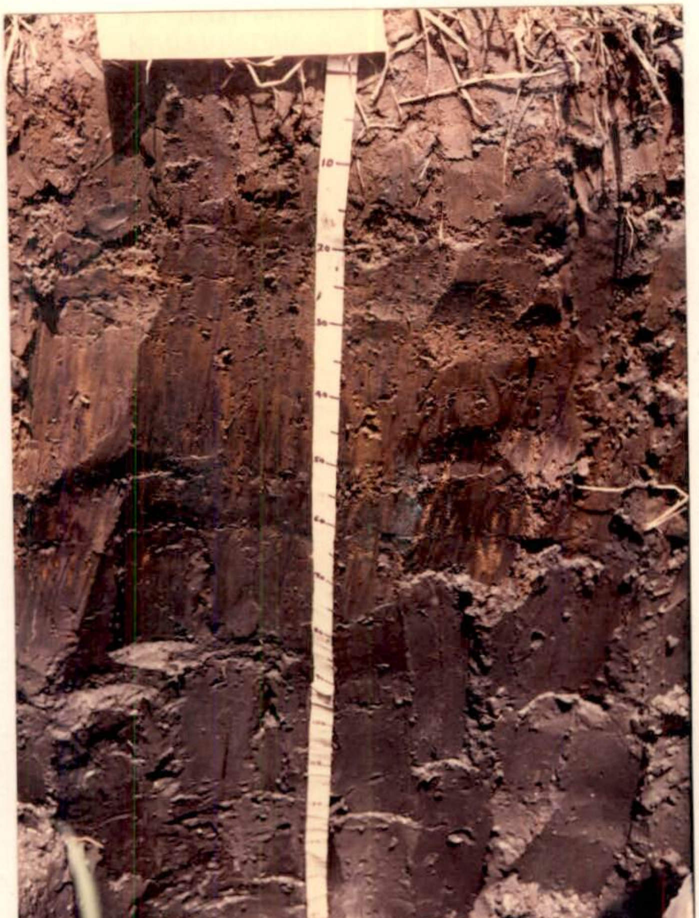
GENERAL VIEW



PROFILE

PEDON 4. KARAPPADAM

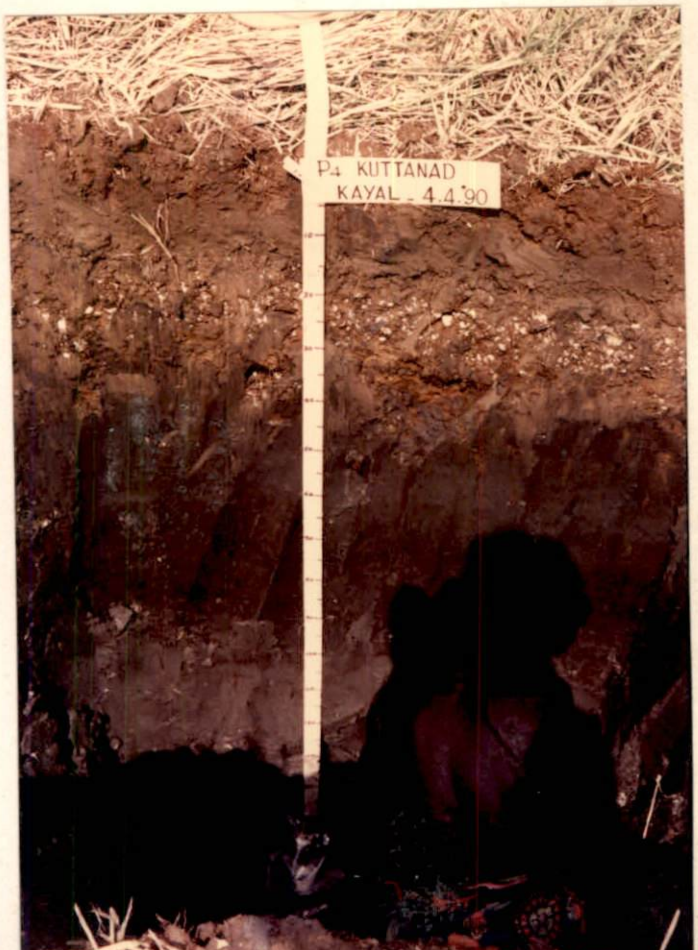
GENERAL VIEW



PROFILE

PEDON 5. KAYAL

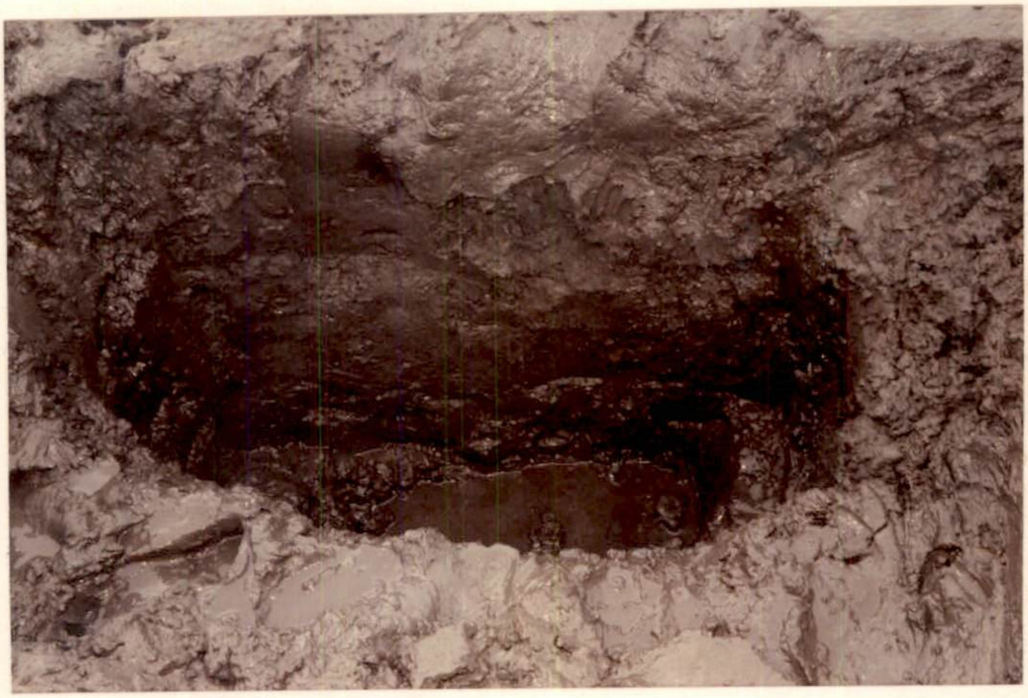
GENERAL VIEW



PROFILE

PEDON 6. POKKALI

GENERAL VIEW



PROFILE

PEDON 7 KOLE

GENERAL VIEW

PEDON 8. PATTAMBI

GENERAL VIEW

PROFILE

PEDON 9. KAIPAD

PROFILE

TABLE SHOWING OCCURENCE OF FINE SAND MINERALS IN PEDONS

LOCATIONS	QUARTZ	FELDSPAR	PYROXENE	AMPHIBOLE	APATITE	KYANITE	SILLIMANITE	MUSCOVITE	BIOTITE	OPAQUES	ZR
1. Vellayani kayal soil	1	3	2	4	T	-	T	-	T	5	-
2. Karamana rice soil	2	1	3	4	-	-	T	T	T	T	-
3. Kari soil	1	2	3	4	T	T	T	T	T	5	-
4. Kayal soil	2	3	-	1	T	-	T	T	-	4	-
5. Karappadom soil	3	1	2	4	T	-	-	-	T	T	T
6. Pokkali soil	1	2	3	T	-	-	T	-	-	4	-
7. Kole soil	1	2	3	-	4	T	-	T	-	T	-
8. Kaipad soil	2	1	3	4	T	T	T	T	-	T	T
9. Pattambi rice soil	2	1	4	5	-	-	-	3	T	T	-

