LAND EVALUATION AND SUITABILITY RATING OF THE MAJOR SOILS OF ONATTUKARA REGION

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THESIS

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DECLARATION

I hereby declare that this thesis entitled " LAND EVALUATION AND SUITABILITY RATING OF THE MAJOR SOILS OF ONATTUKARA REGION " is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society

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CERTIFICATE

Certified that this thesis entitled " LAND EVALUATION AND SUITABILITY RATING OF THE MAJOR SOILS OF ONATTUKARA REGION " is a bonafide record of research work done independently by P.N.Premachandran, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

INTRODUCTION

Soil is one of the most important nonrenewable basic natural resources of any country. Agricultural prosperity of any country is to a great extent dependent on judicious use of soils and rational application of soil data. Knowledge of soils in respect of their extent, distribution, characteristics, problems, potentials and suitability for various land uses have been of great importance. Evaluation of land for land use planning is a consequent step following soil survey and mapping process. In the recent past, it has gained high popularity in almost every land development programme.

The need for a scientific approach in inventory and optimum use of land has never been greater than at present, when rapid population growth and urban expansion are making available for agriculture, land, a relatively scarce commodity. Growing trend of industrialization and civic needs are also creating increasing challenges for the present scarce land resource.

With the increasing demand for food, fodder and fibre, there is overuse or faulty planning of land use that results in soil health hazards such as soil degradation, thereby declining the soil quality. For maintaining the soils in a state of high productivity on sustainable basis, there is a need for rational use of the soils, with respect to their suitability for optimum land use planning, especially in terms of their land capability, land irrigability and crop suitability.

Productivity of soils vary with the type of crop grown; some plants being able to withstand soil drainage or soil fertility conditions which others cannot, and to give economically satisfactory yields where other plants cannot survive (Riquier *et al.* 1976). Further, a soil which qualifies for a high productivity index for one crop, may have only a low index for another crop.

Land evaluation is the assessment of land performance when used for a specified purpose. The principal objective of land evaluation is to select the optimum land use for each defined land unit, taking into account both physical and socio-economic considerations and the conservation of environmental resources for future use. Land evaluation is used as a tool for developing land use plans for land development and management (Reddy *et al.* 1990).

The criteria for evaluation of soils on the major agricultural resources have been subjected to revision by different workers. The extent to which soil and site characteristics can influence actual productivity is to be precisely defined.

The introduction of high yielding varieties launched by green revolution in 1970's resulted in increase in irrigation facilities, associated with high usage of fertilizers and pesticides. The production showed an increasing trend. But this increase is always associated with the pollution and environmental degradation. At present majority of land resources are degraded and needs an immediate attention and care before they loose their resilience. Under these conditions, a proper knowledge of the soils, their extent, distribution, characteristics and their use potentials gain prominence in optimizing land use on sustainable basis.

The unique combination of climate, physiography and vegetation of Kerala provides a wide diversity in soils. The fertility problems of Kerala are so complex and diverse that it is not possible to copy the result obtained by research in one soil type to another satisfactorily.

Onattukara forms a unique agro-ecological region distributed in the taluks of Karunagappally in Kollam district, Karthikapally and Mavelikkara in Alappuzha district. In olden days, this region was considered as *Onam-Oottumkara* (meaning "ushering plenty"). But now it has become an area of low productivity with many constraints limiting production.

The soils of this region exhibit marked variance in their properties. Hence a systematic survey and evaluation of the soils will provide necessary data for interpreting these soils in terms of their suitability for optimum land use planning especially in respect of their land capability, suitability for irrigation and for growing/raising different crops. This will not only help the farmers but also the administrators and policy makers to make best and immediate use of soil resource data for making optimum land use recommendations for the area as well for rational resource allocation.

With the above goal, the present study was undertaken to estimate the extent, distribution, characteristics and use potentials of the soils of the Onattukara region with the following objectives.

- To evaluate the major soils of the Onattukara region based on the principles of land evaluation after conducting a broad reconnaissance soil survey.
- Preparation of a soil map of the region for further interpretation.
- To produce a land capability map based on soil/crop suitability ratings.
- Evolving a potential land use plan for the region in comparison with the present land use.

It is hoped that the present study would open up avenues for further investigations on land evaluation, crop suitability and other management aspects for sustained use of soil resources data to the best advantage.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Not much work has been done in Kerala in evolving a system of land evaluation and soil classification on the basis of productivity parameters. Identification of productivity parameters for various crops and the interpretation of the soil survey data for the sustained use and cultivation of these crops will definitely open up new areas of research application.

The criteria for evaluation of soils on the major agricultural resources have been subjected to revision by different workers all over the world. The extent to which soil and site characteristics can influence actual productivity is to be precisely defined. The socio-economic factors which affect crop productivity also need to be studied. In this chapter, an attempt is made to review the works carried out till recently on land evaluation and soil classification.

2.1. Systems and methods of land evaluation

Storie (1933) evolved a system of classification of soils based on productivity index. The Storie Index expresses numerically the relative degree of suitability or value of soils for general intensive agricultural land use. The rating is based on soil characteristics and is obtained by evaluating only four factors, viz., depth, texture, slope and drainage. The index rating is obtained by multiplying the above four factors.

The *FAO* (1976) defined the concept of land utilization types and suggested the classification of land for specific use. The classification itself is presented in different categories: orders, classes, subclasses and units. There are two orders ('S' for suitable and 'N' for unsuitable which reflect kinds of suitability. There are three classes (S,1-3) under the orders 'S' and two classes (N, 1-2) under the order 'N' reflecting the degree of suitability within the order. The appraisal of the classes within the order is done according to evaluation of land limitations or the main kinds of improvement measures required within classes. The limitations are 'c', climatic limitation, 't', topographic limitation, 'w', wetness limitation, 'n', salinity limitation, 'f', soil fertility limitation and 's', physical soil limitation. They are indicated by symbols using lower case letters following the arabic numeral used for classes.

Riquier *et al.* (1976) developed a system to evaluate productivity and potentiality which is an improvement over earlier methods. They considered nine factors for determining soil productivity, moisture, drainage, effective soil depth, texture, structure, base saturation, soluble salt concentration, organic matter content, ion exchange capacity, nature of clay and mineral reserves. He considered productivity as a function of the intrinsic properties of the soil, firstly as involved in the process of describing the soil profile *in situ* and secondly, by laboratory analysis. Productivity is measured as a product of the above factors. Each factor is rated on a scale from zero to 100, the actual percentages being multiplied by each other to obtain the productivity rating. The resultant index of productivity also lying between zero and 100 is set against a scale placing the soil in one or other of the productivity classes.

Shao (1984) reviewed the research on land evaluation in China. Land evaluation was initially based on climate, land form, vegetation, soil properties and hydrology. Subsequently, a land classification system was devised whereby land use was divided into five classes based on water, soil properties and current land use. This land classification was then used, together with socio-economic considerations, to arrive at land evaluation conclusions.

Wright (1984) described a system of agricultural Land Evaluation and Site Assessment (LESA). This system consists of evaluation of soil quality for crop production and assessment of sites for their economic and social viability. Evaluation of soil quality involves land capability classification, identification of important farm land, soil productivity ratings and soil potential ratings. Site assessment identifies factors other than soils, that contribute to the suitability of an area for retention in agricultural use, such as land use regulations, agricultural viability, alternatives to proposed use, compatibility of proposed use with existing adjacent land use and regional development plans.

Chang and Burrough (1987) used Fuzzy reasoning, a new quantitative aid for land evaluation in a land evaluation exercise for suitability for apple growing in the Liaotung peninsula of North East China. Methods of fuzzy reasoning were developed for situations akin to those found in soil survey and land evaluation, where a decision about land suitability is often coloured by inexactness, complexity and differences of opinion. The basic ideas of fuzzy sets and their relevance to soil science are explained.

Keulen *et al.* (1987) made quantitative land evaluation for agro-ecological characterization. This method is used for estimating the potential yield of crops using the knowledge of crop characteristics and the environment in which they are grown. This method can identify the limiting factors and estimate the change in crop yield if these factors are removed or reduced. The technique is a hierarchical analysis in which limiting factors are eliminated at the highest level and then subsequently accounted for at lower levels.

Ahmadu (1988) devised a system of Land evaluation for irrigation in Bauchi State, Northern Nigeria. A systems approach was adopted, in which land use types were designed and then matched with surveyed land qualities. The method follows the FAO framework of land evaluation. The land use types considered are for small holder irrigated farming and intermediate technology cooperative farms, with emphasis on the former. Several alternative cropping systems were investigated. Major conclusions are that (1) a system approach with assistance for remote sensing can reduce the time of survey of relevant land qualities, which must be established at the beginning and (2) by employing two sets of criteria, in the first place to identify irrigable land and then to refine the classification of suitability, after which, land classification can proceed efficiently with minimum survey effort.

FAO (1988) evolved Guidelines for land evaluation for rainfed agriculture. In this system, practical indications are provided for the planning and execution of the different stages involving land evaluation for rainfed agriculture. The procedures proposed are applicable at the local, regional, national or international levels.

Burrough (1989) proposed Fuzzy reasoning, a new quantitative aid for soil survey and land evaluation. According to him, the rigid data model consisting of discrete, sharply bounded internally uniform entities that is used in hierarchical and relational databases of soil profile, soil map and land evaluation classifications ignores aspects of reality caused by internal inhomogenicity, short range spatial variation, measurement error, complexity and imprecision.

Rossiter (1990) described the Automated Land Evaluation System (ALES) as a framework for land evaluation. Automated land evaluation system is a microcomputer programme that allows land evaluators to build their own knowledge base system with which they can compute the physical and economic suitability of land map units.

Sys *et al.* (1991) discussed the principles in land evaluation and crop production calculations. The assessment of land performance and objectives of land evaluation are described.

Johnson and Egan (1993) introduced integrated land evaluation as an aid to planning in the sugar industry in Australia. A tripartite system of land evaluation was developed in three stages: crop yield predictions based on biophysical simulation modelling and local expert opinion, integration of biophysical and economic data using an expert system and risk analysis of economic data based on biophysical and economic variables. The system was applied to four different land uses at two different sites in the Herbert River district of North Queensland. The results indicated that economic performance could be measured for a large number of spatially diverse land mapping units for the land uses examined.

Smyth and Dumanski (1995) developed a Framework for Evaluation of Sustainable Land Management (FESLM). An assessment of sustainability is achieved by comparing the performance of a given land use with the objective of the five pillars of sustainable land management: productivity, security, protection, viability and acceptability. A classification for sustainability is proposed and plans for future development of the FESLM described.

Thomas *et al.* (1995) studied the cropping systems model PERFECT as a quantitative tool in land evaluation. The mechanistic cropping systems model PERFECT was validated for six different soils and used to evaluate land suitability of wheat cropping in a marginal cropping area of Queensland, Australia. Using 100 years of climatic data from the area and crop, soil and management parameters, simulations described the key interactions of the cropping system. Using this process, the significance of key components of the systems (climate, plant, available water capacity, soil nitrate and soil loss hazard) were quantified. These quantitative data were then used to establish critical values for diagnostic attributes for land suitability evaluation in the area.

2.2. Studies based on different land evaluation systems

2.2.1. Storie Index soil rating

Koreleski (1988) studied the effect on the adaptation of the Storie index for land evaluation in Poland. He observed that the Koreleski's habital fertility index gives results which agree better with farmers experience and soil productivity measurements than the Storie index, which overestimates the adverse effect of any limiting factor.

Lal (1989) made productivity evaluation of sixty four bench mark soils of India using the Modified storie index soil rating. Moderately deep soils occurring on steep slopes with erosion hazards and salt affected soils were grouped in the non-agricultural category (Grade six). Most of the arid soils, poorly drained soils, soils of low fertility status (Ultisols, Oxisols and Oxic subgroups), clayey soils (Vertisols and Vertic subgroups) and sandy soils were placed in grades three and four. Soils of good productivity were graded two or one.

Singh and Mishra (1995) characterized three pedons for land evaluation located each in two toposequences in Bihar following ratings based on the Storie index, land use capability and soil and land irrigability classifications. The productivity and potential productivity ratings were also computed to evaluate the coefficient of improvement. The effect of topography with gentle slope and rolling physiography showed identical soil development and impact on land evaluation, particularly the actual productivity ratings.

2.2.2. FAO framework of land evaluation

Vidacek and Vancine (1985) prepared land suitability maps for physical planning and land protection and reclamation in Croatia, adopting FAO land evaluation criteria.

Born *et al.* (1986) compared two different land evaluation systems based on quantitative and qualitative data for soils, cultivated with winter wheat in Central France. The FAO framework of land evaluation and a French numerical land evaluation system were tested by studying 20 fields of winter wheat on luvisols and fluvisols, in Central France. The FAO system comprises a qualitative suitability classification based on land qualities and quantitative suitability classification based on detailed analysis of costs and benefits. The French system gives a rating number for each soil type according to various soil physical properties.

Kalima and Veldkamp (1987) made application of FAO guidelines on land evaluation for rainfed agriculture in Zambia. The importance of climate in land evaluation has been emphasized. The Zambian system uses sub-qualities with rating options, crop type (single crop) and agro-ecological zone . The suitability classes consists of four suitable and three unsuitable classes.

Rhebergen (1987) used the FAO framework of land evaluation in Botswana for the preparation of land suitability maps at 1: 250,000 scale. Moisture availability, soil drainage, salinity and alkalinity affect land quality ratings most strongly. It is difficult to produce land suitability maps from small scale soil maps.

The Seventh meeting of the East and South African Sub-Committee for Soil Correlation and Evaluation (1987) held in Botswana considered the application of the FAO guidelines on land evaluation for Rainfed Agriculture. Contributors from Botswana, Ethiopia, Kenya, Lesotho, Mozambique, Sudan, Uganda, Zambia and Zimbabwe describe experience with the FAO system and compared it with national system of land evaluation.

Chinene and Shitumbanuma (1988) conducted land evaluation and suitability studies of the Musaba state farm in Zambia for the commonly grown crops using the FAO guidelines on land evaluation. Nutrient availability and oxygen availability to roots were found to be the most limiting land qualities. The soils being strongly weathered and leached, are low in nutrient reserves, pH and base saturation. Sesquioxides are high, resulting in high phosphate fixation. A matching of land qualities with requirements of land use types showed that cassava and sorghum are the best suited crops.

Mensvoort *et al.* (1993) carried out a coarse land evaluation exercise for the acid sulphate soil zones of the Mekong delta, Vietnam using the FAO framework of land evaluation. Nine Land Use Types (LUT) are described, four based on rice, four on upland crops and one on forestry. The land requirements of these land use types are expressed in terms of their tolerance to soil acidity and their hydrological requirements.

2.2.3. Land Evaluation and Site Assessment(LESA)

Googins and Kramer (1984) used the LESA system (Land Evaluation and Site Assessment) as an information aid in farmland retention decisions. The system and its objectives are described and its potential use as an information aid for planning decisions with regard to farm land retention and conversion are outlined.

DeMers (1989) studied the importance of site assessment subsystem in land use planning. Results show that the two subsystems, while distinctly separate, work together to plan the proper use of a dwindling agricultural resource base. Suggestions are made for research methodologies to improve the final grading system of LESA (Land Evaluation and Site Assessment) to reflect local objectives more adequately while responding to the national need.

2.2.4. Automated Land Evaluation System (ALES)

Madero (1993) used the Automated Land Evaluation System (ALES) for the land evaluation of a farm in Tenjo, Colombia. The methodology is described and results are presented and discussed in terms of soil types, production systems and economics.

Yizengaw and Verheye (1994) discussed an expert system for land evaluation and its application in two test areas in Central Ethiopia. This procedure, called Land Evaluation for Central Ethiopia (LEU-CET) uses the framework of Automated Land Evaluation System (ALES). The study demonstrates the use of a computer aided decision support system as a basis for an efficient use of locally available data and expert knowledge for a land evaluation system.

Rossiter (1996) conducted further studies on ALES and classified the land evaluation models and discussed how they take time and space into account and whether they use land qualities as an intermediate between land characteristics and land suitability. Studies show that in the most complex case, land suitability for several land uses are interdependent.

2.2.5. Fuzzy reasoning in land evaluation

Burrough (1989)used Fuzzy reasoning by a land evaluation exercise for suitability for apple growing in the Dalian Wafangdian area of the Liaotung peninsula of North East China.

Dobberman *et al.* (1997) used Fuzzy set theory for soil fertility mapping of irrigated rice land in Philippines. A combination of fuzzy membership functions with Monte Carlo simulation was used to produce maps of membership values for three soil fertility classes and two multivariate soil fertility qualities. Most of the area investigated had a high inherent fertility potential and was rated suitable for intensive rice production.

According to McBratney *et al.* (1997), applications in soil science which may be generated from,or adapted to, Fuzzy set theory and fuzzy logic are wide ranging. Numerical classification of soil and mapping, land evaluation, modelling and simulation of soil physical process, fuzzy soil geostatics and soil quality indices are precisely defined.

McSweeny (1997) discussed the advantage of the *Fuzzy set* approach in land evaluation. In fuzzy set approach, the class boundaries are not sharply defined, thus allowing the possibility of partial membership to a class. A new approach Fuzzy relational calculus is introduced to overcome the problems associated with fuzzy set theory. This new approach is based on fuzzy relations between land qualities and land units.

2.2.6. Integrated land evaluation system

Johnson *et al.* (1994) discussed integrated land evaluation as an aid to land use planning in northern Australia. A framework is presented whereby both biophysical and economic factors affecting land use are included in the assessment. The method provides facility for objective comparison of mapping units, both between and within, land uses. The presence of an improved information base can have a positive impact on land use planning activities.

Johnson and Cramb (1996) introduced an integrated method of land evaluation that generates biophysical and economic measures of land performance using crop yield prediction, expert system and risk analysis. Four typical land use planning scenarios are presented that demonstrate the usefulness of the method.

2.3. Soil survey for land evaluation

Govindarajan *et al.* (1974) made a survey of the natural resource of Goa. Agriculture and present land use, soil genesis and classification, land capability classification and management recommendations were made.

Natarajan *et al.* (1985) studied the soil and land use planning of Rameswaram island. The pH, electrical conductivity and compositions of water collected from shallow open wells at six sites were studied. The suggested land use are shown in a small scale map (1:25,000).

Veltorazzi and Angulo Filho (1986) made characterization of soils of the Riberia de Iguage valley in the State of Sao Paulo by means of topographic indices. Five soil units from latosols, red yellow podzolic soils and cambisols were characterized according to three topographic indices expressing gradient altitude and slope characteristics. The relative efficiency of the indices were discussed.

Bleeker and Laut (1987) described the result of a survey of Lockhant River Valley, Cape York, Queensland . The area which is isolated and of limited accessibility was being considered for possible oil palm development and cashew cultivation. The study concludes that the study area is less than satisfactory for commercial cultivation of oil palm and that only 30 percent of the survey area may be suitable for cashew cultivation.

Eckelman and Raissi (1987) suggested soil evaluation maps as a framework for land consolidation programs. The new terms of reference involve the integration and harmonization of economic and ecological interest, especially where natural and intensive farmed areas are adjacent. Soils with high productive potential which should remain in food production need to be identified and mapped according to an evaluation model.

Gil *et al.* (1987)(a) conducted soil survey and land evaluation studies in the Marmolejo Manjibar (Jaen) regions of the Guodalquivir alley. The soils are divided into three units according to morphology and parent materials. Soils of unit one are fairly level and have developed in Holocene and Pleistocene sediments. Soils of unit two have a more undulating relief and have developed on argillaceous tertiary sediments.. Unit three include mainly hilly soils subjected to selective erosion and developed on heterogeneous parent materials. Soil of the three units include Entisols, Alfisols, Mollisols, Inceptisols and Aridisols.

Wosten *et al.* (1987) conducted a detailed soil survey at 1: 10,000 scale to aid the estimation of the change in grass yields. Additional soil maps were derived from the original at scales of 1: 25,000, 1:50,000 and 1:250,000. The physical properties of representative properties of these maps were interpreted in a simulation of yield changes. The choice of scale has implications for the level of details of information.

The WWF Report (1987) describes the geology, topography, climate, vegetation and agricultural uses of 1320 square kilometers. of land close to the Korop National Park. The soils are classified and their physical and chemical properties discussed. Seven mapping units are identified based on land forms, geology and drainage. The main limitations for agricultural development are steep terrain, low soil fertility and lack of roads. Recommendations include farming systems, settlement areas and location of new roads.

Deshmukh and Bapat (1993) described soils from six different physiographic units, in Raisa district of Madhya Pradesh and calculated their production potential, coefficient of improvement and nature of improvement. The six soils, were, P1-Pathrai (*Lithic Ustrothents*) on hills, P2-Pipali (*Typic Ustochrepts*), on plateau, P3-Saunter (*Vertic Ustochrepts*) in valley, P4-Chicklod (*Typic Chromusterts*) in basin , P5-Padrai (*Entic Chromusterts*) on piedmont alluvial plain and P6 (*Typic Ustochrepts*)on dissected flood plain. Studies showed that soils P1, P2 and P3 were limited by depth, P4, P5 and P6 by organic matter, P3, P4 and P5 by texture/structure, P1 and P2 by moisture storage and P1 and P6 by slope.

Verheye (1993) after general considerations on land use planning and resource management, discussed the advantages of planning at the micro watershed level, with particular reference to Indian conditions.

Cavalieri *et al.* (1995) classified land according to the use system using a geographical information system and the results compared with those obtained from a classification system. Soil characteristics and other factors were collected in a field survey.

Thompson *et al.* (1995) evaluated two of the most common mapping strategies (soil survey and grid sample methods) with the variable rate of anhydrous ammonium application system in maize relative to conventional nitrogen application methods. This was done by evaluating the most appropriate method (or a combination of methods) that defines the observed variability of soils, residual nutrients and crop growth and by testing for variations in maize yields and economic performance between and within mapping strategies.

Zenkovich and Moroz (1995) made cadastral evaluation of land belonging to agricultural enterprises in Belarus. The study concentrated on assessment of land in terms of effective crop production on the basis of a comprehensive survey. This is envisaged with reference to land as a means of production, working medium and spatial operating base.

Baars (1996) conducted land evaluation studies for extensive grazing, to determine the potential carrying capacity of the Western province of Zambia. A vegetative map was produced based on the studies.

Batjes (1997) presented a standardized dataset of derived soil properties for the 106 soil units considered on the FAO-UNESCO 1:5 million scale soil map of the world. It was derived from a statistical analysis of the 4353 soil profiles held in the WISE (World Inventory of Soil Emission) database which was developed at the International Soil Reference and Information Center (ISRIC).

Demas and Brown (1997) discussed the shift of emphasis in soil survey from the conceptual and tacit methodologies of soil mapping towards increased utilization of computer generated maps and statistical analysis of field data to make mapping decisions.

Domburg *et al.* (1997) described a knowledge base system which assists in the design of soil survey schemes. The system facilitates the full use of prior information as well as pedological, operational and statistical knowledge. Models and algorithms are proposed to predict accuracy and the costs of the information taking into account differences in spatial variability or sampling costs between sub regions.

Imhof (1997) described the technologies developed by the Natural Resource Monitoring and Assessment Group aiming to provide soil and land information details. Approaches include digital annotation to show soil and landscape mapping unit boundaries, major features and reference site locations or the presentations of soil/land form mapping by overlaying the maps onto thematic mapping image base.

Soil survey staff (1997) carried out soil survey of Athiyannur panchayat in Thiruvananthapuram district and Kodur panchayat in Malappuram district. Land capability and land irrigability classification and land evaluation studies have been made.

Verheye (1997) studied land use planning and national soil policies of Belgium. Accordingly, decision making on land use options is a current problem of modern societies. Adequate planning and decision making about land use is facilitated by a national soils policy framework. A number of examples are given to illustrate the most relevant issues in national soil policies.

Voltz *et al.* (1997) investigated a method for mapping soil properties at a regional scale with acceptable precision and cost. The study combines soil classification, interpolation and uses sample information from a reference area and simple soil observations over the region. The method consists of two stages. First is the prediction of soil properties at a set of sites covering the region by classifying each site according to the soil classification of the reference area and the second is by interpolating the predictions of the properties from the classes at the observation sites.

Detailed soil survey of Kakkur panchayat in Kozhikode district has been carried out by Soil Survey staff (1998) and made soil survey interpretations.

2.4. Land capability ,irrigability, land suitability and crop suitability in land evaluation

Joseph (1982) conducted study on crop suitability in Thiruvananthapuram district with a view to identify the areas suitable for the different crops and delineate the areas in village maps. Nine soil parameters have been taken for evolving major criteria for crop suitability. Land capability classification has been evolved based on soil survey data.

Chan *et al.* (1984) evolved a land evaluation system for rubber cultivation in peninsular Malaysia. The early system was non-parametric and based on number and type of soil limitations. Later systems were parametric and included the influence of climate. On the basis of current evidence, a land suitability system for rubber cultivation is recommended. To facilitate use of these systems, modern soil classification system has been used to describe the local soil unit, so that this technology can be transferred at a global level.

Kanzaira and Patel (1985) reported seven classes of land capability classification of the soils of Gujarat.

Silva (1985) used a parametric approach for the evaluation of land suitability for sugarcane cultivation in Mexico. Geological, topographical, vegetational, morphological, physical and chemical properties were determined at specific intervals throughout the study area and analyzed by principal component analysis and cluster analysis. Four classes and ten subclasses of land suitability were established. The method was compared with the USDA classification of land capability into eight classes, in the Palaya Vincente region of Veracruz and gave satisfactory results.

Singh *et al.* (1985) undertook land capability classification studies in Haryana and recognized four classes (Class I to IV) based on their suitability for cultivation.

Soils of Maharashtra have been classified for their land capability by Patel and Ghoniskar (1985). They classified the lands under Class II and Class III which need proper soil moisture conservation practices and improved cropping systems were recommended for sustained crop production. Most of the area under high rainfall zone were occupied by Class VII and Class VIII lands where forest vegetation was present in large scale.

Harding *et al.* (1986) derived a methodology for qualitatively evaluating the current land suitability for rainfed Arabica coffee production in Papua New Guinea. The methodology is modified to enable evaluation of individual sites and also large area of variable land such as provinces at two levels of management inputs.

Weigel (1986) studied the potential and constraints of the soils of the Maybar/ Wollo area for agricultural development. Distribution pattern of soils are described, their crop suitability assessed and an agro-ecological development plan proposed. Present trends are extrapolated to the year 2010 and comparison made with other parts of Ethiopian highlands.

Alaily (1987) conducted evaluation of agriculturally useful land in South West Egypt. A soil and land capability map has been prepared for part of the Sahara in South West Egypt at a scale of 1:10,00,000. Capability classes and subclasses are listed and important physical and chemical properties of representative soils tabulated.

Bourgeon (1987) described the agricultural potential of fersiallitic soils *(red soils)* in South India. The capability of these soils to support continuous and relatively intensive agriculture is shown by the history of semi-arid India.

Calvo *et al.* (1987) made land evaluation studies in a mountainous area of Golicia (North West Spain). They have discussed land capability, based on physiographic, climatic and soil characteristics data. Land use suitability maps are presented.

Embrechts *et al.* (1987) made physical land evaluation using a parametric method for application to oil palm plantation in North Sumatra. Climatic records, site and profile description and oil palm yield of 36 plantations with comparable management were collected and conducted studies. Six land qualities were used to estimate land suitability for oil palm and land index calculated using ratings attributed to each land quality. Highly significant relationships were found between yield and selected land qualities and between the yield and land index. A land suitability classification based on yield is proposed. They observed that standard climatic data, site and profile descriptions can be used to predict oil palm yields very accurately.

Farshad and Wijnhond (1987) made land evaluation studies of the wet upland areas in Sri Lanka . Two representative areas in Kandy district and the main land use type to the wet uplands and wet midland regions of Sri Lanka are studied. The factors for rating crop requirements includes climate, topography, wetness, physical soil condition and soil fertility. The requirements of the main crops like rubber, coconut, tea, coffee, cardamom, cinnamon and cloves were tabulated.

Gil *et al.* (1987)(b)made land evaluation of soils in the Guodalquivir valley, Spain using the variables of effective depth, erosion extent, slope and climate as primary characteristics and presence of stones, texture, exchange capacity and sodium saturation as secondary characteristics. Four capability classes were identified using 24 model profiles, each class being mapped using geo-morphological and edaphic properties.

Kanyanda (1987) used the land capability system of land evaluation in Zimbabwe, which consists of eight land capability classes. Its advantages and disadvantages are discussed and compared with the FAO guidelines for land evaluation for rainfed agriculture. The study was proposed in Zimbabwe to adopt the suitability classification.

Kintukwonka (1987) evolved land evaluation for rainfed agriculture in Uganda. The Uganda method of land capability classification is closely related to the FAO and the United States Department of Agriculture systems, with modifications to suit local condition. Eight classes are defined. The method consists of the assessment of climate (mainly rainfall), seven soil and three site factors. Land quality ratings were made.

Kuhand and Karwasara (1987) evaluated the semi-arid Central alluvial plains in Rhotak district, Haryana for sugarcane, wheat and rice cultivation. They used the soil survey data obtained from interpretation of aerial photographs (on 1: 25,000 scale) and classified the lands as highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and currently not suitable (N1) for cultivation of sugarcane, wheat and rice.

Lekholoane (1987) formulated suitability classification of soils and climate for specific land use in Lesotho. The results of land evaluation in Lesotho are based on study of eight key agricultural soils. The land quality used in the Lesotho system include water availability, oxygen availability, nutrient availability, pH , phosphorus availability, temperature and rainfall. The climate and soil requirements of maize, sorghum and wheat are discussed and a suitability classification of soil series for each crop is prepared.

Verheye (1987) conducted land suitability evaluation in major agro-ecological zones of the European community, and its application in land use planning and nature protection. The system provides a basis for assessing non-agricultural use and environmental protection

Fletcher (1988) used the land use capability method of land evaluation for the New Zealand Land Resource Inventory (NZLRI). The survey classified New Zealand into approximately 90,000 map units each containing five sets of inventory information (rock, soil, slope, erosion and vegetation). These map units are grouped into 925 land use capability units within 11 regional land use capability classes.

Khatter *et al.* (1988) have conducted land evaluation studies for agricultural purposes of E_1 Rayan Depression, Egypt. The main soil characteristics considered as limiting factors for agricultural production were local elevation, slope, soil drainage, profile depth, soil texture, $CaCO_3$ content, gravel content, soil structure, salinity and alkalinity of soils . The soils were grouped into four capability classes.

Challa *et al.* (1989) conducted a case study of land evaluation for irrigation in Kanedi village, Dadra and Nagar Haveli, Maharashtra. Based on land features and soil characteristics, the soil units were evaluated by qualitative and parametric methods. According to the former method, about 98 percent of the area was moderately suitable for irrigation with limitations of topography, erosion and compactness in the subsurface soil layers. About one to three percent of the area was marginal land with shallow soils and erosions. Based on the parametric method, 3.5 percent of the area was not suitable for irrigation, whereas 45 percent and 51.5 percent of the area were moderately and marginally suitable respectively.

Riezebos (1989) stated that the reliability of a land suitability classification depends on the homogeneity of physiographically delineated map units with regard to land qualities. The map unit homogeneity of a small area in France was estimated using 64 observation points, arranged according to a nested sampling scheme, followed by nested analysis of variance. The analysis shows that map units are too heterogeneous to accept the suitability classification as being completely reliable.

Reddy *et al.* (1990) used land evaluation as a tool for developing land use plans for land development and management. They used satellite remote sensing in combination with collateral and adequate ground truth data for small scale maps and land resource maps at regional and national level showing association of soil families with dominant phases. Soil and land resource units shown on the small scale maps were evaluated for their suitability for growing sorghum crop by matching the relevant land qualities against the land requirements for sorghum. They classified the areas as highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N1) for agriculture.

Ahuja *et al.* (1992) classified soils in Bhiwani district into two land suitability classes such as suitable for horticultural plantations and lands suitable for cultivating agricultural crops.

Driessen and Konijn (1992) discussed the concepts and definitions in analysis of land suitability, qualitative assessment of land suitability and dynamic analyses of land use systems. The strength and weakness of parametric method of land evaluation are also discussed.

Soil survey staff (1992) conducted soil survey of the Ayacut area of Aralam Irrigation Project and identified four land irrigability classes, such as 2d, 2t, 3t and 4t.

Sys *et al.* (1993) described the crop requirements for land evaluation with regard to climate, landscape and soil conditions for a wide range of crops commonly cultivated in the tropical and subtropical regions.

Xie and Zhang (1994) derived land capability classes for Scotland by studying the relationship between land capability classes and land properties. A computer aided land evaluation map was obtained by combining the model and a soil information system. This map was compared with a conventional land capability map. Suggestions for improving the computer aided system are made.

Bhattacharyya (1995) used the Fertility Capability Classification (FCC) system to group soils with similar limitations for fertility management in parts of Western Maharashtra. Thirty six mapping units at the level of the series associations were converted into eleven FCC units. The meaning and interpretation of FCC units were discussed using the prepared FCC map.

Brignall and Rounsevell (1995) estimated the effects of climatic change on crop suitability in England and Wales, by systematically adjusting agro-climatic data inputs to a land evaluation model. The study shows that winter wheat suitability in England and Wales is affected more by changes in precipitation than by changes in temperature.

Vega (1995) studied the soil fertility aspect (physical and chemical soil properties) and the effects of current land use practices. Results showed that plot with the same soil type (*Mollic Gleysols, Rendzic Leptosols, Calcic Phaeozems* and *Stagnic Lixisols*) and different land use did not differ too much in physical and chemical properties. Relevant types of agricultural use or land utilization were defined and crop suitability for 22 species was given.

Wandahwa *et al.* (1995) made qualitative land suitability assessment for Pyrethrum cultivation in west Kenya based on computer captured expert knowledge and GIS. Climate, soil and land form requirement for Pyrethrum cultivation are provided. Climatic and land suitability maps are presented.

Contractor and Badanur (1996) studied the effect of forest vegetation on properties of a Vertisol. The study revealed that *Tectona grandis* (Teak), *Acacia nilotica, Tamarindus indica* (Tamarind) and

Azadirachta indica (Neem) were the most suitable for growing in the dry tracts of Karnataka.

Nair *et al.* (1996) used soil information as an aid for district planning. The procedure is demonstrated with the example of Citradurga district of Karnataka. Soil map data was input to GIS through manual digitization and associated land and soil characteristics in tabular form through keyboard entry. From the digital data set, thematic maps depicting various land characteristics, land suitability for specific purposes and ultimately a potential land use map was generated. The use of these outputs in devising sustainable land use plan is discussed.

Singh and Mishra (1996) studied the soils of Chota Nagpur, Bihar and reported that the soils were coming under three land capability classes such as IVe, IIIe and IIw. Land irrigability groups identified were 4st, 3st and 2sd where soil (s), drainage (d) and topography (t) were considered as limitations.

Soil survey staff (1996) carried out soil survey of Kalluvathukkal panchayat and identified five land capability classes and seven land irrigability classes.

Giriprakash *et al.* (1997) conducted the resource inventory of Gudiyatam taluk, Vellore district, Tamil Nadu and grouped the soils under four land capability classes such as Class II, Class III, Class IV and Class VI. Limitations due to topography (t), soils (s), climate (c) and wetness (w) were also identified at the level of land capability subclasses.

Habarurema and Steiner (1997) discussed the field studies conducted in farmers field in south Rwanda for evolving soil suitability classification. The classification was based on the identification of different soil types according to their agricultural potential and tillage properties. The main criteria applied were fertility (productivity), depth, structure and colour. Nine major soil types were distinguished.

Naidu *et al.* (1997) made evaluation of land suitability of major coconut growing areas of India. The climate and soils of coconut growing areas and production levels were analyzed to identify the potentials and constraints. A set of criteria were proposed for evaluating site and soil suitability for the crop. Using the criteria, the climate and soils of major coconut growing districts of India were rated for coconut cultivation. The evaluation was validated using the average crop yield reported for the districts. Based on suitability, the coconut growing districts were grouped into eight major zones. The climate and soil suitability of the zones or coconut production and means of alleviating the constraints such as long dry period, poor soil fertility, drainage problems, low water holding capacity and shallow rooting depth are discussed. Site selection for coconut plantation and supplementary irrigation were found the key management factors for overcoming the soil and climatic limitations.

Saxena *et al.* (1997) characterized the land in the Chikli watershed, Maharashtra for scientific management using landsat TM FCC data. A soil map was superimposed over the wasteland category map. The area consisted of seven physiographic units: hills and ridges with pediments (P1), isolated hills with pediments (P2), undulating upper pediments (P3), gently sloping lower pediments (P4), gently to moderately sloping plain (P5), very gently sloping plain (P6) and dissected alluvial plains (P7). Four categories of wastelands were identified: undulating upland with or without scrub (U), degraded forest(F), barren rocky/stony waste (R) and gullies/ravines (G). Most of U, F and R waste lands occurred in P3. Out of 82 percent of degraded lands in P1, 75 percent was under degraded forest land. The land capability of the soils of the wastelands are discussed with management recommendations.

Soil survey staff (1997) carried out land capability and irrigability classification of the soils of Kuttanad . The land capability classes and irrigability classes identified are IIw, IVw, IVsw, VIw and 3sd, 4td, 4std and 5 respectively.

Pedons occurring in spatially differing area between Ranchi in South and Madhubani in North Bihar were differed in irrigability classes and differences were related to various soil limitations by Singh and Mishra (1997).

Land capability classification and irrigability classification of Mannar panchayat was undertaken by Soil survey staff (1998) and identified four land capability classes and four land irrigability classes. The land capability classes identified are IIIs, IIIw , IIIws and IVw The land irrigability classes identified are 3d, 3ds, 3s and 4d.

2.5. Soil classification

Dihar *et al.* (1973) classified the red and laterite soils of Orissa as *Ultic Haplustalfs, Ultic Paleustalfs* and *Ultic Rhodustalfs.*

The laterite soils of Tamil Nadu were classified into *Typic Eutritoxs, Typic Haplustoxs, Oxic Haplustalfs, Oxic Rhodustalfs* and *Typic Paleustalfs* by Manickam (1977).

Eswaran *et al.* (1992) classified the Low activity clay (LAC) soils with coarse textured surface horizons and finer textured subsurface horizons by using 'Kandi'(Kaolinite, dickite minerals) horizon. The 'Kandi' horizon is now included in the orders of Alfisols , Ultisols and Oxisols.

Saxena (1992) classified soils of Ghaggar plains of Patiala, Punjab as Entisols and Inceptisols respectively.

Based on climatic, morphological, physical, chemical and mineralogical properties, Kumar and Kumar (1993) classified the salt affected soils of Gangetic alluvial tract as *Coarse-loamy, micaceous, hyperthermic, Typic Natrustalfs.*

Sehgal (1993) classified the lateritic soils of India as Alfisols, Oxisosls and Ultisols occurring in association with Entisols and Inceptisols.

Diwakar and Singh (1994) classified the soils of Diara land occurring in Gangetic plains of Bihar as Entisols. They are fluvents as they do not have fragments of diagnostic horizons. Considering the moisture regime as the basis, these soils are classified as *Ustifluvents.* They are further classified as *Typic Ustifluvents.*

Sharma *et al.* (1994) grouped the Soan river valley soils under *Ustipsamments* and *Ustifluvents.* The minerology of these soils was considered to be *mixed* for classifying them at family level.

The alluvial soils of riverine plain in Arunachal Pradesh were classified by Walia and Chamuah (1994) under Entisols and Inceptisols. At subgroup level, the soils have been classified as *Typic*

Udifluvents, Typic Eutrochrepts, Aeric Fluvaquents, Dystric Eutrochrepts and *Typic Udipsamments.*

Bhaskar and Subbaiah (1995) classified the laterites and associated soils along the east coast of Andhra Pradesh under the order Alfisols, Inceptisols and Entisols based upon their physical and chemical properties.

Kudrat *et al.* (1995) classified the Ajoy catchment laterite soils of West Bengal as *Typic Ustrochrepts* and *Aeric Haplaquepts.*

Rajkumar (1995) observed that transdunal soils and most of the soils occurring on alluvial terraces developed under weak aridic moisture regime have a cambic horizon. These soils have been classified as *Ustochreptic Camborthids.* Some of the soils occurring on alluvial terraces are highly calcareous and these soils are classified as *Ustochreptic Calciorthids.*

Rajkumar *et al.* (1995) undertook further studies and classified alkali soils of Siwalik hills of northwest India as *Typic Udorthents.*

Sahu *et al.* (1995) has carried out the classification and land use planning of the soils of a watershed in the Eastern Ghats region of Orissa. The soils described are situated at higher elevations or valley bottom and are classified as *Haplustalfs* and *Vertic Eutrochrepts* respectively. Physical and chemical properties are discussed and their agricultural potential considered.

Ahuja *et al.* (1996) conducted land evaluation studies of sand dunal toposequences of Haryana. Three representative sand dune sites were identified in Western Haryana and each were separated topographically into sand dune top, slope, base, plain and depression. Based on the land qualities, soil problems and their limitations, each facet of the sand dune was evaluated for their suitability, capability and irrigability classes. Soils of the sand dune top, sand dune base, hummocks and internudal depressions are classified as *Typic Torripsamments/ Aridic Ustipsamments* and that of sand dune base and plains as *Coarse-loamy/ Fine-loamy Typic Cryorthents.* The soils of the sand dune tops and slope are classed as 4tds for land irrigability classes.

Dhaliwal *et al.* (1996) classified the flood plain soils of northwest India as *Typic Ustorthents* or *Ustifluvents* and *Aquic Ustorthents* or *Ustifluvents.*

Singh and Mishra (1996) made pedogenic characterization of some typical soils of Gandak Command area of Bihar for evaluation of land suitability. Four representative pedons in a toposequence on an alluvial fan of the Gandak command area are classified as *Typic Ustorthents, Typic Eutrochrepts, Typic Haplustalfs and Typic Hapludalfs* respectively. The soils associated with pedon one is moderately suitable for maize, wheat and rice whereas pedon two is suitable for wheat and maize and moderately suitable for rice. Soils represented by pedons three and four are suitable only for rice, while pedon three is also moderately suitable for both wheat and maize.

Walia and Rao(1996) classified the red soils of Bundelkhand region of Uttar Pradesh as *Typic or Dystric Ustrochrepts and Ustic Haplustalfs.*

Mandal and Sharma (1997) classified the salt affected soils of Rajasthan as *Typic Torripsamments and Typic Torrifluvents.*

Patil and Dasog (1997) classified the lowland soils associated with laterites in the Western Ghat region as *Typic Endoaquepts.*

Sharma *et al.* (1997) classified the Inceptisols of northwest India as *Natric Ustrochrepts* and *Fluventic* or *Typic Ustrochrepts.*

Soil survey staff (1997) conducted soil survey of Kuriarkutty Karappara Irrigation Project and classified soils into five orders viz., Entisols, Inceptisols, Vertisols, Ultisols and Alfisols.

Soil survey staff (1997) carried out soil survey of Pinrayi panchayat and identified four soil orders.viz., Entisols, Inceptisols, Alfisols and Ultisols.

Tew *et al.* (1997) mapped the soils of the Desert Experimental Range, Utah, USA to determine the kind, extent and distribution of major soils and soil groups, the type of vegetation associated with each soil group and the correlation between herbage production and soil groups. The results showed that these soils were primarily *Haplocalcids, Torriorthents* and *Torrifluvents.*

Soil survey of Dharmadam panchayat was carried out by Soil survey staff (1998) and undertook taxonomic classification. The orders recognized are Entiosls and Inceptisols.

2.6. Productivity rating for land evaluation

Anilan (1983) classified the rice lands in Thiruvananthapuram district based on productivity parameters. The productivity parameters studies are soil texture, nutrient status, soil reaction, total nitrogen percentage and drainage.

McCormack and Stocking (1986) introduced soil potential ratings as an alternative form of land evaluation. The soil potential ratings emphasizes the actual performance of soils. Individual soil properties are not rated. The relative quality of a soil for a particular use is assessed in terms of yields or performance levels.

Ornig (1986) made land evaluation in Austria. Land evaluation of all agricultural land in Austria, over three million hectares, was completed. Sample areas are chosen for each different landscape. The remainder is evaluated in relation to the samples and their grading expressed as a value between 0 (unproductive land) and 100 (the best location in Austria). An assessment frame has been developed for both arable and grassland.

Gbadegesin (1987) made soil rating for crop production in the Savanna belt of southwest Nigeria. A method for grouping soils for specific purposes is presented, using as example, maize cultivation in the savanna zone of Nigeria. This technique has two stages. The first is the identification of those soil properties influencing maize production in the study area, while the second is the rating of the soils based on the properties identified. Using an index of soil variable contribution to the growth and yield of maize in the area, only two of the twenty soil parameters were analyzed. In the second stage, six soil productivity classes ranging from A (excellent) to E (poor) were established for maize production in the area.