Key. 1. More than 40 percent

2. 30 - 40 percent

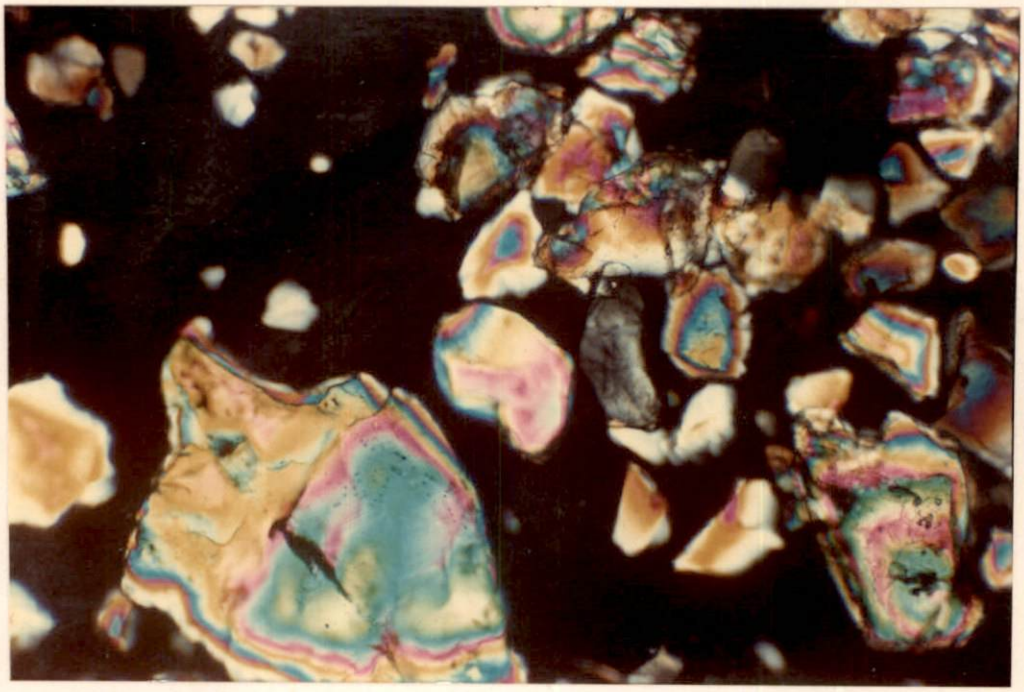
3. 20 - 30 percent

4. 10 - 20 percent

5. 0 - 10 percent

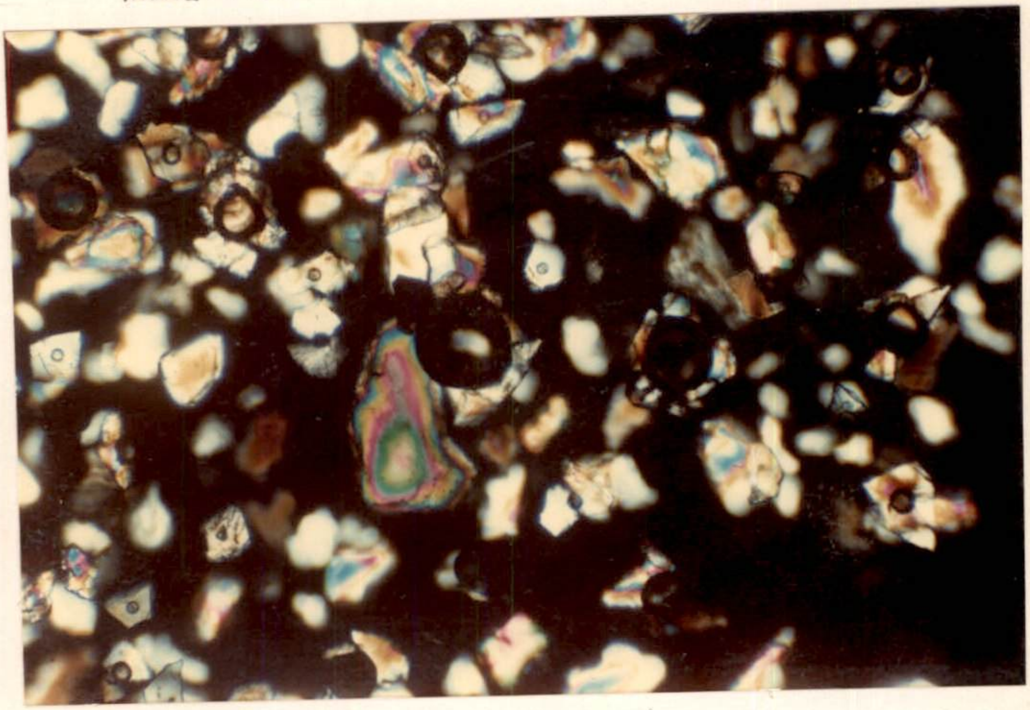
T. Traces

MINERALS IN FINE SAND FRACTION



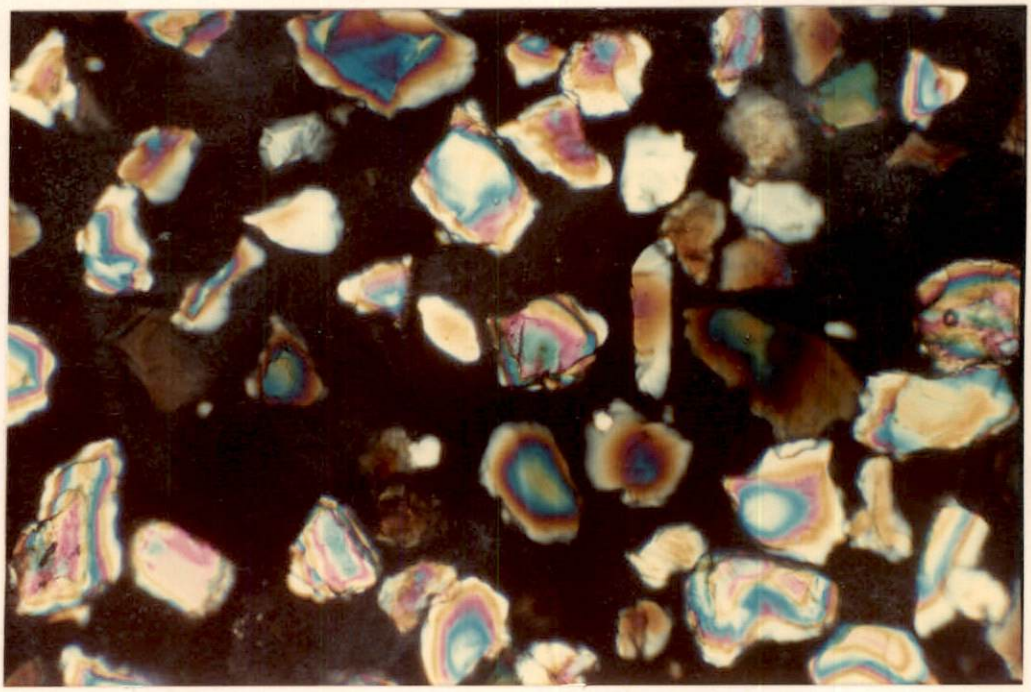
PEDON.1_VELLAYANI

MINERALS IN FINE SAND FRACTION



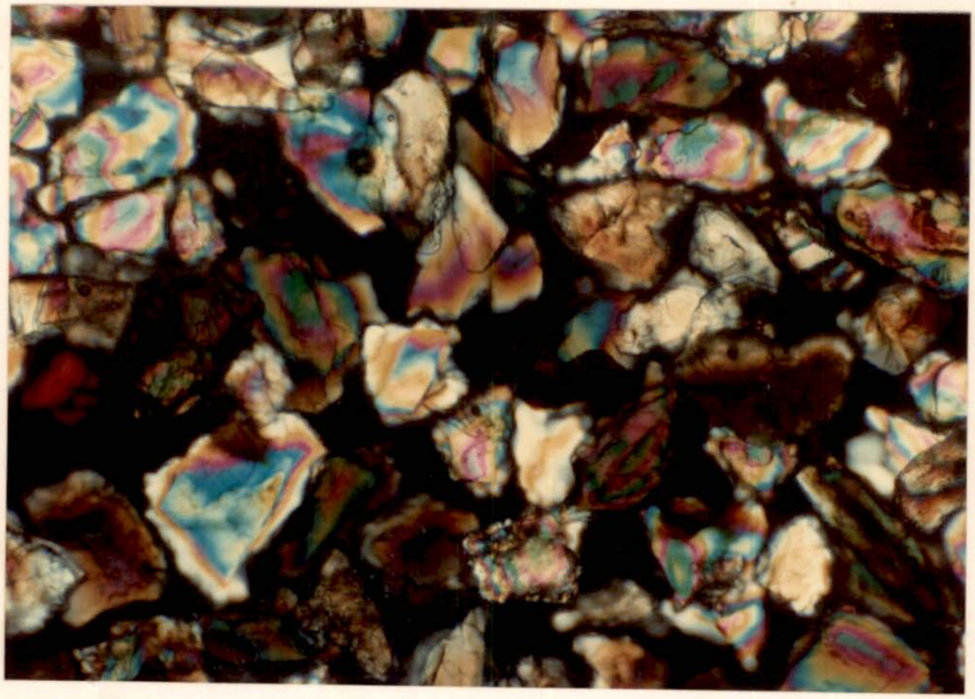
PEDON.2 KARAMANA

MINERALS IN FINE SAND FRACTION



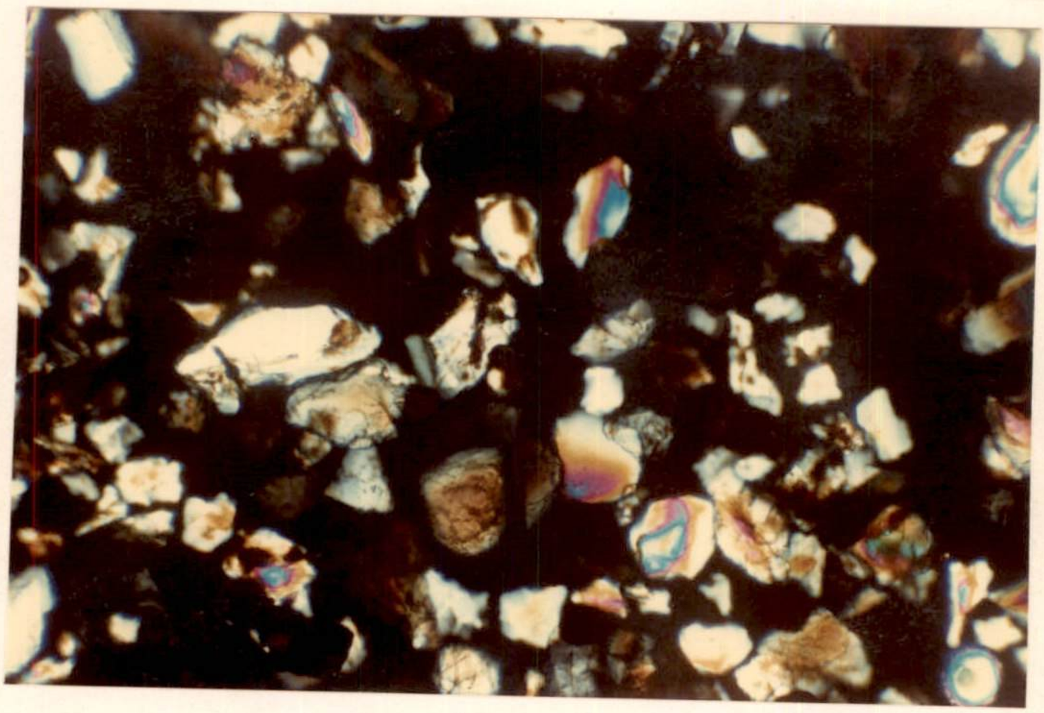
PEDON.3. KARI

MINERALS IN FINE SAND FRACTION



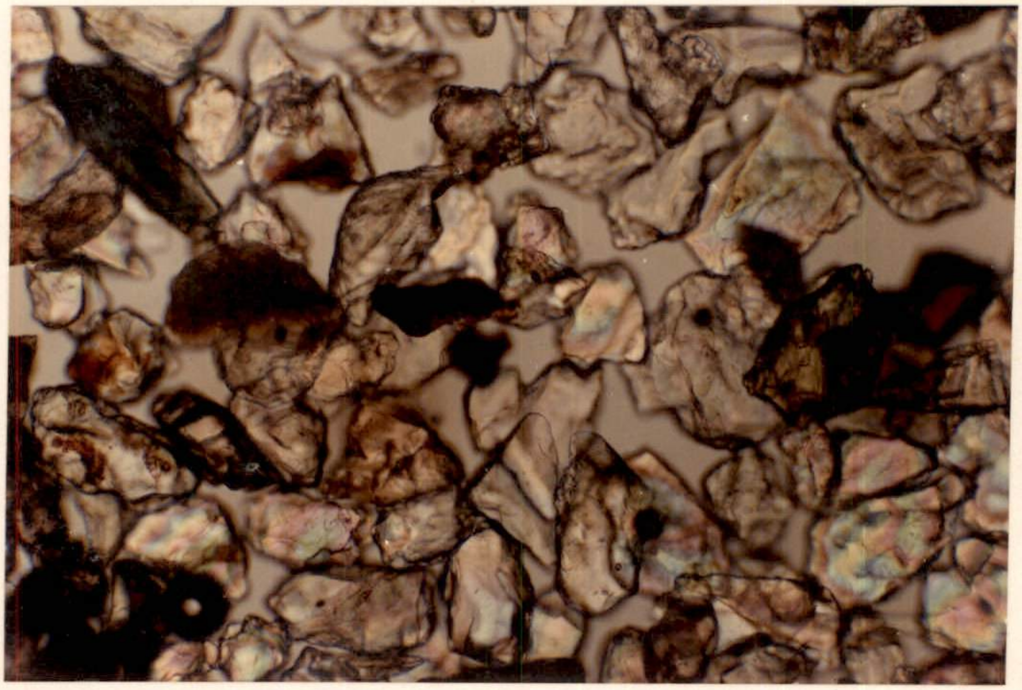
PEDON. 4 KARAPPADAM

MINERALS IN FINE SAND FRACTION