Premachandran (1992) conducted evaluation and suitability rating of the ten major soil series of Kallada Irrigation Project, with the objective of evaluating the soils, based on their morphological and physico-chemical characteristics. The soil series were evaluated on the basis of land evaluation and rating of productivity parameters. The land capability and land irrigability classifications were carried out and a proposed land use map has been evolved based on soil survey data generated.

Gaikawad *et al.* (1995) evaluated eleven soil series in Maharashtra for their productivity potentials based on soil site characteristics and physical, physico-chemical and chemical properties. Ratings/grades for these characteristics were allotted and their mean values compared. The land evaluation gradings, A to K, ie., extremely low productivity potentials were observed.

Khadse and Gaikawad (1995) evaluated the yield influencing factors for different crops in Nagpur district of Maharashtra. The most important yield influencing factors for sorghum were available water capacity (AWC) followed by CEC, clay , depth and $CaCO_3$ content; for soyabean, clay content followed by AWC, CEC, depth and $CaCO_3$ and for cotton, AWC followed by depth, $CaCO_3$, CEC and clay content. Extrapolation of these results to similar soils in the same agro-ecological regions is discussed.

Kovacevic (1995) discussed the soil formation factors and land productivity for agricultural crops in Croatia. The effects of geo-morphological, physical, climatic topographic and anthropogenic factors of soil formation are described and the role of natural factors on the productivity of orchards, vineyards, grasslands and arable lands are discussed.

Rhoton and Lindbo (1997) studied the potential of the *Effective Soil Depth* (ESD) in soil quality assessment. They used effective soil depth to characterize productivity and erodibility, the two common indicators of soil quality. Selected soil properties were determined for a range of ESD above a fragipan horizon in a soil from the lower Mississippi river valley, USA. ESD was considered a reasonably accurate method of assigning a soil quality index to soils that have a limited depth.

2.7. Productivity parameters in land evaluation

Productivity is a function of the intrinsic properties of a soil, firstly, as described in the soil profile *in situ* in the field and secondly, by laboratory analysis. A soil map and the accompanying report provide the data necessary for working out the productivity. From among the number of factors that influence soil productivity, the most commonly accepted and most easily measurable alone are selected. The productivity parameters considered in the present study are discussed below.

2.7.1. Soil texture

Texture is considered as one of the most important characteristics with regard to physical soil qualities (Sys *et al.*, 1991). The interplay of factors dependent up on the relative proportion of various mechanical fractions in the soil, influences the physical properties of the soil, the availability and movement of soil water and air and the supply of nutrients to the plants, besides emphasizing the dominance of soil texture in crop production.

Plant growth is related to the particle size composition of soils, and has been recognized to be important for many years. Factors such as water holding capacity, pore space, percolation capacity, total surface area of soil particles and a number of other factors are directly attributable to texture (Riquier *et al.*, 1976).

The productivity ratings for soil texture have been prepared after consideration of the degree of importance of each textural class. Sandy clay loam or finer textured soils are good for rice crop (Richard and Protz,1981) and coarse textured soils are recognized to be poor to unsuitable (Bali and Karale, 1978).

Texture is particularly important for irrigated farming (Sys *et al.*, 1991). Soils of all textural classes, with the possible exception of very coarse sand can be successfully irrigated, choosing proper irrigation methods.

2.7.2. Soil depth

The depth of the soil that may be exploited by plant roots is an important criterion for land evaluation (Sys *et al.*, 1991). Insufficient soil depth, which often modifies the root system of plants ultimately reflecting on crop growth and yield, is an obvious soil limitation, very often ignored. The proper root development of a crop is considered to be very important for better anchorage and nutrient uptake.

Moisture retention and infiltration resulting in runoff and soil loss, depends on the depth of soil. Depth of the soil has a direct relation to rooting habits and yield of crops. Depending on the rooting habit of crops, minimum soil depth required for each crop has to be fixed (Storie, 1933) .

A deep, well drained soil shows root penetration, until below 150cm, for most crops. For annual crops, the dense root system is usually at a depth of less than 60 cm, while most tree crops even have a dense to moderate root system until a depth of 150 cm (Sys *et al.*, 1991).

2.7.3. Slope

The influence of landscape on agricultural land use is multiple. Relief is the expression of the interaction of several different phenomena and processes within the earth's crust and on its surface

(Sys *et al.,* 1991). Relief can influence the microclimatic conditions and hydrology.

Slope, which varies according to topography and relief of the land, in turn, determines the drainage conditions and pattern of land features. In a sloppy land, a considerable amount of precipitation received is lost by run off. This loss has two consequences. First, crop plants are deprived of this water which might otherwise have entered the soil and second, the runoff water carries with it some of the valuable top soil. This means not only a loss of natural fertility by both soil and nutrient loss, but also of the added nutrient through fertilizers. Hence, when cultivation is carried out in a sloppy land, a better package of management practices will have to be adopted. This inturn affects the cost of production and profit. So, it is of great importance to select crops that can be grown under minimum management levels in such sloppy lands.

2.7.4. Drainage

Better drainage of land provides favourable soil moisture and aeration, for the growth and satisfactory cultivation of crops. Drainage, sometimes together with the depth of ground water table, is considered in almost every system of land capability classification (Sys *et al.*, 1991). Drainage helps to develop sufficiently deep, effective and extensive rooting zone. Good drainage conditions promote granulation of the soil.

The greatest contribution of drainage is towards better aeration of the soil, allowing ready diffusion of oxygen to and carbon dioxide from the plant root zones. The activation of aerobic soil micro organisms is dependent upon soil aeration, which, inturn influence the availability of nutrients such as nitrogen, phosphorus and sulphur.

In a nutshell , removal of excess water from soil is as important as watering of crops, when soil moisture is low to promote better growth and production of crops. The ratings are low for water logged soils, where dewatering operations and good water management practices are required, and high for moderately drained soils.

2.7.5. Coarse fragments

The surface coarse fragments present as gravels and cobbles at the surface and in the top 20 cm, will influence the tillage conditions as well as the capacity to retain nutrients and water (Sys *et al.*, 1991). Soil texture and coarse fragments such as gravels and stones determine the workability of soil. The ease with which cultivation operations can be carried out is denoted by workability. Light textured soils are more easy to work, than heavy textured soils; seasonal and annual crops require intensive cultural operations and fine tilth. Hence presence of coarse materials such as gravels, stones and boulders which hinder the workability of soil is not desirable in the field where such crops are to be grown.

The presence of stones (size more than 25 cm) at the surface will interfere with the movement of machines and tractors. In heavy mechanized farming, it may hamper the movement of machinery. (Sys *et al.*, 1991). Workability is not that important in the case of perennial and plantation crops, which do not require frequent cultivation operations. In fact, these crops require zero or minimum tillage with the interspaces either covered with a cover crop, or allowed to mulch with the litter fall and recycle nutrients. Workability determines the cost of cultivation operations and hence coarse fragments will have to be considered to determine crop suitability of an area (Riquier *et al.*, 1976).

2.7.6. Soil reaction

Tropical crop plants differ widely in their ability to tolerate acid soil conditions, which is to a large extent tolerance to toxicity of aluminium, manganese and iron and deficiency of calcium and magnesium. Soil acidity gives information about probable soil toxicities with a negative effect on crop development (Sys *et al.*, 1991).

Crops like coffee, rubber, tea, pineapple and certain legumes are very tolerant to high levels of acidity (Riquier *et al* 1976). Several essential elements tend to become less available as pH is raised from 5.0 to 7.5 or 8. pH levels to large extent determines the levels of available phosphorus.

In general, it is recognized that changes in soil pH affect type and amount of plant nutrients in soil solution and the microbial activity which are connected with nitrification and nitrogen fixation. Slightly or strongly acid soils are considered to be good for rice crop. A pH ranging from 5.0 to 6.5 have been stated to be optimum for rice (Bali and Karale, 1978).

2.7.7. Cation exchange capacity

The exchange property of a soil mainly determines the availability of plant nutrients. The capacity to retain and release the nutrient elements is expressed in terms of the cation exchange capacity. A soil with high cation exchange capacity(CEC) will retain the plant nutrient elements more efficiently against leaching loss and will release them to plants.

In arid and semi-arid areas, most soils are calcareous and hence have an appreciable reserve in weatherable minerals. Therefore, their apparent CEC is always more the 24 cmol(+)kg^{-1}clay. At the ultimate stage of tropical weathering, the soils have an oxic horizon, without weatherable minerals and a very low activity of the clays, with apparent CEC values of less than 16 cmol(+)kg^{-1} clay (Sys *et al.*, 1991). Some extremely weathered soils may even have a positive charge.

2.7.8. Base saturation

The degree to which the cation exchange capacity is saturated with exchangeable bases is meant by its base saturation. The sum of exchangeable cations (Na^+,K^+,Ca^{++}, Mg^{++}) is a expression of the quantity of cations or nutrients available for plant growth (Sys *et al.*, 1991). A soil with high base exchange capacity is more productive than one with low base saturation. This factor is also taken as a parameter in the productivity rating system.

2.7.9. Total soluble salts (T.S.S.)

Total soluble salts (T.S.S.) is a parameter directly related with the concentration of neutral soluble salts present in soil solution. Soils in good condition have no soluble salts and an exchange complex dominated by calcium and magnesium and only minor amounts of sodium. High salinity and alkalinity are important limitations for agricultural development (Sys *et al.,* 1991). High total soluble salts interfere with the growth and productivity of many crops. Hence, saline condition of soils will have to be seriously looked into before accommodating crops in saline areas.

2.7.10. Organic carbon

Under natural vegetation, the organic carbon content is often a good expression of the natural fertility of the soil. Therefore, this characteristic is important for evaluation, particularly in highly weathered tropical soils, having no mineralogical reserve and where organic matter constitutes the only source of nutrients.

As the organic carbon content of the soil is closely related to the agro-ecological zones, it will be necessary to workout evaluation per ecological zone or even at a regional level (Sys *et al.,* 1991). Further, the organic carbon of the soil is closely related to soil texture. Optimal organic matter levels have to be defined per agro-ecological zone or even at regional scale.

2.8. Soil survey interpretation in land evaluation

In the criteria for classifying soils into rice groupings, Bali and Karale (1978) listed out seven soil properties,viz., texture, depth, salinity, ESP, puddling qualities, permeability and slope percentage. According to them, purposeful and practical interpretations are most important in the utilization of soil resource data.

Chan (1978) made soil survey interpretation for improved rubber production in peninsular Malaysia. He evaluated the pedological properties as soil texture, soil depth, effective depth, slope and drainage.

Bouma (1989) reviewed the qualitative and quantitative procedures in soil survey interpretation and land evaluation, modern land use systems and innovative uses of soil survey data.

The soil properties important for rice crop have been enumerated by Richard and Protz (1981) as slope, effective soil depth, soil texture, structure , drainage, water release, salinity and pH.

Sys (1985) described the stages in rural land use planning, land use resources, land utilization type, land characteristics and land qualities, evaluation of land characteristics and land qualities and guidelines for the interpretations of land use requirements.

Abdulkadir (1986) put forward some methodological arguments in interrelationship among land evaluation, soil survey and land use planning. There are several approaches to land evaluation, giving rise to an alternative system based on different principles. In this system, apart from the physical land conditions, other parameters used in the assessment exercise include social, economic and environmental consideration, so that land can be used on a sustained basis. Land evaluation has thus developed as a system distinct from survey and planning.

Sys (1986) also formulated suggestions for soil survey interpretations for rice cultivation. Four main types of rice cultivation are considered,viz., rainfed upland rice, bunded rice, cultivation under natural flood and irrigated rice. The parameters qualified to determine FAO land classes are rainfall, temperature, relative air humidity and sunshine. Land form requirements and wetness conditions are discussed. Soil conditions include surface and sub surface texture, coarse fragments, soil depth, lime and gypsum content. Quantification of these parameters as related to FAO land classes were made.

Verheye (1989) discussed the value and utilization of marginal lands of Brussles in different agro-ecological zones. The focus is on the role of crop quality factors in land evaluation, such as physiological reaction mechanisms of plants in relation to specific climate and soil conditions.

Mays *et al.* (1997) used Fuzzy set logic to express the risk in soil interpretation ratings. Uncertainty inherent in the definition of estimated sets of properties used to characterize a given map unit is described with the help of fuzzy sets.

2.9. Remote sensing and Geographical Information System in land evaluation

Sharma and Bharagava (1988) made evaluation studies of the alkali soils in Haryana, using satellite imagery. They observed that reclaimed soil has significantly improved properties and gave good yields of rice and wheat after reclamation .

Ghabour and Antrop (1993) studied the use of low-cost geographical information system in land evaluation at local level. A low-cost GIS package with minimal requirement in terms of equipment and information is presented. A land evaluation according to the irrigation suitability of the soil in E1-Minya village, Egypt is described.

Chattopadhyay and Chattopadhyay (1994) described the methodology utilized in the project, *Terrain analysis in Kerala,* through remote sensing. Terrain units were mapped from 1: 250,000 images. The close association between terrain character and agricultural land use was shown.

Lilly and Mathews (1994) studied the prolonged soil water saturation and land use options over large areas in Scotland. A combination of soil and climatic data within the framework of a geographical information system provides data sets for use in the regional agricultural land use. The spatial distribution of soils was derived from the digital 1: 25,0000 scale soil map for Scotland with the soil assessment database. The manipulation of these data sets within geographical information system and relational data base environments produced an assessment of the soil water regimes for the dominant soil in each one kilometer square under prevailing climatic conditions.

Adinarayana *et al.* (1995) described a method for compiling a treatment oriented land use planning scheme for a hilly watershed in the Western Ghats region of India using geographical information system. Soil depth and slope steepness classes were obtained from a remote sensing based soil map and a digital elevation model respectively. Integrated physical land units were created from the soil depth and slope steepness data. Knowledge base rules were used to manipulate the data and generate a sustainable land use system for the watershed.

Pal *et al.* (1995) studied the land use and land cover mapping of Birbhum district of West Bengal using IRS satellite data. The study revealed that district wise land use/land cover map in the scale of 1:250,000 is ideal for agro-climatic zonal planning. An agricultural season map for 1988-89 was developed by aggregation of two major agricultural season, classified output using VAX 11/780 environment, complemented by adequate software support. District boundary, notified forest boundaries and cultural features were digitized and individual mask files created. Statistics for different land use categories with special emphasis on agriculture are presented.

Rao *et al.* (1995) discussed the application of remotely sensed data in evaluating rubber cultivation in Kerala. The potential use of remote sensing for soil surveys, identifying rubber and determining the area under rubber plantation, assessing agronomic conditions and applying geographical information system are discussed.

Verma *et al.* (1995) established the relationship between the mapping unit and salinity / alkalinity levels by the precise delineation of salt affected soils using multispectral TM FCC and B/W TM band 6 in Etah district of Uttar Pradesh.

Mckenzie *et al.* (1996) discussed the potential of terrain analysis for assessing land resources. The advantage of digital terrain analysis and allied technologies were discussed.

Nair *et al.* (1996) used a geographical information system to prepare a digital soil map of Kerala. Soil and land characteristics were organized as relational tables using general purpose database management software. Data created include a digital soil map, relational tables for site characteristics, morphology and relevant properties of the soil. Various thematic maps were generated through reclassification and land evaluation made for some specified uses. Land use requirement and climatic data are used for land evaluation.

Dwivedi *et al.* (1997) discussed a case study of evaluation of Landsat MSS and TM and spot MLA data for part of the Bijapur district for mapping eroded lands. The approach involved in the geometric registration of all these data to a common map grid using type points and third order polynomial transformations. Thematic maps showing eroded lands were generated on a micro VAX based DIPEX system using a maximum likelihood classifier.

2.10. Other related studies

Radcliffe (1992) examined the application of simulation modelling in Botswana, Southern Africa to evaluate land for sustainable production. The study considered land use characterization and risk analysis using CYSLAMB (Crop Yield Simulation and Land Assessment Model for Botswana). The study matches the requirements of a specified type of land use against the properties of a defined area of land and rating the land in terms of its ability to satisfy the requirements of the land use.

Verheye (1992) studied the quality concept in land evaluation studies. The study shows that the crop quality is largely determined by the secondary plant metabolism and is often governed by ecological stress conditions such as moisture stress, excessive temperature and excessive concentration of soil nutrients.

Guruswamy and Krishnamurthy (1994) characterized the Entisols from arecanut gardens affected by yellow leaf disease in the Thirthahalli taluk of Karnataka. Results showed that these soils are acidic, low in soluble salts with medium to adequate organic carbon, low to medium available phosphorous and potash, adequate calcium and magnesium and low to medium available sulphur. Boron levels were found to be very low.

Kukal *et al.* (1994) evolved soil conservation strategy based on morpho-conservation mapping of an area in submountains of Punjab. A morpho-conservation map was prepared based on the technique of geomorphological mapping depicting slope steepness, slope shape, present land use, extent and location of sheet, rill and gully erosion. Suitable soil and water conservation measures have also been suggested for each type of proposed land use.

Sharma *et al.* (1994) conducted land evaluation studies for the characterization and management of the soils of Punjab Agricultural University, Regional Fruit Research Station, Abohar. Chemical, physical and morphological properties of three soil series are described. Fertility and management of *Ustic Torriorthents* developed near the sand dune base and of *Ustochreptic Camborthids* developed as alluvial terraces and as internudal areas are discussed.

Nazir *et al.* (1996) made statistical evaluation of soil properties which influence saffron growth in Kashmir. The similarity of the properties and the mineralogical compositions of serozems and grey - cinnamon brown soils of Kashmir, soils which are favorable for growing saffron were distinguished by the least weathered material with high totals and similar reserves of potassium and magnesium. Such soils are identified by a linear discriminant function which includes four properties of the upper horizon (0-20cm): pH, dithionite-soluble iron, sodium and potassium in maslova extract.

Shields *et al.* (1996) reviewed the purpose and significance of land evaluation in Australia. The need for land evaluation is assessed and the present situation in this regard, described. Future directions for land evaluation in Australia are discussed and include short, medium and long term goals. Examples are provided for existing land evaluation applications.

Venketeswarlu *et al.* (1996) summarized the different methods used to classify the Indian subcontinent into homogenous agro-climatic zones and an attempt made to regroup the 126 agro-climatic zones identified by the Indian Council of Agricultural Research under the *National Agricultural Research Project* (NARP). Contiguous zones having similar soil, climatic, physiographic and cropping patterns were combined, thereby reducing the total number of zones to 60 in addition to the two zones representing the Andaman - Nicobar and Lakshadweep islands.

Heinig (1997) made evaluation of environmental elements for ecosystem environment assessment. The main classical assessment procedures used in nature conservation research are outlined and the claims which they must satisfy to be used for evaluating the land's ecosystem are formulated.

Zdruli *et al.* (1997) studied the Major Land Resource Area (MLRA) concept in Albania. Each MLRA encompasses geographically associated soils, the majority of which have broadly similar patterns of climate, water resources and land uses. This provides an overview of the landscape and the natural resources. MLRA can be used to assess land suitability for various crops, oppurtunities to achieve self sufficiency in food production, selection of areas for both field crops and high value crops for export and identification of appropriate farming system technologies.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present study relates mainly to the evaluation of the major soils of Onattukara region after conducting reconnaissance soil survey. A systematic survey and evaluation of the soils of this region was taken up for classification and further interpretation of soil survey data.

3.1. Description of the study area

Onattukara forms a unique agro-ecological region distributed in the taluks of Karunagappally in Kollam district and Karthikapally and Mavelikkara in Alappuzha district. Onattukara region lies inbetween 8° 55' to 9° 20' North latitude and 76° 23' to 76° 37' East longitude. The elevation of the region ranges from zero to 20 meters above mean sea level. Location of Onattukara region is given in Figure 1.

3.1.1. Boundary of Onattukara region

The Northern boundary of the Onattukara region is fixed at Pallipad, Haripad area (near Thottappally pozhi and Kuttanad region) and the Southern side is bounded by Neendakara azhi and Ashtamudi lake.

LOCATION OF ONATTUKARA

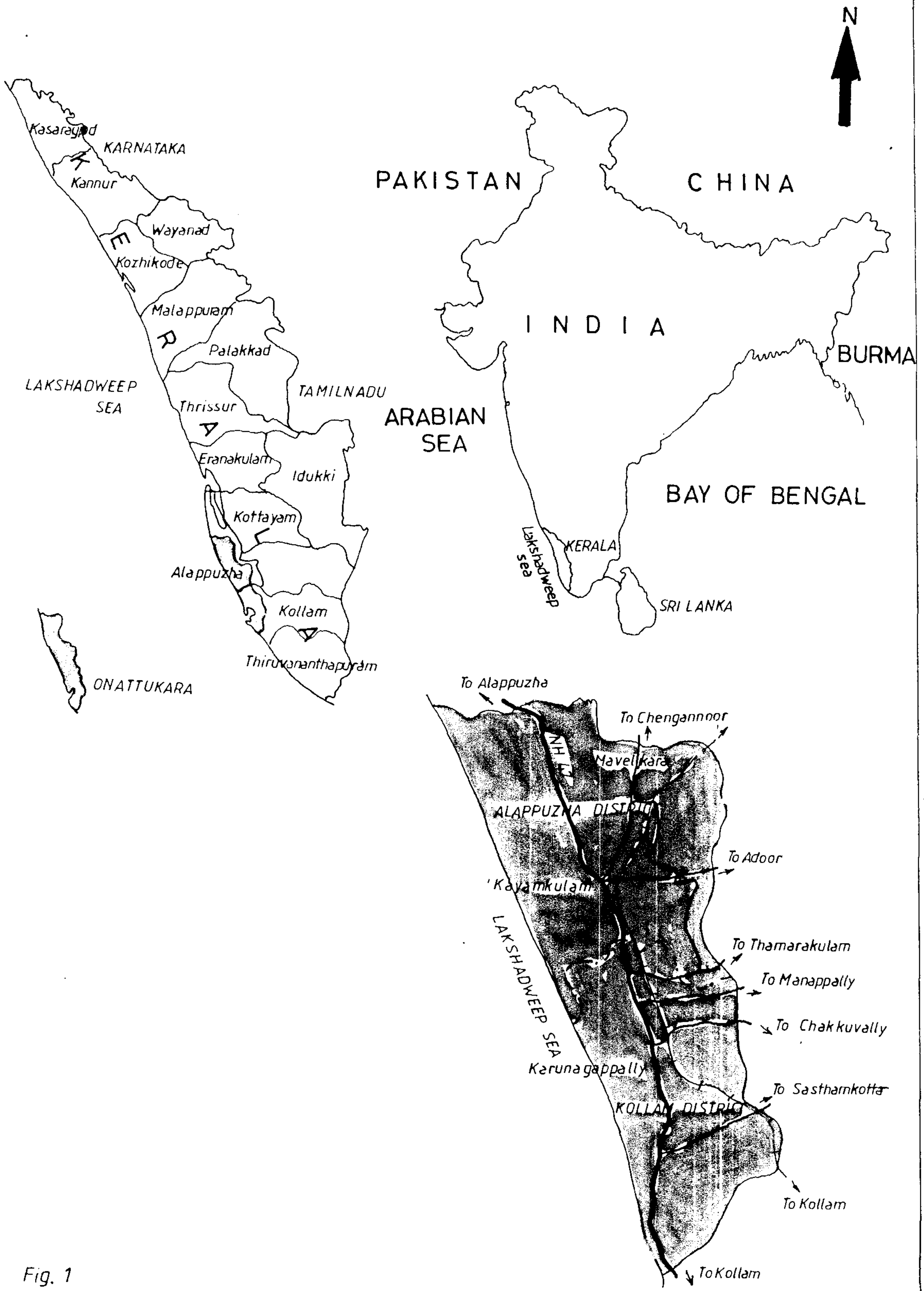


Fig. 1

The Eastern side is bounded by midland laterite along the places connecting Edavanchery, Vattakayal and Kattanam. The coastal area forms the Western boundary.

3.2. Base materials for the study

The Survey of India toposheets in the scale of 1:50,000 were used as base maps for conducting the reconnaissance soil survey. The Survey of India toposheets of 58 C/7, 58 C/8, 58 C/12 and 58 D/9 were used for soil survey and for fixing up the boundaries of Onattukara region.

In addition, landsat imageries (1:50,000) with the geocoded subscence SAT-1 D-IRS-1B, 58 C/7, 58 C/8, 58 C/12 and 58 D/9 were also used in this study.

3.3. Field studies

The Survey of India toposheets in the scale of 1:50,000 and the landsat imageries with geocoded subscene SAT-1D-IRS-1B were used as base maps for the study.

3.3.1. Reconnaissance soil survey

Reconnaissance soil survey of the area was carried out according to the principles envisaged in the Soil Survey Manual (1970). The area was traversed at close intervals and soils examined for physical and chemical characteristics.

Profile pits to a depth of two meters or upto the parent material were dug in the typical areas identified and the profiles were examined in detail for horizonwise characteristics such as texture, structure, consistency, concretions, colour, mottling, soil reaction, pores, root distribution and permeability and recorded in profile description sheets as per the Soil Survey Manual (1970). The salient features of the area in respect of location, physiography, drainage, vegetation and land use were also recorded.

3.3.2. Identification of soil series

On the basis of differentiating characteristics, the soils of Onattukara region have been grouped into different soil series. All the series identified were named after the type location where it was first identified.

3.3.3. Photographs of the profile and land use

Before detailed examination of soil profiles and collection of soil samples, photographs of typical profiles and present land use were taken for visual interpretation.

3.3.4. Soil sample collection

After morphological examination of the profiles, soil samples representing the different horizons of the typifying pedons were collected for laboratory examination

3.4. Laboratory studies

The required physical and chemical properties of the soil samples collected representing the soil series were determined by standard analytical procedures, for comparing against a productivity scale.

3.4.1. Methods of soil analyses

The physical and chemical methods of soil analysis required in connection with the study are given in Table 1

3.5. Climate

The Onattukara region, in general, enjoys a humid tropical climate. The region gets South West monsoon during June to September and North East monsoon in October to November. The average rainfall is 2800mm, major share of which is received from the

Table 1 . **Methods of soil analysis**

Estimation	*Methodology*	*Author*
(A) PHYSICAL PROPERTIES		
Gravel content	Gravimetry	Govindarajan and Koopar(1975)
Mechanical analysis	International pipette method	Piper(1966)
(B)PHYSICO-CHEMICAL AND CHEMICAL PROPERTIES		
pH	Potentiometry	Soil survey staff(1992)
Electrical conductivity	Conductometry	Jackson(1973)
Cation exchange capacity	Neutral normal ammonium acetate method	Schollenberger and Dreibelbis(1930)
Exchangeable calcium	Atomic absorption spectrophotometry	Page *et al.*(1982)
Exchangeable magnesium	Atomic absorption spectrophotometry	Page *et al.*(1982)
Exchangeable sodium	Atomic absorption spectrophotometry	Page *et al.*(1982)
Exchangeable potassium	Atomic absorption spectrophotometry	Page *et al.*(1982)
Organic carbon	Chromic acid wet digestion	Walkley and Black (1934)

former. The maximum temperature in the region varies from 30° to 36°C. The minimum temperature falls with the range of 21 to 25°C.

3.6. Geology

Recent to subrecent quaternary deposits of alluvium overlie the tertiary formation in Onattukara region. The tertiary formations are often 100 to 300 meters thick and are underlain by crystalline rocks. Stratigraphic studies reveal that the region has been transgressed by the sea periodically. Transgression and recedence more or less coincide with periods of glaciation and interglaciation in the mid and high latitudes. Evidences reveal incidence of sea level fluctuations of more than 150 cm. Tropical climate is said to have prevailed in this part of the world from gnetaceous period onwards (70 million onwards). It is postulated that towards the end of Pleistocene, the basin might have been uplifted due to diastrophic earth movements which were subsequently subjected to erosion. Geo-morphological evidence in the region indicate neo-tectonic activity which has contributed to the general physiography of this region.

The recent to subrecent deposits from 10 to 30 meters consists of thick sand with shell fragments occasionally with sticky black clays of fluvial, marine and lacustrine origin. The predominant soil mineral encountered is quartz. Heavy minerals like illmanite, rutile, titanite, monazite, sillimanite are frequented in these soils.

3.7. Land use and cropping pattern

About 77 percent of the population of the region purely depend upon agriculture for their livelihood. A very intensive cropping pattern of two rice crops and a sesamum/pulses/vegetable crop is followed in this region.

Rice is raised in the rice fields during *Viruppu* and *Mundakan* seasons. Sesamum is cultivated in the rice fields during summer season, utilizing the residual soil moisture. Coconut based farming system is prevalent in gardenlands with arecanut and fruit crops as mixed crops and banana, cassava, vegetables and yams as intercrops.

3.8. Soil classification

The soils of Onattukara region has been classified as per the comprehensive soil classification system, *Soil Taxonomy* (U.S. Soil Survey Staff, 1975) and *Keys to Soil Taxonomy* (U.S. Soil Survey Staff, 1994 and 1996).

3.9. Land capability classification

Based on the inherent soil characteristics, external land features and environmental factors that limit the use of land, land capability classification of the soils of Onattukara region has been made as per *Soil Survey Manual*, 1970.

3.10. Land irrigability classification

Soil irrigability classes are useful to make grouping of soils according to their suitability for sustained use under irrigation. On the basis of their physical and chemical characteristics, the soils of Onattukara region has been classified into different land irrigability classes as per *Soil Survey Manual*, 1970.

3.10.1.Available water content(AWC)

Under rainfed conditions, the potential of agricultural productivity is related basically to the period, when water need of the plants are met to the optimum in various stages of its growth. When the available water content, the period and levels of water availability matches the water need of the crop, the productivity potential can be expected to be high. Hence, the available water content (AWC) in the soil series helps to assess the length of farming season, predict drought, water budgeting and planning irrigation.

The application of available water content is more important during summer season for scheduling irrigation, since AWC of most of the soils of Onattukara region are low to medium. The available water content for the twenty soil series identified in Onattukara region was determined base on the methodology of Nair and Valsaji (1995) to estimate the moisture storage capacity of these soils. The AWC ratings of soils are given in Table 2.

Table 2. **Available water content(AWC) rating for soils**

Sl no	*Rating class*	*Rating(cm)*
1	Very low	less than 5.1
2	Low	5.1 - 10
3	Medium	10.1 - 15
4	High	15.1 - 20
5	Very high	more than 20

3.11. Productivity parameters and productivity index

The productivity parameters considered in the present study include soil texture, depth, slope, drainage, coarse fragments, soil reaction, cation exchange capacity, base saturation percentage, total soluble salts (TSS) and organic carbon. For each parameter, a range of scale is prepared and numerical values assigned for each crop based on the principles of land evaluation (Riquier *et al.* 1976). The land use studies reveal that rice, coconut, sesamum, banana and cassava are the major crops grown in the area. A range of scale is prepared for the parameters considered in this study and numerical values assigned for the above crops.

The rating of productivity parameters for rice, coconut, sesamum, cassava and banana are given in Table 3 to 7. Table 8 gives rating for organic carbon.

Table 3. **Rating of productivity parameters for rice**

SOIL TEXTURE(T)

Productivity class	*Textural grades*	*Rating.*
T1	Sand	40
T2	Loamy sand	60
T3	Sandy loam	80
T4	Loam	70
T5	Silty loam	70
T6	Silt	50
T7	Sandy clay loam	100
T8	Clay loam	90
T9	Silty clay loam	90
T10	Sandy clay	80
T11	Silty clay	70
T12	Clay	70

DEPTH (R)

Rating class	*cm.*	*Rating.*
R1	less than 50	80
R2	50 - 75	100
R3	76 - 100	90
R4	101 - 150	80
R5	more than 150	70

SLOPE(S)

Rating class	*Percentage*	*Rating*
S1	Flat or almost flat (0 - 3)	100
S2	Gently sloping (3 - 5)	90
S3	Moderately sloping (5 - 10)	80
S4	Strongly sloping (10 - 15)	70
S5	Moderately steep to steep(15 - 25)	50

DRAINAGE(D)

Rating class	*Drainage classes*	*Rating*
D0	Water logged	80
D1	Poorly drained	90
D2	Imperfectly drained	100
D3	Moderately well drained	70
D4	Well drained	60
D5	Excessively drained	50

COARSE FRAGMENTS (G)

Rating class	*Gravel percentage*	*Rating*
G1	Extremely gravelly (more than 60)	50
G2	Very gravelly (50 - 60)	60
G3	Gravelly (35 - 50)	70
G4	Slightly gravelly (15 - 35)	80
G5	Non gravelly (less than 15)	100

SOIL REACTION(H)

Rating class	*pH*	*Rating*
H1	Extremely acid (less than 4.5)	60
H2	Very strongly acid (4.5 - 5.0)	70
H3	Strongly acid (5.1 - 5.5)	90
H4	Medium acid (5.6 - 6.0)	100
H5	Slightly acid (6.1 - 6.5)	100
H6	Neutral (6.6 - 7.3)	90

CATION EXCHANGE CAPACITY (C)

Rating class	*cmol* kg^{-1}	*Rating*
C1	Low (less than 16)	70
C2	Marginal (16 - 24)	90
C3	Medium (24 - 32)	100
C4	Moderate (32 - 60)	90
C5	High (more than 60)	80

BASE SATURATION (B)

Rating class	*percentage*	*Rating*
B1	Low (less than 35)	70
B2	Marginal (35 - 50)	90
B3	Medium (50 - 60)	100
B4	Moderate (60 - 90)	90
B5	High (more than 90)	80

TOTAL SOLUBLE SALTS (E)

Rating class	*dS/m*	*Rating*
E1	High (more than 4)	50
E2	Moderate (2 - 4)	60
E3	Medium (1 - 2)	80
E4	Marginal (0.5 - 1)	90
E5	Low (less than 0.5)	100

Table 4. **Rating of productivity parameters for coconut**

SOIL TEXTURE (T)

Rating class	*Textural grades*	*Rating.*
T1	Sand	60
T2	Loamy sand	70
T3	Sandy loam	90
T4	Loam	100
T5	Silty loam	70
T6	Silt	60
T7	Sandy clay loam	80
T8	Clay loam	80
T9	Silty clay loam	70
T10	Sandy clay	70
T11	Silty clay	60
T12	Clay	50

DEPTH (R)

Rating class	*cm*	*Rating*
R1	less than 50	50
R2	50 - 75	60
R3	76 - 100	90
R4	101 - 150	100
R5	more than 150	90

SLOPE(S)

Rating class	*Percentage*	*Rating*
S1	Flat or almost flat (0 - 3)	90
S2	Gently sloping (3 - 5)	100
S3	Moderately sloping (5 - 10)	90
S4	Strongly sloping (10 - 15)	70
S5	Moderately steep to steep (15 - 25)	50

DRAINAGE(D)

Rating class	*Drainage class*	*Rating*
D0	Water logged	50
D1	Poorly drained	60
D2	Imperfectly drained	60
D3	Moderately well drained	90
D4	Well drained	100
D5	Excessively drained	90

COARSE FRAGMENTS (G)

Rating class	*Percentage*	*Rating*
G1	Extremely gravelly (more than 60)	60
G2	Very gravelly (50 - 60)	70
G3	Gravelly (35 - 60)	80
G4	Slightly gravelly (15 - 35)	100
G5	Non gravelly (less than 15)	90

SOIL REACTION(H)

Rating class	*pH*	*Rating*
H1	Extremely acid (less than 4.5)	70
H2	Very strongly acid (4.5 - 5.0)	80
H3	Strongly acid (5.1 - 5.5)	90
H4	Medium acid (5.6 - 6.0)	100
H5	Slightly acid (6.1 - 6.5)	100
H6	Neutral (6.6 - 7.3)	90

CATION EXCHANGE CAPACITY(C)

Rating class	*cmol kg^{-1}*	*Rating*
C1	Low (less than 16)	70
C2	Marginal (16 - 24)	80
C3	Medium (24 - 32)	90
C4	Moderate (32 - 60)	90
C5	High (more than 60)	100

BASE SATURATION (B)

Rating class	*Percentage*	*Rating*
B1	Low (less than 35)	70
B2	Marginal (35 - 50)	80
B3	Medium (50 - 60)	90
B4	Moderate (60 - 90)	100
B5	High (more than 90)	90

TOTAL SOLUBLE SALTS (E)

Rating class	*dS/m*	*Rating*
E1	High (more than 4)	50
E2	Moderate (2 - 4)	60
E3	Medium (1 - 2)	70
E4	Marginal (0.5 - 1)	90
E5	Low (less than 0.50)	100

Table 5. **Rating of productivity parameters for sesamum**

SOIL TEXTURE(T)

Rating class	*Textural grades*	*Rating.*
T1	Sand	50
T2	Loamy sand	80
T3	Sandy loam	80
T4	Loam	100
T5	Silty loam	60
T6	Silt	50
T7	Sandy clay loam	90
T8	Clay loam	80
T9	Silty clay loam	70
T10	Sandy clay	70
T11	Silty clay	60
T12	Clay	50

DEPTH (R)

Rating class	*cm*	*Rating*
R1	less than 50	80
R2	50 - 75	90
R3	76 - 100	100
R4	101 - 150	90
R5	more than 150	80

SLOPE(S)

Rating class	*Percentage*	*Rating*
S1	Flat or almost flat (0 - 3)	100
S2	Gently sloping (3 - 5)	90
S3	Moderately sloping (5 - 10)	80
S4	Strongly sloping (10 - 15)	70
S5	Moderately steep to steep (15 - 25)	50

DRAINAGE (D)

Rating class	*Drainage class*	*Rating*
D0	Water logged	50
D1	Very poorly drained	60
D2	Poorly drained	70
D3	Moderately well drained	90
D4	Well drained	100
D5	Excessively drained	80

COARSE FRAGMENTS (G)

Rating class	*Percentage of gravel*	*Rating*
G1	Extremely gravelly (more than 60)	70
G2	Very gravelly (50 - 60)	75
G3	Gravelly (35 - 50)	80
G4	Slightly gravelly (15 - 35)	90
G5	Non gravelly (less than 15)	100

SOIL REACTION (H)

Rating class	*pH*	*Rating*
H1	Extremely acid (less than 4.5)	60
H2	Very strongly acid (4.5 - 5.0)	70
H3	Strongly acid (5.1 - 5.5)	90
H4	Medium acid (5.6 - 6.0)	100
H5	Slightly acid (6.1 - 6.5)	100
H6	Neutral (6.6 - 6.5)	90

CATION EXCHANGE CAPACITY (C)

Rating class	*cmol* kg^{-1}	*Rating*
C1	Low (less than 16)	70
C2	Marginal (16 - 24)	90
C3	Medium (24 - 32)	100
C4	Moderate (32 - 60)	90
C5	High (more than 60)	80

BASE SATURATION(B)

Rating class	*Percentage*	*Rating*
B1	Low (Less than 35)	70
B2	Marginal (35 - 50)	80
B3	Medium (50 - 60)	85
B4	Moderate (60 - 70)	90
B5	High (more than 70)	100

TOTAL SOLUBLE SALTS (E)

Rating class	*dS/m*	*Rating*
E1	High (more than 4)	50
E2	Moderate (2 - 4)	60
E3	Medium (1 - 2)	70
E4	Marginal (0.5 - 1)	90
E5	Low (less than 0.50)	100

Table 6. **Rating of productivity parameters for cassava**

SOIL TEXTURE(T)

Rating class	*Textural grades*	*Rating*
T1	Sand	50
T2	Loamy sand	60
T3	Sandy loam	90
T4	Loam	100
T5	Silty loam	70
T6	Silt	60
T7	Sandy clay loam	100
T8	Clay loam	80
T9	Silty clay loam	70
T10	Sandy clay	60
T11	Silty clay	50
T12	Clay	40

DEPTH (R)

Rating class	*cm*	*Rating.*
R1	less than 50	50
R2	50 - 75	60
R3	76 - 100	90
R4	101 - 150	100
R5	more than 150	90

SLOPE(S)

Rating class	*Percentage*	*Rating*
S1	Flat or almost flat (0 - 3)	90
S2	Gently sloping (3 - 5)	100
S3	Moderately sloping (5 - 10)	90
S4	Steeply sloping (10 - 15)	80
S5	Moderately steep to steep(15 - 25)	70

DRAINAGE (D)

Rating class	*Drainage class*	*Rating*
D0	Water logged	40
D1	Very poorly drained	50
D2	Poorly drained	60
D3	Moderately well drained	90
D4	Well drained	100
D5	Excessively drained	100

COARSE FRAGMENTS(G)

Rating class	*Percentage of gravels*	*Rating*
G1	Extremely gravelly (more than 60)	50
G2	Very gravelly (50 - 60)	70
G3	Gravelly (35 - 50)	80
G4	Slightly gravelly (15 - 35)	100
G5	Non gravelly (less than 15)	90

SOIL REACTION(H)

Rating class	*pH*	*Rating*
H1	Extremely acid (less than 4.5)	60
H2	Very strongly acid (4.5 - 5.0)	70
H3	Strongly acid (5.1 - 5.5)	90
H4	Medium acid (5.6 - 6.0)	100
H5	Slightly acid (6.1 - 6.5)	100
H6	Neutral (6.6 - 7.3)	90

CATION EXCHANGE CAPACITY (C)

Rating class	*cmol kg^{-1}*	*Rating*
C1	Low (less than 16)	70
C2	Marginal (16 - 24)	100
C3	Medium (24 - 32)	90
C4	Moderate (32 - 60)	80
C5	High (more than 60)	80

BASE SATURATION (B)

Rating class	*Percentage*	*Rating*
B1	Low (less than 35)	70
B2	Marginal (35 - 50)	100
B3	Medium (50 - 60)	90
B4	Moderate (60 - 70)	80
B5	High (more than 90)	80

TOTAL SOLUBLE SALTS (E)

Rating class	*dS/m*	*Rating*
E1	High (more than 4)	50
E2	Moderate (2 - 4)	60
E3	Medium (1 - 2)	70
E4	Marginal (0.5 - 1)	90
E5	Low (less than 0.50)	100

Table 7. **Rating of productivity parameters for banana**

SOIL TEXTURE (T)

Rating class	*Textural grades*	*Rating*
T1	Sand	50
T2	Loamy sand	70
T3	Sandy loam	90
T4	Loam	100
T5	Silty loam	70
T6	Silt	60
T7	Sandy clay loam	100
T8	Clay loam	80
T9	Silty clay loam	70
T10	Sandy clay	60
T11	Silty clay	50
T12	Clay	40

DEPTH (R)

Rating class	*cm*	*Rating.*
R1	less than 50	50
R2	50-75	60
R3	76-100	90
R4	101-150	100
R5	more than 150	90

SLOPE (S)

Rating class	*Percentage*	*Rating*
S1	Flat or almost flat (0 - 3)	90
S2	Gently sloping (3 - 5)	100
S3	Moderately sloping (5 - 10)	90
S4	Steeply sloping(10 - 15)	80
S5	Moderately steep to steep(15 - 25)	70

DRAINAGE(D)

Rating class	*Drainage class*	*Rating*
D0	Water logged	40
D1	Very poorly drained	50
D2	Poorly drained	60
D3	Moderately well drained	90
D4	Well drained	100
D5	Excessively drained	90

COARSE FRAGMENTS (G)

Rating class	*Percentage of gravels*	*Rating*
G1	Extremely gravelly (more than 60)	50
G2	Very gravelly (50 - 60)	70
G3	Gravelly (35 - 50)	80
G4	Slightly gravelly(15-35)	90
G5	Non gravelly (less than 15)	100

SOIL REACTION(H)

Rating class	*pH*	*Rating*
H1	Extremely acid (less than 4.5)	60
H2	Very strongly acid (4.5 - 5.0)	70
H3	Strongly acid (5.1 - 5.5)	90
H4	Medium acid (5.6 - 6.0)	100
H5	Slightly acid (6.1 - 6.5)	100
H6	Neutral (6.6 - 7.3)	90

CATION EXCHANGE CAPACITY (C)

Rating class	*cmol* kg^{-1}	*Rating*
C1	Low (less than 16)	70
C2	Marginal (16 - 24)	90
C3	Medium (24 - 32)	100
C4	Moderate (32 - 60)	80
C5	High (more than 60)	80

BASE SATURATION(B)

Rating class	*Percentage*	*Rating*
B1	Low (less than 35)	70
B2	Marginal (35 - 50)	90
B3	Medium (50 - 60)	100
B4	Moderate (60 - 70)	80
B5	High (more than 90)	80

TOTAL SOLUBLE SALTS (E)

Rating class	*dS/m*	*Rating*
E1	High (more than 4)	50
E2	Moderate (2 - 4)	60
E3	Medium (1-2)	70
E4	Marginal (0.5-1)	90
E5	Low (less than 0.50)	100

Table 8. **Rating for organic carbon (N)**

Rating class	*Percentage*	*Rating*
N1	Very low (0.00-0.16)	50
N2	Low (0.17-0.50)	70
N3	Marginal (0.51-1.00)	80
N4	Medium (1.01-1.50)	90
N5	High (1.51-2.16)	100
N6	Very high (2.17-2.50)	100

3.12. Productivity calculation

If favourable conditions extraneous to the soil are present (good varieties, sound husbandry, freedom from pest and disease etc.) the productivity can be expressed by reference to the intrinsic soil characteristics like depth, moisture, base status, organic matter content and texture (Riquier *et al.*, 1976). Productivity is a function of the intrinsic properties of a soil, firstly, as described in the soil profile *in situ* in the field, and secondly, by laboratory analysis.