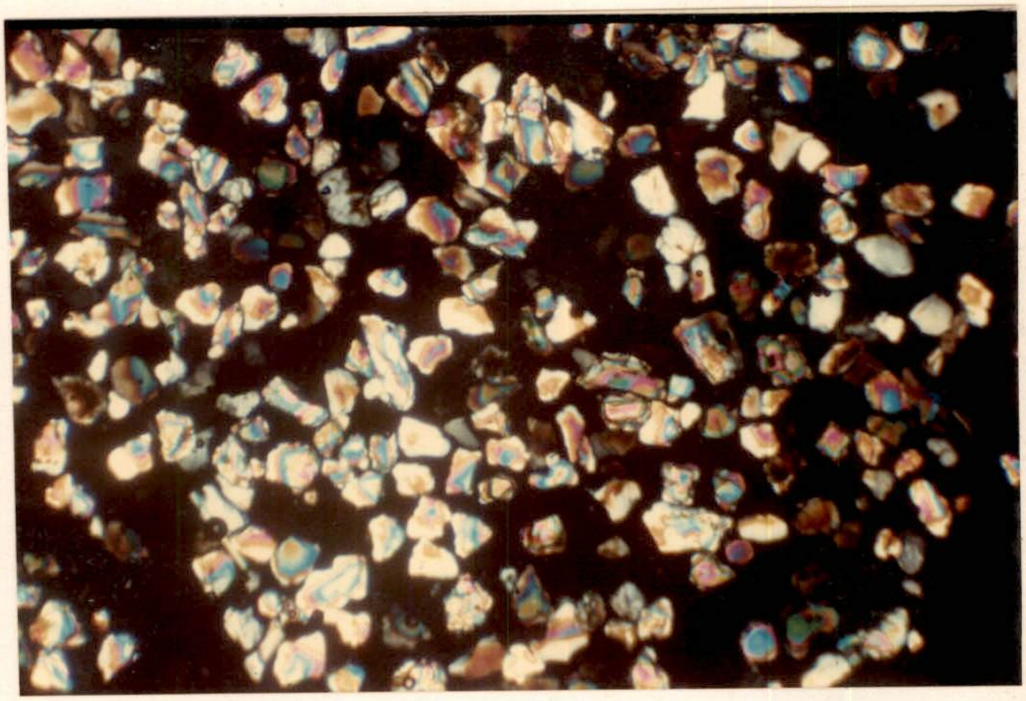
PEDON 5 KAYAL

MINERALS IN FINE SAND FRACTION



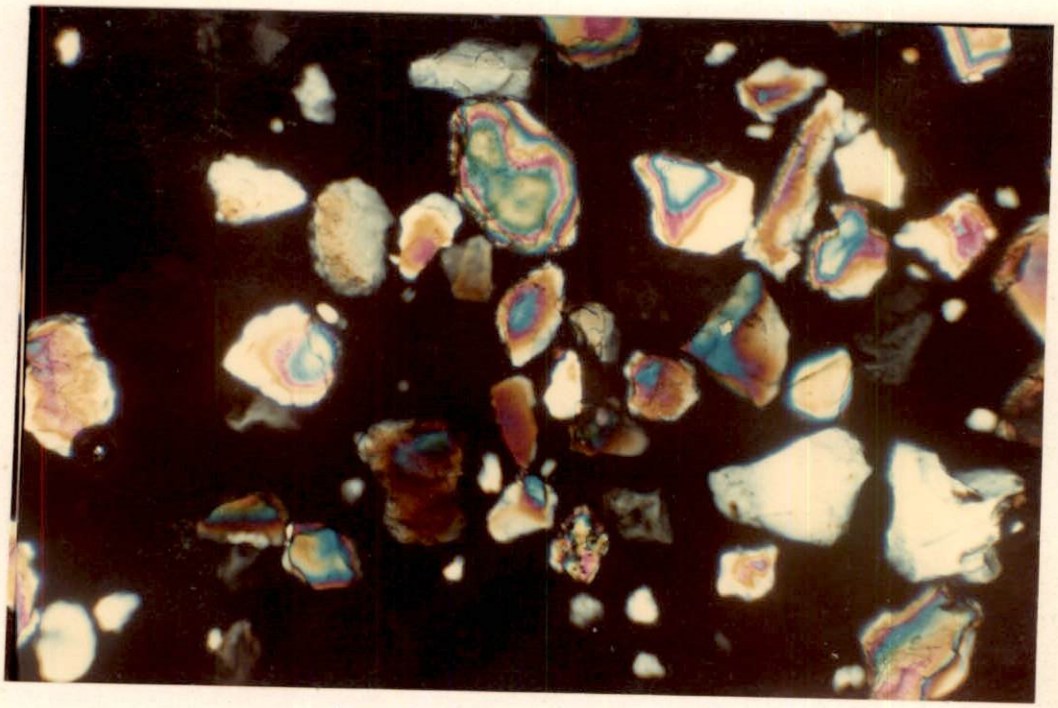
PEDON. 6 POKKALI

MINERALS IN FINE SAND FRACTION



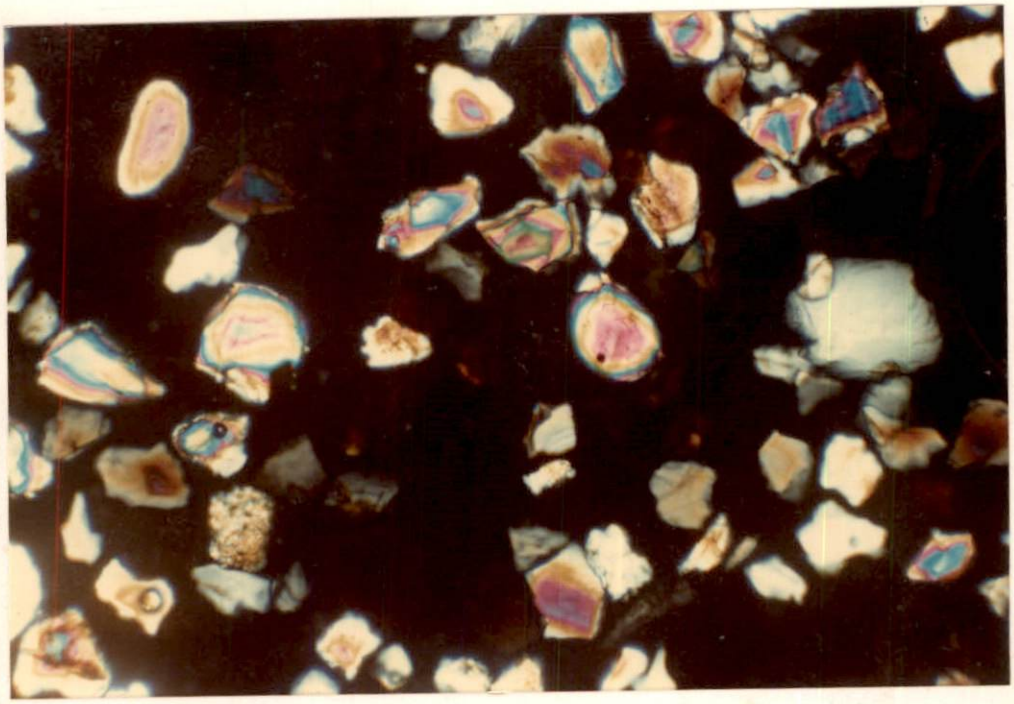
PEDON 8. KOLE

MINERALS IN FINE SAND FRACTION



PEDON. 8 PATTAMBI

MINERALS IN FINE SAND FRACTION



PEDON. 9 KAIPAD

ABSTRACT

Wet land soils acclaim much importance because of their varied uses in agriculture. These soils give sustenance to vast quantities of food crops like paddy, the staple food grain of majority of World population. Wet land soils in general can be grouped as natural and man made wet lands.