From among the number of factors that influence soil productivity, the most commonly accepted and most easily measurable factor of productivity alone are selected (Sys *et al.*, 1991).

A soil is considered more fertile if, more volume of it is at the disposal of plants(depth), is rich in bases (base saturation) and contains more water, more nutrients and facilitates better root penetration (texture and structure). Certain additional factors such as organic matter content, nature of clay, drainage and mineral resources are also considered.

Since more organic matter is there, more nutrients are available and more stable is the structure. The greater the cation exchange capacity, more nutrients are retained in the soil with less leaching of fertilizer elements and greater the mineral reserves, more will be the nutrient replacement.

3.12.1. Productivity classes

The productivity of the soil is calculated by multiplying the ratings of the individual parameters selected in this study, and expressed as percentage. The resultant index of productivity is set against a scale placing the soil in one or other of the six productivity classes viz., extremely poor, poor, average, good, very good and excellent. The rating of productivity classes are given in Table 9.

Table 9. **Rating of productivity classes**

Serial no	*Productivity class*	*Rating*
1	Extremely poor	0 - 7
2	Poor	8 - 19
3	Average	20 - 24
4	Good	25-34
5	Very good	35 - 64
6	Excellent	65 - 100

RESULTS

4.RESULTS

Soil resources play an important role in determining man's economic, social and cultural progress. A thorough knowledge of the potentialities and limitations of every piece of land is a pre-requisite in its efficient utilization. For maintaining the soils in a state of high productivity on sustainable basis, there is a need for rational use of the soils.

A systematic survey and evaluation of the soils of Onattukara region was taken up to classify soils based on their inherent soil characteristics, land capability, land irrigability and land suitability for different crops.

4.1. Field studies

Field studies consists of reconnaissance soil survey of Onattukara region for soil classification, land capability classification, land irrigability classification and evaluation of productivity parameters.

4.1.1. Reconnaissance soil survey

The reconnaissance soil survey of Onattukara region was carried out according to the principles envisaged in the *Soil Survey*

Manual(1970). The survey of India toposheets of 57C/7, 58C/8, 58C/12 and 58D/9 (1:50,000) were used as base maps for conduct of the survey.

The False Colour Composite (1: 50,000) of Landsat (TM) with the geocoded subscene SAT ID - IRS - 1B, 58C/7, 58C/8, 58/12 and 58D/9 were interpreted for physiography by studying the image characteristics along with reviewing of all available information.

Traversing of the entire area was carried out and soils examined for physical and chemical characteristics. Profile pits to a depth of two meters or upto the parent material were dug in the typical areas identified and the profiles examined in detail for horizonwise characteristics such as texture, structure, consistency, concretions, colour, mottling, soil reaction, pores, root distribution, permeability, etc. These morphological features observed were recorded as per the *Soil Survey Manual* (1970). The salient features of the area in respect of location, physiography, drainage, vegetation and land use were also recorded.

4.1.2. Identification of soil series

On the basis of the differentiating characteristics, the soils of Onattukara region have been grouped into twenty soil series. All the soil series identified were named after the type location where it was first identified.

4.1.3. Photographs of the profile

Before detailed examination of the soil profiles and collection of soil samples, the photographs of typical profiles and present land use were taken for visual interpretation. The photographs of profiles and land use of the twenty soil series are given in Appendix.

4.1.4. Soil sample collection

The soil samples representing the different horizons of the typifying pedons of the twenty soil series were collected for laboratory examination.

4.2. Description and characterization of soils

Detailed examination of the profiles were carried out in the field and the profile description of the identified twenty soil series were made.

4.2.1. Description of pedomorphic characteristics of soil series

The profile description of the soil series with their general characteristics, typifying pedon, range in characteristics, crops grown and type location are described hereunder.

4.2.1.1. NEENDAKARA SERIES

Neendakara series represent very deep, light textured, recent marine alluvium located adjoining coastal sand. These soils have very dark grey to dark grey, strongly acid, sand, 'Ap' horizon and grey to very dark grey, strongly acid to medium acid, sand to loamy sand, subsurface horizons. Sea shells and rare minerals like illmenite, monazite etc., are seen in the profile.

These soils are classified under Mixed, isohyperthermic, Typic Ustipsamments.

Typifying pedon : Neendakara sand-cultivated.

Ap	0-17cm	Very dark grey (10YR 3/1 M) sand; single grain; loose, non-sticky and non-plastic; abundant fine and medium roots; very rapid permeability; clear wavy boundary; pH 5.2.
C1	17-59cm	Grey (5 YR 5/1 M) sand; single grain; loose, non-sticky and non-plastic; abundant medium roots; very rapid permeability; clear wavy boundary; pH 5.1.
C2	59-71cm	Light grey (10 YR 7/2 M) sand; single grain; loose, non-sticky and non-plastic; abundant medium roots; very rapid permeability; clear wavy boundary; pH 5.6.
C3	71-160+cm	Very dark grey (7.5YR 3/0 M) loamy sand; single grain; very friable, non-sticky and non-plastic; roots absent; rapid permeability; pH 5.6.

Range in characteristics

Thickness of the soil column is more than 150cm. Thickness of the 'Ap' horizon ranges from 15 to 20cm. The colour is in hue 10YR, value 3 to 4 and chroma 1. Texture is predominantly sand. Colour of the 'C' horizon is in hue 5YR and 10 YR, value 3 to 5 and chroma 1 to 2.. The texture is predominantly sand but varies from sand to loamy sand.

Drainage and permeability

Excessively drained with very rapid permeability.

Use and vegetation

Cultivated with coconut.

Type location

Neendakara village, Karunagapally taluk.

4.2.1.2. KANDALLUR SERIES

Kandallur series represent light yellowish brown to dark yellowish brown, very deep, coarse textured soils developed from marine alluvium of recent origin. They are located on nearly level to very gently sloping marine terraces with slope gradient of below three percent. The surface soils are sand to loamy sand while the subsurface soils are sand. These soils are closely related to Mannar soils which contains more finer materials.

These soils are classified under Mixed, isohyperthermic, Typic Ustipsamments.

Typifying pedon : Kandallur loamy sand-cultivated.

Ap	0-10cm	Dark yellowish brown (10YR 4/4 M) loamy sand; single grain; loose, non-sticky and non-plastic; few fine roots; rapid permeability; gradual smooth boundary; pH 5.1.

AC	10-29cm	Dark yellowish brown (10 YR 4/4 M) sand; single grain; loose, non-sticky and non-plastic; few very fine roots; very rapid permeability; clear smooth boundary; pH 5.3.
C1	29-37cm	Yellowish brown (10 YR 5/6 M) sand; single grain; loose, non-sticky and non-plastic; few coarse roots; very rapid permeability; gradual smooth boundary; pH 5.2.
C2	37-80cm	Yellowish brown (10 YR 5/4 M) sand; single grain; loose, non-sticky and non-plastic; few coarse roots; very rapid permeability; gradual smooth boundary; pH 5.3.
C3	80-125+cm	Brownish yellow (10 YR 6/8 M) sand; single grain; loose, non-sticky and non-plastic; roots nil, very rapid permeability; pH 5.6.

Range in characteristics

Thickness of the soil column is always more than 120cm. The 'Ap' horizon is 15 to 20cm thick. Its colour is in hue 10YR, value 4 to 6 and chroma 4. Texture is predominantly loamy sand and varies from sand to loamy sand. The 'C' horizon is more than 100cm thick. Its colour is in hue 10 YR, value 5 to 6 and chroma 4 to 8.. The texture is predominantly sand.

Drainage and permeability

Excessively drained with very rapid permeability.

Use and vegetation

Cultivated with coconut, sesamum and vegetables.

Type location

Valiavila, Kandallur village, Karthikapally taluk.

4.2.1.3. MANNAR SERIES

Mannar series represents the very deep, sandy, coastal alluvium located on gently sloping coastal plains adjoining the coastal sandy belt. They are very young in origin and show very little profile development. These soils are characterized by very pale brown to dark grey, slightly acid, sand to loamy sand 'Ap' horizon over brown to light grey, slightly acid to neutral, loamy sand subsurface soils. Occasionally, sandy loam subsurface textures are also seen.

These soils are classified under Mixed, isohyperthermic, Typic Ustipsamments.

Typifying pedon : Mannar loamy sand-cultivated.

Ap	0-17cm	Dark grey (10 YR 4/1 M) loamy sand; single grain; loose, non-sticky and non-plastic; abundant fine and medium roots; rapid permeability; clear smooth boundary; pH 6.2.
C1	17-99cm	Greyish brown (10 YR 5/2 M) loamy sand; single grain; loose, non-sticky and non-plastic; common medium roots; moderately rapid permeability; gradual smooth boundary. pH 6.3.
C2	99-150+cm	Light grey (10 YR 6/1 M) loamy sand; single grain; loose, non-sticky and non-plastic; roots absent; rapid permeability; pH 7.0.

Range in characteristics

The depth of the soil column is always more than 150cm. The texture and structure are strikingly uniform throughout the profile clearly revealing the immature condition. Few yellow and brown mottlings are observed in the lower layers in areas with high water table. Its colour and distribution varies with degree of hydration. The texture of the 'Ap' horizon is mostly loamy sand. Dark grey is the predominant colour and varies in hue 10 YR, with value 4 to 7 and chroma 1 to 4. The 'C' horizons have similar texture and colour varies in hue 10YR, with value 4 to 7 and chroma 1 to 3.

Drainage and permeability

Well drained with rapid permeability.

Use and vegetation

Cultivated with coconut, cassava, banana, sesamum, fruit trees and vegetables.

Type location

Panmana village, Karunagapally taluk.

4.2.1.4. THRIKKUNNAPUZHA SERIES

Thrikkunnapuzha series represent very deep, imperfectly drained, highly gleyed, very dark grey soils developed from marine and lacustrine deposits of recent origin with ill defined horizons. The presence of organic debris, mainly decayed wood, is seen in the lower horizon. Sand streaks are also observed in the subsurface horizons. The loamy sand surface horizon is followed by loamy sand to clay subsurface horizons. The water table is very high and flooding is a common feature during rainy season.

These soils are classified under Fine-loamy, mixed, isohyperthermic, subactive, Tropic Fluvaquents.

Typifying pedon : Thrikkunnapuzha loamy sand-cultivated.

Ap	0-15cm	Very dark grey (10YR 3/1 M) loamy sand; weak medium granular; very friable, non-sticky and non-plastic; abundant fine roots; many medium and coarse pores; rapid permeability; gradual wavy boundary; pH 5.4.
Cg1	15-31cm	Very dark greyish brown (10 YR 3/2 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; common fine prominent red (2.5 YR 4/6) mottlings; abundant medium roots; many medium and coarse pores; rapid permeability; clear smooth boundary; pH 5.3.
Cg2	31-62cm	Very dark grey (10 YR 3/1 M) sandy loam; weak fine subangular blocky; friable, non-sticky and non-plastic; roots nil; fine medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 5.5.
2Cg1	62-90cm	Black (10 YR 2/1 M) clay; massive; firm, very sticky and very plastic;; few fine interstitial pores; decayed wood debris; elongated sand streaks; slow permeability; pH 5.7.
2Cg2	90-130+cm	Black (10YR 2/1 M) clay; massive; firm, very sticky and very plastic; few fine interstitial pores; higher amounts of decayed wood debris; very slow permeability; pH 5.4.

Range in characteristics

The depth of the soil column is always more than 130cm. The texture of 'Ap' horizon ranges from loamy sand to sandy loam. The colour ranges in hue 10 YR, value 3 to 4 and chroma 1 to 3. The texture of the 'C' horizon ranges from sandy loam to clay with colour range in hue 10 YR, value 2 to 3 and chroma 1. The amount of organic debris in the subsoil depends on the topography of the terrain.

Drainage and permeability

Poorly drained with slow permeability.

Use and vegetation

Cultivated with coconut and banana.

Type location

Thrikkunnapuzha, Thrikkunnapuzha village, Karthikapally taluk.

4.2.1.5. MAHADEVIKAD SERIES

Mahadevikad series represent the very deep, light textured, marine alluvium occurring on gently sloping plains adjoining the coastal belt. The surface texture is predominantly loamy sand with sand to sandy loam subsoils. These are very young soils with ill defined horizons. The subsurface horizon is characterized by redoximorphic concentrations ranging from red to brownish yellow mottlings.

These soils are classified under Mixed, isohyperthermic, Typic Ustipsamments.

Typifying pedon: Mahadevikad loamy sand-cultivated

Ap	0-18cm	Dark greyish brown (10 YR 4/2 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; abundant fine and medium roots; few medium pores; rapid permeability; clear smooth boundary; pH.5.1.

C1	18-33cm	Brown (10 YR 5/3 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; few fine roots; few medium pores; rapid permeability; clear smooth boundary; pH 5.3
C2	33-65cm	Greyish brown (10 YR 5/2 M) sand; single grain; loose, non-sticky and non-plastic; common medium faint brownish yellow (10 YR 6/8) mottlings; very rapid permeability; clear smooth boundary; pH 5.8.
C3	65-100cm	Brown (10 YR 5/3 M) sandy loam; weak fine subangular blocky; very friable, slightly sticky and non-plastic; common medium prominent and faint red (2.5 YR 5/8) and brownish yellow (10 YR 6/8) mottlings; common fine pores; moderately rapid permeability; pH 5.3.

Range in characteristics

The thickness of the soil column is always more than 100cm. The surface texture varies from sand to loamy sand with a colour range in hue 10 YR, value 4 to 6 and chroma 2 to 3. The texture of the 'C' horizon ranges from sand to loamy sand with colour in hue, 10 YR, value 5 and chroma 2 to 3. Red and brownish yellow mottlings are noticed in the subsoil.

Drainage and permeability

Moderately well drained with moderately rapid permeability.

Use and vegetation

Cultivated with coconut and fruit trees.

Type location

Mahadevikad, Karthikapally village, Karthikapally taluk.

4.2.1.6. ATTUVA SERIES

Attuva series represent very deep, coarse textured, alluvial soils located in between the coastal plains and laterite belt. These soils have dark greyish brown to dark brown, strongly acid, loamy sand surface soils followed by dark yellowish brown to grey, medium acid, loamy sand to sandy loam subsoils. A regular increase in clay content is noticed down the profile.

These soils are classified under Coarse-loamy, mixed, isohyperthermic, active, Fluventic Dystropepts.

Typifying pedon : Attuva loamy sand-cultivated.

Ap	0-17cm	Dark greyish brown (10 YR 4/2 M) loamy sand; single grain; loose, non-sticky and non-plastic; abundant fine to medium roots; very rapid permeability; clear wavy boundary; pH 5.5.
Bw1	17-59cm	Greyish brown (10 YR 5/2 M) sandy loam; weak fine granular; friable, non-sticky and non-plastic; abundant fine to medium roots; common medium pores; rapid permeability; clear wavy boundary; pH 5.5.
Bw2	59-99cm	Greyish brown (10 YR 5/6 M) sandy loam; weak fine subangular blocky; friable, non-sticky and non-plastic; abundant fine to medium roots; common medium pores; rapid permeability; clear wavy boundary; pH 5.5.
Bw3	99-150+cm	Light grey (10 YR 6/1 M) sandy loam; weak fine subangular blocky; friable, slightly sticky and non-plastic; roots absent; common fine and medium pores; moderately rapid permeability; pH 5.8.

Range in characteristics

Thickness of the solum is more than 150cm. Thickness of the 'Ap' horizon ranges from 11 to 20cm. Its colour is in hue 7.5 YR and 10 YR with value 3 and 4 and chroma 2 to 4 and texture is predominantly loamy sand. The colour of the 'B' horizon is in hue 7.5YR and 10 YR, value 4 to 6 and chroma 1 to 6. The texture ranges from loamy sand to sandy loam.

Drainage and permeability

Moderately well drained with rapid to moderately rapid permeability.

Use and vegetation

Cultivated with coconut, banana and cassava.

Type location

Kulasekharapuram village, Karunagapally taluk.

4.2.1.7. KOLLAKA SERIES

Kollaka series represent the very deep, light textured, strong brown to red, marine alluvial deposits located on gently to moderately sloping undulating plains of the eastern portion of Onattukara region. The reddish colour throughout the profile is the major distinguishing character of this series.

These soils are classified under Mixed, isohyperthermic, Typic Ustipsamments.

Typifying pedon: Kollaka loamy sand-cultivated

Ap	0-15cm	Strong brown (7.5 YR 5/6 M) loamy sand; weak medium granular; very friable, non-sticky and non-plastic; abundant fine and medium roots; many fine and medium pores; rapid permeability; clear smooth boundary; pH 4.7
C1	15-50cm	Red (2.5 YR 4/6 M) loamy sand; weak medium granular; very friable, non-sticky and non-plastic; common fine roots; few fine and medium pores; rapid permeability; clear smooth boundary; pH 4.6.
C2	50-95cm	Red (2.5 YR 5/6 M) loamy sand; weak medium granular; very friable, non-sticky and non-plastic; few medium and coarse roots; few fine and medium pores; rapid permeability; clear smooth boundary; pH 5.2.
C3	95-160cm	Strong brown (7.5 YR 5/6 M) sand; single grain; loose, non-sticky and non-plastic; very rapid permeability; pH 5.3.

Range in characteristics

The thickness of the soil column is always more than 150cm. The surface texture varies from sand to loamy sand with a colour range in hue 7.5 YR, value 4 to 5 and chroma 4 to 6. The texture of the subsoil ranges from sand to loamy sand with colour range in hue of 2.5 YR to 7.5 YR, value 4 to 6 and chroma 6 to 8.

Drainage and permeability

Well drained with rapid to moderately rapid permeability.

Use and vegetation

Cultivated with coconut, cassava and fruit trees.

Type location

Kollaka, Ward No.1, Vadakathala village, Karunagapally taluk.

4.2.1.8. ALAPPUZHA SERIES

Alappuzha series represent very deep, coarse textured, coastal alluvial soils located on level to gently sloping lands. The characteristic feature of this series is the presence of *Kalashi*, a black to dark brown coloured iron oxide and organic matter rich sand which is hard under submerged condition noticed in this series beyond a depth of 150cm. Alappuzha soils have light brownish grey to dark brown, slightly acid, sand to loamy sand 'Ap' horizon and white to black, sand to loamy sand 'C' horizon. The soils have more or less uniform characters throughout the profile.

These soils are classified under Mixed, isohyperthermic, Ustic Quartzipsamments.

Typifying pedon: Alappuzha sand-cultivated.

Ap	0-23cm	Pale brown (10 YR 6/3 M) sand; single grain; loose, non-sticky and non-plastic; frequent medium and coarse roots; rapid permeability; diffuse smooth boundary; pH 6.5.
C1	23-110cm	Light grey (10 YR 7/1 M) sand; single grain; loose, non-sticky and non-plastic; few medium and coarse roots; rapid permeability; gradual smooth boundary; pH 6.6.
C2	110-160cm	Greyish brown (10 YR 5/2 M) sand; single grain; loose, non-sticky and non-plastic; roots absent; rapid permeability; clear smooth boundary; pH 6.6.
C3	160+cm	Black (10 YR 2/1 M) sand; weak fine subangular blocky; friable, non-sticky and non-plastic; roots absent; moderate permeability; *Kalashi*, a mixture of sand, iron oxides and organic matter; pH 6.4 .

Range in characteristics

The depth of soil column is always more than 150cm. The 'Ap' horizon is 15 to 45cm thick. The surface colour is in hue 10 YR, value 3 to 7 and chroma 1 to 4 The texture is predominantly sand and varies from sand to loamy sand. The 'C' horizon is more than 100cm thick. Its colour is in hue 10YR and 7.5 YR, value 2 to 8 and chroma 1 to 4. Texture is usually sand but varies from sand to loamy sand. In areas with high water table, *Kalashi* is noticed at lower depths.

Drainage and permeability

Excessively drained with rapid permeability.

Use and vegetation

Cultivated with coconut and cashew.

Type location

Kayamkulam municipality, Ward No. 19. Karthikapally taluk.

4.2.1.9. PALLIPAD SERIES

Pallipad series represent the very deep alluvial soils with initial stages of laterisation in deeper layers occurring on gently to moderately sloping plains. They have greyish brown to very dark greyish brown, strongly acid, loamy sand to sandy loam, 'Ap' horizon followed by very dark grey to light yellowish brown, medium acid, sandy loam to sandy clay loam subsurface horizons.

These soils are classified under Coarse-loamy, mixed, isohyperthermic, Kanhaplic Haplustalfs.

Typifying pedon : Pallipad loamy sand-cultivated.

Ap	0-19cm	Greyish brown (10 YR 5/2 M) loamy sand; single grain; loose, non-sticky and non-plastic; abundant medium roots; rapid permeability; clear wavy boundary; pH 5.3.
Bw1	19-60cm	Very dark greyish brown (10 YR 3/2 M) sandy loam; weak fine granular; friable, slightly sticky and non-plastic; abundant medium roots; common medium pores; moderately rapid permeability; clear smooth boundary; pH 5.5.
Bw2	60-110cm	Dark greyish brown (10 YR 4/2 M) sandy loam; weak medium subangular blocky; friable, sticky and plastic; few medium roots; common medium pores; moderately rapid permeability; gradual wavy boundary; pH 5.7.
Bt1	110-157cm	Greyish brown (10 YR 5/2 M) sandy clay loam; weak medium subangular blocky; friable, slightly sticky and slightly plastic; common medium distinct and prominent strong brown (7.5 YR 5/6) and red (2.5 YR 4/8) mottlings; thin patchy cutans; roots absent; few fine and medium pores; moderate permeability; pH 5.8.
BC	157+cm	Soil mixed with laterite.

Range in characteristics

The depth of the solum is more than 150cm.. The Ap' horizon, is 16 to 25 cm thick. Its colour ranges in hue 10 YR, with value 3 to 5 and chroma 2 and 3. The texture is mostly loamy sand but ranges from loamy sand to sandy loam. The 'B' horizon is more than 100cm thick. Its colour ranges in hue 10 YR with value 3 to 6 and chroma 1 and 6. The texture varies from sandy loam to sandy clay loam. Strong brown and red mottlings are observed in the subsurface horizons.

Drainage and permeability

Moderately well drained with moderate permeability.

Use and vegetation

Cultivated with coconut, cassava banana and fruit trees.

Type location

Pallipad village, Karthikapally taluk.

4.2.1.10. MYNAGAPALLY SERIES

Mynagapally series represent the deep to very deep, well drained laterite soils occurring on moderately sloping to strongly sloping low mounds. They have reddish brown to yellowish red, very strongly acid, gravelly loam to gravelly silty clay loam, 'Ap' horizon, red to yellowish red, very strongly to strongly acid, gravelly sandy clay loam to gravelly clay, 'B' horizon. The entire solum rests on a continuous layer of Plinthite developed from gneissic rocks.

These soils are classified under Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults.

Typifying pedon : Mynagapally gravelly sandy clay loam-cultivated.

Ap	0-28cm	Yellowish red (5 YR 5/6 M) gravelly sandy clay loam; moderate medium subangular blocky; friable, slightly sticky and slightly plastic; abundant fine roots; common medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 4.8.

Bt1	28-57cm	Yellowish red (5 YR 5/8 M) gravelly sandy clay; moderate medium subangular blocky; firm, sticky and plastic; frequent medium roots; few fine interstitial pores; patchy thin cutans; moderately rapid permeability; clear wavy boundary; pH 5.0.
Bt2	57-98cm	Red (2.5 YR 5/8 M) gravelly clay; strong medium subangular blocky; firm, sticky and plastic; few medium roots; few fine interstitial pores; patchy thin cutans; moderate permeability; clear wavy boundary; pH 5.1.
B3	98-113cm	Red (2.5YR 4/6 M) gravelly sandy clay loam; strong medium subangular blocky; very firm, sticky and plastic; roots absent; few fine interstitial pores; moderately slow permeability; pH 4.5.
C	113+cm	Plinthite

Range in characteristics

Thickness of the solum is more than 85cm. Thickness of the 'Ap' horizon ranges from 18 to 30cm. Its colour is in hue 5YR, value 4 to 5 and chroma 4 to 8. Texture varies from gravelly loam to gravelly silty clay loam . Thickness of the 'B' horizon is more than 70cm and its colour is in hue 2.5YR and 5YR, value 4 to 5 and chroma 6 to 8.. The texture varies from gravelly sandy clay loam to gravelly clay.

Drainage and permeability

Well drained with moderate to moderately slow permeability.

Use and vegetation

Cultivated with coconut, cassava and banana.

Type location

Thodiyoor village, Karunagapally taluk.

4.2.1.11. KATTANAM SERIES

Kattanam series represent the alluvio-colluvial soils resting over a sandy marine deposit, on gently sloping plains, adjoining the undulating laterite belt. They are very deep, dark brown to brown, strongly acid to medium acid, light textured soils with loamy sand to sandy loam surface and loamy sand to sandy loam subsurface. These soils are young in origin and horizonisation is ill defined.

These soils are classified under Coarse-loamy, mixed, isohyperthermic, semiactive, Fluventic Ustropepts.

Typifying pedon: Kattanam loamy sand-cultivated.

Ap	0-23cm	Dark brown (7.5 YR 3/2 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; common fine and medium roots; common coarse interstitial pores; rapid permeability; clear smooth boundary; pH 5.1
Bw1	23-60cm	Brown (7.5 YR 5/4 M) sandy loam; weak fine subangular blocky; very friable, non-sticky and non-plastic; few fine and medium roots; common fine and medium interstitial pores; rapid permeability; clear smooth boundary; pH 5.2.
Bw2	60-78cm	Brown (7.5 YR 5/4 M) sandy loam; weak medium subangular blocky; friable non-sticky and non-plastic; few medium roots; common fine and medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 5.1.
BC	78-120cm	Strong brown (7.5 YR 5/8 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; roots nil; few fine medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 5.3
C	120-180+cm	Reddish yellow (7.5 YR 6/8 M) loamy sand; weak fine granular; loose, non-sticky and non-plastic ; moderately rapid permeability; pH 5.4.

Range in characteristics

The thickness of the solum is always more than 100cm. The colour of 'Ap' horizon ranges in hue 7.5 YR, with value 3 to 5 and chroma 2 to 4. Its texture is predominantly loamy sand, but ranges from loamy sand to sandy loam. The 'B' horizon is predominantly sandy loam with colour ranging in hue 7.5 YR, value 4 to 6 and chroma 4 to 8.

Drainage and permeability

Moderately well drained with moderately rapid permeability.

Use and vegetation

Cultivated with coconut, cassava, banana, sesamum and vegetables.

Type location

Kattanam, Bharanikavu village, Mavelikkara taluk.

4.2.1.12. PALAMEL SERIES

Palamel series represent very deep, well drained, dark brown, light to medium textured soils occurring towards the north eastern part of Onattukara region. They have reddish brown to dark brown, strongly to medium acid, gravelly sandy loam to gravelly sandy clay loam surface soils and reddish yellow to strong brown, medium acid to slightly acid, sandy clay loam to clay subsoils. The gravel content below 100 cm reaches upto 40 percent. The soils are developed over laterite from recent and subrecent sediments.

These soils are classified under Fine-loamy, mixed, isohyperthermic, subactive, Ustoxic Humitropepts.

Typifying pedon: Palamel gravelly sandy loam-cultivated.

Ap	0-16cm	Dark brown (7.5 YR 4/4 M) gravelly sandy loam; weak medium granular; friable, slightly sticky and slightly plastic; abundant fine and medium roots; common fine and medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 5.5.
Bw1	16-38cm	Strong brown (7.5 YR 5/6 M) sandy clay; moderate coarse subangular blocky; friable, sticky and plastic; common medium roots; few fine and very fine interstitial pores; moderately slow permeability; clear smooth boundary; pH 5.3.
Bw2	38-107cm	Yellowish red (5 YR 4/8 M) sandy clay; coarse subangular blocky; friable, sticky and plastic; few medium roots; few fine interstitial pores; moderately slow permeability; gradual irregular boundary; pH 6.3.
B3	107-137cm	Yellowish red (5 YR 5/8 M) gravelly clay; medium coarse subangular blocky; friable, sticky and plastic; few fine interstitial pores; moderately slow permeability; clear smooth boundary; pH 6.1.
C	137+cm	Plinthite

Range in characteristics

The depth of solum ranges from 110 to 150 cm. Coarse fragments occur mostly in the surface and just above the laterite layer. The water table during summer is around 10 m. and rises upto a level of 3 m. during rainy season. The texture of 'Ap' horizon ranges from gravelly sandy loam to gravelly sandy clay loam and colour varies from reddish brown to dark brown in hue 5YR and 7.5YR, value 3 to 5 and chroma 3 to 4. The 'B' horizons are predominantly sandy clay in texture but ranges from sandy clay loam to clay. The colour varies from strong brown to yellowish red in hue 5YR and 7.5YR, value 4 to 5 and chroma 6 to 8. The 'B3' horizon is mostly gravelly clay and the colour range is from reddish yellow to yellowish red in hue 5YR, value 5 and 6 and chroma 6 to 8. This horizon contains relatively higher proportion of laterite gravels. The 'C' horizon is mostly soft laterite.

Drainage and Permeability

Well drained with moderate permeability.

Use and vegetation

Cultivated with coconut, banana, cassava and vegetables.

Type location

Mavelikkara village, Mavelikkara taluk.

4.2.1.13. SOORANAD SERIES

Sooranad series represent the very deep, poorly drained soils developed from colluvial material over laterite. These soils occur in gently sloping depressions of the central portion of Onattukara region. They have grey to dark greyish brown, medium acid, sandy loam to sandy clay loam 'Ap' horizon and brownish yellow to yellowish red, medium acid to very strongly acid, sandy clay loam to clay subsoils.

These soils are classified under Fine, mixed, isohyperthermic, subactive, Typic Plinthustults.

Typifying pedon : Sooranad sandy loam-cultivated.

Ap	0-18cm	Dark greyish brown (10 YR 4/2 M) sandy loam; weak medium granular; friable, non-sticky and non-plastic; abundant fine roots; rapid permeability; clear smooth boundary; pH 5.9.
Bw1	18-37cm	Yellowish brown (10 YR 5/4 M) sandy clay loam; weak medium subangular blocky; friable, slightly sticky and slightly plastic; few fine roots; common fine and medium interstitial pores; moderately slow permeability; clear wavy boundary; pH 4.9.
Bt1	37-120cm	Yellowish red (5 YR 5/6 M) gravelly clay; moderate medium subangular blocky; firm, sticky and plastic; roots absent; dark brown (7.5 YR 4/2) mottlings; patchy thin cutans; few fine interstitial pores; moderately slow permeability; pH 6.0.
C	120+cm	Plinthite

Range in characteristics

The depth of the solum ranges from 120 to 150cm depending on the depth of laterite. The colour of the 'Ap' horizon ranges in hue 10YR, value 4 and 5 and chroma 1 and 2. The texture ranges from sandy loam to sandy clay loam. The colour of the 'B' horizon ranges in hue 5YR and 10 YR with value 4 to 6 and chroma 6 to 8. The texture ranges from sandy clay loam to gravelly clay. The clay content and gravel content increases with depth. Laterisation is in its initial stage below the 'B' horizon.

Drainage and permeability

Poorly drained with moderate permeability.

Use and vegetation

Cultivated with rice.

Type location

Thamarakulam village, Mavelikkara taluk.

4.2.1.14. VALLIKUNNAM SERIES

Vallikunnam soils represent very deep, gravelly soils located on gently to moderately sloping lands on the eastern boundary of Onattukara region. These soils have reddish brown, strongly acid, gravelly sandy clay loam to gravelly clay loam 'Ap' horizon followed by gravelly clay loam to gravelly clay strongly acid, strong brown to yellowish red, 'B' horizons. These soils are developed from gneissic rocks and rests over a continuous layer of plinthite.

These soils are classified under Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults.

Typifying pedon : Vallikunnam gravelly sandy clay loam-cultivated.

Ap	0-10cm	Reddish brown (5 YR 4/4 M) gravelly sandy clay loam; weak medium subangular blocky; friable, slightly sticky and slightly plastic; abundant fine roots; common fine and medium interstitial pores; moderate permeability; clear wavy boundary; pH 5.4.
AB	10-27cm	Reddish brown (5 YR 5/4 M) gravelly sandy clay loam; weak medium subangular blocky; friable, sticky and slightly plastic; abundant fine roots; common fine and medium interstitial pores; moderate permeability; clear wavy boundary; pH 5.1.
Bt1	27-69cm	Strong brown (7.5 YR 5/6 M) gravelly clay; moderate medium subangular blocky; firm, sticky and plastic; few fine roots; common fine interstitial pores; moderately slow permeability; gradual wavy boundary; pH 5.3.

Bt2	69-110cm	Strong brown (7.5 YR 5/8 M) gravelly clay; strong medium subangular blocky; firm, very sticky and plastic; few fine roots; few fine interstitial pores; moderately slow permeability; pH 5.2
C	110+cm	Plinthite

Range in characteristics

Thickness of the solum is more than 90cm. Thickness of the 'Ap' horizon ranges from 25 to 30cm. Its colour is in hue 5 YR, value 4 to 5 and chroma 4. Texture is predominantly gravelly clay loam. Thickness of the 'B' horizon is more than 80cm and its colour is in hue 7.5YR, value 5 and chroma 6 to 8.. The texture varies from gravelly clay loam to gravelly clay.

Drainage and permeability

Well drained with moderate permeability.

Use and vegetation

Cultivated with coconut and cassava.

Type location

Chunakkara village, Mavelikkara taluk.

4.2.1.15. KOTTAKAKAM SERIES

Kottakakam series represents the deep to very deep, alluvial soils deposited in the depressions of coastal plains. These soils are typically characterized by mottled subsurface horizons. They have greyish brown to very dark greyish brown, strongly acid, sandy loam to loam

'Ap' horizon and dark brown to pale brown, very strongly acid, loamy sand to sandy clay loam 'C' horizon.

These soils are classified under Coarse-loamy. mixed, isohyperthermic, subactive, Aeric Tropaquepts.

Typifying pedon : Kottakakam sandy loam-cultivated.

Ap	0-20cm	Dark greyish brown (10 YR 4/2 M) sandy loam; weak medium granular; very friable, non-sticky and non-plastic; abundant fine roots; common medium interstitial pores; moderately rapid permeability; clear smooth boundary; pH 5.4.
AB	20-54cm	Dark brown (7.5 YR 3/2 M) sandy loam; weak medium subangular blocky; very friable, slightly sticky and non-plastic; common medium distinct brown (10 YR 5/3) mottlings; common medium interstitial pores; gradual smooth boundary. pH 4.4.
Bw	54-90cm	Pale brown (10 YR 6/3 M) sandy loam; weak medium subangular blocky; friable, slightly sticky and non-plastic; common medium distinct reddish brown (2.5 YR 4/4) mottlings; few fine interstitial pores; moderate permeability; pH 4.2.

Range in characteristics

The thickness of the soil column is 70 to 110cm. The 'Ap' horizon is 20 to 35cm thick. Its colour is in hue 10 YR, value 3 to 5 and chroma 2 to 3. The texture varies from loamy sand to sandy loam. The 'C' horizon is 50 to 80cm thick. Texture varies from sandy loam to sandy clay loam. Its colour is in hue 10YR, value and chroma 2 to 6. These soils have high water table.

Drainage and permeability

Poorly drained with moderate permeability.

Use and vegetation

Cultivated with rice and sesamum.

Type location

Pallipad village, Karthikapally taluk.

4.2.1.16. PATHIYOOR SERIES

Pathiyoor series represent the imperfectly drained, very deep, fine textured alluvial soils. They are dark yellowish brown to greyish brown with clay loam surface texture and clay loam to clay subsoils. They are located on level to gently sloping depressions of lowland plains. These soils are submerged during monsoon. The water table goes down to 0.5 to 1 meter during summer months.

These soils are classified under Fine, mixed, isohyperthermic, semiactive, Aeric Tropaquepts.

Typifying pedon: Pathiyoor clay loam-cultivated

Ap	0-20cm	Dark yellowish brown (10 YR 4/4 M) clay loam; moderate medium subangular blocky; friable, slightly sticky and slightly plastic; common fine and medium roots; common fine interstitial pores; moderate permeability; abrupt smooth boundary; pH 5.4
Bw1	20-43cm	Greyish brown (10 YR 5/2 M) clay loam; moderate medium subangular blocky; friable, sticky and slightly plastic; common fine and medium roots; common fine interstitial pores; moderate permeability; abrupt smooth boundary; pH 5.2.
Bw2	43-75cm	Dark greyish brown (10 YR 4/2 M) clay; moderate medium subangular blocky; firm, sticky and plastic; few fine faint yellowish brown (10 YR 5/6) mottlings;

		few fine faint yellowish brown (10 YR 5/6) mottlings; common fine interstitial pores; slow permeability; clear smooth boundary; pH 5.1.
Bw3	75-110cm	Greyish brown (10 YR 5/2 M) clay; moderate medium subangular blocky; firm, sticky and plastic; few fine faint yellowish brown (10 YR 5/6) mottlings; common fine interstitial pores; moderately slow permeability; clear smooth boundary; pH 5.0.
BC	110-150+cm	Greyish brown (10 YR 5/2 M) sandy clay; moderate medium subangular blocky; firm, sticky and plastic; few fine faint yellowish brown (10 YR 5/8) mottlings; few fine interstitial pores; slow permeability; pH 4.9.

Range in characteristics

The thickness of the solum is always more than 150cm. The texture of the 'Ap' horizon ranges from sandy clay loam to clay loam. Its colour is in hue 10 YR, with value 4 to 5 and chroma 3 to 4. The 'B' horizon is more than 100cm thick. Its colour is in hue 10 YR, with value 4 to 5 and chroma 1 to 3 and texture varies from sandy clay loam to clay. Mottlings are noticed in the subsoil.

Drainage and permeability

Imperfectly drained with slow to moderately slow permeability

Use and vegetation

Cultivated with rice.

Type location

Pathiyoor village, Karthikapally taluk.

4.2.1.17. CHERUKOL SERIES

Cherukol series represents the very deep, coarse textured, coastal alluvium of recent origin that are typically light coloured with slight profile development on the surface. The surface layer is usually dark greyish brown, very strongly acid, loamy sand, followed by yellowish brown to light yellowish brown, medium acid, loamy sand to sandy loam subsoils. In very deep profiles, sandy clay loam soils are also noticed. These soils are located in very gently sloping depressions in the coastal plains.

These soils are classified under Coarse-loamy, mixed, isohyperthermic, subactive, Typic Tropofluvents.

Typifying pedon: Cherukol loamy sand-cultivated.

Ap	0-13cm	Dark greyish brown (10 YR 4/2 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; abundant very fine and fine roots; rapid permeability; clear smooth boundary; pH 4.9.
C1	13-24cm	Light yellowish brown (10 YR 6/4 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; few fine roots; rapid permeability; gradual smooth boundary; pH 5.2.
C2	24-66cm	Yellowish brown (10 YR 5/4 M) loamy sand; weak fine granular; very friable, non-sticky and non-plastic; few fine faint yellowish brown (10 YR 5/6) mottlings; roots absent; rapid permeability; gradual smooth boundary; pH 5.2.
C3	66-150+cm	Yellowish brown (10 YR 5/8 M) sandy clay loam; weak fine subangular blocky; friable, slightly sticky and slightly plastic; few fine faint yellowish red (5 YR 4/6) mottlings; roots absent; moderate permeability; pH 5.6.

Range in characteristics

The depth of soil column is always more than 150cm. The texture and structure are strikingly uniform throughout the profile except in the last layer. Yellowish brown to strong brown mottles are observed in the third layer and yellowish red to yellowish brown, in the fourth layer. Colour and distribution of mottlings vary with degree of hydration. Texture of the surface soil varies from sand to loamy sand. The colour is in hue 10 YR, value 4 and 5 and chroma 2. The texture of 'C' horizon ranges from loamy sand to sandy clay loam with hue 10YR, value 5 to 6 and chroma 3 to 8.

Drainage and permeability

Moderately well drained with rapid to moderately rapid permeability.

Use and vegetation

Cultivated with rice and sesamum.

Type location

Thekkekara village, Maveikkara taluk.

4.2.1.18. VETTIKODE SERIES

Vettikode series represent very deep, heavy textured, imperfectly drained alluvial soils on very gently to gently sloping depressions of lowlands.. They are dark grey to very dark grey, medium acid, clay loam to clay surface soils and grey to black, very strongly to medium acid, clay subsoils. The maximum accumulation of clay is observed in the second and third layers.

These soils are classified under Very fine, mixed, isohyperthermic, subactive, Tropic Fluvaquents.

Typifying pedon : Vettikode clay-cultivated.

Ap	0-14cm	Very dark grey (10 YR 3/1 M) clay; strong coarse subangular blocky; very firm, very sticky and plastic; abundant fine roots; common very fine and fine interstitial pores; moderately slow permeability; clear smooth boundary; pH 5.7.
Bg1	14-32 cm	Dark grey (10 YR 4/1 M) clay; strong coarse subangular blocky; firm, very sticky and very plastic; few fine roots; common very fine interstitial pores; slow permeability; clear wavy boundary; pH 4.9.
Bg2	32-115cm	Grey (10 YR 5/1 M) clay; strong coarse subangular blocky; very firm, very sticky and very plastic; roots absent; slow permeability; clear wavy boundary; pH 5.8.
Bg3	115-130+cm	Light grey (10 YR 6/1 M) silty clay; massive; firm, sticky and plastic; roots absent; slow permeability; pH 5.4.

Range in characteristics

The depth of the solum is more than 125 cm. The Ap' horizon, is 10 to 20cm thick. Its colour ranges in hue 10 YR with value 3 to 4 and chroma 1 and 2. The texture ranges from clay loam to clay. The 'B' horizon is more than 100cm thick. Its colour ranges in hue 10 YR with value 1 to 6 and chroma 1 and 2. The texture is predominantly clay.

Drainage and permeability

Imperfectly drained with slow permeability.

Use and vegetation

Cultivated with rice.

Type location

Chunakkara village, Mavelikkara taluk

4.2.1.19. KEERIKKAD SERIES

Keerikkad series represent very deep, coarse textured, coastal alluvium located in depressions, developed in-between two subdued sand dunes which are 0.5 to 1m below the general surface of the coastal belt. They are very narrow, running parallel to the beach line. The surface soils are dark yellowish brown, strongly acid, sand to loamy sand. The subsoils are light grey to yellowish brown, strongly to medium acid, sand to loamy sand. These soils are submerged during monsoon with imperfect drainage. The water table is high and is located at 1 to 2 m even during summer time.

These soils are classified under Mixed, isohyperthermic, Typic Psammaquents.

Typifying pedon: Keerikkad loamy sand-cultivated

Ap	0-25cm	Dark yellowish brown (10YR 4/4 M) loamy sand; single grain; loose, non-sticky and non-plastic; few fine and coarse roots; rapid permeability; abrupt smooth boundary; pH 5.1.
AC	25-40cm	Light yellowish brown (10 YR 6/4 M) sand; single grain; loose, non-sticky and non-plastic; few fine and coarse roots; moderately rapid permeability; clear smooth boundary; pH 5.2.

Cg1	40-84cm	Dark grey (10 YR 4/1 M) sand; single grain; loose, non-sticky and non-plastic; few coarse roots; moderately rapid permeability; clear smooth boundary; pH 5.9.
Cg2	84-116cm	Light grey (10 YR 7/2 M) sand; single grain; loose, non-sticky and non-plastic; few coarse roots; moderately rapid permeability; clear smooth boundary; pH 5.8.
2C	116-196+cm	Brownish yellow(10 YR 6/6 M) sandy loam; weak fine subangular blocky; very friable, slightly sticky and non-plastic; few coarse roots; moderately rapid permeability; pH 5.4.

Range in characteristics

Thickness of the soil column is more than 150cm. The 'Ap' horizon is 20cm thick. Its colour is in hue 10YR, value 4 to 6 and chroma 2 to 4. Texture ranges from sand to loamy sand. The 'C' horizon is more than 100cm and its colour ranges in hue 10 YR, value 4 to 7 and chroma 1 to 6.. The texture ranges from sand to loamy sand. Sandy loam textures are also noticed in deeper layers.

Drainage and permeability

Imperfectly drained with rapid permeability.

Use and vegetation

Land raised to ridges and furrows for coconut cultivation. Paddy is also grown.

Type location

Keerikkad village, Karunagapally taluk.

4.2.1.20. CHUNAD SERIES

Chunad series represent the imperfectly drained, very deep, dark brown soils occurring on level to gently sloping depressions of lowland plains. The surface texture ranges from sandy loam to sandy clay loam, followed by clay loam to clay subsurface horizons. Red and yellow mottlings as well as very dark grey and black mottlings are seen from the second layer downwards. During monsoon, the fields are submerged under water. The water table goes down to 1 to 1.5 m during summer months.