India has about four million hectares of wet lands which can be grouped as marine, brackish, fresh water and unclassified wet lands. In Kerala it is estimated that there are 10,5000 ha. of natural and 75,000 ha. of man made wet lands. The natural wet lands of Kerala are unique due to their nearness to coastal line and periodical inundation with salt water. The concept of natural and man made wet lands was evolved as result of early attempts to classify them.

Indigenous classification of wet lands of Kerala was mainly based on their geomorphology, hydrology, general characterstics and constraints of production. Accordingly

these soils were classified as *Kayal* (lakes), *Kari* (acid peat), *Karappadam* (acid riverine alluvium), *Pokkali* (saline acid), *Kaipad* (saline acid) and*Ela* (lateritic alluvium). A comprehensive evaluation and grouping of the wet land soils of the states to fit them to an International soil classification system, which was absent hither to, is attempted here. The present study is expected to form the basis for agrotechnology transfer.

Nine soil pedons, seven from natural wet lands and two from man made wet lands were studied. The locations were Vellayani (Natural/fresh water *Kayal*), Karamana (Manmade valley bottom), Thakazhi (Natural/*Kayal*), Nedumudi (Natural/*Karappadam*), D-block (Natural/*Kayal*), Njrackkal (Natural/*Pokkali*), Anthikad/(Nztural *Kole*) Pattambi (Manmade valley bottom)and Pazhayangadi (Natural/*Kaipad*), Pedons were described systematically and subjected physcio chemical & mineralogical analysis.

From the studies it was revealed that the wet lands of the State in general had immature soil morphology. Characteristics of the soils were mainly attributed to the parent materials. Absense of characterstic horizonation and diagnostic surface or subsurface horizons indicated that these soils were young. Three soil orders namely Entisols, (Vellayani, Karamana, *Kari*, *Kayal* & *Kaipad* pedons)

Inceptisols (Karappadam, pokkali and kole pedons) and Ultisoils (Pattambi) dominated the wet land pedons analysed. Isohyperthermic temperature and aquic moisture regimes were dominant. in, all pedons. Saline acid and Sulphidic soils identified in conventional terminology could be confirmed in the present study also.

The derivation of terminology for the wet land soils of Kerala, based on the assumptions of USDA-SCS helps to categorise these soils according to soil taxonomy, the nomenclature in vogue.