These soils are classified under Fine-loamy, mixed, isohyperthermic, semiactive, Aeric Tropaquepts.

Typifying pedon: Chunad sandy loam-cultivated

Ap	0-18cm	Dark brown (10 YR 4/3 M) sandy loam; weak medium granular; very friable, non-sticky and non-plastic; common fine roots; common fine interstitial pores; moderately rapid permeability; clear smooth boundary; pH 4.9.
AB	18-34cm	Dark greyish brown (10 YR 4/2 M) sandy clay loam; moderate medium subangular blocky; firm, sticky and plastic; few fine faint yellowish red (5YR 5/8) mottlings; few fine roots; few fine interstitial pores; moderately slow permeability; gradual wavy boundary; pH 5.2.
Bg1	34-75cm	Greyish brown (10 YR 5/2 M) clay loam; moderate medium subangular blocky; firm, sticky and plastic; few fine faint very dark grey (7.5 YR 3/0) mottlings; few interstitial pores; moderately slow permeability; gradual smooth boundary; pH 4.3.

Bg2	75-125cm	Greyish brown (10 YR 5/2 M) sandy clay; moderate medium subangular blocky; firm, sticky and plastic; common faint strong brown (7.5 YR 5/8) mottlings; few fine interstitial pores; moderately slow permeability; pH 4.2

Range in characteristics

The thickness of the solum is always more than 120cm. The texture of the surface horizon ranges from sandy loam to sandy clay loam. Its colour is in hue 10 YR, value 3 to 5 and chroma 1 to 3. The 'B' horizon is more than 80cm thick. Its colour is in hue 10 YR, with value 4 to 5 and chroma 1 to 2 and texture varies from sandy clay loam to clay. Brown and grey mottlings are noticed in the subsoil.

Drainage and permeability

Imperfectly drained with moderate to slow permeability

Use and vegetation

Cultivated with rice. Banana and vegetables are also grown.

Type location

Thazhava village, Karunagapally taluk.

4.2.2. Extent and distribution of the soil series

Based on systematic survey, the delineated soil boundaries were transferred planimetrically to accurate topobases and the extent of each identified soil series were calculated using digital planimeter.

The names of soil series identified with their extent and percentage to total area are given in Table 10. The visual

Table 10. **Soil series identified in Onattukara region**

Sl no	*Name of soil series*	*Area(ha)*	*Percentage*
1	Neendakara	440	1.07
2	Kandallur	2982	7.28
3	Mannar	22325	54.52
4	Thrikkunnapuzha	998	2.44
5	Mahadevikad	1580	3.86
6	Attuva	1300	3.17
7	Kollaka	355	0.87
8	Alappuzha	180	0.44
9	Pallipad	1015	2.02
10	Mynagapally	325	1.25
11	Kattanam	65	0.16
12	Palamel	553	1.35
13	Sooranad	725	1.77
14	Vallikunnam	453	1.11
15	Kottakakam	698	1.70
16	Pathiyoor	350	0.85
17	Cherukol	1058	2.58
18	Vettikode	493	1.20
19	Kerrikad	400	0.98
20	Chunad	958	2.34
	water body	3695	9.02
	TOTAL	40948	

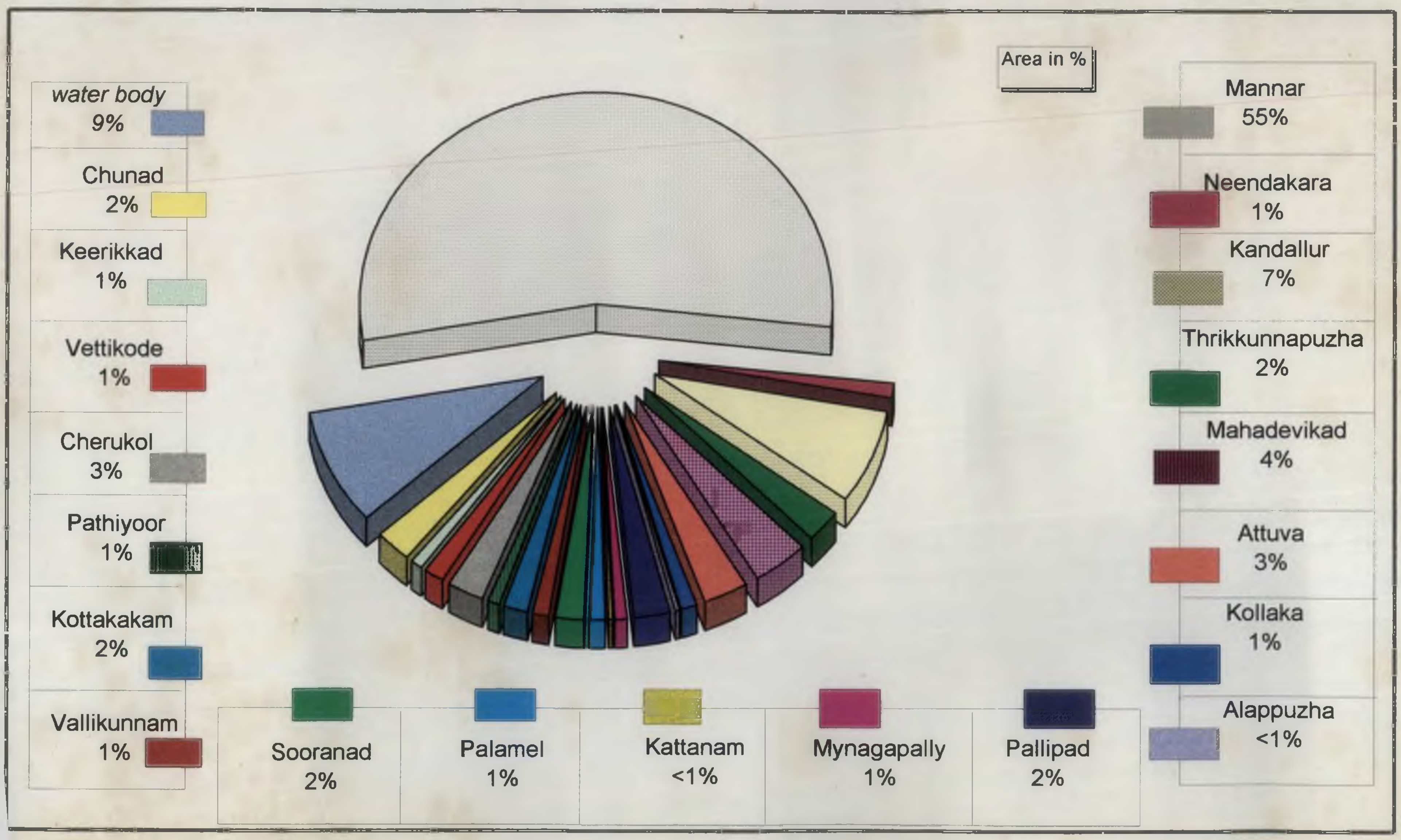


Fig. 2. **Soil series distribution**

interpretation of the extent and distribution of the soil series are presented in Figure 2.

Out of the twenty soil series identified, thirteen series fall under gardenlands (Table 11) and seven series fall under wetland soils (Table 12).

Detailed studies shows that Onattukara region extends to an area of only 40,948 ha rather than 72,550 ha as reported in the NARP Status report (1989). Among the soils, Mannar with an extent of 22,325 ha (55 percent) is the predominant soil series. Kattanam with an extent of 65 ha (less than one percent) has the least coverage.

4.2.3. Laboratory studies

The physical and chemical properties of the soil samples collected, representing the twenty soil series were determined by standard analytical procedures.

4.2.3.1. Physical properties

The data on particle size distribution including gravel fraction of the identified twenty soil series are presented in Table 13 and Figure3.

Table 13. **Particle size distribution**

Sl no	Soil series	Depth (cm)	Gravel (%)	Percentage Coarse sand	Fine sand	Silt	Clay
1	Neendakara	0-17	0.00	62.00	31.00	4.20	2.80
		17-59	0.00	63.00	32.50	2.00	2.50
		59-71	0.00	58.50	36.00	3.10	2.40
		71-160+	0.00	53.50	33.00	8.30	5.20
2	Kandallur	0-10	0.00	50.20	36.10	09.70	04.00
		10-29	0.00	51.00	40.00	05.20	03.80
		29-37	0.00	42.50	50.00	03.50	04.00
		37-80	0.00	44.50	50.50	02.00	03.00
		80-125+	0.00	54.50	41.50	02.00	02.00
3	Mannar	0-17	0.00	60.00	23.10	6.90	10.00
		17-99	0.00	62.30	22.40	6.29	9.01
		99-150+	0.00	68.30	17.40	5.18	9.12
4	Thrikkunnapuzha	0-15	0.00	48.00	40.00	06.50	5.50
		15-31	0.00	42.00	41.00	11.50	6.50
		31-62	0.00	39.50	35.50	13.00	12.00
		62-90	0.00	17.50	22.50	15.00	44.50
		90-130+	0.00	16.50	21.50	13.00	49.00
5	Mahadevikad	0-18	0.00	58.50	24.50	08.00	09.00
		18-33	0.00	60.50	25.50	05.50	08.50
		33-65	0.00	62.00	30.50	03.50	04.00
		65-100	0.00	43.50	34.00	11.00	11.50

Table 11. **Soil series identified in gardenlands**

Sl no	*Name of soil series*	*Area(ha)*
1	Neendakara	440
2	Kandallur	2982
3	Mannar	22325
4	Thrikkunnapuzha	998
5	Mahadevikad	1580
6	Attuva	1300
7	Kollaka	355
8	Alappuzha	180
9	Pallipad	1015
10	Mynagapally	325
11	Kattanam	65
12	Palamel	553
13	Vallikunnam	453
	TOTAL	32571

Table 12. **Soil series identified in wetlands**

Sl no	*Name of soil series*	*Area(ha)*
1	Sooranad	725
2	Kottakakam	698
3	Pathiyoor	350
4	Cherukol	1058
5	Vettikode	493
6	Keerikkad	400
7	Chunad	958
	TOTAL	4682

Sl no	Soil series	Depth (cm)	Gravel (%)	Percentage			
				Coarse sand	Fine sand	Silt	Clay
6	Attuva	0-17	0.00	64.50	19.50	10.50	5.50
		17-59	0.00	65.75	16.15	7.60	10.50
		59-99	0.00	55.20	25.85	5.95	13.00
		99-150+	0.00	67.75	11.30	4.95	16.00
7	Kollaka	0-15	0.00	52.50	34.50	06.00	07.00
		15-50	0.00	49.50	35.50	06.50	08.50
		50-95	0.00	54.50	33.00	05.30	07.20
		95-160	0.00	61.50	29.50	05.20	03.80
8	Alappuzha	0-23	0.00	50.50	48.50	1.00	0.00
		23-110	0.00	43.00	55.50	1.50	0.00
		110-160	0.00	64.00	35.00	1.00	0.00
		160+	0.00	35.00	59.50	5.50	0.00
9	Pallipad	0-19	0.00	62.00	28.50	06.20	03.30
		19-60	0.00	48.50	27.00	13.50	11.00
		60-110	0.00	44.50	29.50	14.00	12.00
		110-157	0.00	36.00	29.00	11.00	24.00
10	Mynagapally	0-28	23.00	49.88	18.99	09.88	21.25
		28-57	26.00	41.99	15.15	04.86	38.00
		57-98	71.00	32.50	02.12	11.28	54.10
		98-113	60.00	40.43	15.55	15.25	28.77

Sl no	Soil series	Depth (cm)	Gravel (%)	Percentage			
				Coarse sand	Fine sand	Silt	Clay
11	Kattanam	0-23	0.00	51.50	34.50	05.00	09.00
		23-60	0.00	40.50	37.50	10.50	11.50
		60-78	0.00	35.00	40.00	11.00	14.00
		78-120	0.00	45.50	39.50	06.50	08.50
		120-180+	0.00	48.00	40.00	05.00	07.00
12	Palamel	0-16	34.69	43.50	29.80	9.20	17.50
		16-38	11.66	38.00	16.30	8.70	37.00
		38-107	11.59	33.10	26.00	7.50	33.40
		107-137	39.30	31.80	14.70	12.00	41.50
13	Sooranad	0-18	14.83	29.70	45.50	11.10	13.70
		18-37	14.96	26.75	20.50	21.55	31.20
		37-120	32.83	24.40	14.00	14.10	47.50
14	Vallikunnam	0-10	33.00	39.00	30.50	08.70	21.80
		10-27	37.00	30.50	28.50	16.50	24.50
		27-69	42.00	29.30	14.60	11.60	44.50
		69-110	45.00	29.50	12.50	12.00	46.00
15	Kottakakam	0-20	0.00	68.73	9.27	6.00	16.00
		20-54	0.00	69.70	8.35	6.25	15.70
		54-90	0.00	60.05	10.10	10.35	19.50

Sl no	Soil series	Depth (cm)	Gravel (%)	Percentage			
				Coarse sand	Fine sand	Silt	Clay
16	Pathiyoor	0-20	0.00	20.00	23.90	19.00	37.10
		20-45	0.00	14.00	20.00	28.00	38.00
		45-73	0.00	09.50	10.50	31.50	48.50
		73-115	0.00	20.00	11.30	22.20	46.50
		115-154+	0.00	21.50	27.50	14.50	36.50
17	Cherukol	0-13	0.00	23.37	65.87	2.00	8.76
		13-24	0.00	34.75	51.00	3.25	11.00
		24-66	0.00	35.63	48.64	5.20	10.53
		66-150+	0.00	36.26	38.04	4.50	21.20
18	Vettikode	0-14	0.00	8.65	12.35	24.00	55.00
		14-32	0.00	8.62	12.38	17.00	62.00
		32-115	0.00	1.00	3.70	35.30	60.00
		115-130+	0.00	2.00	5.60	42.40	50.00
19	Keerikkad	0-25	0.00	52.50	35.00	07.50	5.00
		25-40	0.00	50.50	42.00	3.00	4.50
		40-84	0.00	41.00	52.00	3.00	4.00
		84-116	0.00	38.50	53.50	3.50	4.50
		116-196+	0.00	40.50	37.50	12.00	10.00
20	Chunad	0-18	0.00	40.00	31.20	12.60	16.20
		18-34	0.00	30.50	24.00	17.50	28.00
		34-75	0.00	26.00	23.10	18.20	32.70
		75-125	0.00	20.50	19.60	21.20	38.70

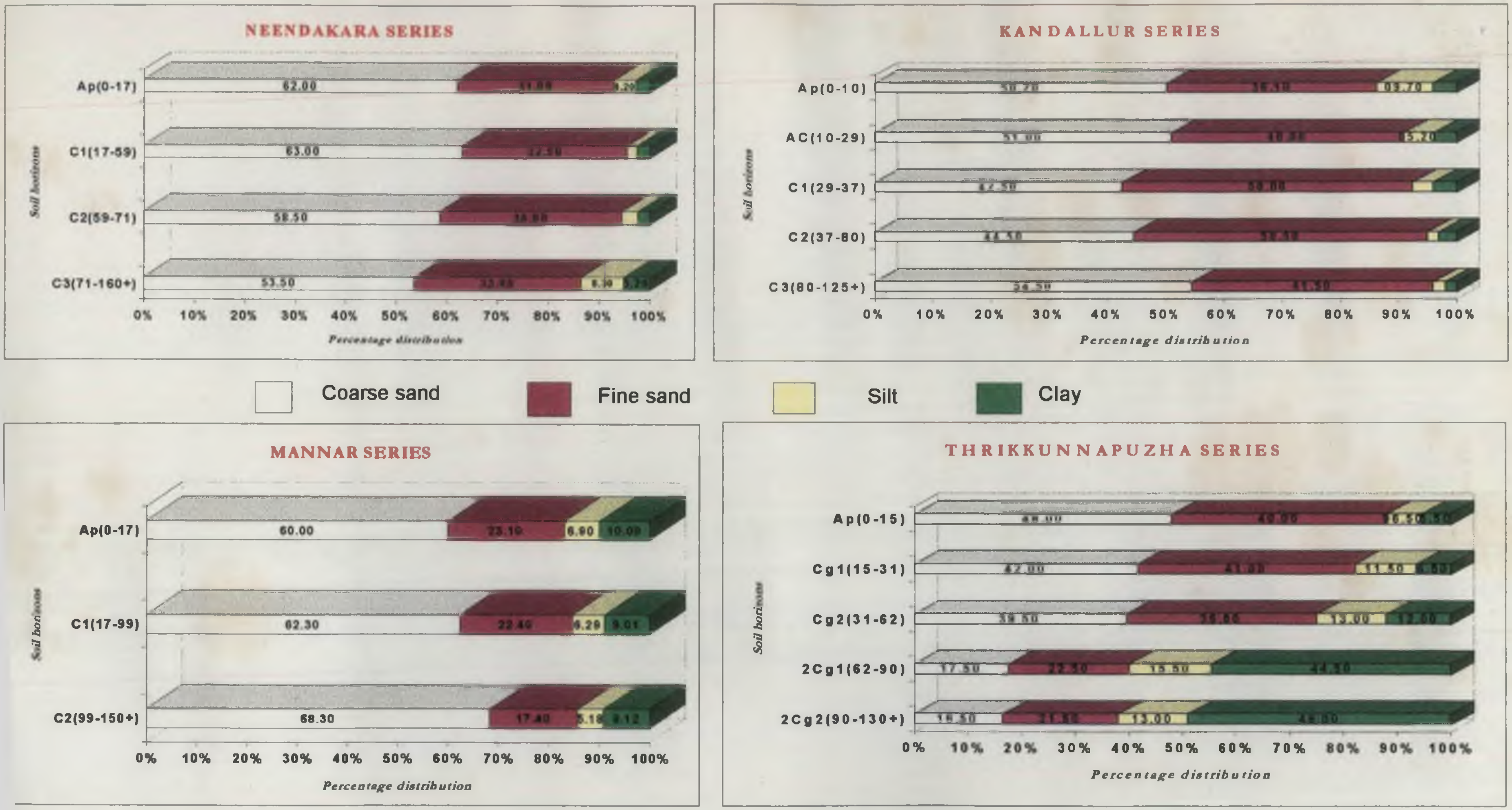
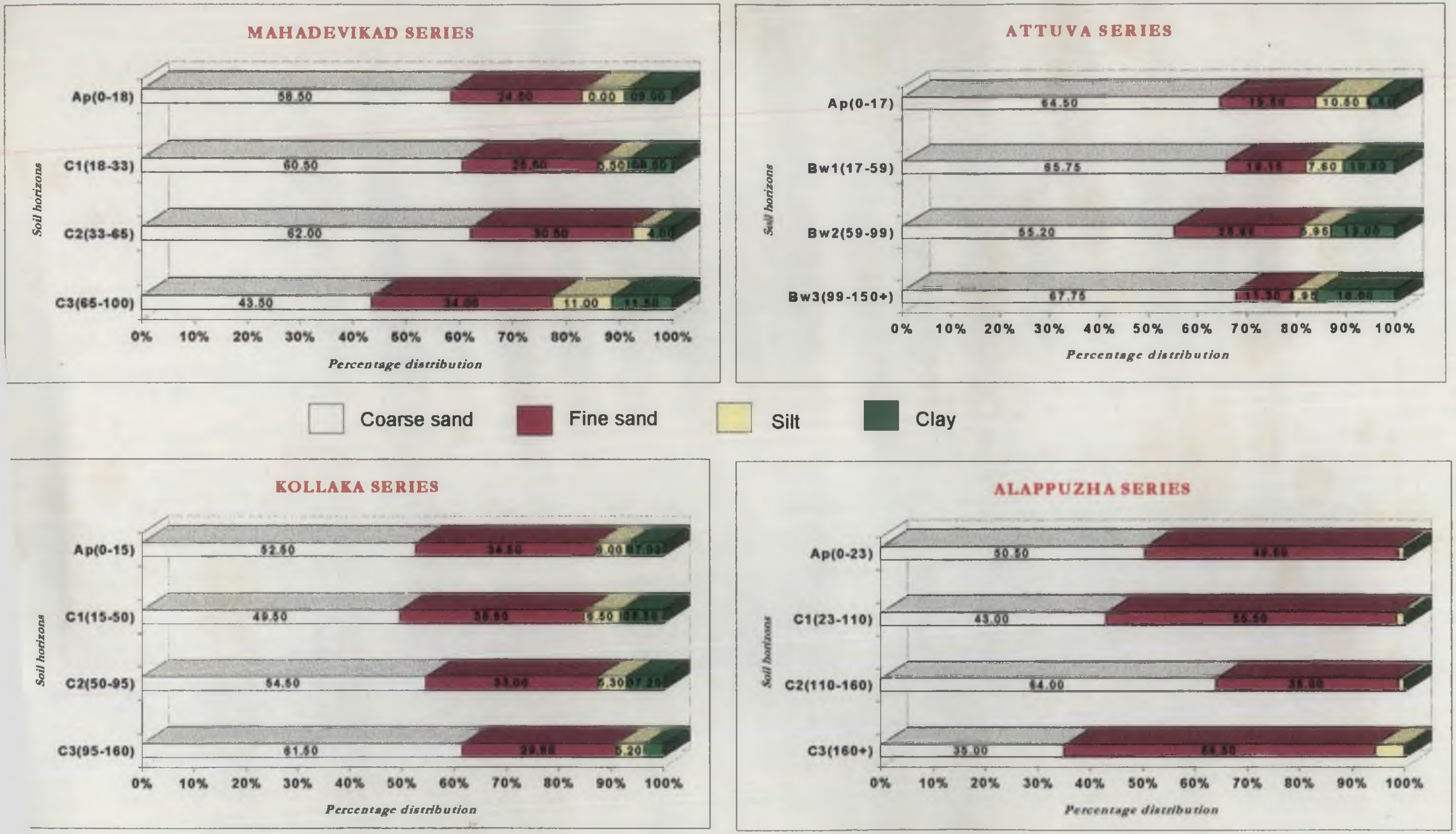
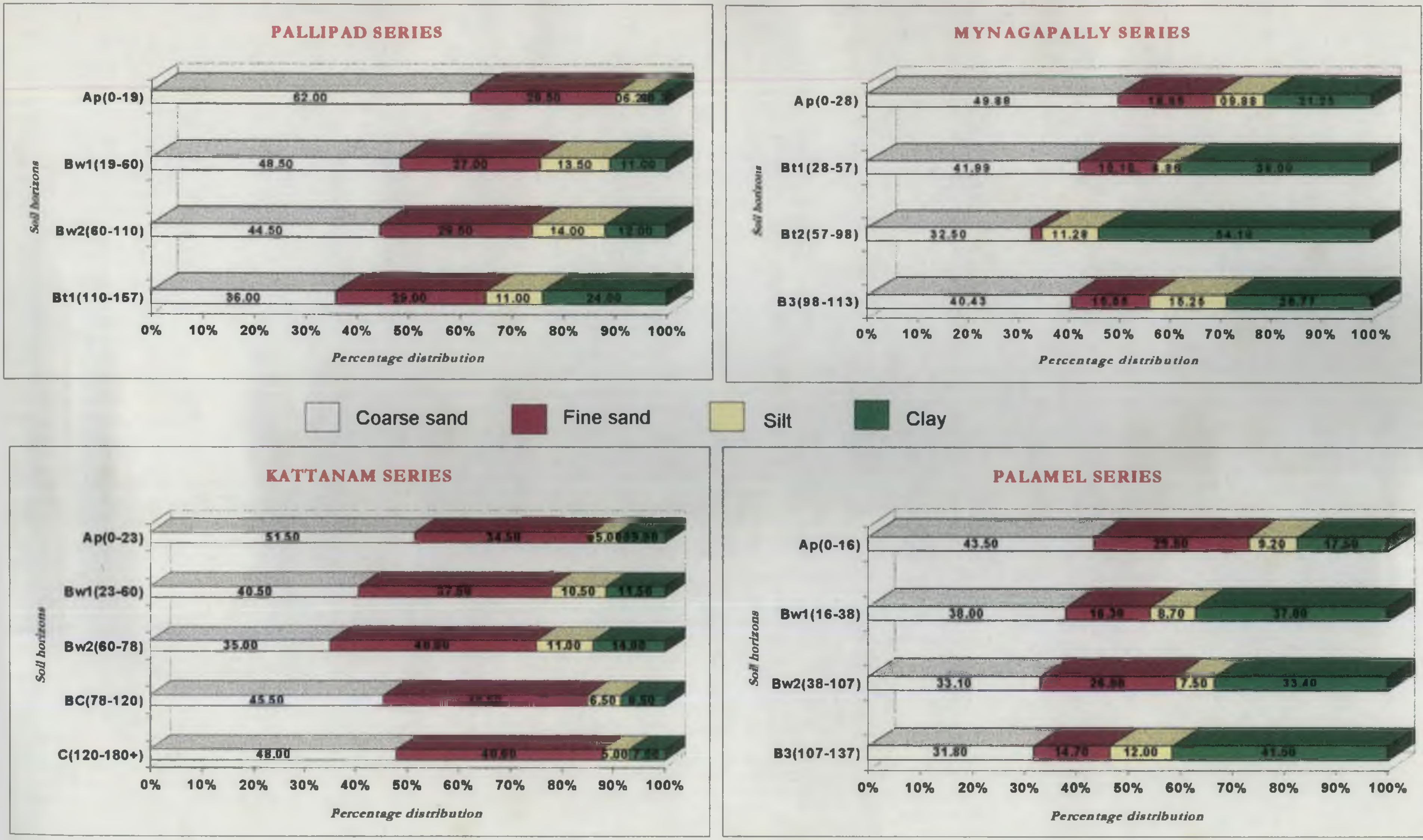
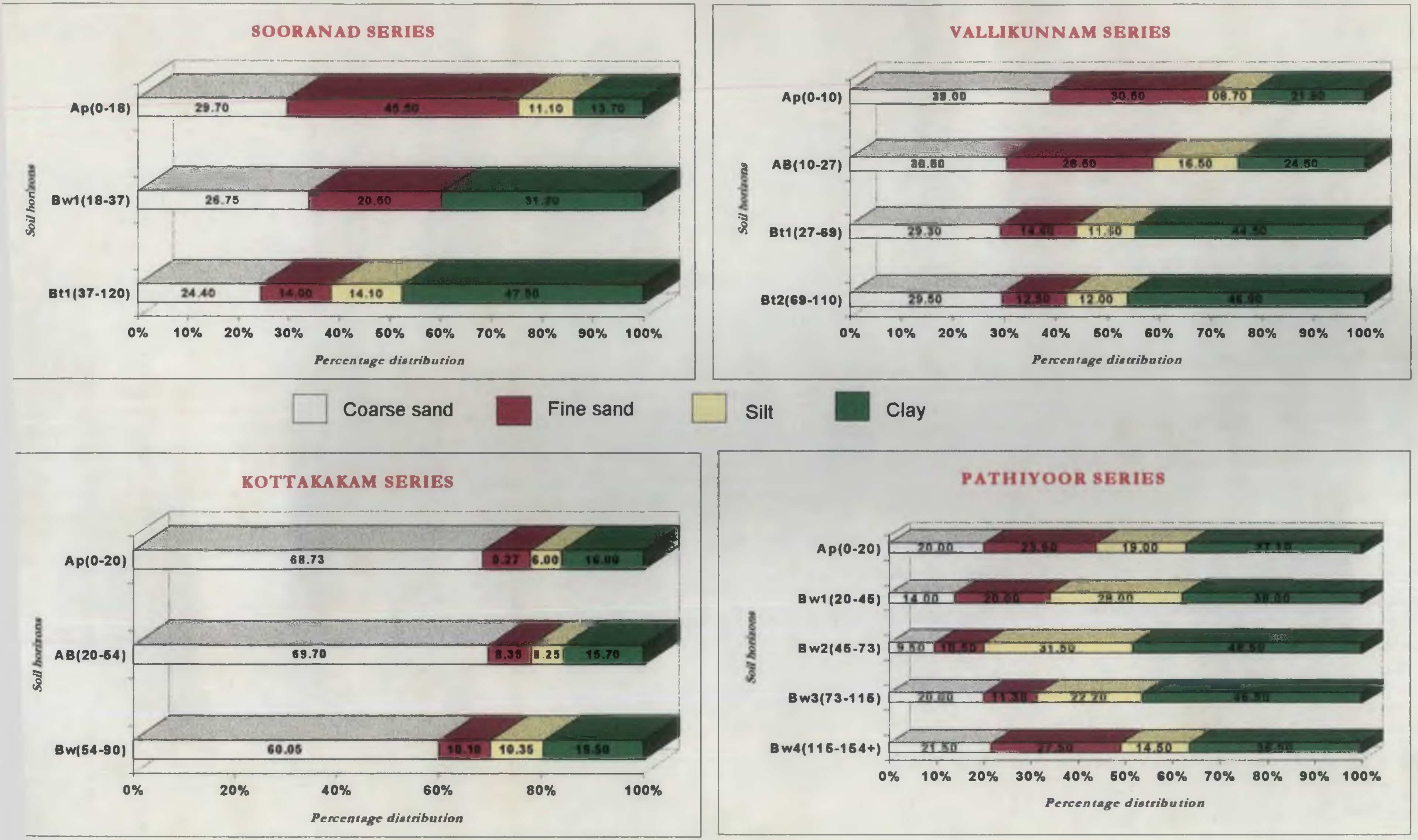
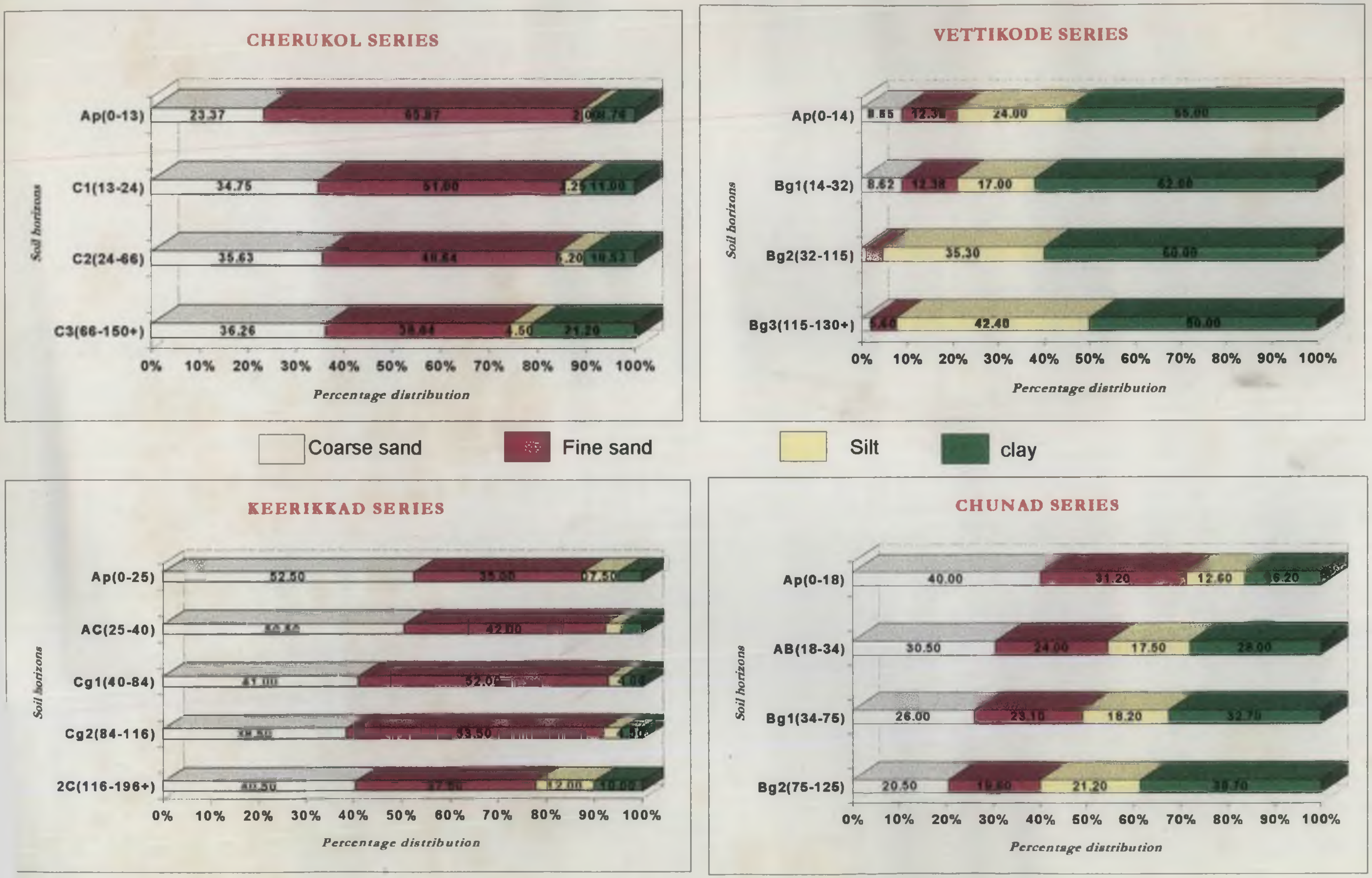


Fig.3. **Horizon wise particle size distribution of soils**


MAHADEVIKAD SERIES
Ap(0-18)
C1(18-33)
C2(33-65)
C3(65-100)
58.50
24.50
0.00
09.00
60.50
62.00
4.00
43.50
11.00
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
ATTUVA SERIES
Ap(0-17)
Bw1(17-59)
Bw2(59-99)
Bw3(99-150+)
64.50
10.50
65.75
7.60
55.20
67.75
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
Coarse sand
Fine sand
Silt
Clay
KOLLAKA SERIES
Ap(0-15)
C1(15-50)
C2(50-95)
C3(95-160)
52.50
49.50
54.50
5.30
61.50
5.20
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
ALAPPUZHA SERIES
Ap(0-23)
C1(23-110)
C2(110-160)
C3(160+)
50.50
43.00
64.00
35.00
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution


PALLIPAD SERIES
Ap(0-19)
Bw1(19-60)
Bw2(60-110)
Bt1(110-157)
62.00
48.50
27.00
13.50
44.50
14.00
36.00
11.00
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
MYNAGAPALLY SERIES
Ap(0-28)
Bt1(28-57)
Bt2(57-98)
B3(98-113)
41.99
32.50
40.43
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
Coarse sand
Fine sand
Silt
Clay
KATTANAM SERIES
Ap(0-23)
Bw1(23-60)
Bw2(60-78)
BC(78-120)
C(120-180+)
51.50
40.50
10.50
35.00
11.00
45.50
6.50
48.00
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution
PALAMEL SERIES
Ap(0-16)
Bw1(16-38)
Bw2(38-107)
B3(107-137)
43.50
38.00
8.70
33.10
7.50
33.40
31.80
12.00
Soil horizons
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percentage distribution


SOORANAD SERIES
Ap(0-18)
Bw1(18-37)
Bt1(37-120)
Soil horizons
Percentage distribution
VALLIKUNNAM SERIES
Ap(0-10)
AB(10-27)
Bt1(27-69)
Bt2(69-110)
Soil horizons
Percentage distribution
Coarse sand
Fine sand
Silt
Clay
KOTTAKAKAM SERIES
Ap(0-20)
AB(20-54)
Bw(54-90)
Soil horizons
Percentage distribution
PATHIYOOR SERIES
Ap(0-20)
Bw1(20-45)
Bw2(45-73)
Bw3(73-115)
Bw4(115-154+)
Soil horizons
Percentage distribution


CHERUKOL SERIES
Ap(0-13)
C1(13-24)
C2(24-66)
C3(66-150+)
23.37
34.75
51.00
11.00
35.63
36.26
21.20
Soil horizons
Percentage distribution
VETTIKODE SERIES
Ap(0-14)
Bg1(14-32)
Bg2(32-115)
Bg3(115-130+)
24.00
17.00
35.30
42.40
Soil horizons
Percentage distribution
Coarse sand
Fine sand
Silt
clay
KEERIKKAD SERIES
Ap(0-25)
AC(25-40)
Cg1(40-84)
Cg2(84-116)
2C(116-196+)
52.50
42.00
53.50
Soil horizons
Percentage distribution
CHUNAD SERIES
Ap(0-18)
AB(18-34)
Bg1(34-75)
Bg2(75-125)
40.00
31.20
12.60
30.50
24.00
17.50
28.00
26.00
18.20
20.50
21.20
Soil horizons
Percentage distribution
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4.2.3.2. Physico-chemical and chemical properties

The physico-chemical properties such as pH, electrical conductivity, cation exchange capacity, exchangeable cations, base saturation percentage and organic carbon percentage of the soil samples collected from the different horizons have been determined and presented in Table 14 and the average values of pH, cation exchange capacity, base saturation and organic carbon are given in Figures 4 to 7.

4.3. Preparation of soil map

The systematic soil survey of Onattukara region was carried out using Survey of India toposheets and FCC (1:50,000) of Landsat (TM) with geocoded subscene SAT 1D - IRS - IB. Based on the survey, the delineated soil boundaries are transferred planimetrically to accurate topobases for the preparation of soil maps.

The soil map showing the distribution of the identified twenty soil series in Onattukara region has been prepared along with the mapping legend and presented in Figure 8.

4.4. Collection and computation of climatological data

Onattukara region, in general, has a humid tropical climate. The climatological data for ten years from 1988 to 1997 from Central

Table 14. Physico-chemical and chemical properties

Sl no	Soil series	Depth (cm)	pH	EC dS/m	CEC cmol(+)/kg	Exchangeable cations(cmol/kg)				Base saturation %	Organic carbon %
						Ca++	Mg++	Na+	K+		
1	Neendakara	0-17	5.20	0.20	2.80	1.00	0.60	0.02	0.04	59	0.61
		17-59	5.10	0.10	3.00	0.80	0.62	0.03	0.04	49	0.32
		59-71	5.60	0.10	3.10	0.30	0.05	0.02	0.04	13	0.04
		71-160+	5.60	0.10	3.60	0.30	0.10	0.02	0.04	13	0.07
2	Kandallur	0-10	5.10	0.10	5.00	1.46	0.90	0.05	0.10	50	0.40
		10-29	5.30	0.10	4.80	1.23	0.90	0.10	0.05	47	0.23
		29-37	5.20	0.00	4.30	0.80	0.90	0.10	0.05	24	0.25
		37-80	5.30	0.10	4.10	0.61	0.06	0.02	0.01	17	0.20
		80-125+	5.60	0.10	3.60	0.50	0.07	0.03	0.01	17	0.30
3	Mannar	0-17	6.20	0.00	5.30	0.90	0.85	0.06	0.09	36	0.40
		17-99	6.30	0.00	4.80	0.80	0.70	0.04	0.06	33	0.24
		99-150+	7.00	0.00	4.40	0.60	0.80	0.03	0.04	33	0.26
4	Thrikkunnapuzha	0-15	5.40	0.10	4.90	0.08	0.97	0.06	0.01	23	0.56
		15-31	5.30	0.10	4.80	0.70	0.80	0.05	0.01	32	0.49
		31-62	5.50	0.20	6.50	1.80	0.60	0.10	0.20	41	0.61
		62-90	5.70	0.30	7.10	1.90	0.40	0.05	0.20	35	0.90
		90-130+	5.40	0.20	7.80	1.90	0.40	0.05	0.20	32	1.35

Sl no	Soil series	Depth (cm)	pH	EC dS/m	CEC cmol(+)/kg	Exchangeable cations(cmol/kg)				Base saturation %	Organic carbon %
						Ca++	Mg++	Na+	K+		
5	Mahadevikad	0-18	5.10	0.10	4.80	0.85	0.90	0.06	0.02	38	0.56
		18-33	5.30	0.10	5.30	0.88	0.79	0.05	0.03	33	0.58
		33-65	5.80	0.10	3.50	0.70	0.70	0.04	0.02	41	0.24
		65-100	5.30	0.10	4.40	0.80	0.70	0.04	0.03	36	0.36
6	Attuva	0-17	5.50	0.01	5.50	1.02	1.00	0.04	0.03	38	0.63
		17-59	5.60	0.04	5.80	1.15	1.10	0.04	0.03	41	0.58
		59-99	5.50	0.02	6.00	1.15	1.13	0.05	0.04	40	0.54
		99-150+	5.80	0.04	6.20	1.20	1.10	0.09	0.08	40	0.47
7	Kollaka	0-15	4.70	0.00	5.00	1.46	0.90	0.05	0.10	50	0.40
		15-50	4.60	0.00	4.80	1.23	0.90	0.10	0.05	47	0.23
		50-95	5.20	0.00	4.30	0.80	0.90	0.10	0.05	24	0.25
		95-160	5.30	0.00	4.10	0.61	0.06	0.02	0.01	17	0.20
8	Alappuzha	0-23	6.50	0.01	1.40	0.08	0.04	0.02	0.01	11	0.38
		23-110	6.60	0.01	2.40	0.10	0.09	0.07	0.06	13	0.23
		110-160	6.60	0.01	1.40	0.21	0.14	0.03	0.03	29	0.23
		160+	6.40	0.01	1.70	0.15	0.10	0.03	0.02	18	1.91

Sl no	Soil series	Depth (cm)	pH	EC dS/m	CEC cmol(+)/kg	Exchangeable cations(cmol/kg)				Base saturation %	Organic carbon %
						Ca++	Mg++	Na+	K+		
9	Pallipad	0-19	5.30	0.04	5.00	0.80	0.95	0.01	0.07	37	0.65
		19-60	5.50	0.01	4.80	0.95	0.96	0.06	0.07	43	0.42
		60-110	5.70	0.01	4.90	0.94	0.95	0.05	0.07	42	0.31
		110-157	5.80	0.02	4.80	0.95	0.96	0.06	0.06	43	0.29
10	Mynagapally	0-28	4.80	0.04	6.00	0.94	0.96	0.20	0.06	36	0.85
		28-57	5.00	0.02	4.80	0.95	0.96	0.06	0.07	43	0.85
		57-98	5.10	0.01	4.30	0.80	0.81	0.01	0.01	38	0.54
		98-113	4.50	0.01	3.90	0.60	0.65	0.02	0.01	33	0.31
11	Kattanam	0-23	5.10	0.10	3.70	0.90	0.75	0.01	0.01	45	0.51
		23-60	5.20	0.10	4.50	1.20	1.10	0.02	0.01	52	0.32
		60-78	5.10	0.10	4.60	1.30	1.15	0.02	0.02	54	0.41
		78-120	5.30	0.10	4.20	1.10	1.10	0.02	0.02	53	0.21
		120-180+	5.40	0.00	3.40	0.65	0.44	0.04	0.02	34	0.23
12	Palamel	0-16	5.50	0.00	3.70	0.90	0.75	0.01	0.01	45	1.13
		16-38	5.30	0.00	4.50	1.10	0.80	0.05	0.04	44	0.89
		38-107	6.30	0.00	4.70	1.20	0.90	0.05	0.03	46	0.85
		107-137	6.10	0.00	5.10	1.10	0.90	0.04	0.05	41	0.65

Sl no	Soil series	Depth (cm)	pH	EC dS/m	CEC cmol(+)/kg	Exchangeable cations(cmol/kg)				Base saturation %	Organic carbon %
						Ca++	Mg++	Na+	K+		
13	Sooranad	0-18	5.90	0.00	3.90	0.52	0.73	0.06	0.02	35	0.44
		18-37	4.90	0.00	4.50	0.95	0.96	0.06	0.07	46	0.45
		37-120	6.00	0.00	5.60	0.10	0.82	0.05	0.04	18	0.37
14	Vallikunnam	0-10	5.40	0.02	5.50	1.60	0.97	0.04	0.21	51	0.90
		10-27	5.10	0.01	5.20	0.91	0.72	0.04	0.09	34	0.75
		27-69	5.30	0.01	4.90	0.68	0.47	0.05	0.09	26	0.63
		69-110	5.20	0.02	5.00	0.94	0.79	0.05	0.08	37	0.32
15	Kottakakam	0-20	5.40	0.80	5.20	0.85	0.95	0.02	0.08	37	0.98
		20-54	4.40	0.60	3.80	0.80	0.76	0.01	0.05	43	0.29
		54-90	4.20	0.80	4.20	0.72	0.63	0.01	0.02	33	0.27
16	Pathiyoor	0-20	5.40	0.10	6.70	1.25	0.71	0.12	0.41	37	0.75
		20-45	5.20	0.10	9.40	1.32	0.71	0.13	0.57	29	0.76
		45-73	5.10	0.20	10.50	1.34	0.76	0.11	0.52	26	0.78
		73-115	5.00	0.10	12.30	1.52	0.78	0.35	0.42	25	0.85
		115-154 +	4.90	0.10	10.50	1.30	0.71	0.32	0.35	26	1.10

Sl no	Soil series	Depth (cm)	pH	EC dS/m	CEC cmol(+)/kg	Exchangeable cations(cmol/kg)				Base saturation %	Organic carbon %
						Ca++	Mg++	Na+	K+		
17	Cherukol	0-13	4.90	0.01	3.60	0.54	0.46	0.03	0.01	29	0.25
		13-24	5.20	0.02	3.10	0.47	0.42	0.04	0.03	31	0.16
		24-66	5.20	0.01	3.40	0.65	0.44	0.04	0.02	34	0.23
		66-150+	5.60	0.01	3.30	0.55	0.40	0.02	0.02	30	0.12
18	Vettikode	0-14	5.70	0.02	5.30	0.90	0.70	0.20	0.06	35	2.24
		14-32	4.90	0.03	6.30	0.90	0.80	0.30	0.08	33	2.20
		32-115	5.80	0.05	6.70	0.80	1.10	0.30	0.08	34	2.14
		115-130+	5.40	0.02	5.40	0.70	1.00	0.20	0.06	36	2.04
19	Keerikkad	0-25	5.10	0.90	5.30	0.90	0.85	0.06	0.10	36	0.43
		25-40	5.20	0.80	5.00	0.08	0.97	0.06	0.01	23	0.29
		40-84	5.90	0.90	3.60	0.54	0.46	0.03	0.01	29	0.48
		84-116	5.80	0.90	3.60	0.52	0.48	0.02	0.02	29	0.24
		116-196+	5.40	0.70	3.40	0.66	0.43	0.05	0.01	34	0.24
20	Chunad	0-18	4.90	0.10	3.10	0.16	0.25	0.17	0.22	25	0.90
		18-34	5.20	0.10	8.70	1.44	2.04	0.22	0.21	45	0.53
		34-75	4.40	0.10	11.80	1.94	3.13	0.23	0.28	47	0.38
		75-125	4.20	0.10	9.30	1.47	2.73	0.24	0.34	51	0.19

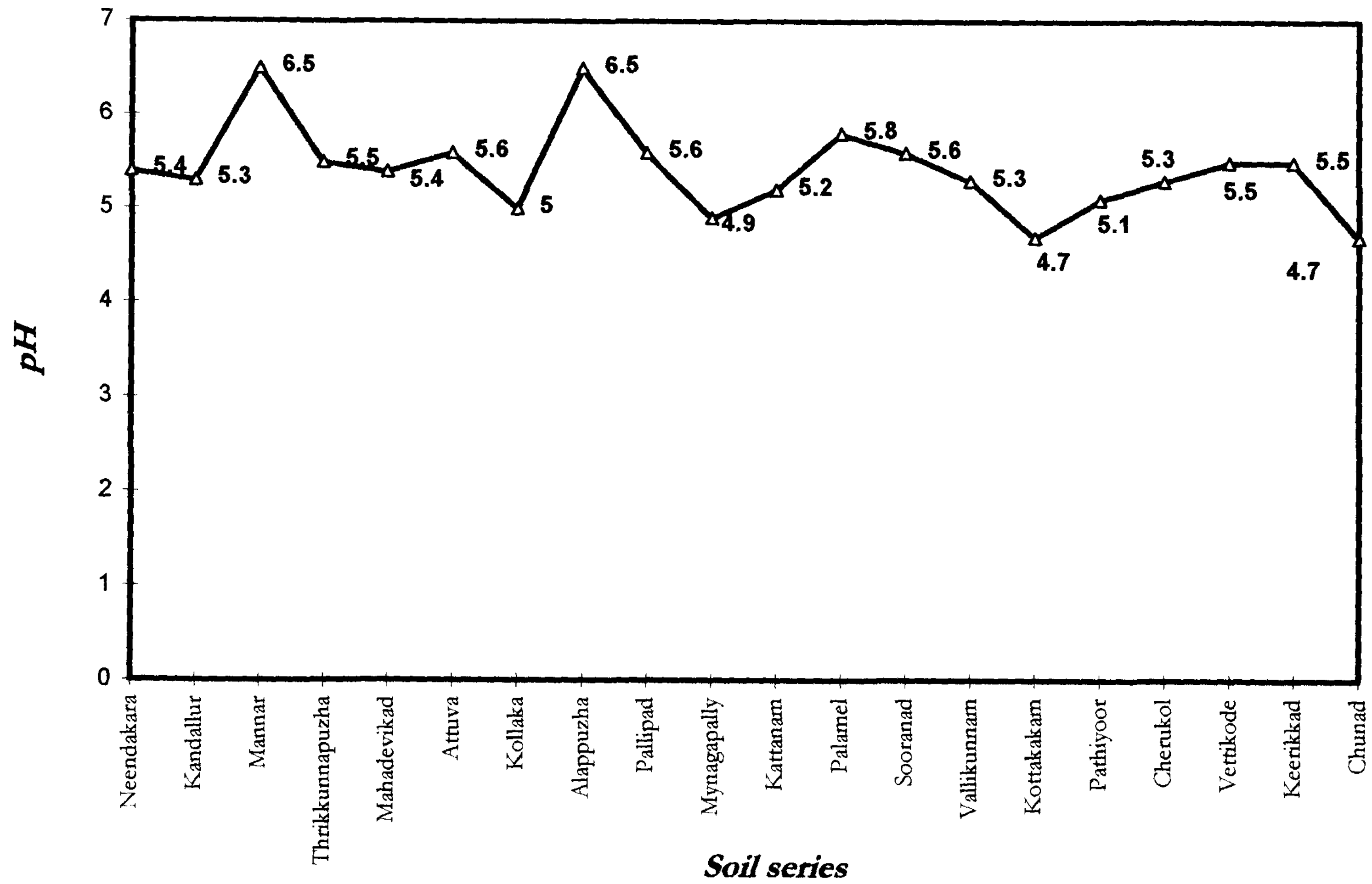


Fig.4. **Average pH of soils**

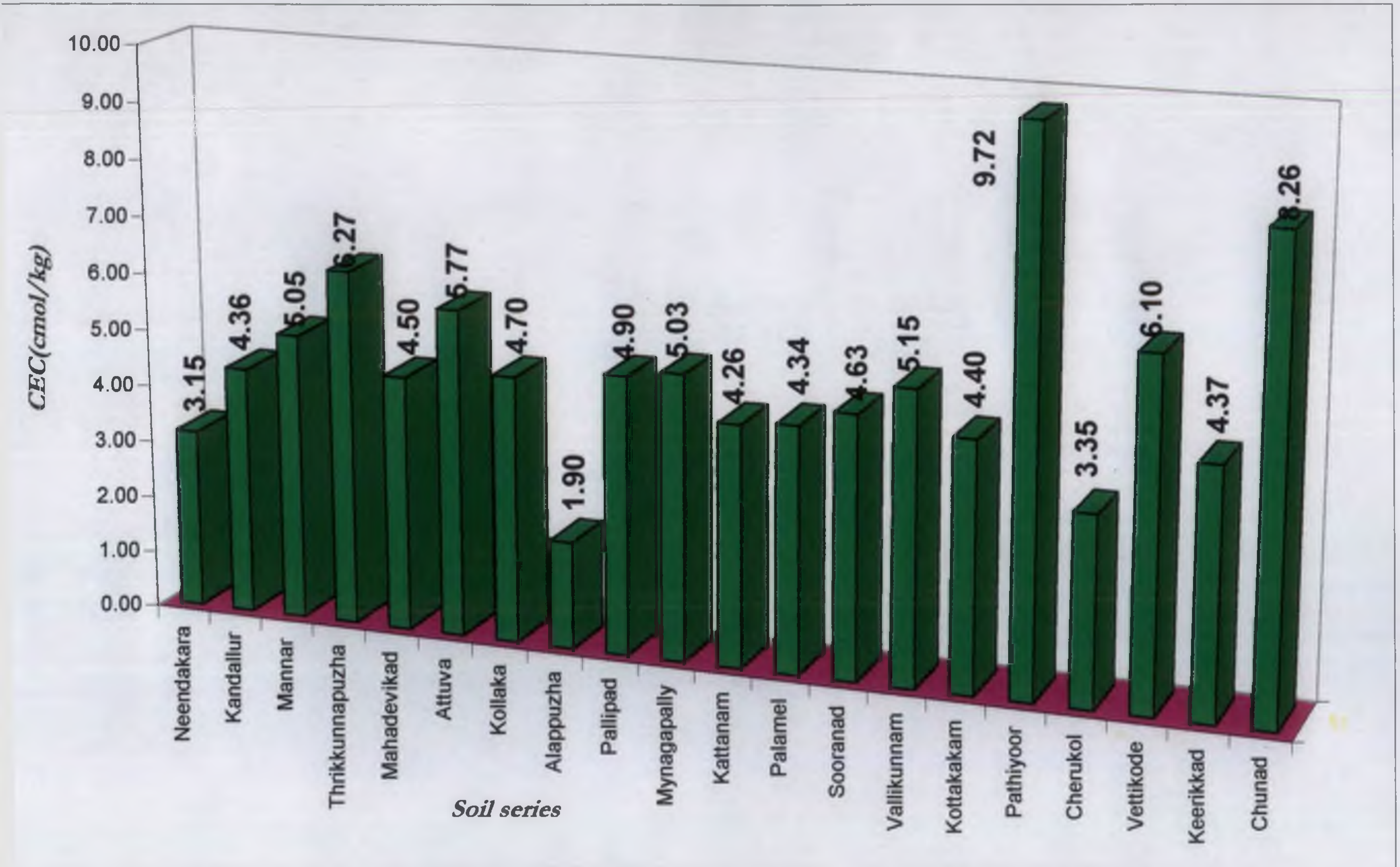


Fig.5. **Cation exchange capacity of soils**

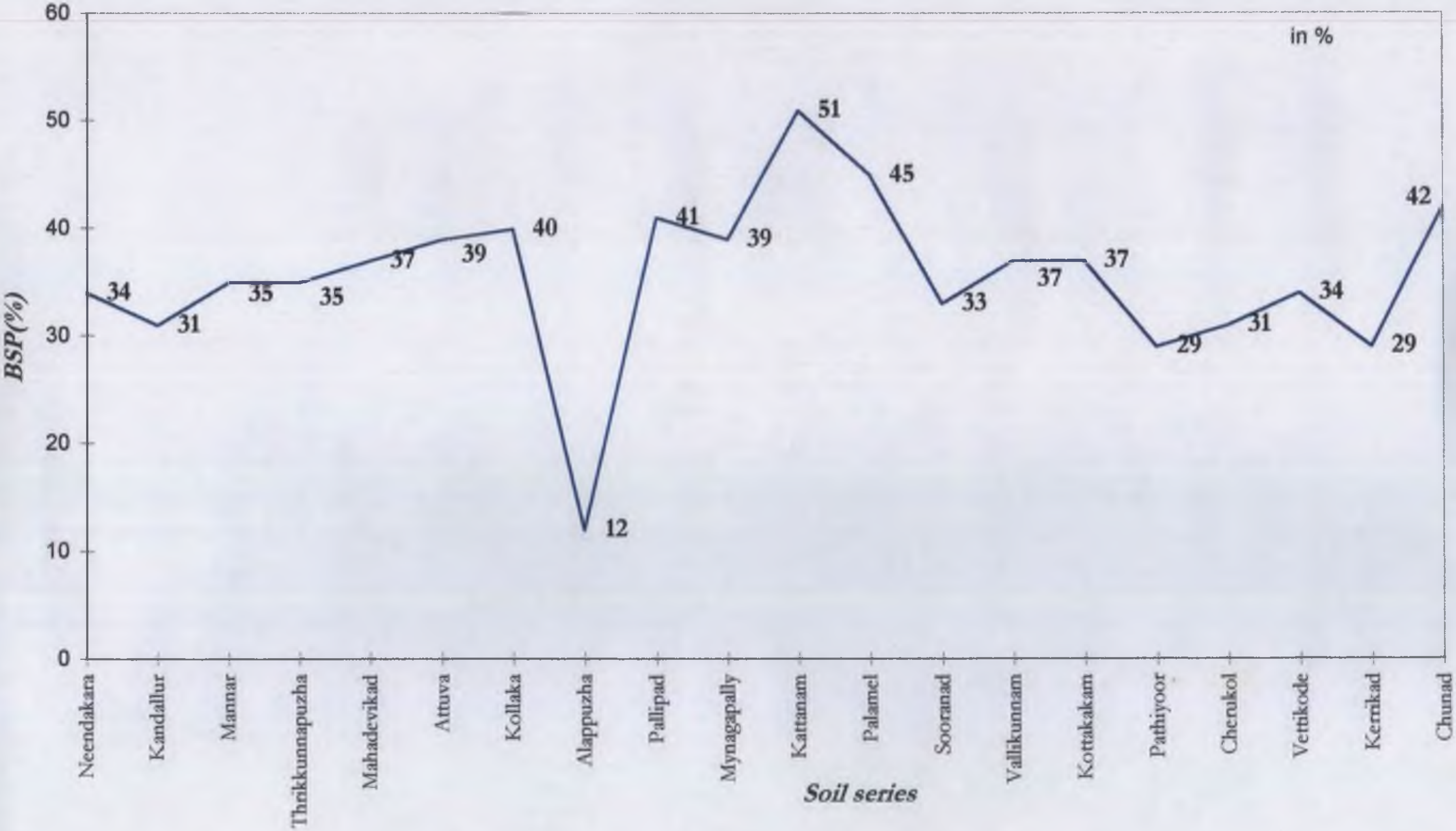


Fig.6. **Average base saturation percentage of soils**

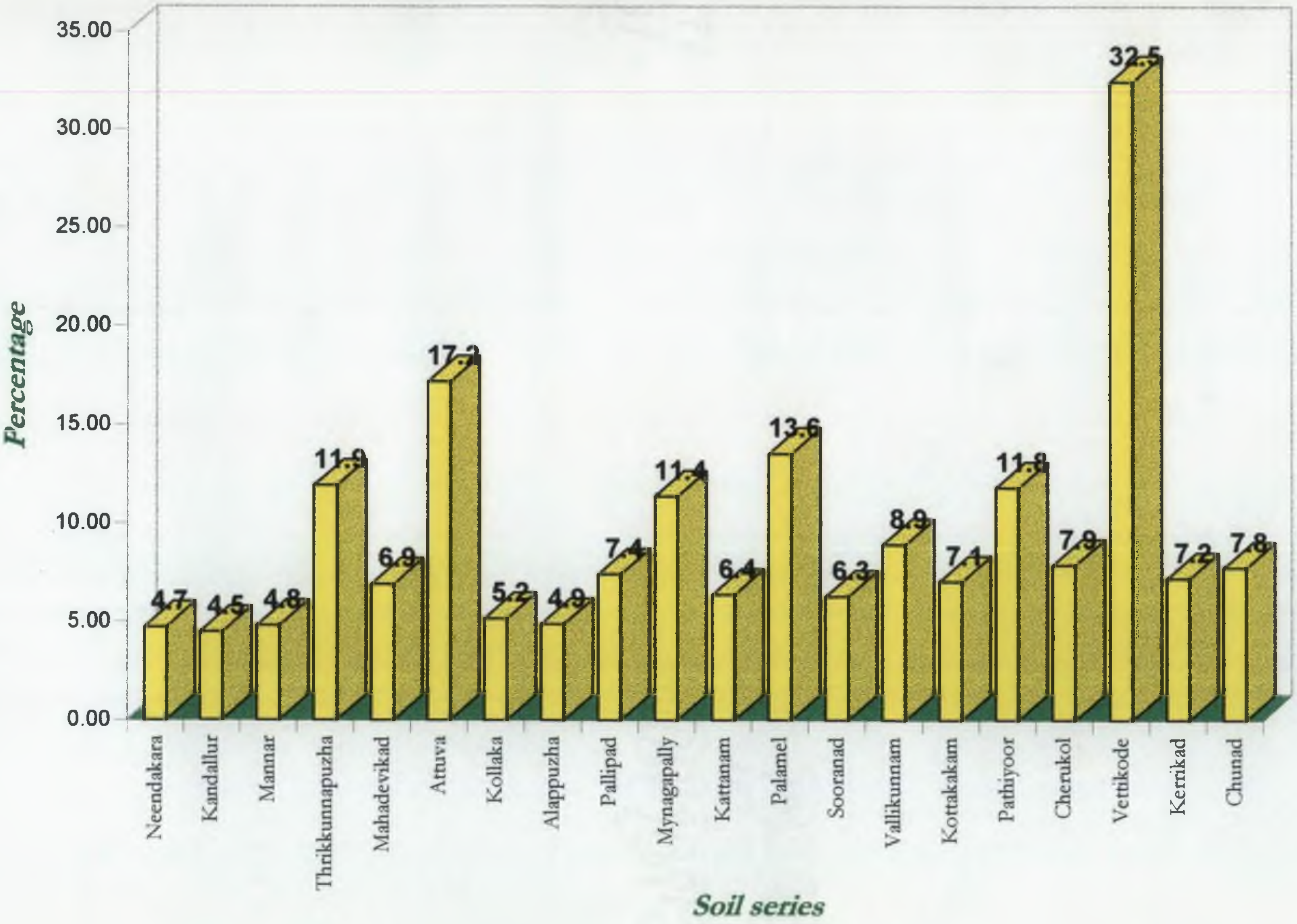


Fig.7. **Organic carbon content of soils**

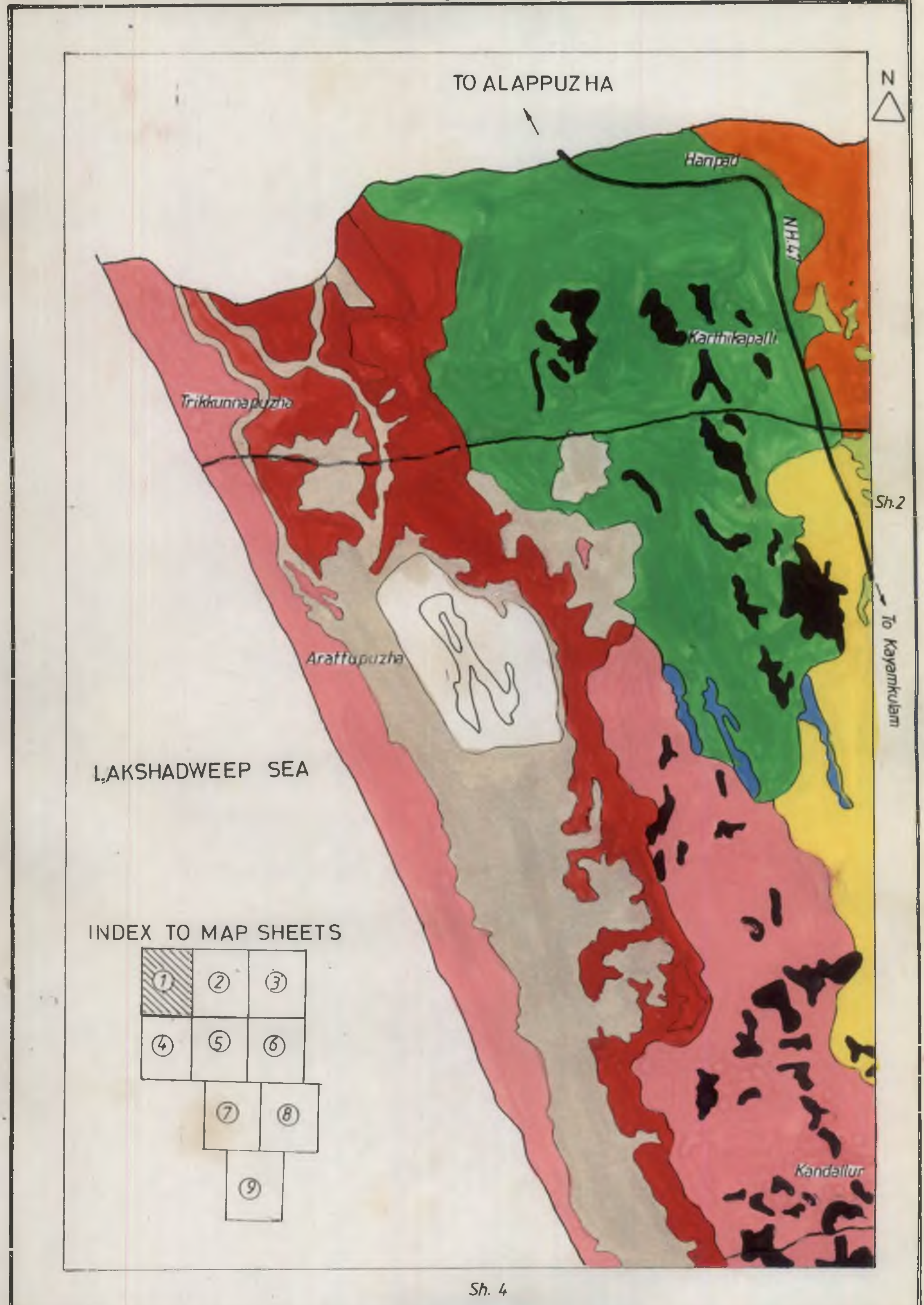
ONATTUKARA SOILS

LEGEND

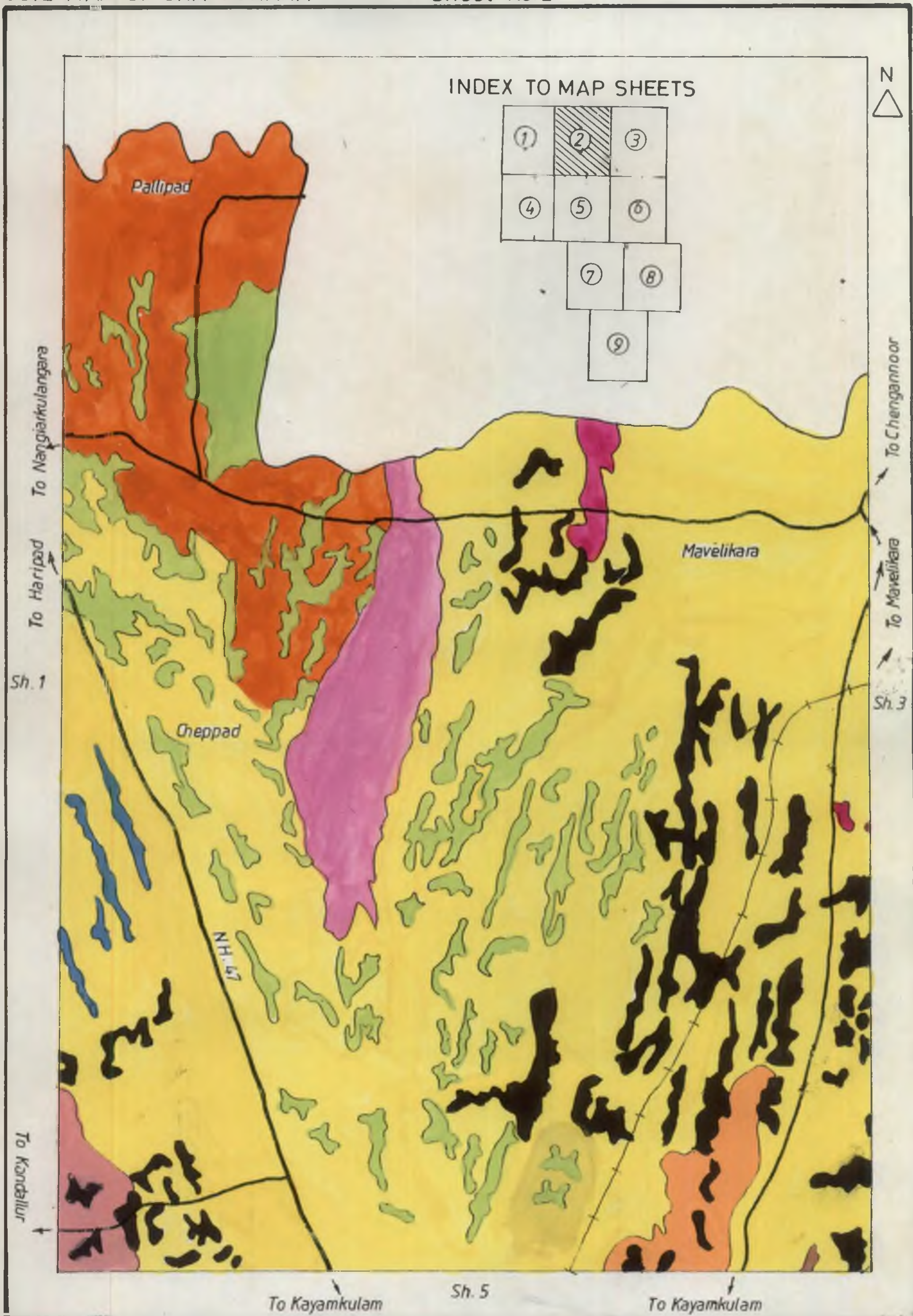
- Neendakara
- Kandallur
- Mannar
- Thrikkunnapuzha
- Mahadevikad
- Attuva
- Kollaka
- Alappuzha
- Pallipad
- Mynagapally
- Kattanam
- Palamel
- Sooranad
- Vallikunnam
- Kottakakam
- Pathiyoor
- Cherukol
- Vettikode
- Keerikkad
- Chunad

LOCATION OF ONATTUKARA

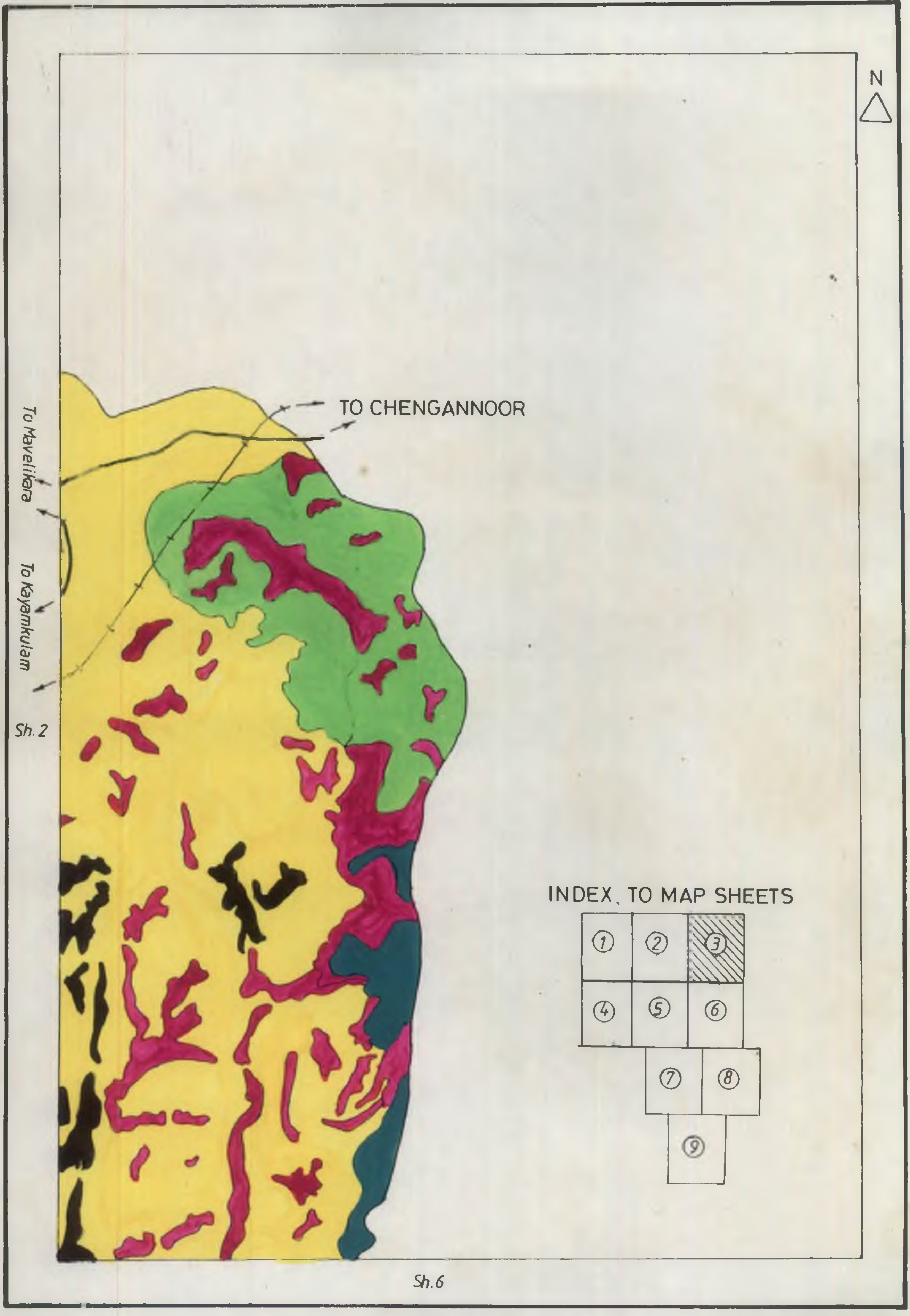
SOIL MAP OF ONATTUKARA Sheet No.1 SCALE 1:50000



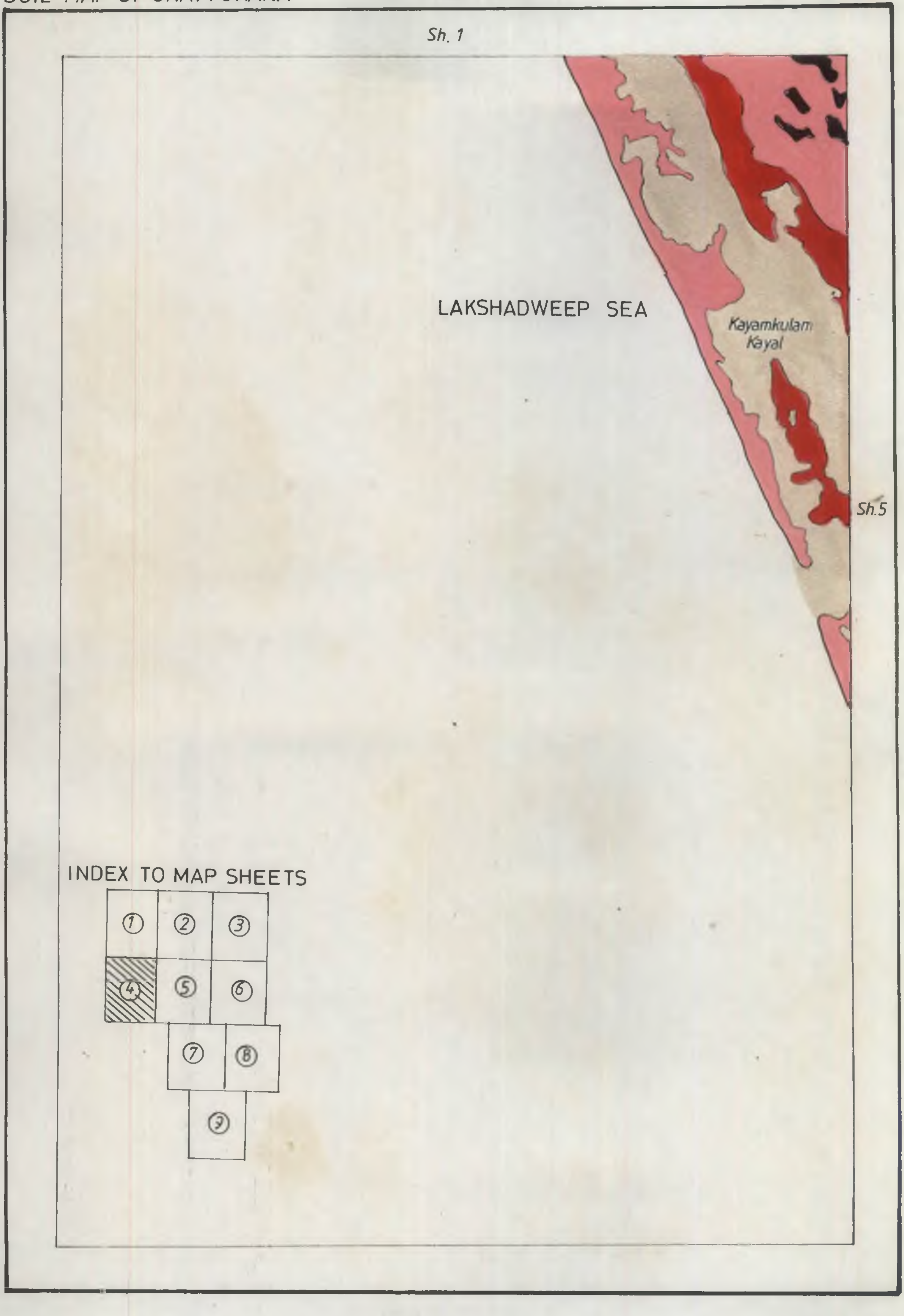
SOIL MAP OF ONATTUKARA Sheet No. 2 SCALE 1:50000



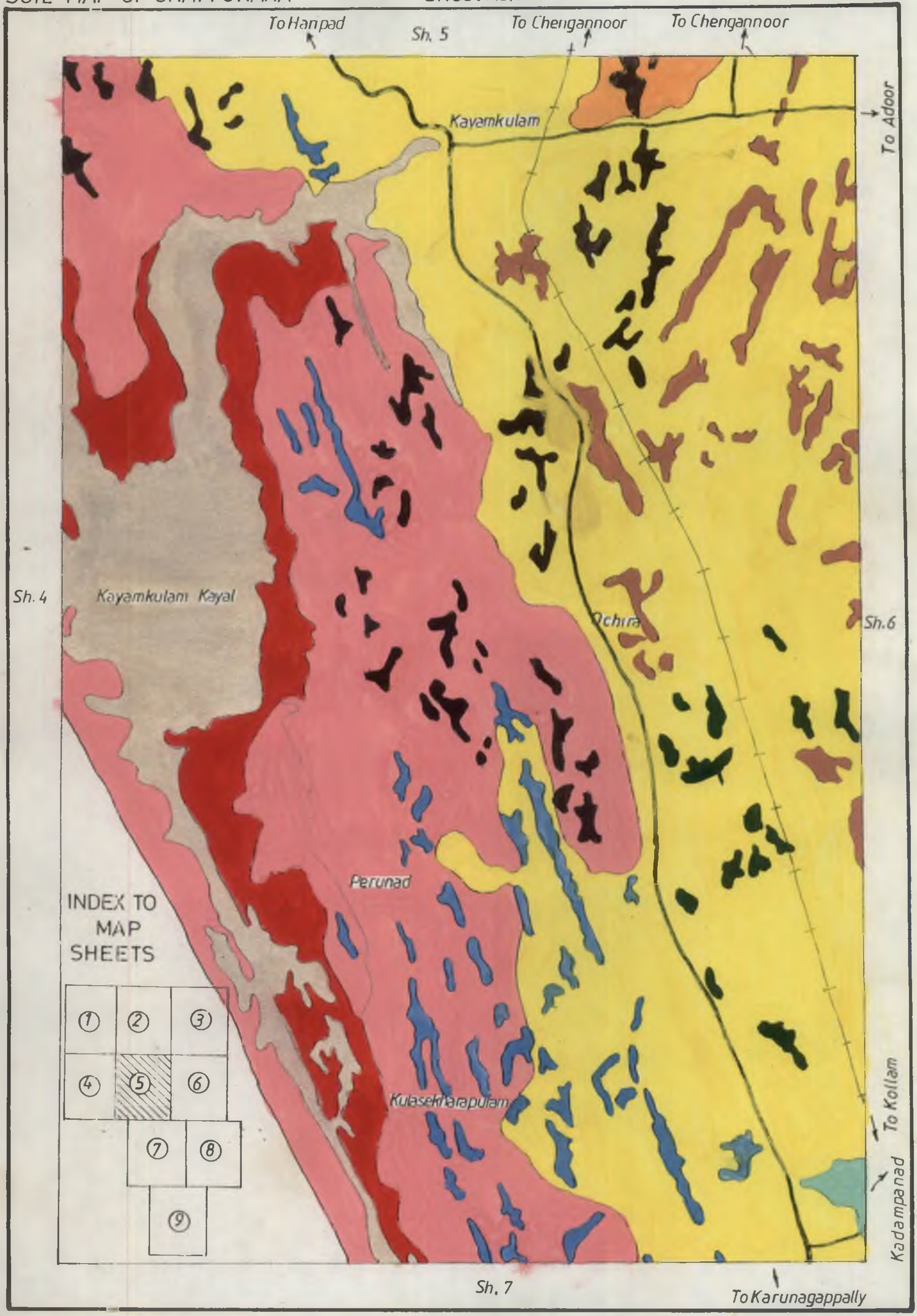
SOIL MAP OF ONATTUKARA Sheet No.3 SCALE 1:50000



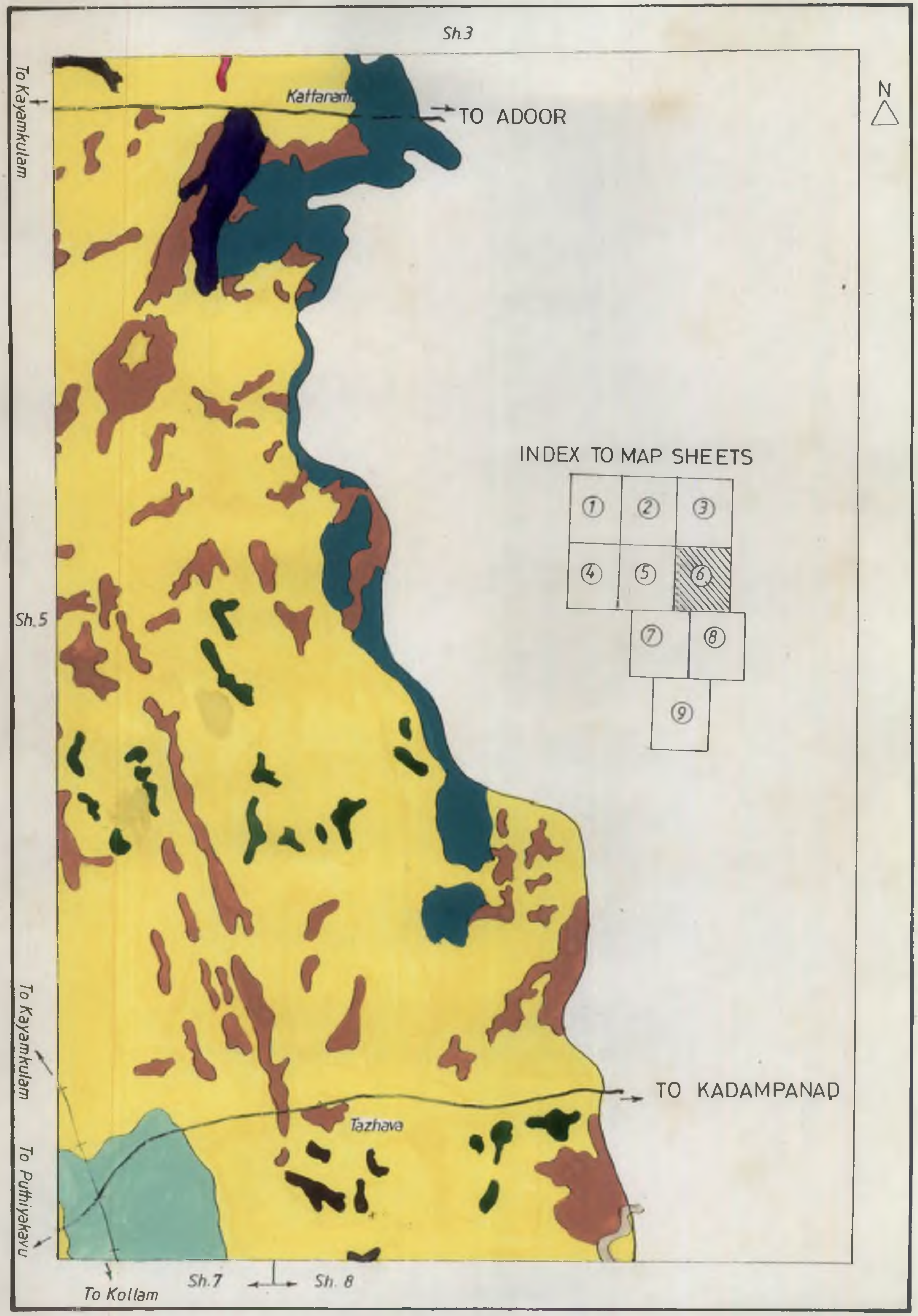
SOIL MAP OF ONATTUKARA Sheet No.4 SCALE 1 50000



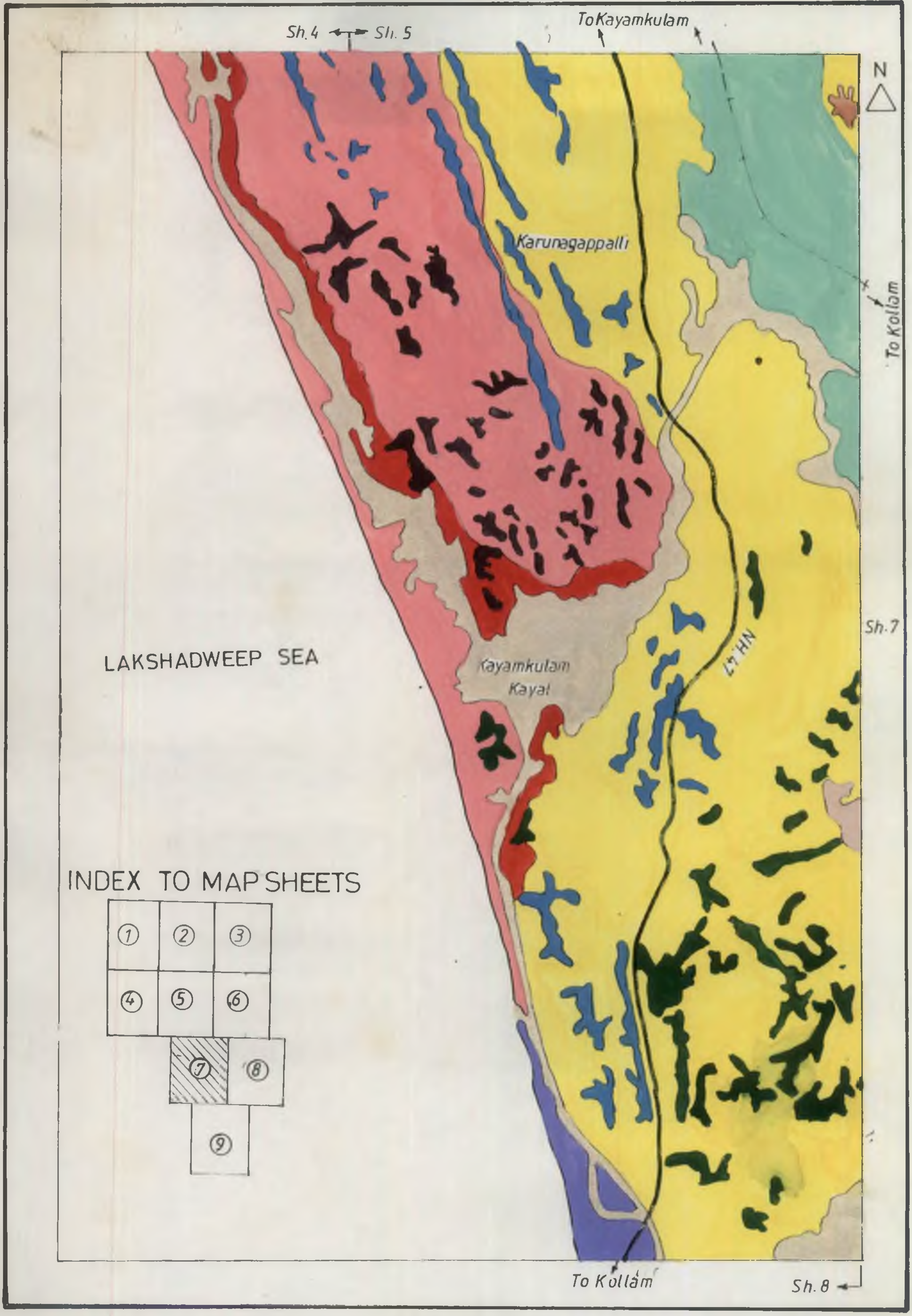
SOIL MAP OF ONATTUKARA Sheet No.5 SCALE 1:50000



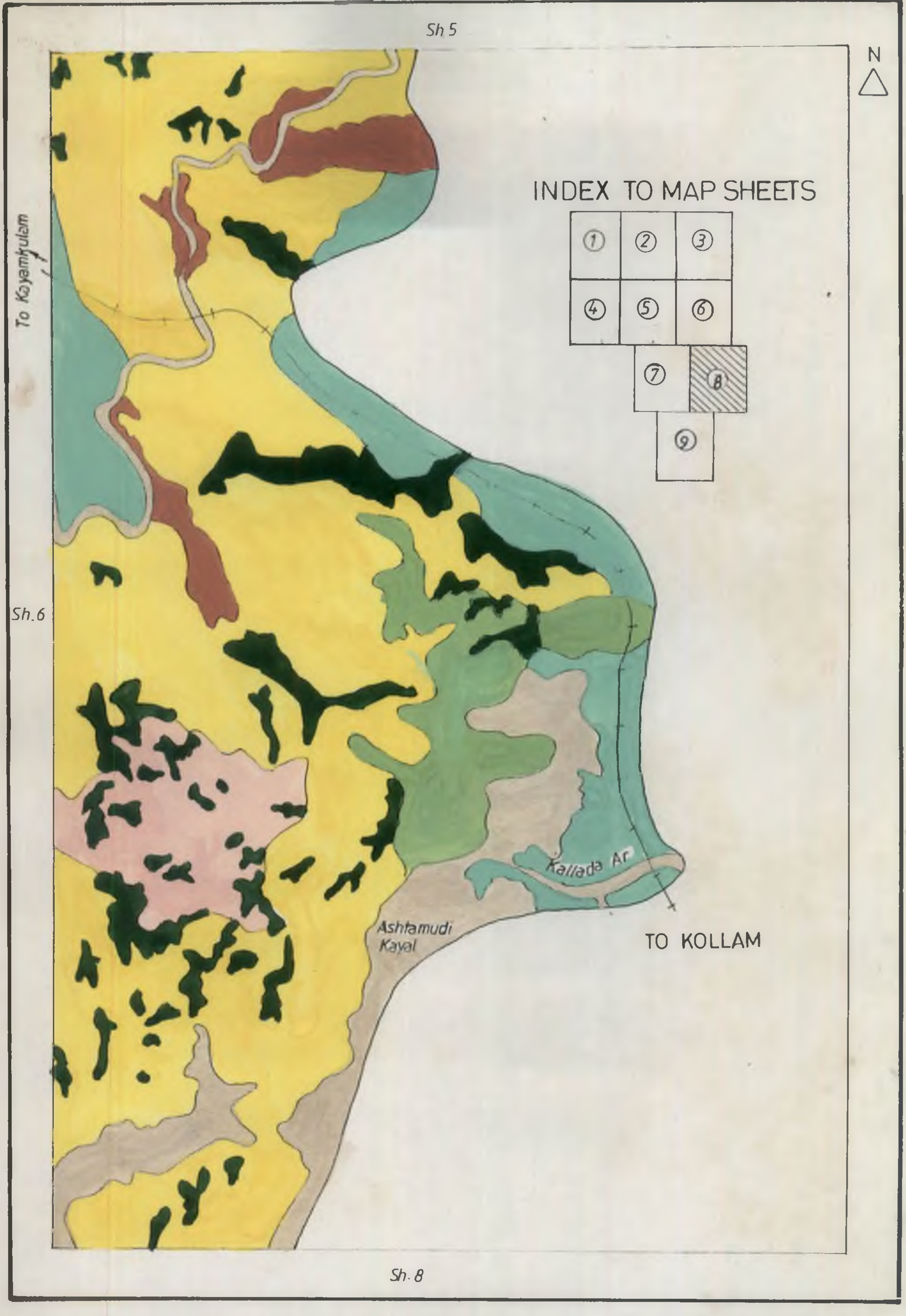
SOIL MAP OF ONATTUKARA Sheet No. 6 SCALE 1:50000



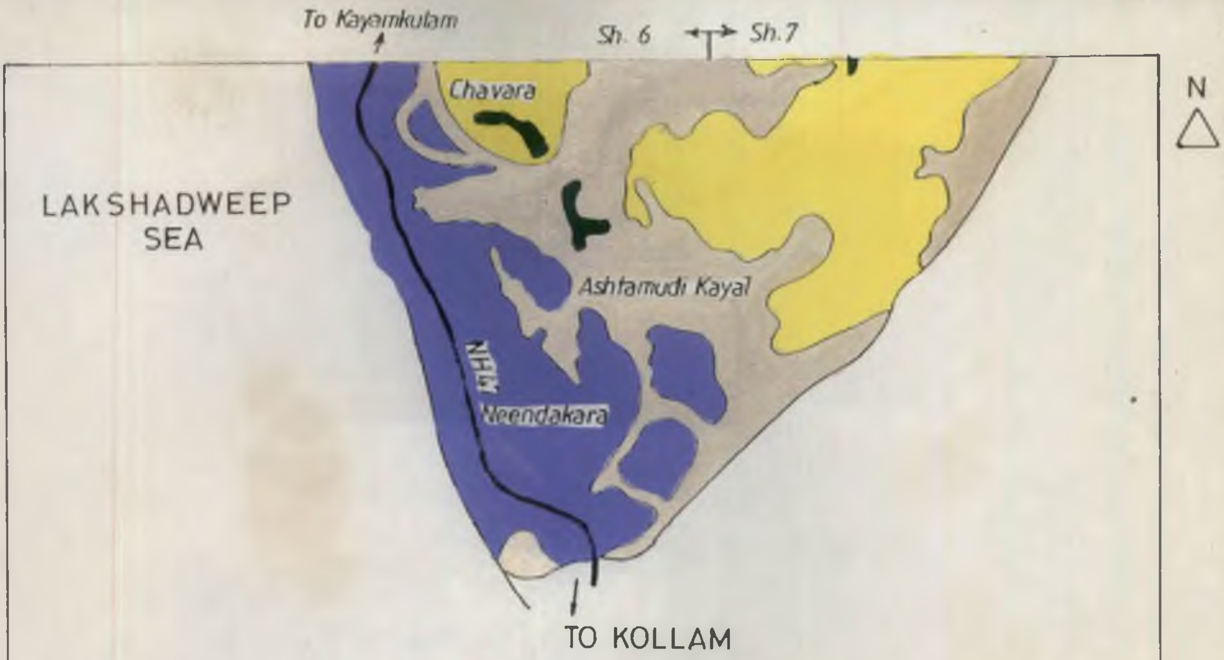
SOIL MAP OF ONATTUKARA Sheet No.7 SCALE 1:50000



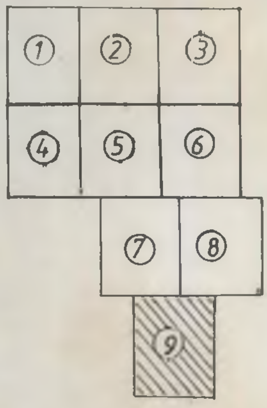
SOIL MAP OF ONATTUKARA Sheet No 8 SCALE 1:50000



SOIL MAP OF ONATTUKARA Sheet No.9 SCALE 1: 50000



INDEX TO MAP SHEETS



Plantation Crops Research Institute, Kayamkulam were collected and compiled for further interpretation. The data on rainfall, temperature, humidity, sunshine hours, wind velocity and evaporation were collected, tabulated and presented in Tables 15 to 20 and Figures 9 to 14.

4.5. Computation of available water content

The data on available water content (AWC) of the soils help to assess the length of farming season, predict drought, water budgeting and planning irrigation.

The available water content studies are more relevant during summer season since AWC of most of the soils are low to medium. The available water content (AWC) for the twenty soil series of the Onattukara region was determined to estimate the moisture storage capacity of these soils. The derived data on available water content of the twenty soil series are presented in Table 21 and Figure 15.

4.6. Soil classification

Taxonomic soil classification has two basic functions. First, it identifies, organizes and names soils in an orderly fashion and stimulates the revelation and formulation of relationships within the soil population. Second, it serves as a base for the application of soil

Table 15 **Rainfall**

n.rain.days: number of rainy days (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
1988	00.00	48.60	89.00	144.50	317.60	339.20	588.20	263.90	658.60	54.00	48.90	23.20	2575.7
n.rain.days	*0*	*3*	*3*	*8*	*10*	*24*	*18*	*19*	*22*	*6*	*5*	*2*	*120*
1989	11.00	00.00	14.20	147.50	211.60	613.40	432.10	233.20	252.00	369.30	27.40	08.20	2319.9
n.rain.days	*1*	*0*	*2*	*9*	*12*	*27*	*19*	*16*	*13*	*20*	*3*	*2*	*124*
1990	32.80	04.40	15.00	83.00	657.70	356.00	585.00	89.40	79.20	352.50	42.70	02.90	2300.6
n.rain.days	*2*	*1*	*2*	*5*	*21*	*19*	*26*	*10*	*4*	*20*	*3*	*1*	*114*
1991	00.00	07.20	20.00	88.90	291.10	1214.90	527.80	297.00	12.90	248.80	11.50	01.00	2721.1
n.rain.days	*0*	*1*	*4*	*8*	*9*	*28*	*22*	*15*	*1*	*17*	*3*	*0*	*108*
1992	00.00	02.60	00.00	140.10	313.20	651.60	580.90	680.80	280.60	345.10	289.90	00.00	3284.8
n.rain.days	*0*	*0*	*0*	*6*	*12*	*23*	*27*	*19*	*14*	*11*	*11*	*0*	*123*
1993	00.00	02.00	13.50	63.00	251.20	572.50	747.60	137.00	96.40	502.30	347.30	61.00	2793.8
n.rain.days	*0*	*0*	*2*	*6*	*11*	*20*	*26*	*13*	*10*	*17*	*10*	*4*	*119*

Source : Central Plantation Crops Research Institute, Kayamkulam

n.rain.days: number of rainy days (mm)

Year	Months												Total
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	
1994	06.10	64.70	04.60	111.40	392.80	365.40	737.40	263.00	123.40	768.40	110.60	00.00	2947.8
n.rain.days	*1*	*1*	*0*	*7*	*14*	*19*	*25*	*16*	*9*	*24*	*5*	*0*	*121*
1995	24.20	04.40	96.10	301.50	191.70	455.30	372.40	317.30	221.10	170.70	142.90	01.00	2298.6
n.rain.days	*1*	*1*	*2*	*17*	*9*	*22*	*18*	*19*	*11*	*14*	*9*	*0*	*123*
1996	30.60	00.00	21.00	101.80	50.80	415.10	358.10	123.20	261.10	266.20	153.40	58.50	1839.8
n.rain.days	*1*	*0*	*2*	*8*	*4*	*17*	*26*	*14*	*17*	*15*	*8*	*5*	*117*
1997	00.00	04.90	47.90	109.80	84.30	559.60	579.60	342.80	431.70	417.90	240.80	153.30	2972.6
n.rain.days	*0*	*1*	*3*	*7*	*7*	*14*	*28*	*14*	*14*	*14*	*14*	*7*	*123*

Source : Central Plantation Crops Research Institute, Kayamkulam

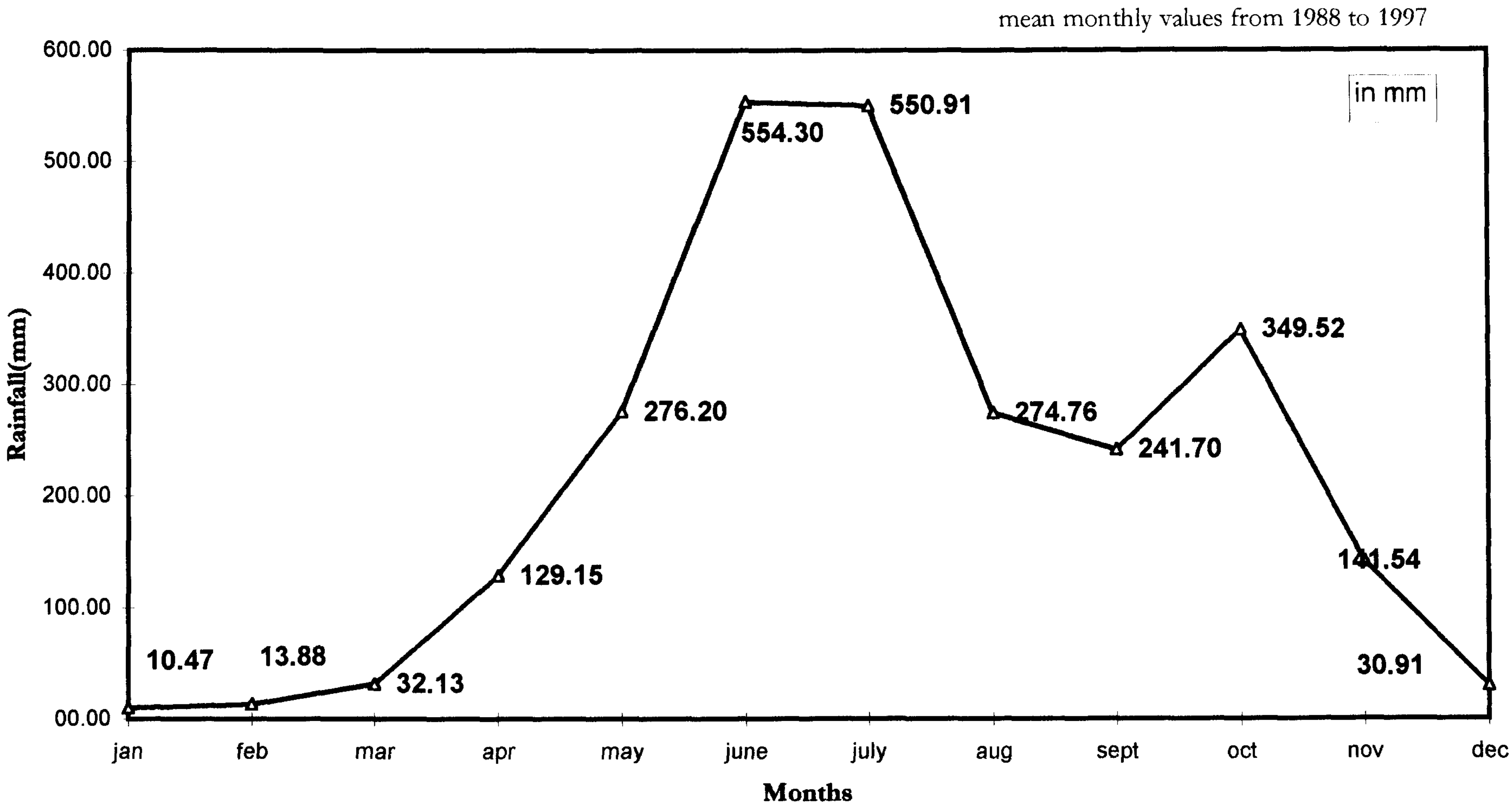


Fig.9. **Mean monthly rainfall**

Table 16 **Temperature**

(°C)

Year		Months											
		January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1988	Max	35.40	35.50	35.00	35.60	34.80	34.60	33.00	33.00	33.00	34.00	33.60	34.90
	Min	15.00	17.50	20.00	21.20	20.90	20.60	19.50	20.50	20.20	19.90	16.70	15.00
1989	Max	33.50	33.70	34.40	34.30	32.60	30.60	30.10	30.70	30.80	31.20	32.60	33.40
	Min	16.40	16.80	19.10	20.60	19.70	18.60	18.70	18.60	18.40	18.30	16.90	15.00
1990	Max	32.80	34.30	34.70	34.30	31.40	31.30	30.10	30.80	31.40	31.40	32.40	33.30
	Min	13.40	15.30	17.60	18.90	17.70	17.20	16.10	16.30	16.20	16.20	15.60	13.80
1991	Max	33.40	34.30	34.90	32.50	34.40	29.60	30.50	30.10	32.30	31.20	32.40	33.00
	Min	16.50	20.70	24.00	24.10	24.40	23.00	21.80	22.20	22.30	21.80	20.40	18.60
1992	Max	33.20	32.90	34.10	34.30	32.10	30.60	29.40	30.00	30.50	30.90	31.30	32.90
	Min	16.60	19.80	20.10	21.60	21.40	20.90	19.30	23.20	19.60	19.40	18.90	16.00

Source : Central Plantation Crops Research Institute, Kayamkulam

(°C)

Year		Months											
		January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1993	Max	32.60	32.90	34.10	34.00	32.50	30.40	29.60	30.10	30.90	30.90	31.00	31.00
	Min	14.10	16.50	18.40	19.70	19.30	18.60	16.10	18.00	22.80	22.80	22.90	22.00
1994	Max	33.00	31.90	33.70	33.40	32.00	30.60	29.90	30.40	31.30	30.90	32.40	33.70
	Min	20.40	22.60	23.10	24.00	23.80	23.40	22.70	23.40	23.50	23.10	22.90	20.20
1995	Max	33.60	33.90	34.10	33.30	32.70	31.10	30.30	30.20	31.10	31.60	31.50	33.60
	Min	21.40	22.40	23.40	23.80	25.00	24.20	23.50	23.50	23.50	23.70	22.50	19.30
1996	Max	33.40	33.90	34.10	33.30	34.30	30.70	30.30	29.90	29.90	30.90	31.50	31.90
	Min	19.90	21.30	23.00	24.30	24.80	23.50	23.20	23.30	23.50	22.90	22.90	21.20
1997	Max	33.30	33.40	34.20	33.80	33.10	31.80	30.40	30.40	31.20	32.50	32.00	33.20
	Min	20.50	21.90	23.50	23.70	24.10	23.50	23.30	23.30	23.50	23.30	23.30	22.80

Source : Central Plantation Crops Research Institute, Kayamkulam

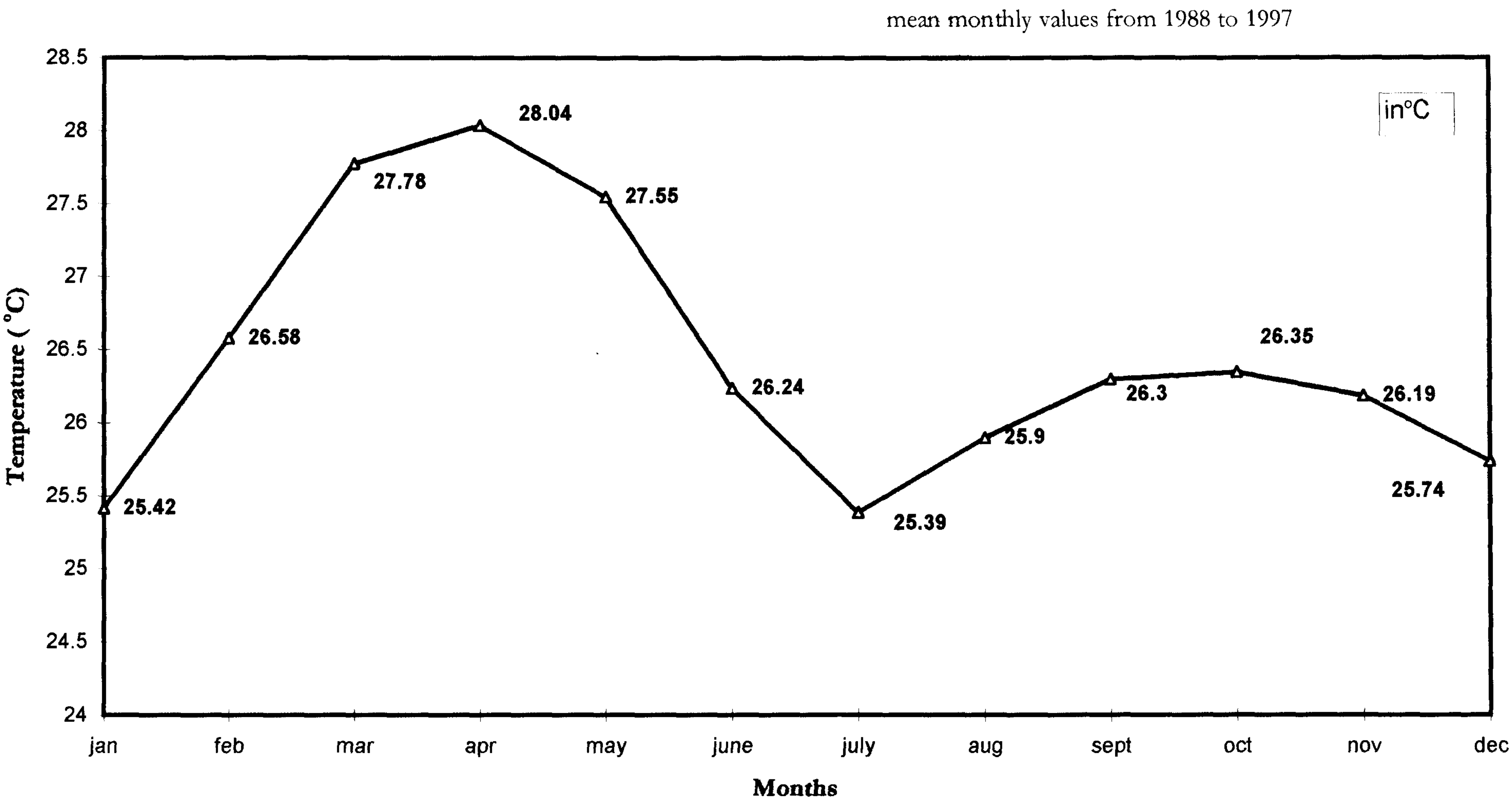


Fig.10. **Mean monthly temperature**

Table 17 **Humidity**

(%)

Year	Months											
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1988	91	93	91	92	91	93	95	95	94	95	92	93
1989	90	94	92	91	92	93	94	93	92	94	92	87
1990	91	93	91	90	92	95	95	96	93	93	93	91
1991	91	92	92	91	91	96	96	94	92	94	92	90
1992	89	90	90	86	90	91	95	96	94	95	94	86
1993	90	91	90	90	92	99	95	94	91	94	92	93
1994	90	90	91	88	91	94	95	96	93	93	92	87
1995	90	93	92	92	90	94	95	96	94	95	95	91
1996	89	88	91	91	90	95	95	95	95	95	95	94
1997	92	92	91	93	93	93	96	96	95	95	96	95

Source : Central Plantation Crops Research Institute, Kayamkulam

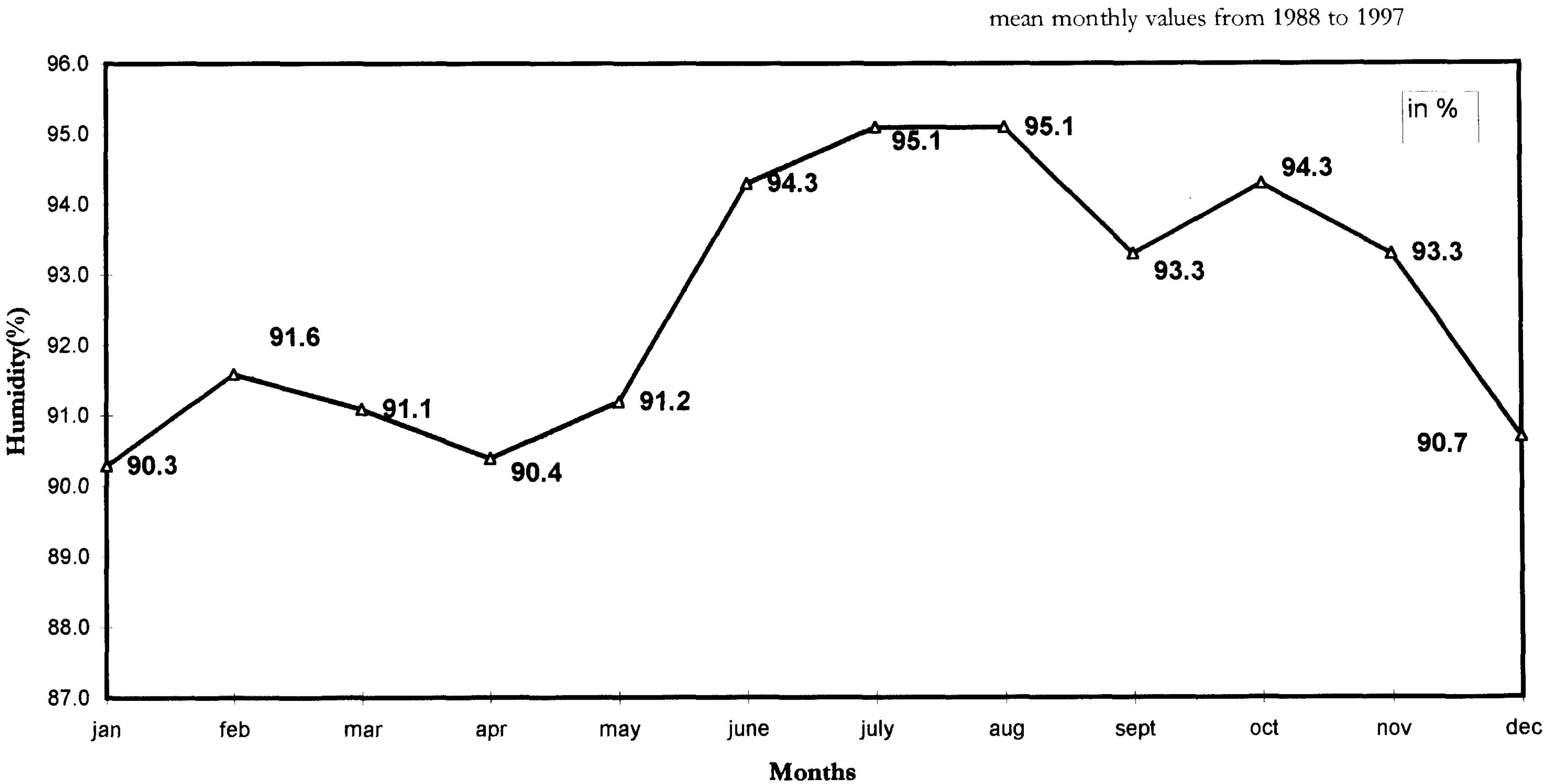


Fig.11. **Mean monthly humidity**

Table 18 Sunshine hours

(hrs)

Year	Months											
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1988	319.60	293.20	294.30	263.70	206.50	156.60	153.30	154.00	195.10	263.00	236.80	297.10
1989	254.90	276.00	317.10	263.10	198.20	111.80	155.30	164.40	183.80	189.60	230.40	296.30
1990	268.20	283.80	313.80	255.40	142.80	161.10	130.10	166.90	237.00	220.70	228.60	269.60
1991	294.60	287.60	295.10	277.40	268.80	78.20	105.30	100.50	253.40	151.90	236.60	260.80
1992	298.00	272.50	298.10	265.10	220.50	122.40	112.50	158.60	173.20	158.20	184.50	280.90
1993	269.60	287.90	309.80	271.60	208.20	149.90	111.90	167.50	218.50	159.80	164.20	216.50
1994	288.50	261.80	294.70	251.80	204.20	117.30	94.50	147.80	213.30	197.70	209.60	306.60
1995	293.80	265.20	293.40	249.90	224.20	157.70	112.90	170.90	218.80	230.30	203.70	324.00
1996	301.20	296.80	298.70	254.10	273.90	138.90	130.70	156.20	134.00	231.30	214.50	231.60
1997	325.20	266.90	293.70	271.60	240.90	183.20	106.30	173.70	215.50	253.40	187.40	244.60

Source : Central Plantation Crops Research Institute, Kayamkulam

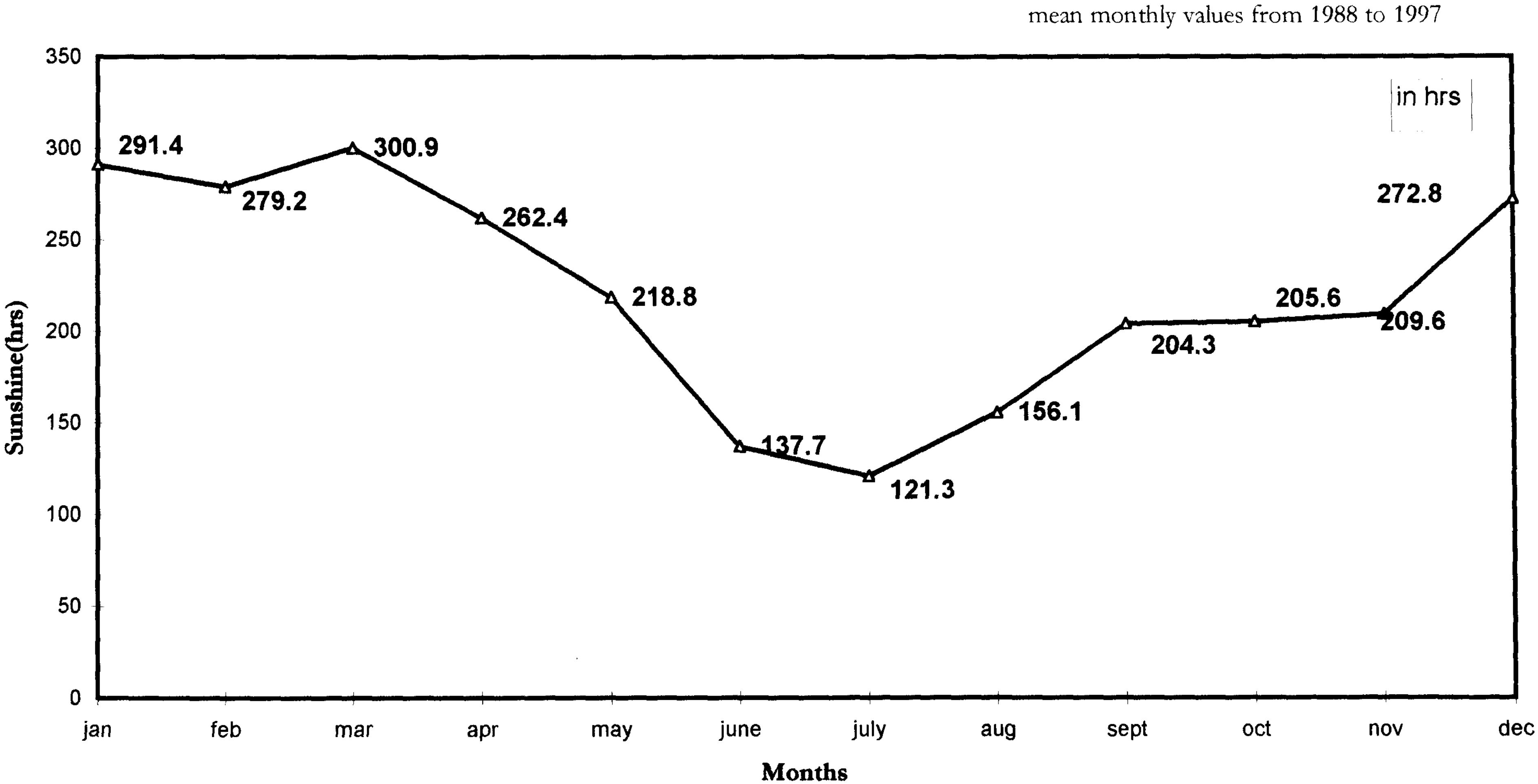


Fig.12. **Mean monthly sunshine hours**

Table 19 **Wind velocity**

(km/hr)

Year	Months											
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1988	1.3	1.6	1.8	1.9	1.8	1.6	1.4	1.3	1.2	1.2	0.8	1.0
1989	1.1	1.3	1.5	1.5	1.6	1.3	1.5	1.4	1.5	1.3	1.1	1.0
1990	1.2	1.4	1.7	1.8	1.9	1.6	1.4	1.6	1.6	1.2	0.9	1.1
1991	1.5	1.6	1.8	1.9	1.6	1.3	1.4	1.7	1.6	1.0	0.9	1.0
1992	1.3	1.5	1.6	2.8	1.9	2.6	1.8	2.1	1.6	1.4	3.8	1.4
1993	1.6	2.1	2.7	2.4	1.9	1.7	2.3	2.2	2.0	1.5	1.5	1.4
1994	1.7	2.0	2.1	2.1	1.7	1.6	1.7	1.5	1.9	1.3	1.0	1.8
1995	2.0	2.3	2.5	2.4	2.9	2.5	2.5	2.3	2.3	1.9	1.7	1.9
1996	2.1	2.3	2.6	2.5	2.6	2.5	2.3	2.7	2.1	2.0	1.6	1.5
1997	1.8	2.1	2.2	2.2	1.9	2.0	2.2	2.2	2.0	1.7	1.4	1.4

Source : Central Plantation Crops Research Institute, Kayamkulam

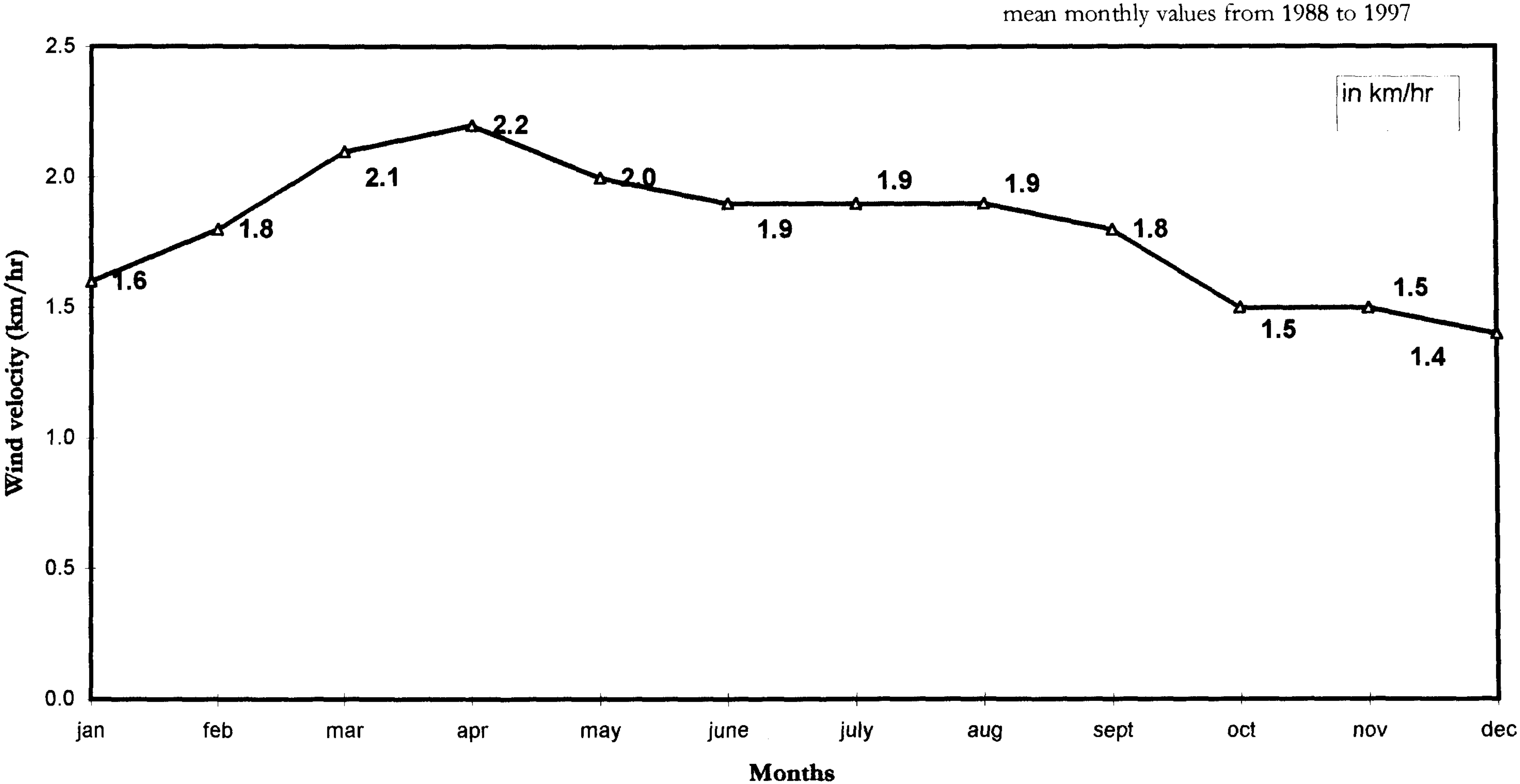


Fig.13. **Mean monthly wind velocity**

Table 20 **Evaporation**

(mm)

Year	Months											
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
1988	3.8	4.4	5.3	5.1	4.3	3.3	3.1	2.7	3.3	3.8	3.0	3.1
1989	3.5	3.7	3.9	4.4	3.5	3.0	2.7	3.5	3.2	2.7	2.7	3.5
1990	3.7	4.2	4.3	4.6	3.8	2.9	2.7	3.3	3.4	2.9	3.1	3.2
1991	3.5	4.8	4.6	4.4	4.4	1.8	2.4	2.5	3.8	2.4	3.2	3.6
1992	4.5	4.6	5.2	4.9	3.2	2.3	2.1	2.5	2.8	3.1	2.7	4.1
1993	4.2	4.8	5.4	4.7	3.5	2.2	0.4	3.1	3.6	3.3	2.3	3.2
1994	4.3	4.5	4.7	4.0	3.0	2.9	2.8	3.0	3.7	3.6	3.4	4.2
1995	4.4	4.7	4.8	3.9	3.7	2.9	2.5	2.7	3.2	3.1	2.9	4.0
1996	4.4	4.9	5.1	4.1	4.6	2.9	2.8	2.9	2.9	3.3	3	2.8
1997	4.1	4.6	5	4.6	3.7	3.6	2.8	2.9	3.8	3.7	2.8	3

Source : Central Plantation Crops Research Institute, Kayamkulam

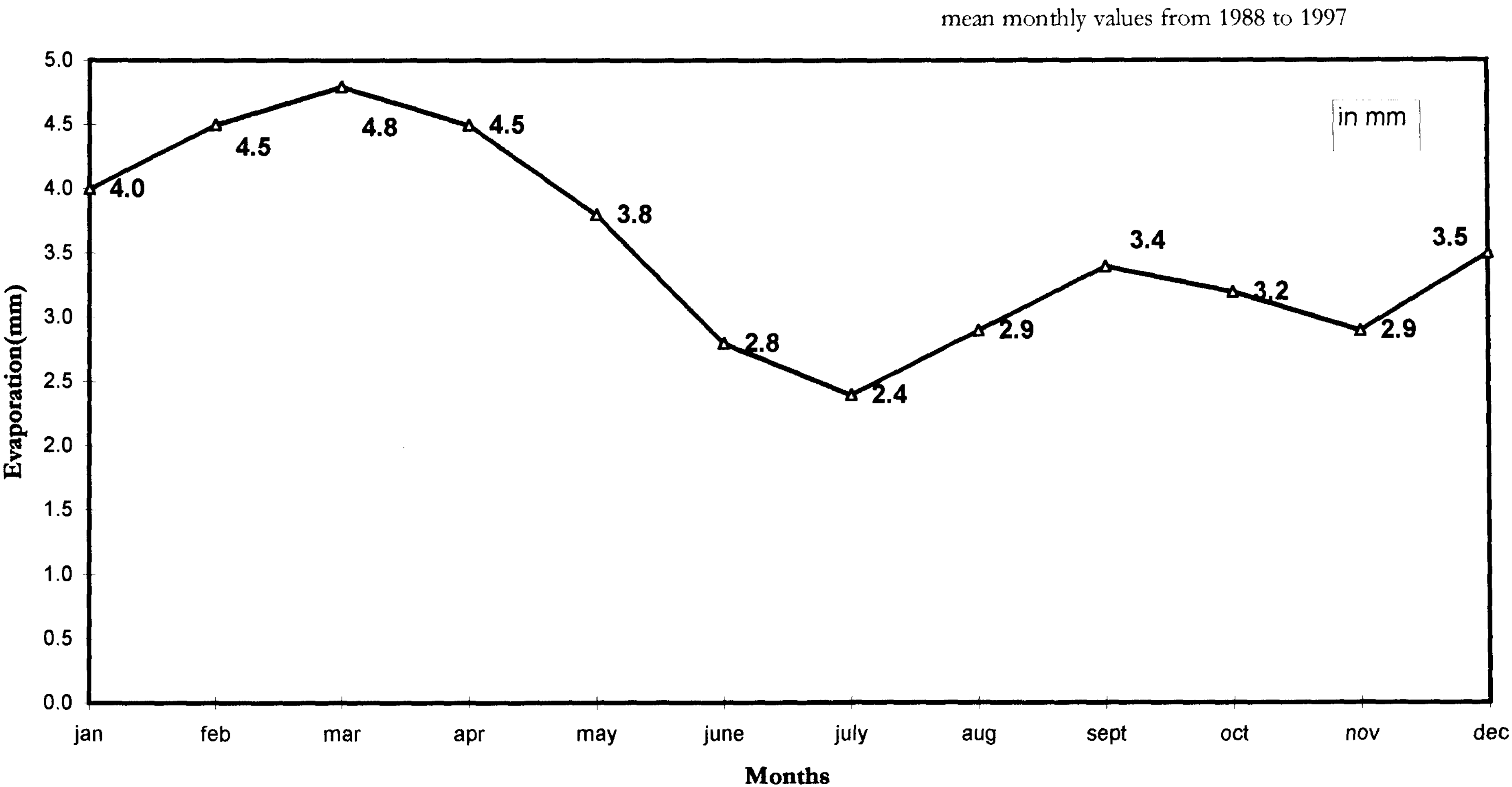


Fig.14. **Mean monthly evaporation**

Table 21 **Available water content of soils**

Sl no	*Name of soil series*	*AWC ratings*	*Rating class*
1	Neendakara	2.60	Very low
2	Kandallur	2.20	Very low
3	Mannar	4.00	Very low
4	Thrikkunnapuzha	10.80	Medium
5	Mahadevikad	4.80	Very low
6	Attuva	5.70	Low
7	Kollaka	3.90	Very low
8	Alappuzha	2.00	Very low
9	Pallipad	6.90	Low
10	Mynagapally	14.00	Medium
11	Kattanam	6.20	Low
12	Palamel	13.90	Medium
13	Sooranad	15.20	High
14	Vallikunnam	15.50	High
15	Kottakakam	8.00	Low
16	Pathiyoor	17.20	High
17	Cherukol	7.30	Low
18	Vettikode	18.50	High
19	Keerikkad	2.50	Very low
20	Chunad	14.70	Medium

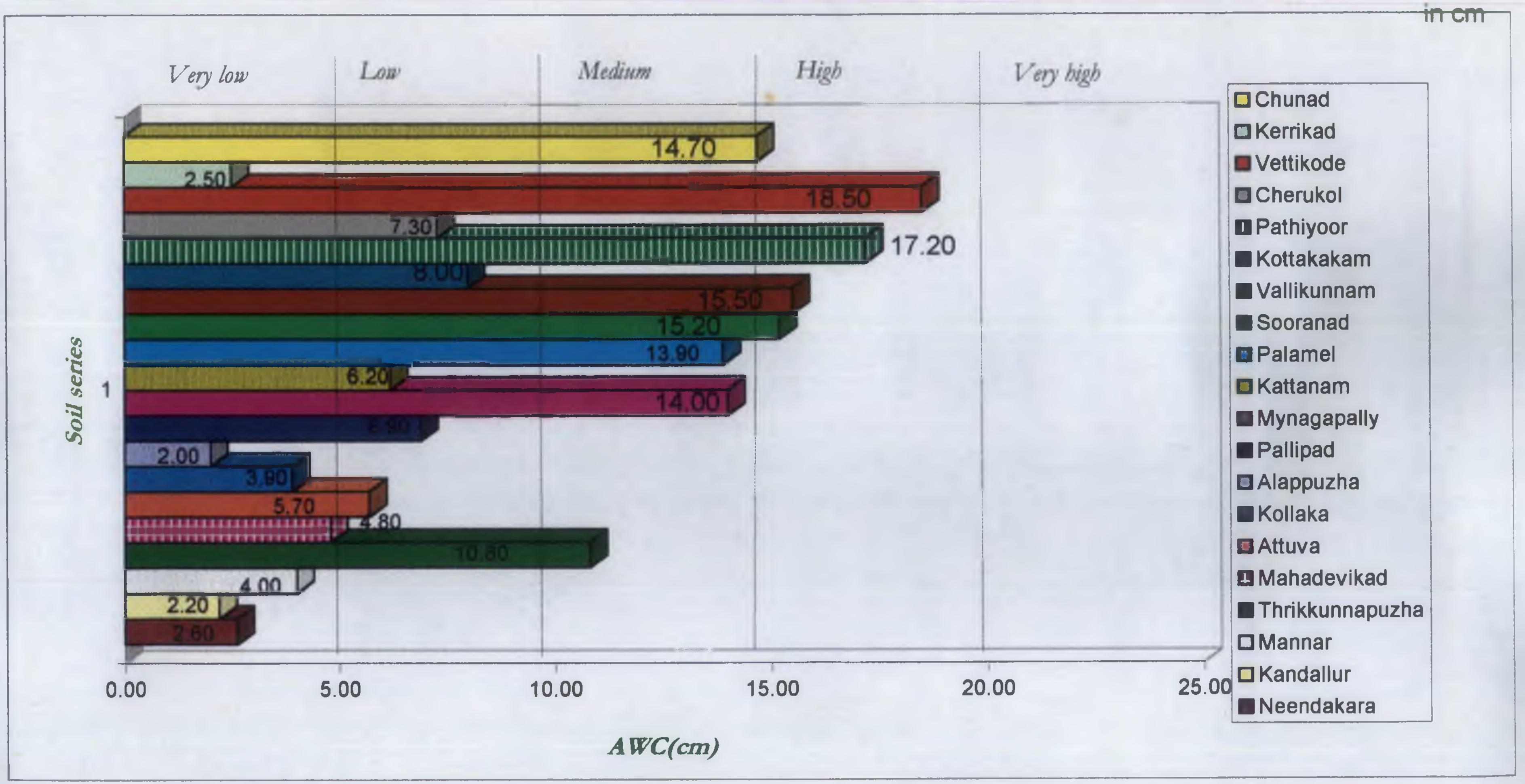


Fig.15. **Available water content of soils**

technology for the interpretation of soils as classified and delineated on soil maps and for the transfer of experience.

Scientific study and classification of soils are the primary requirements for grouping soils according to their capability for uses of varying intensity. The ability of a soil to respond to use, management and crop growth will be available once the taxonomic soil units are established after field and laboratory studies.

A reconnaissance soil survey has been carried out to determine the extent and distribution of the soils of Onattukara region. On the basis of the survey, twenty soil series were identified.

The soils of Onattukara region have been classified as per the comprehensive soil classification system - Soil Taxonomy (U.S. Soil Survey Staff, 1975) and Keys to Soil Taxonomy (U.S. Soil Survey Staff, 1994 and 1996).

Out of the twenty soil series identified, ten series, namely, Neendakara, Kandallur, Mannar, Thrikkunnapuzha, Mahadevikad, Kollaka, Alappuzha Cherukol, Vettikode and Keerikkad were classified under Entisols, six series, namely, Attuva, Kattanam, Palamel, Kottakakam, Pathiyoor and Chunad under Inceptisols, three series, namely, Mynagapally, Sooranad and Vallikunnam, under Ultisols and Pallipad series under Alfisols. The details of soil classification are presented in Table 22.

Table 22 **Taxonomic classification of soils**

Sl no	*Name of series*	*Family*	*Subgroup*	*Great group*	*Suborder*	*Order*
1	Neendakara	Mixed, isohyperthermic	Typic Ustipsamments	Ustipsamments	Psamments	Entisols
2	Kandallur	Mixed, isohyperthermic	Typic Ustipsamments	Ustipsamments	Psamments	Entisols
3	Mannar	Mixed, isohyperthermic	Typic Ustipsamments	Ustipsamments	Psamments	Entisols
4	Thrikkunnapuzha	Fine-loamy, mixed, isohyperthermic, subactive	Tropic Fluvaquents	Fluvaquents	Aquents	Entisols
5	Mahadevikad	Mixed, isohyperthermic	Typic Ustipsamments	Ustipsamments	Psamments	Entisols
6	Attuva	Coarse-loamy, mixed, isohyperthermic, active	Fluventic Dystropepts	Dystropepts	Tropepts	Inceptisols
7	Kollaka	Mixed, isohyperthermic	Typic Ustipsamments	Ustipsamments	Psamments	Entisols

Sl no	*Name of series*	*Family*	*Subgroup*	*Great group*	*Suborder*	*Order*
8	Alappuzha	Mixed, isohyperthermic	Ustic Quartzipsamments	Quartzipsamments	Psamments	Entisols
9	Pallipad	Coarse-loamy, mixed, isohyperthermic	Kanhaplic Haplustalfs	Haplustalfs	Ustalfs	Alfisols
10	Mynagapally	Clayey-skeletal, mixed, isohyperthermic, subactive	Typic Plinthustults	Plinthustults	Ustults	Ultisols
11	Kattanam	Coarse-loamy, mixed, isohyperthermic, semiactive	Fluventic Ustropepts	Ustropepts	Tropepts	Inceptisols
12	Palamel	Fine-loamy, mixed, isohyperthermic, subactive	Ustoxic Humitropepts	Humitropepts	Tropepts	Inceptisols
13	Sooranad	Fine, mixed, isohyperthermic, subactive	Typic Plinthustults	Plinthustults	Ustults	Ultisols
14	Vallikunnam	Clayey-skeletal, mixed, isohyperthermic, subactive	Typic Plinthustults	Plinthustults	Ustults	Ultisols

Sl no	*Name of series*	*Family*	*Subgroup*	*Great group*	*Suborder*	*Order*
15	Kottakakam	Coarse-loamy, mixed, isohyperthermic, subactive	Aeric Tropaquepts	Tropaquepts	Aquepts	Inceptisols
16	Pathiyoor	Fine, mixed, isohyperthermic, semiactive	Aeric Tropaquepts	Tropaquepts	Aquepts	Inceptisols
17	Cherukol	Coarse-loamy, mixed, isohyperthermic, subactive	Typic Tropofluvents	Tropofluvents	Fluvents	Entisols
18	Vettikode	Very fine, mixed, isohyperthermic, subactive	Tropic Fluvaquents	Fluvaquents	Aquents	Entisols
19	Keerikkad	Mixed, isohyperthermic	Typic Psammaquents	Psammaquents	Aquents	Entisols
20	Chunad	Fine-loamy, mixed, isohyperthermic, semiactive	Aeric Tropaquepts	Tropaquepts	Aquepts	Inceptisols

4.7. Land capability classification

Land capability classification shows, in general, the suitability of soils for most kinds of field crops. The soils are grouped according to the limitations for field crops, the risk of damage if they are used for crops and the way they respond to management.

Classification of soil units into capability groupings enables to get a clear picture of the hazards of the soil to various factors which cause soil damage, deterioration or lowering in fertility and its potentiality for production. In a nutshell, the land capability classification is an interpretative grouping of soils to show the suitability of the land for different kinds of uses.

Based on the inherent soil characteristics and landscape features, the land capability classification of the soils of Onattukara region has been made and given in Table 23. The soils identified have been grouped into three land capability classes and nine capability subclasses. Based on the studies, map showing the distribution of the different land capability classes in Onattukara region has been prepared and presented in Figure 16.

4.8. Land irrigability classification

Based on the physical and chemical characteristics of the soils, the soils are primarily grouped into soil irrigability classes. Soil

Table 23 **Land capability class and subclass**

Sl no	*Land capability class & subclass*	*Soil series mapped*	*Area (ha)*	*Total area(ha)*	*Soil characteristics and associated problems*	*Management recommendations*
1	IIe	Kattanam	65	65	Good arable lands with slight erosion	Contour cultivation
2	IIw	Sooranad Chunad	725 958	1683	Imperfectly to poorly drainage drained and subject to flooding during monsoon	Deepening of existing drainage channels and construction of permanent drainage channels
3	IIIe	Mynagapally Vallikunnam Palamel	325 453 553	1331	Moderately good cultivable lands subject to moderate erosion	Contour cultivation and construction of earthen contour bunds protected with vegetative cover
4	IIIes	Attuva	1300	1300	Very deep, coarse textured soils subject to slight soil erosion. Poor water holding and nutrient holding capacity	Application of heavy doze of organic manures and controlled irrigation
5	IIIw	Pathiyoor Vettikode	350 493	843	Very deep, imperfectly drained heavy textured soils subject to overflow and submergence during monsoon	Construction of permanent drainage channels

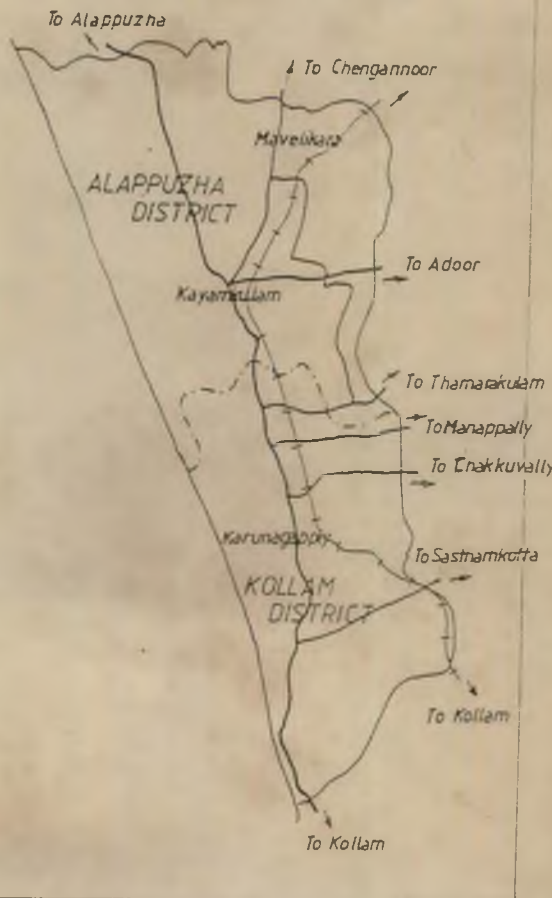
Sl no	Land capability class & subclass	Soil series mapped	Area (ha)	Total area(ha)	Soil characteristics and associated problems	Management recommendations
6	IIIs	Neendakara Mannar Pallipad Mahadevikad Kollaka	440 22325 1015 1580 355	25715	Very deep and moderately well drainedcoarse textured soils. Poor water and nutrient holding capacity	Application of high amount of organic manures and controlled irrigation
7	IIIws	Kottakakam Cherukol Keerikkad	698 1058 400	2156	Very deep, coarse textured, coastal alluvium. Poor drainage overflow and flooding	Adequate drainage, addition of organic manures and controlled irrigation
8	IVs	Alappuzha Kandallur	180 2982	3162	Very deep, sandy, marine alluvium located on coastal plains. Poor water and nutrient holding capacity	Application of heavy doze of organic manures, coconut husk burial and addition of soil amendments
9	IVws	Thrikkunnapuzha	998	998	Very deep, imperfectly drained, highly gleyedsoils developed from marine and lacustrine deposits Clayey and massive subsoil. Very high water table and flooding.	Adequate drainage

ONATTUKARA LAND CAPABILITY

LEGEND

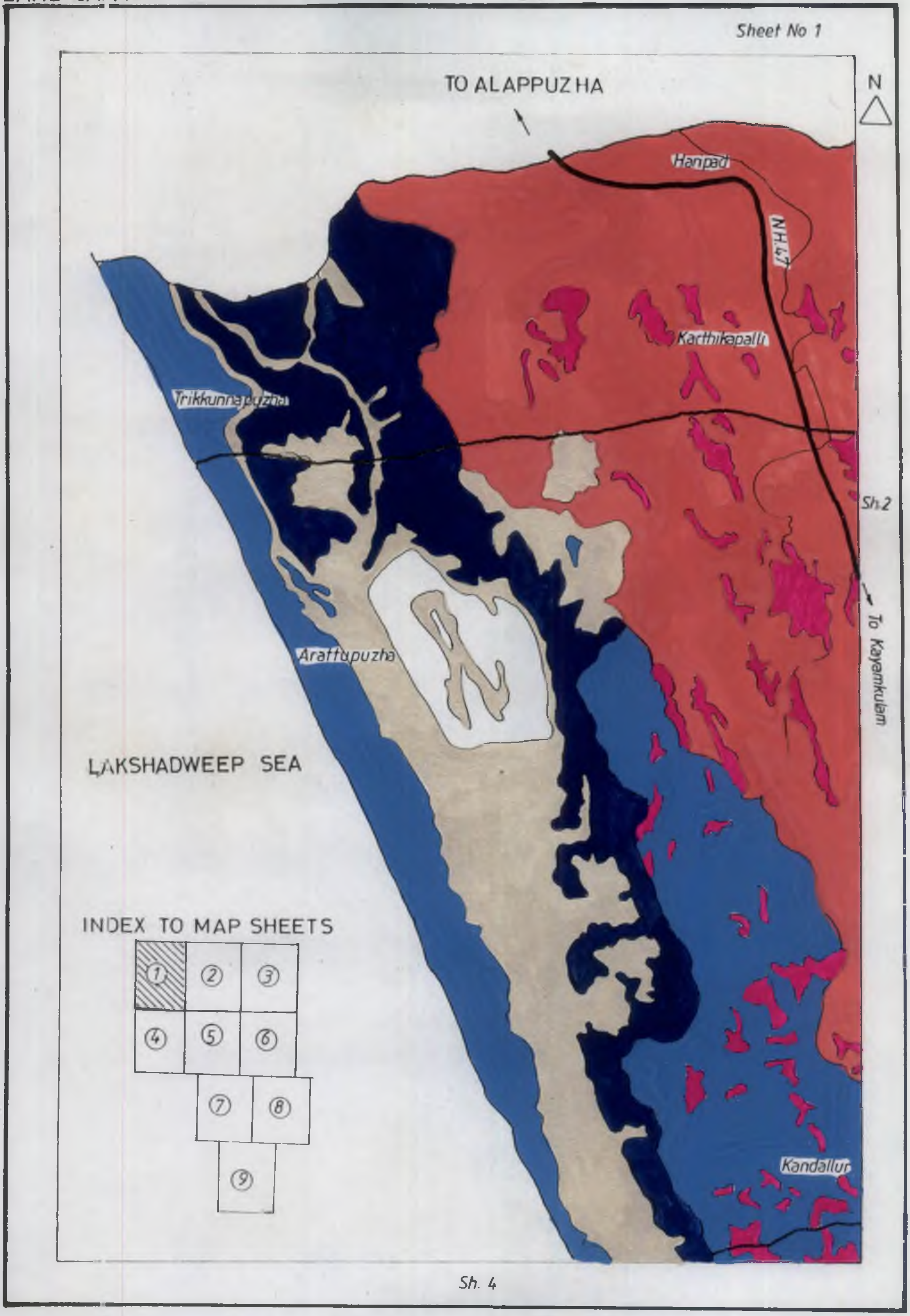
IIe	Kattanam
IIw	Sooranad, Choonad
IIIe	Mynagappally, Vallikunnam, Palamel
IIIes	Attuva
IIIw	Patniyoor, Vettikode
IIIs	Neendakara, Mannar, Kollaka, Pallipad, Mahadevikad
IIIws	Kottakakam, Cherukol, Keerikkad
IVs	Alappuzha, Kandallur
IVws	Thrikkunnapuzha

LOCATION OF ONATTUKARA



LAND CAPABILITY MAP OF ONATTUKARA

SCALE 1: 50000



LAND CAPABILITY MAP OF ONATTUKARA

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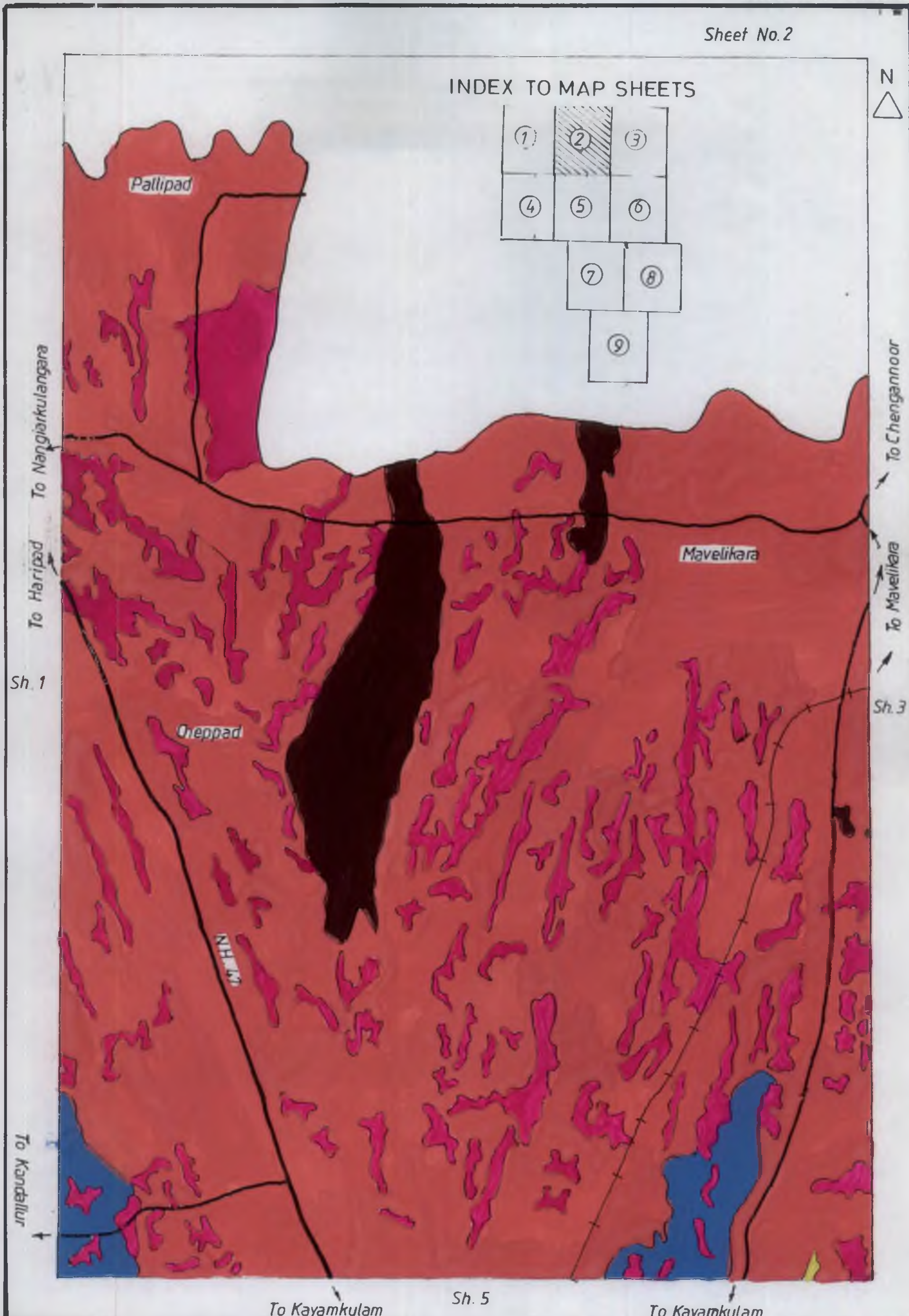

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LAND CAPABILITY MAP OF ONATTUKARA

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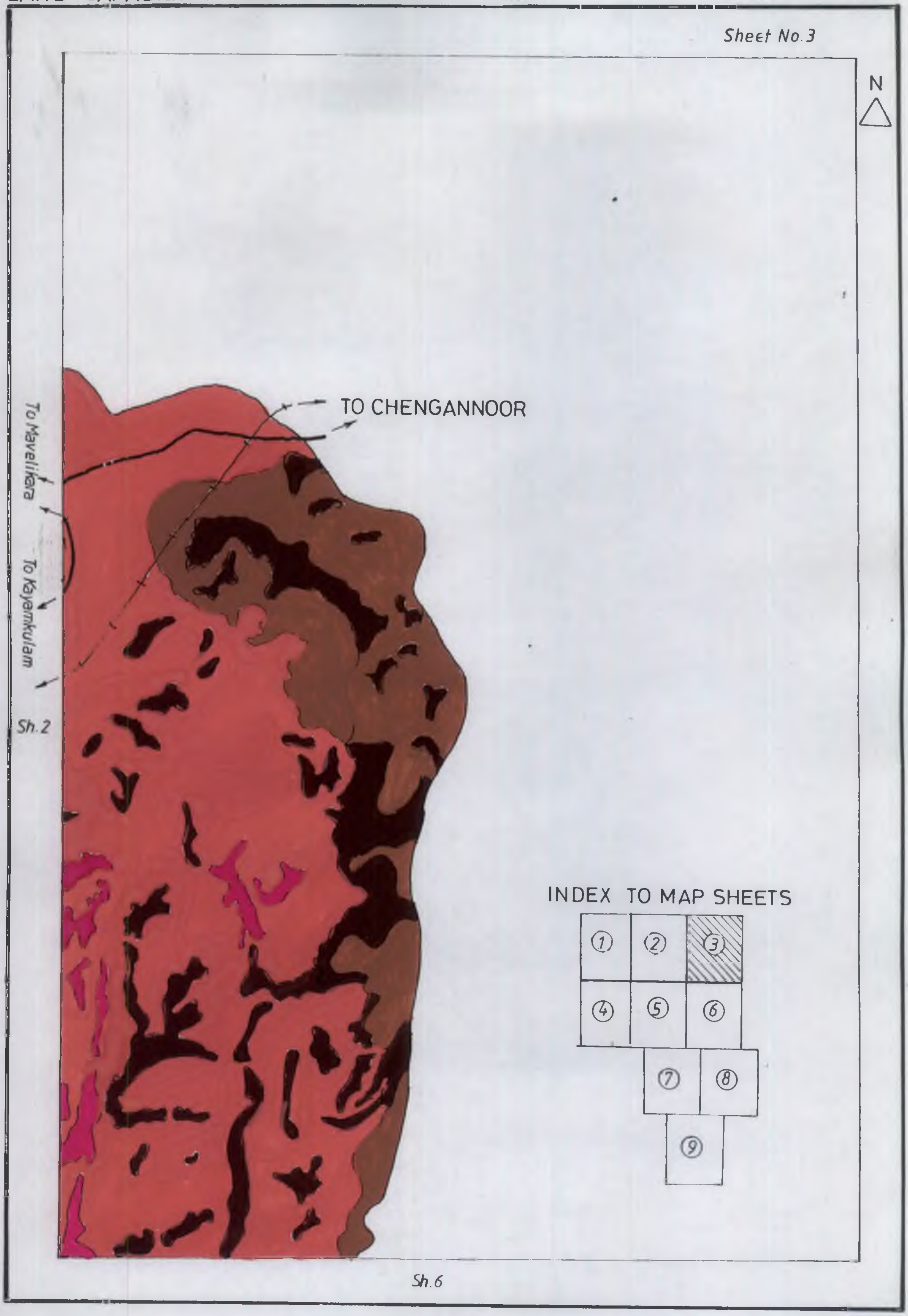

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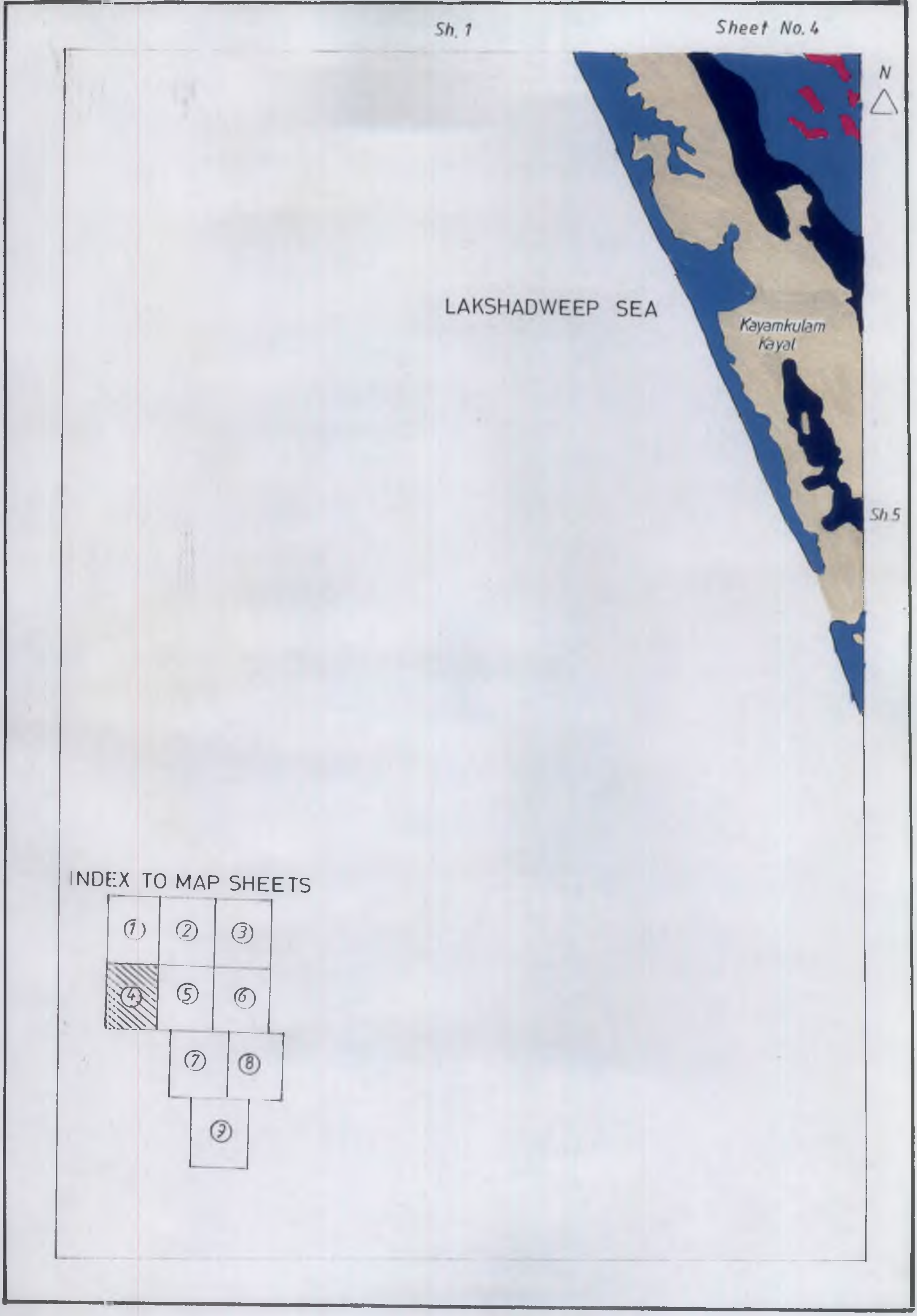

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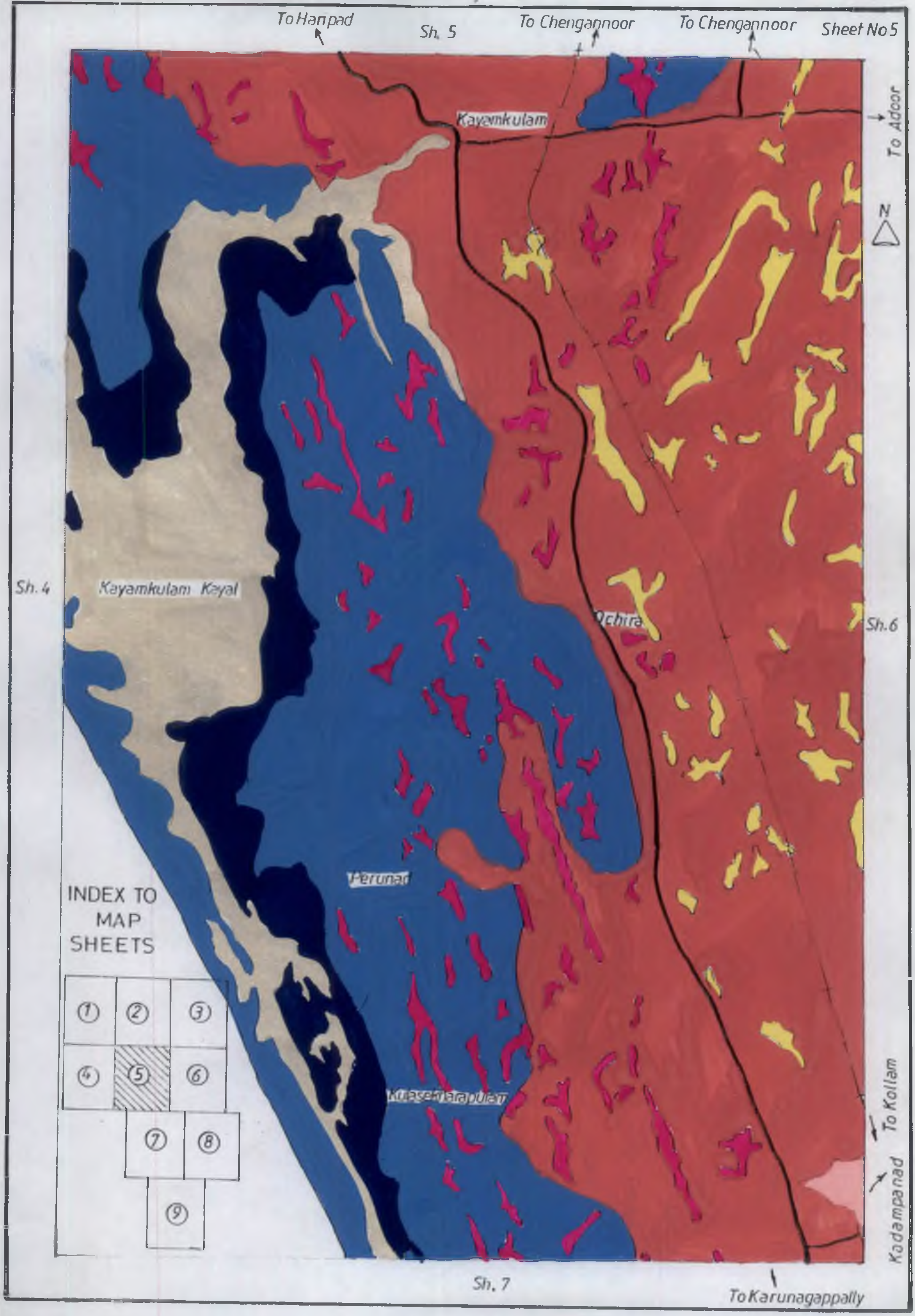

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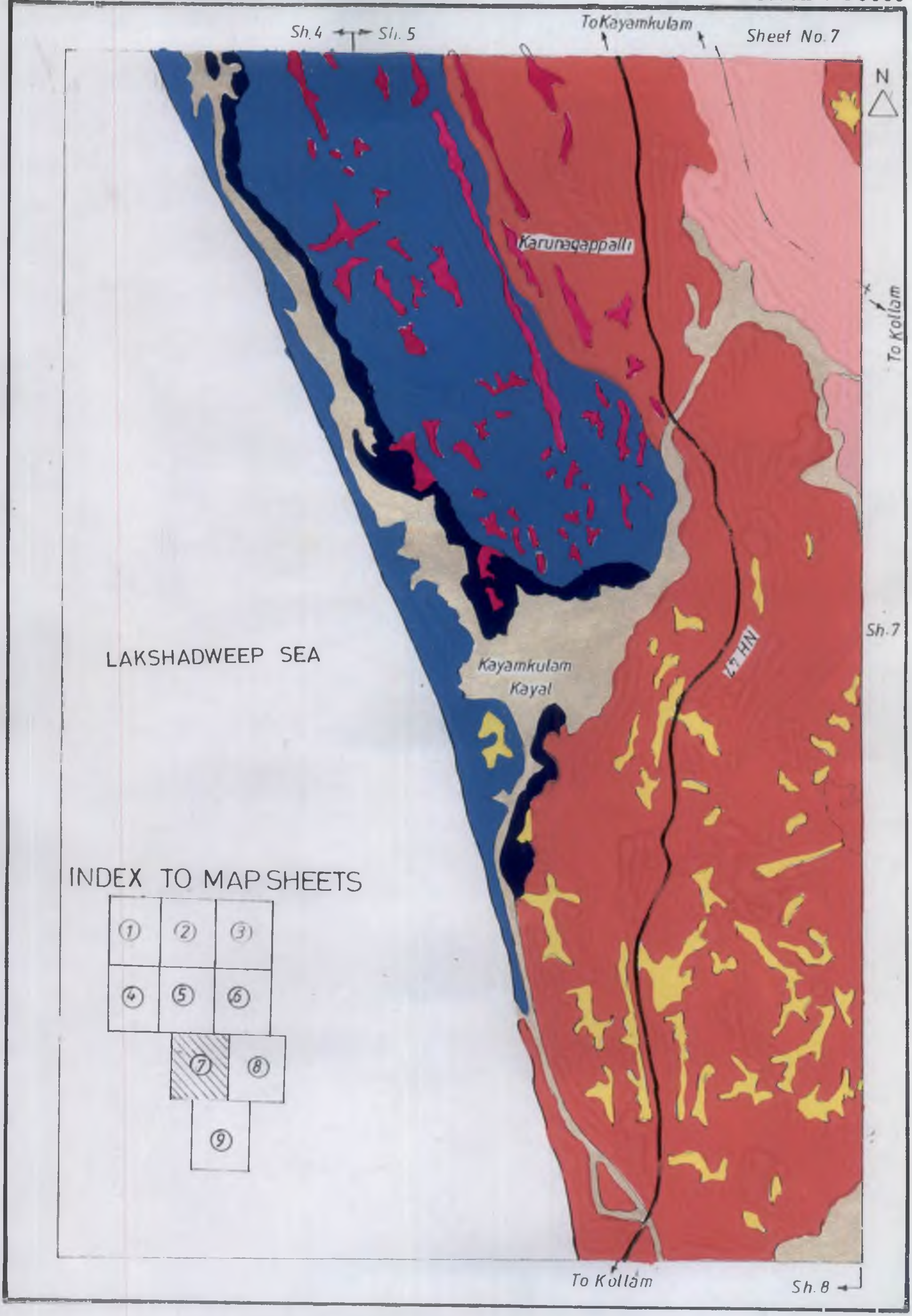

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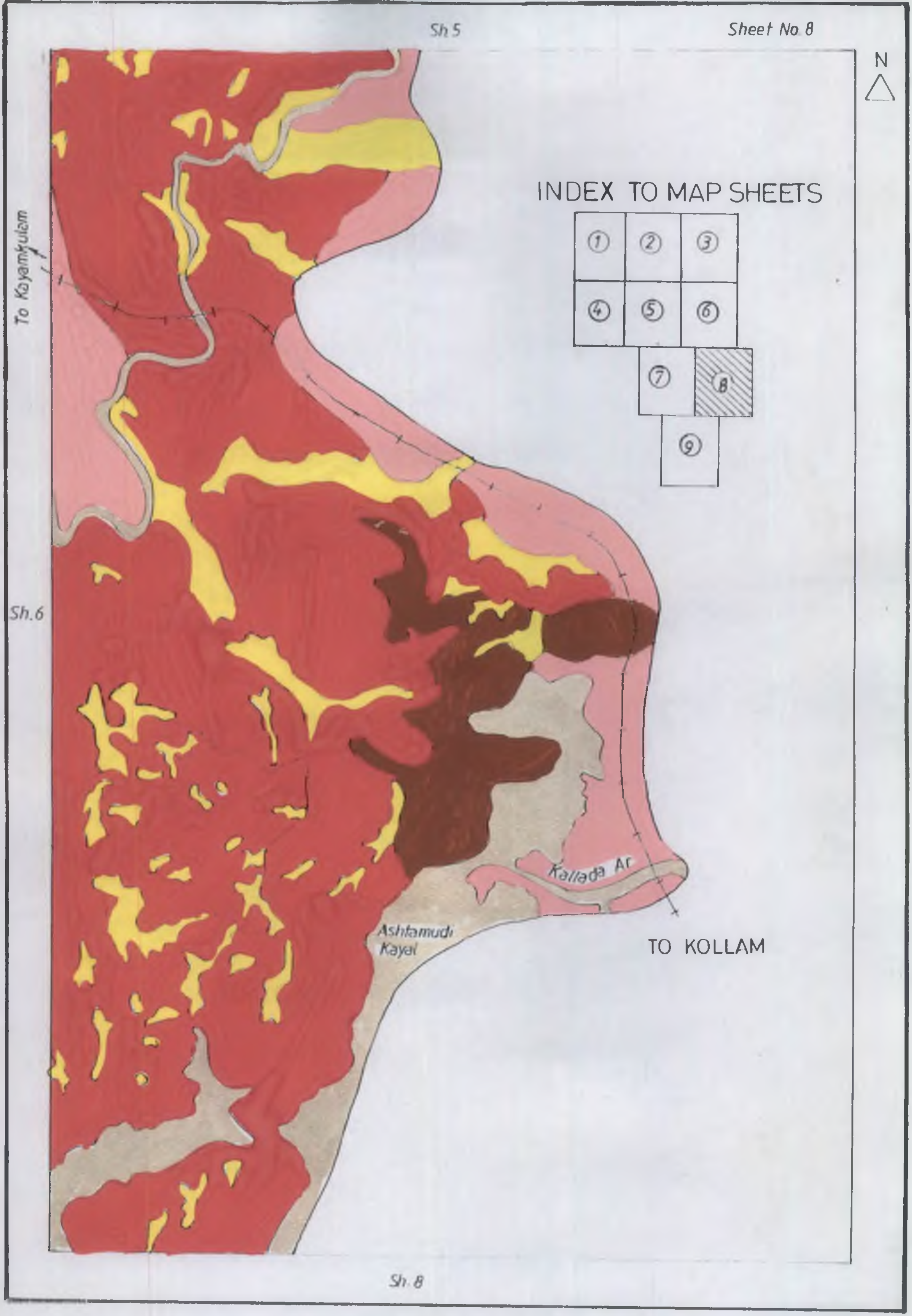

LAND CAPABILITY MAP OF ONATTUKARA

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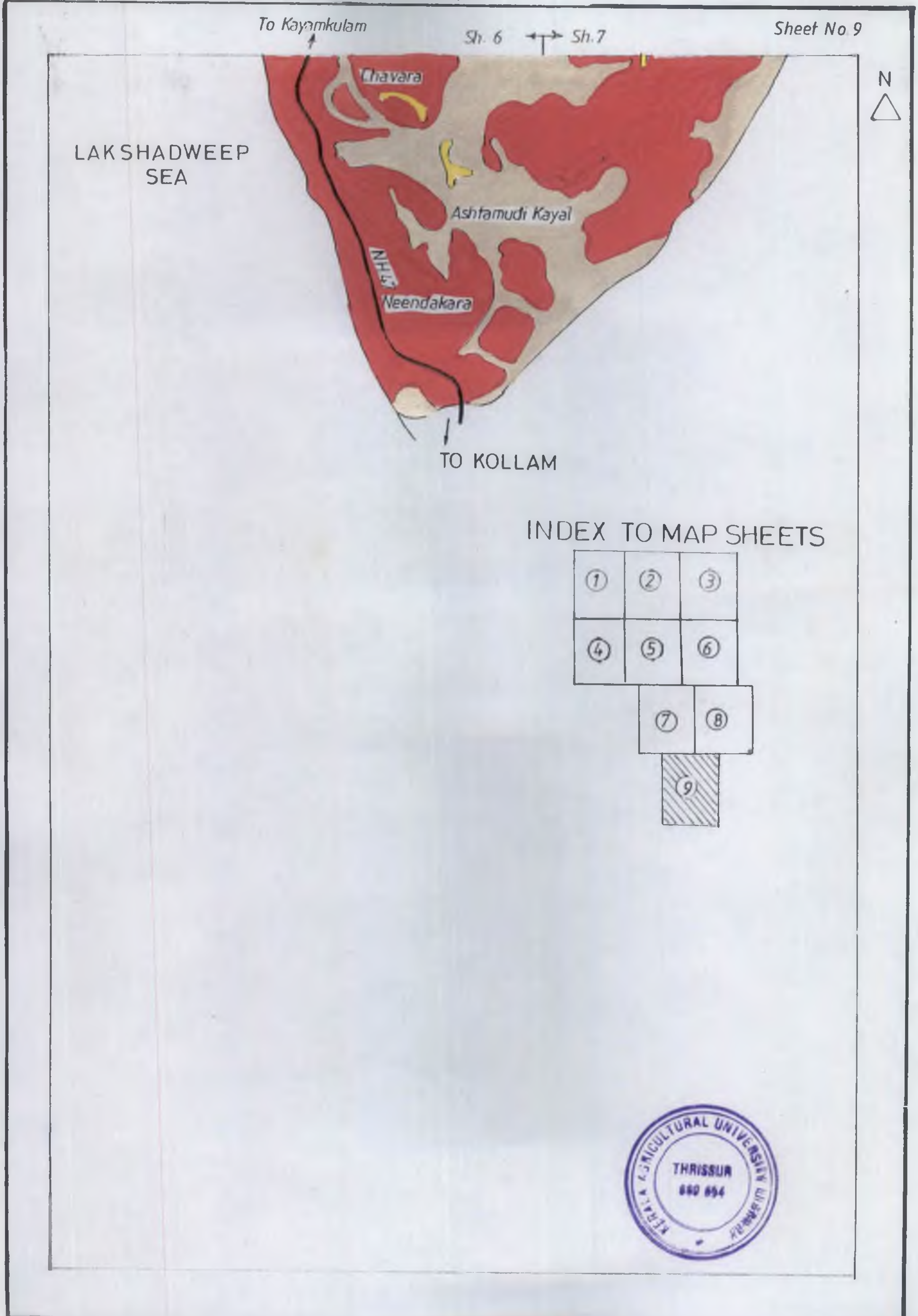


irrigability classes are useful to make grouping of soils according to their suitability for sustained use under irrigation.

The classes are defined in terms of the degree of soil limitations. In addition to soil limitation, land irrigability depends upon features like slope, terrain conditions, land development costs, economic considerations and drainage requirements.

The soils identified in Onattukara region are grouped into four land irrigability classes and eight irrigability subclasses. The extent of different land irrigability subclasses are given in Table 24.

Based on the studies,the map showing distribution of different land irrigability classes in Onattukara region has been prepared and presented in Figure 17.

4.9. Productivity rating

From among the number of factors that influence soil productivity, the most commonly accepted and most easily measurable factors of productivity alone are selected.

4.9.1. Productivity index

The five important crops namely, rice, coconut, sesamum, cassava and banana cultivated in Onattukara region are considered for suitability rating. The productivity parameters considered in the present study include soil texture, depth, slope, drainage, coarse

ONATTUKARA

LAND IRRIGABILITY

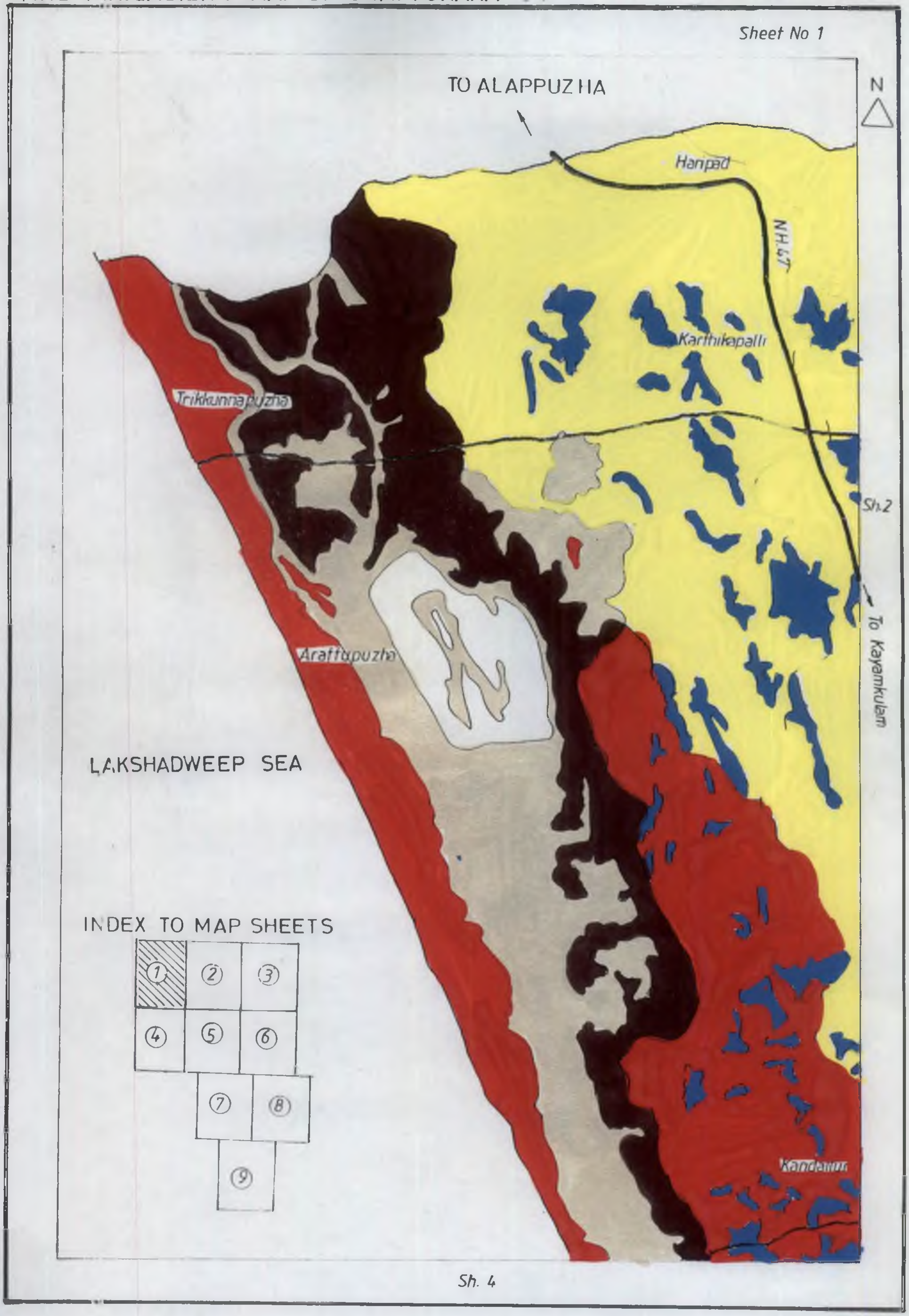
LEGEND

- 2d — Sooranad, Choonad
- 2t — Kattanam
- 3d — Kottakakam, Pathiyoor, Vettikod, Cherukol, Keerikkad
- 3s — Neendakara, Mannar, Kollaka, Mahadevikad, Pallipad
- 3t — Mynagappally, Attuva, Vallikunnam, Palamel
- 4s — Kandallur
- 4sd — Alappuzha
- 6d — Thrikkunnapuzha

LOCATION OF ONATTUKARA

LAND IRRIGABILITY MAP OF ONATTUKARA

SCALE 1:50000



LAND IRRIGABILITY MAP OF ONATTUKARA

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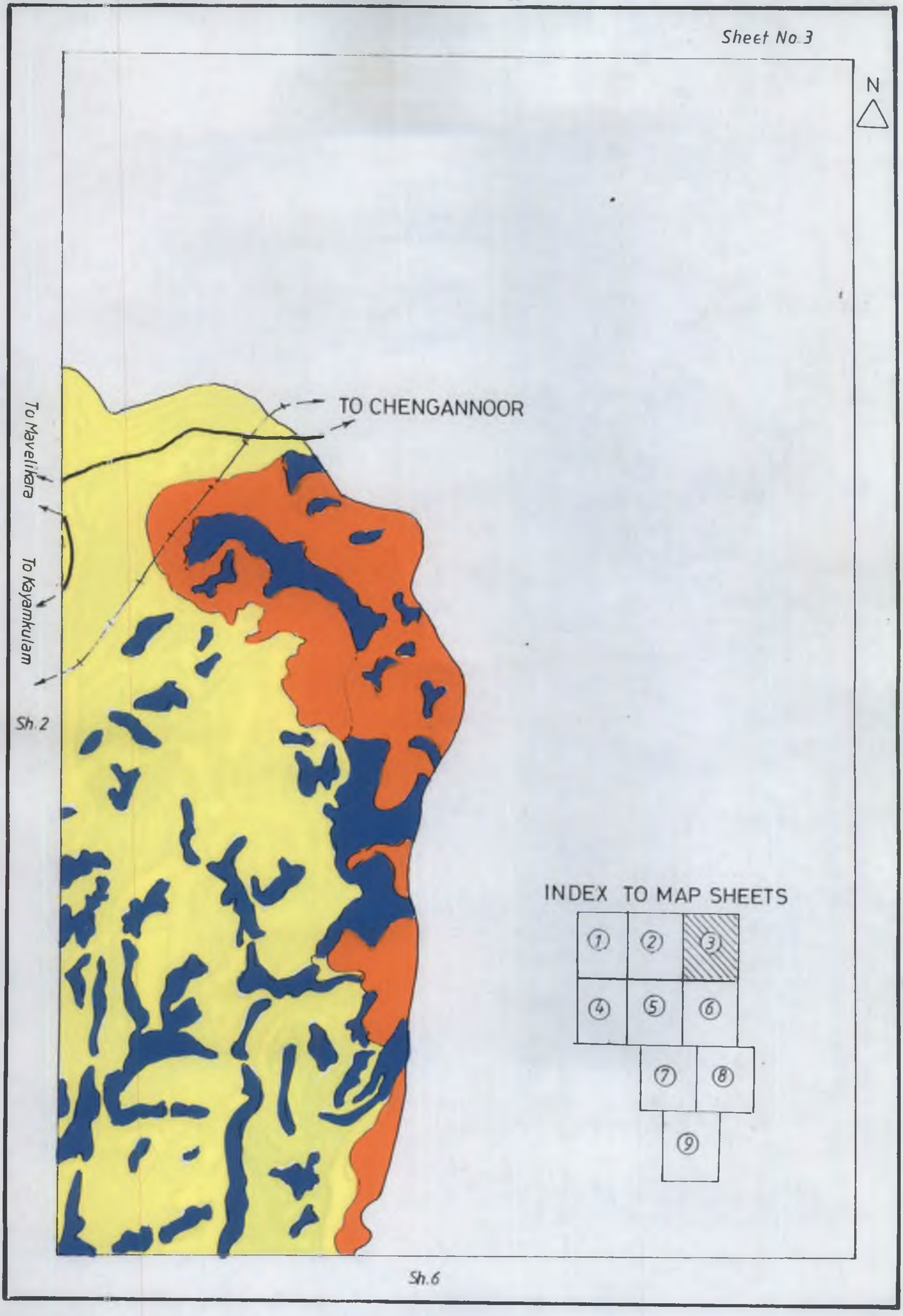
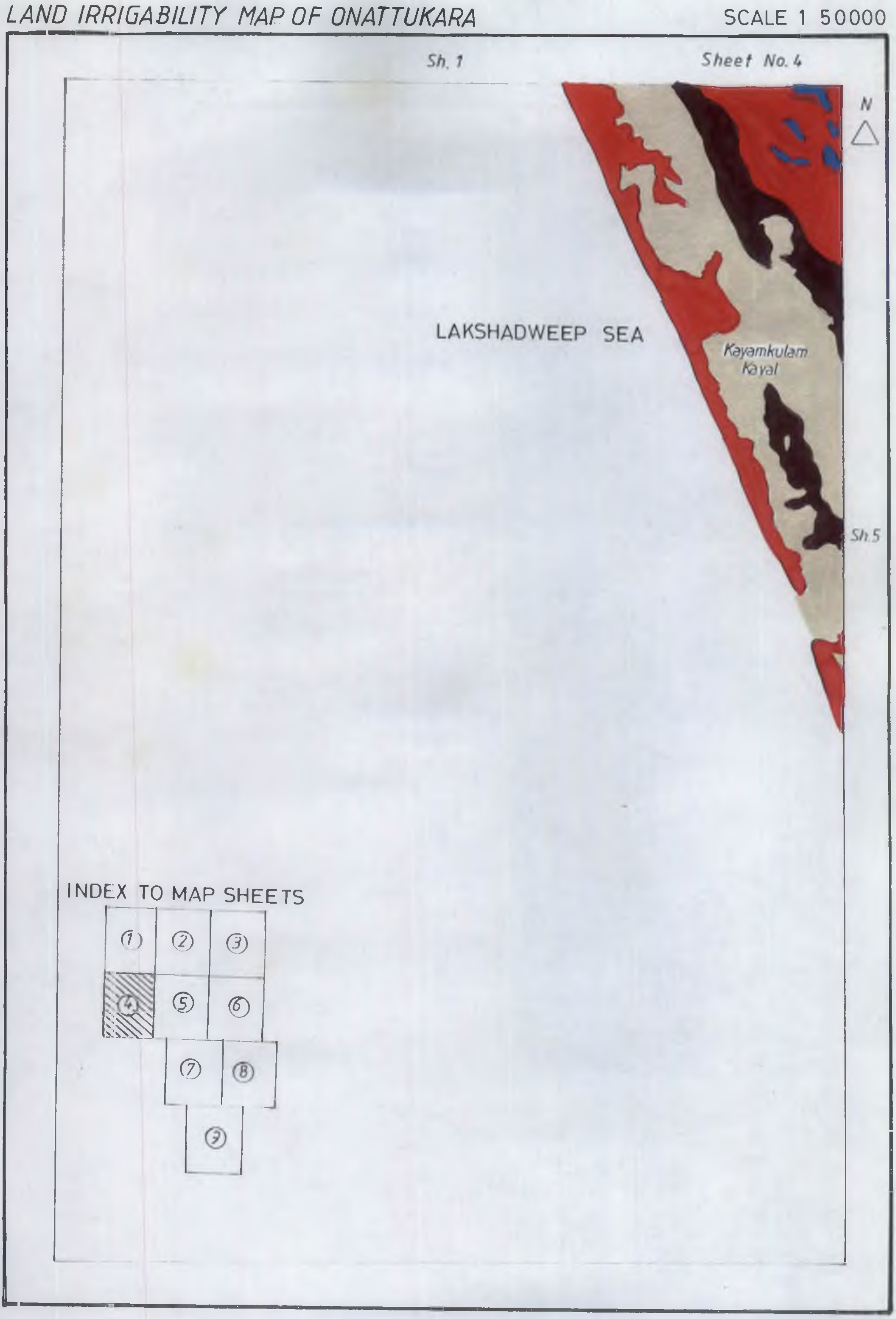
206.

LAND IRRIGABILITY MAP OF ONATTUKARA

SCALE 1:50000

Sheet No 3




LAND IRRIGABILITY MAP OF ONATTUKARA
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LAND IRRIGABILITY MAP OF ONATTUKARA

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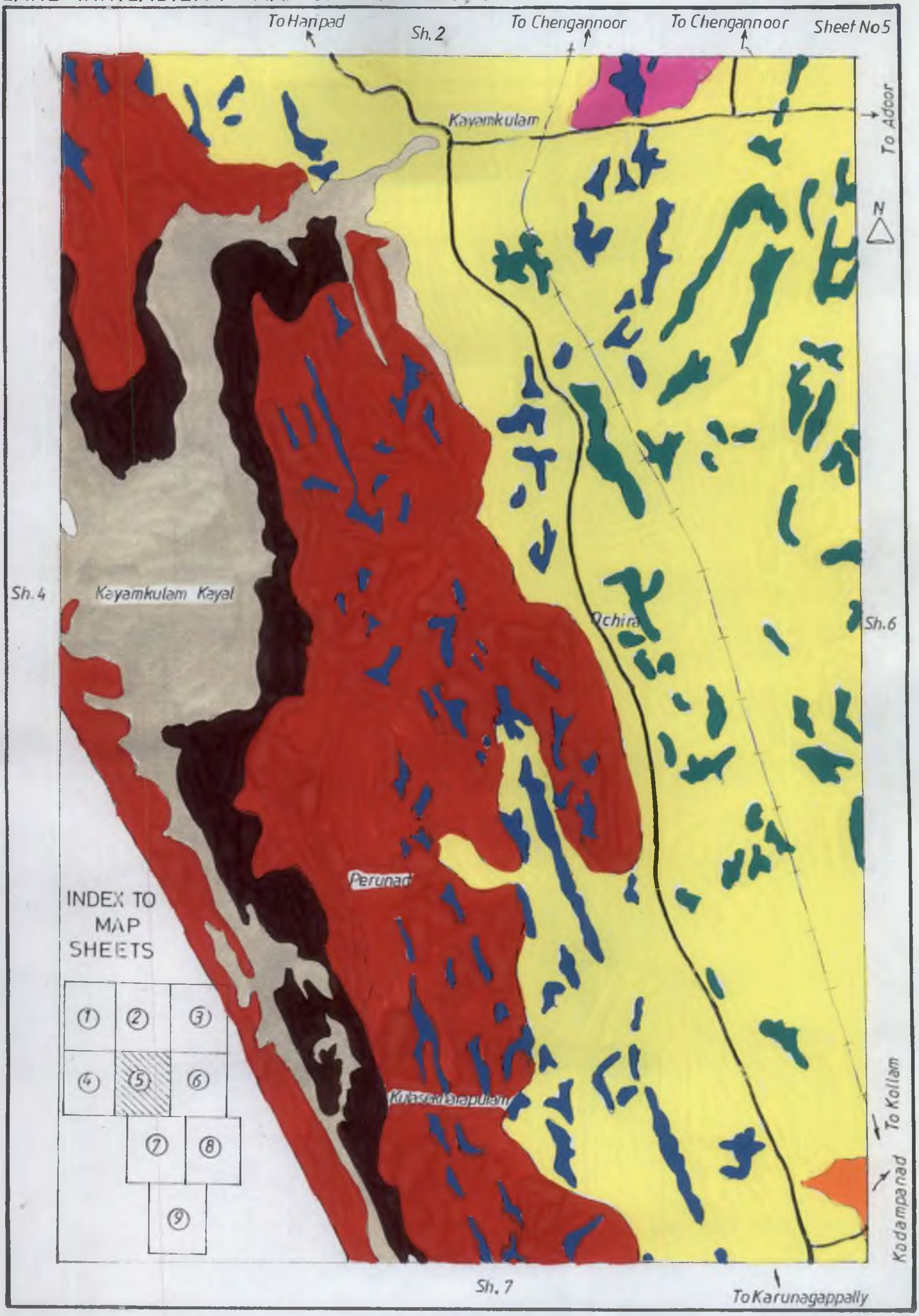

LAND IRRIGABILITY MAP OF ONATTUKARA

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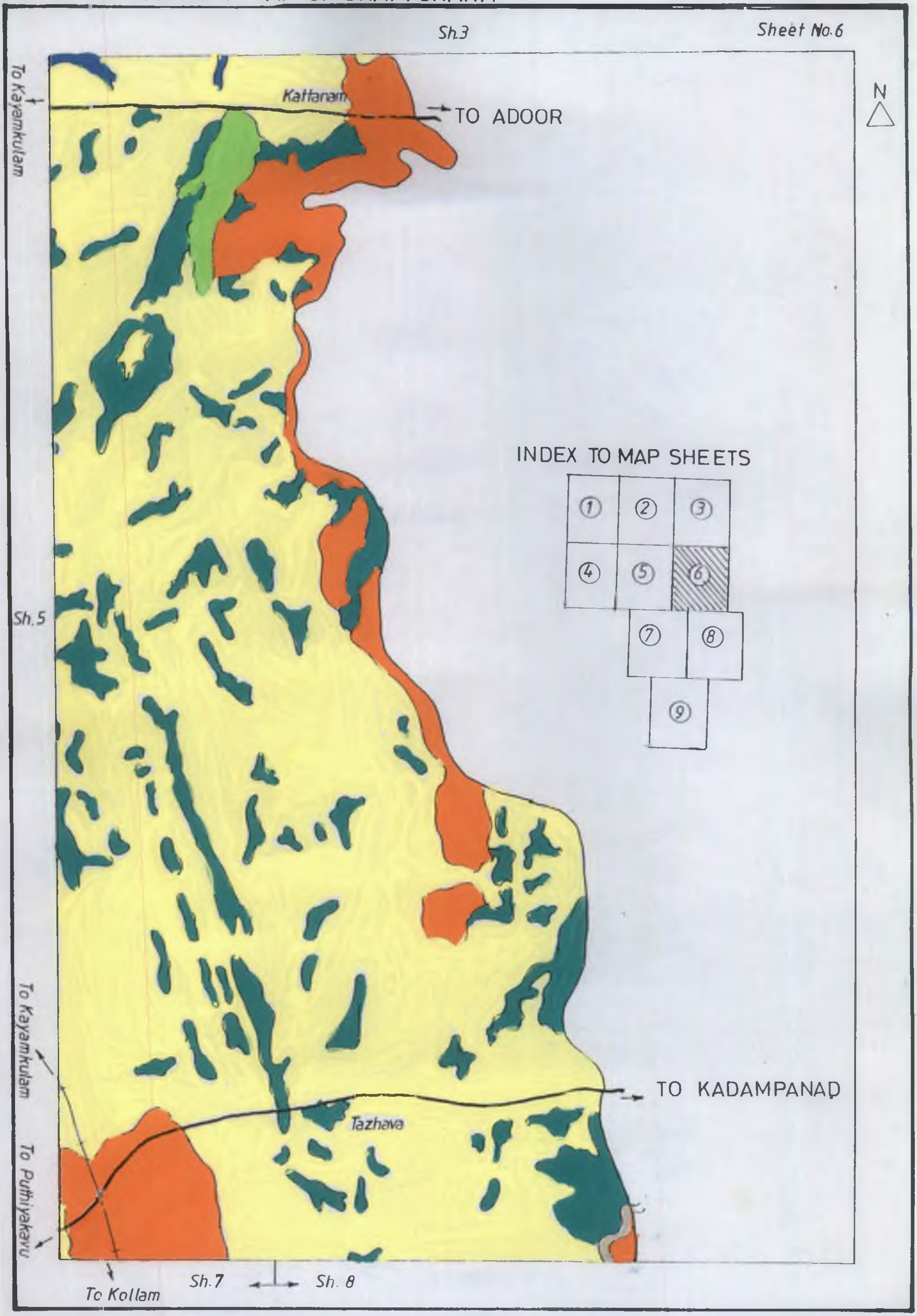

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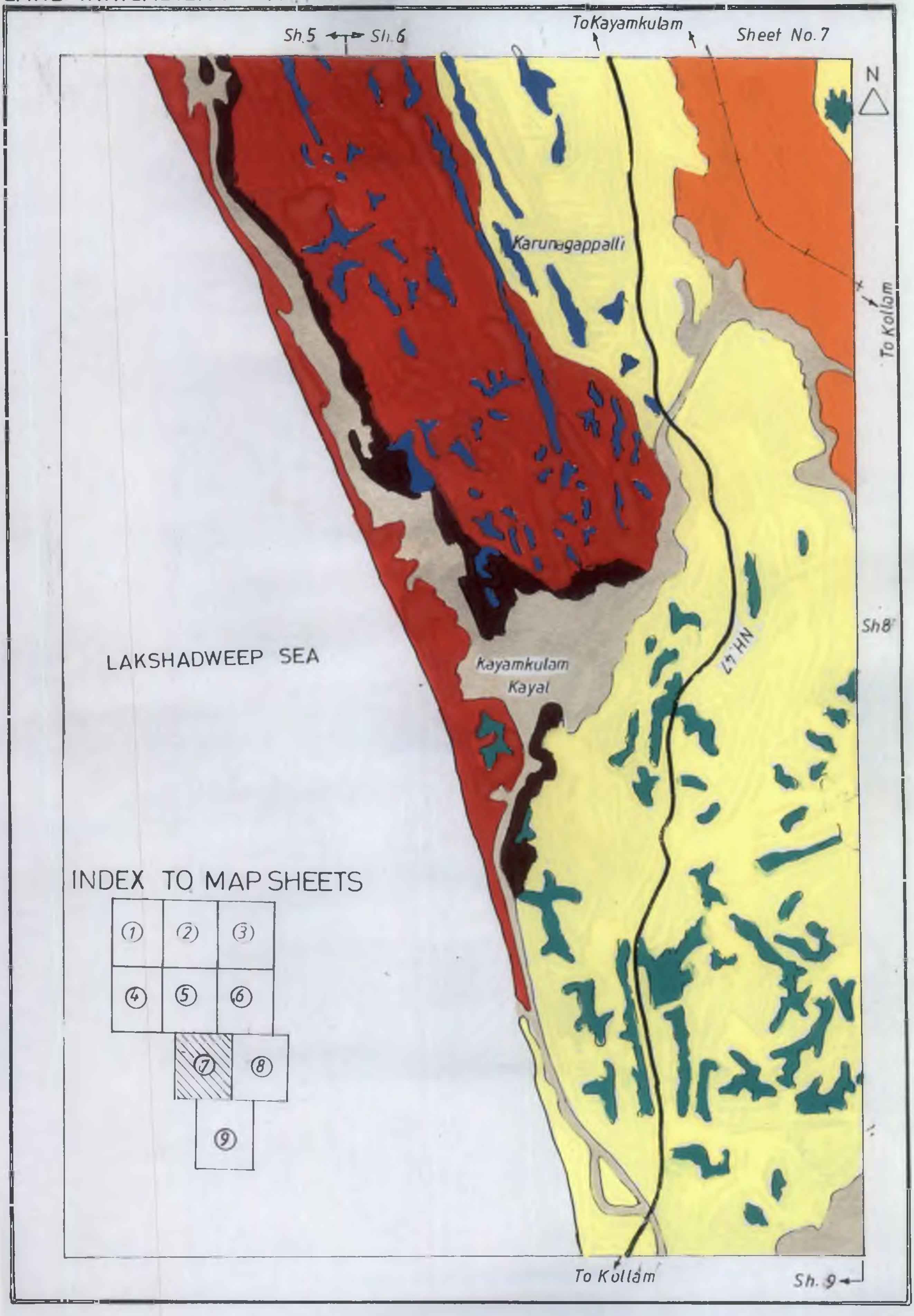

LAND IRRIGABILITY MAP OF ONATTUKARA

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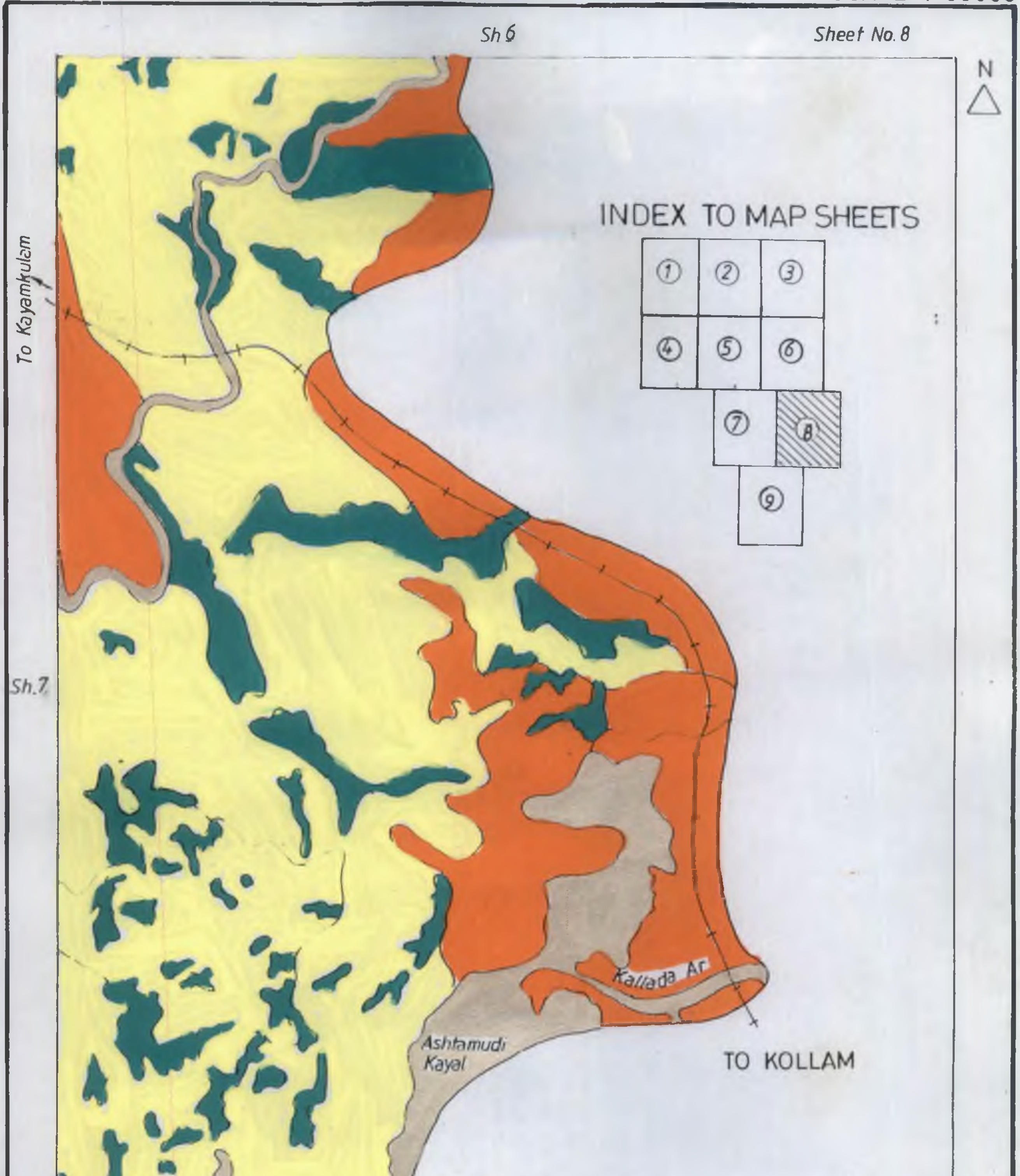

LAND IRRIGABILITY MAP OF ONATTUKARA

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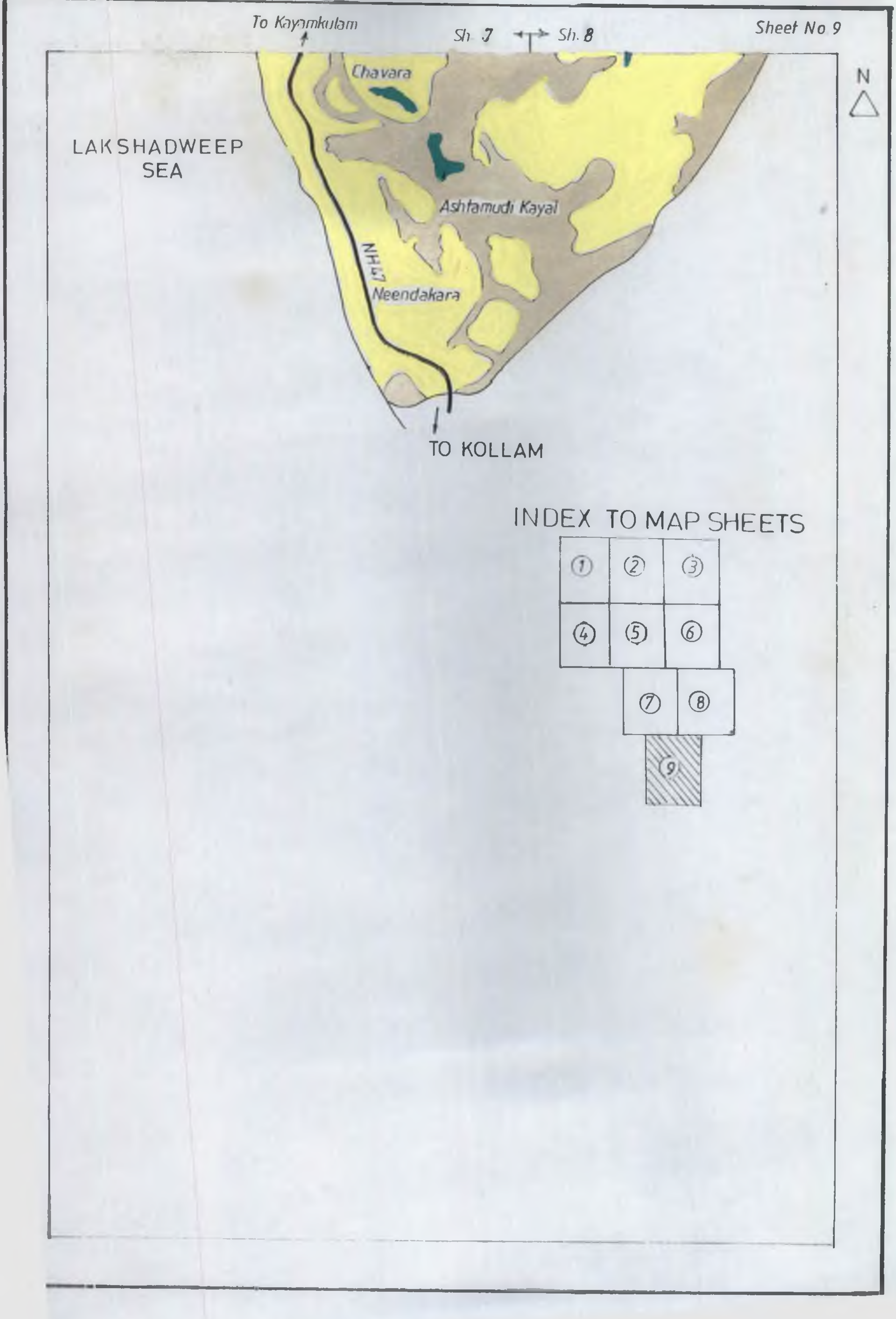

Table 24 **Land irrigability class and subclass**

Sl no	*Land irrig-ability class & subclass*	*Soil series mapped*	*Area (ha)*	*Total area(ha)*	*Major limitations*
1	2d	Sooranad Chunad	725 958	1683	Impeded drainage
2	2t	Kattanam	65	65	Undulating topography.
3	3d	Kottakakam Pathiyoor Vettikode Cherukol Keerikkad	698 350 493 1058 400	2999	Poor drainage and occassional flooding
4	3s	Neendakara Mannar Kollaka Mahadevikad Pallipad	440 22325 355 1580 1015	25715	Sandy textural grades with low water holding and nutrient holding capacity
5	3t	Mynagapally Attuva Vallikunnam Palamel	325 1300 453 553	2631	Undulating to rolling topography
6	4s	Kandallur	2982	2982	Soil limitation(sand). Low water holding and nutrient holding capacity
7	4sd	Alappuzha	180	180	Sandy textural grade with impeded drainage
8	6d	Thrikkunnapuzha	998	998	High water table and very poor drainage conditions due to proximity 'to Kayal.

fragments, soil reaction, cation exchange capacity, base saturation, total soluble salts and organic carbon. The productivity index of the identified twenty soil series were derived based on the inherent soil characteristics and ratings and are given in Table 25.

4.9.2. Productivity calculation

The productivity of the soil is calculated by multiplying the ratings of the individual parameters and expressed as percentage. The productivity rating of the soils for the five important crops grown in Onattukara region has been calculated and presented in Tables 26 to 30.

The resultant index of productivity is set against a scale placing the soil in one or other of the six productivity class, viz., extremely poor, poor, average, good, very good and excellent.

4.9.2.1. Productivity rating for rice

Among the seven wetland soils, Kottakakam series with a rating of 25.4 percent ranks first with *good* rating class and Cherukol series ranks least with only 9.3 percent in the *poor* rating class.

Table 25 **Productivity index code for soil series**

Sl no	*Soil series*	*Texture*	*Depth*	*Slope*	*Drainage*	*Coarse frag.*	*pH*	*CEC*	*BSP*	*EC*	*OC*
		T	*R*	*S*	*D*	*G*	*H*	*C*	*B*	*E*	*N*
1	Neendakara	T1	R5	S1	D5	G5	H3	C1	B1	E5	N2
2	Kandallur	T2	R4	S1	D5	G5	H3	C1	B1	E5	N2
3	Mannar	T2	R5	S1	D4	G5	H5	C1	B1	E5	N2
4	Thrikkunnapuzh	T2	R4	S1	D2	G5	H3	C1	B1	E5	N3
5	Mahadevikad	T2	R3	S1	D3	G5	H3	C1	B2	E5	N2
6	Attuva	T2	R4	S2	D3	G5	H4	C1	B2	E5	N3
7	Kollaka	T2	R5	S2	D4	G5	H2	C1	B1	E5	N2
8	Alappuzha	T1	R5	S1	D5	G5	H5	C1	B1	E5	N3
9	Pallipad	T2	R5	S2	D3	G5	H4	C1	B2	E5	N2
10	Mynagapally	T7	R4	S3	D4	G3	H2	C1	B2	E5	N3

Sl no	Soil series	Texture	Depth	Slope	Drainage	Coarse frag.	pH	CEC	BSP	EC	OC
		T	R	S	D	G	H	C	B	E	N
11	Kattanam	T2	R5	S2	D3	G5	H3	C1	B2	E5	N2
12	Palamel	T3	R4	S3	D4	G4	H4	C1	B2	E5	N3
13	Sooranad	T3	R4	S2	D2	G4	H4	C1	B1	E5	N2
14	Vallikunnam	T7	R4	S3	D4	G3	H3	C1	B1	E5	N3
15	Kottakakam	T3	R3	S1	D2	G5	H2	C1	B2	E5	N3
16	Pathiyoor	T8	R5	S2	D2	G5	H2	C1	B2	E5	N3
17	Cherukol	T2	R4	S2	D3	G5	H3	C1	B1	E5	N2
18	Vettikode	T1	R4	S2	D2	G5	H3	C1	B1	E5	N5
19	Keerikkad	T2	R5	S1	D2	G5	H3	C1	B1	E5	N2
20	Chunad	T3	R4	S2	D2	G5	H2	C1	B2	E5	N2

Table 26 **Productivity rating of soil properties for rice**

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
1	Sooranad	T3,R4,S2,D2,G4,H4,C1,B1,E5,N2	80/100 x 80/100 x 90/100 x 100/100 x 80/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100= 0.158	15.80
2	Kottakakam	T3,R3,S1,D2,G5,H2,C1,B2,E5,N3	80/100 x 90/100 x 100/100 x 100/100 x 100/100 x 70/100 x 70/100 x 90/100 x 100/100 x 80/100 = 0.254	25.40
3	Pathiyoor	T8,R5,S2,D2,G5,H2,C1,B2,E5,N3	90/100 x 70/100 x 90/100 x 100/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 80/100=0.20	20.00
4	Cherukol	T2,R4,S2,D3,G5,H3,C1,B1,E5,N2	60/100 x 80/100 x 90/100 x 70/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.093	9.30
5	Vettikode	T12,R4, S2,D2,G5,H3,C1,B1,E5,N5	70/100 x 80/100 x 90/100 x 100/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100=0.222	22.20
6	Keerikkad	T2,R5,S1,D2,G5,H3,C1,B1,E5,N2	60/100 x 70/100 x 100/100 x 100/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.129	12.90
7	Chunad	T3,R4,S2,D2,G5,H2,C1,B2,E5,N2	80/100 x 80/100 x 90/100 x 100/100 x 100/100 x 70/100 x 70/100 x 90/100 x 100/100 x 70/100=0.177	17.70

Table 27 Productivity rating of soil properties for coconut

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
1	Neendakara	T1,R5,S1,D5,G5,H3,C1,B1,E5,N2	60/100 x 90/100 x 90/100 x 90/100 x 70/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.122	12.20
2	Kandallur	T2,R4,S1,D5,G5,H3,C1,B1,E5,N2	70/100 x 100/100 x 90/100 x 90/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100 =0.158	15.80
3	Mannar	T2,R5,S1,D4,G5,H5,C1,B1,E5,N2	70/100 x 100/100 x 90/100 x 100/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.195	19.50
4	Thrikkunnapuzha	T2,R4,S1,D2,G5,H3,C1,B1,E5,N3	70/100 x 100/100 x 90/100 x 60/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 80/100= 0.120	12.00
5	Mahadevikad	T2,R3,S1,D3,G5,H3,C1,B2,E5,N2	70/100 x 90/100 x 90/100 x 90/100 x 90/100 x 90/100 x 70/100 x 80/100 x 100/100 x 70/100=0.162	16.20
6	Attuva	T2,R4,S2,D3,G5,H4,C1,B2,E5,N3	70/100 x 100/100 x 100/100 x 90/100 x 90/100 x 100/100 x 70/100 x 80/100 x 100/100 x 80/100 = 0.254	25.40
7	Kollaka	T2,R5,S2,D4,G5,H2,C1,B1,E5,N2	70/100 x 90/100 x 100/100 x 100/100 x 90/100 x 80/100 x 70/100 x 70/100 x 100/100 x 70/100=0.156	15.60
8	Alappuzha	T1,R5,S1,D5,G5,H5,C1,B1,E5,N3	60/100 x 90/100 x 90/100 x 90/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 80/100=0.154	15.40
9	Pallipad	T2,R5,S2,D3,G5,H4,C1,B2,E5,N2	70/100 x 90/100 x 100/100 x 90/100 x 90/100 x 100/100 x 70/100 x 80/100 x 100/100 x 70/100=0.200	20.00
10	Mynagapally	T7,R4,S3,D4,G3,H2,C1,B2,E5,N3	80/100 x 100/100 x 90/100 x 100/100 x 80/100 x 80/100 x 70/100 x 80/100 x 100/100 x 80/100=0.206	20.60
11	Kattanam	T2,R5,S2,D3,G5,H3,C1,B2,E5,N2	70/100 x 90/100 x 100/100 x 90/100 x 90/100 x 90/100 x 70/100 x 80/100 x 100/100 x 70/100=0.180	18.00
12	Palamel	T3,R4,S3,D4,G4,H4,C1,B2,E5,N3	90/100 x 100/100 x 90/100 x 100/100 x 100/100 x 100/100 x 70/100 x 80/100 x 100/100 x 80/100=0.363	36.30
13	Vallikunnam	T7,R4,S3,D4,G3,H3,C1,B1,E5,N3	80/100 x 100/100 x 90/100 x 100/100 x 80/100 x 90/100 x 70/100 x 80/100 x 100/100 x 80/100=0.232	23.20

Table 28 Productivity rating of soil properties for sesamum

Sl no	Soil series	Productivity index code	Productivity calculation	Rating percentage
1	Neendakara	T1,R5,S1,D5,G5,H3,C1,B1,E5,N2	50/100 x 80/100 x 100/100 x 80/100 x 100/100 x' 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.099	9.90
2	Kandallur	T2,R4,S1,D5,G5,H3,C1,B1,E5,N2	80/100 x 80/100 x 100/100 x 80/100 x 100/100 x' 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.158	15.80
3	Mannar	T2,R5,S1,D4,G5,H5,C1,B1,E5,N2	80/100 x 80/100 x 100/100 x 100/100 x 100/100 x' 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.22	22.00
4	Thrikkunnapuzha	T2,R4,S1,D2,G5,H3,C1,B1,E5,N3	80/100 x 90/100 x 100/100 x 70/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 80/100=0.178	17.80
5	Mahadevikad	T2,R3,S1,D3,G5,H3,C1,B2,E5,N2	80/100 x 100/100 x 100/100 x 90/100 x 100/100 x 90/100 x 70/100 x 80/100 x 100/100 x 70/100=0.254	25.40
6	Attuva	T2,R4,S2,D3,G5,H4,C1,B2,E5,N3	80/100 x 90/100 x 90/100 x 90/100 x 100/100 x 100/100 x 70/100 x 80/100 x 100/100 x 80/100=0.261	26.10
7	Kollaka	T2,R5,S2,D4,G5,H2,C1,B1,E5,N2	80/100 x 80/100 x 90/100 x 100/100 x 100/100 x 70/100 x 70/100 x 70/100 x 100/100 x 70/100=0.138	13.80
8	Alappuzha	T1,R5,S1,D5,G5,H5,C1,B1,E5,N3	50/100 x 80/100 x 100/100 x 80/100 x 100/100 x 100/100 x 70/100 x 70/100 x 100/100 x 80/100=0.125	12.50
9	Pallipad	T2,R5,S2,D3,G5,H4,C1,B2,E5,N2	80/100 x 80/100 x 90/100 x 90/100 x 100/100 x 100/100 x 70/100 x 80/100 x 100/100 x 70/100=0.203	20.30
10	Mynagapally	T7,R4,S3,D4,G3,H2,C1,B2,E5,N3	90/100 x 90/100 x 80/100 x 100/100 x 80/100 x 70/100 x 70/100 x 80/100 x 100/100 x 80/100=0.163	16.30

Sl no	Soil series	Productivity index code	Productivity calculation	Rating percentage
11	Kattanam	T2,R5,S2,D3,G5,H3,C1,B2,E5,N2	80/100 x 80/100 x 90/100 x 90/100 x 100/100 x 100/100 x 70/100 x 80/100 x 100/100 x 70/100=0.203	20.30
12	Palamel	T3,R4,S3,D4,G4,H4,C1,B2,E5,N3	80/100 x 90/100 x 80/100 x 100/100 x 90/100 x 100/100 x 70/100 x 80/100 x 100/100 x 80/100=0.232	23.20
13	Sooranad	T3,R4,S2,D2,G4,H4,C1,B1,E5,N2	80/100 x 90/100 x 90/100 x 70/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.140	14.00
14	Vallikunnam	T7,R4,S3,D4,G3,H3,C1,B1,E5,N3	90/100 x 90/100 x 80/100 x 100/100 x 80/100 x 90/100 x 70/100 x 80/100 x 100/100 x 80/100=0.209	20.90
15	Kottakakam	T3,R3,S1,D2,G5,H2,C1,B2,E5,N3	80/100 x 100/100 x 100/100 x 70/100 x 100/100 x 70/100 x 70/100 x 80/100 x 100/100 x 80/100=0.176	17.60
16	Pathiyoor	T8,R5,S2,D2,G5,H2,C1,B2,E5,N3	80/100 x 80/100 x 90/100 x 70/100 x 100/100 x 70/100 x 70/100 x 70/100 x 100/100 x 80/100=0.111	11.10
17	Cherukol	T2,R4,S2,D3,G5,H3,C1,B1,E5,N2	80/100 x 90/100 x 90/100 x 90/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.180	18.00
18	Vettikode	T12,R4, S2,D2,G5,H3,C1,B1,E5,N5	50/100 x 90/100 x 90/100 x 70/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100=0.125	12.50
19	Keerikkad	T2,R5,S1,D2,G5,H3,C1,B1,E5,N2	80/100 x 80/100 x 100/100 x 70/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.138	13.80
20	Chunad	T3,R4,S2,D2,G5,H2,C1,B2,E5,N2	80/100 x 90/100 x 90/100 x 70/100 x 100/100 x 70/100 x 70/100 x 80/100 x 100/100 x 70/100=0.124	12.40

Table 29 **Productivity rating of soil properties for cassava**

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
1	Neendakara	T1,R5,S1,D5,G5,H3,C1,B1,E5,N2	50/100 x 90/100 x 90/100 x 100/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.113	11.30
2	Kandallur	T2,R4,S1,D5,G5,H3,C1,B1,E5,N2	60/100 x 100/100 x 90/100 x 100/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100 =0.150	15.00
3	Mannar	T2,R5,S1,D4,G5,H5,C1,B1,E5,N2	60/100 x 90/100 x 90/100 x 100/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.150	15.00
4	Thrikkunnapuzha	T2,R4,S1,D2,G5,H3,C1,B1,E5,N3	60/100 x 100/100 x 90/100 x 60/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 80/100= 0.163	16.30
5	Mahadevikad	T2,R3,S1,D3,G5,H3,C1,B2,E5,N2	60/100 x 90/100 x 90/100 x 90/100 x 90/100 x 90/100 x 70/100 x 100/100 x 100/100 x 70/100=0.174	17.40
6	Attuva	T2,R4,S2,D3,G5,H4,C1,B2,E5,N3	60/100 x 100/100 x 100/100 x 90/100 x 90/100 x 100/100 x 70/100 x 100/100 x 100/100 x 70/100= 0.238	23.80
7	Kollaka	T2,R5,S2,D4,G5,H2,C1,B1,E5,N2	60/100 x 90/100 x 100/100 x 100/100 x 90/100 x 70/100 x 70/100 x 70/100 x 100/100 x 70/100=0.117	11.70
8	Alappuzha	T1,R5,S1,D5,G5,H5,C1,B1,E5,N3	50/100 x 90/100 x 90/100 x 100/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 80/100=0.143	14.30
9	Pallipad	T2,R5,S2,D3,G5,H4,C1,B2,E5,N2	60/100 x 90/100 x 100/100 x 90/100 x 90/100 x 100/100 x 70/100 x 100/100 x 100/100 x 70/100=0.104	10.40
10	Mynagapally	T7,R4,S3,D4,G3,H2,C1,B2,E5,N3	100/100 x 100/100 x 90/100 x 100/100 x 80/100 x 70/100 x 70/100 x 100/100 x 100/100 x 80/100=0.282	28.20

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
11	Kattanam	T2,R5,S2,D3,G5,H3,C1,B2,E5,N2	60/100 x 90/100 x 100/100 x 90/100 x 90/100 x 90/100 x 70/100 x 100/100 x 100/100 x 70/100=0.193	19.30
12	Palamel	T3,R4,S3,D4,G4,H4,C1,B2,E5,N3	90/100 x 100/100 x 90/100 x 100/100 x 100/100 x 100/100 x 70/100 x 100/100 x 100/100 x 80/100=0.45	45.30
13	Sooranad	T3,R4,S2,D2,G4,H4,C1,B1,E5,N2	90/100 x 100/100 x 100/100 x 60/100 x 100/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100= 0.185	18.50
14	Vallikunnam	T7,R4,S3,D4,G3,H3,C1,B1,E5,N3	100/100 x 100/100 x 90/100 x 100/100 x 80/100 x 90/100 x 70/100 x 100/100 x 100/100 x 80/100=0.363	36.30
15	Kottakakam	T3,R3,S1,D2,G5,H2,C1,B2,E5,N3	90/100 x 90/100 x 90/100 x 60/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100 x 80/100 = 0.154	15.40
16	Pathiyoor	T8,R5,S2,D2,G5,H2,C1,B2,E5,N3	80/100 x 90/100 x 100/100 x 60/100 x 90/100 x 70/100 x 70/100 x 70/100 x 100/100 x 80/100=0.107	10.70
17	Cherukol	T2,R4,S2,D3,G5,H3,C1,B1,E5,N2	60/100 x 100/100 x 100/100 x 90/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.150	15.00
18	Vettikode	T12,R4, S2,D2,G5,H3,C1,B1,E5,N5	40/100 x 100/100 x 100/100 x 60/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100=0.095	9.50
19	Keerikkad	T2,R5,S1,D2,G5,H3,C1,B1,E5,N2	60/100 x 90/100 x 90/100 x 60/100 x 90/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.081	8.10
20	Chunad	T3,R4,S2,D2,G5,H2,C1,B2,E5,N2	90/100 x 100/100 x 100/100 x 50/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100 x 70/100=0.139	13.90

Table 30 **Productivity rating of soil properties for banana**

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
1	Neendakara	T1,R5,S1,D5,G5,H3,C1,B1,E5,N2	50/100 x 90/100 x 90/100 x 90/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.113	11.30
2	Kandallur	T2,R4,S1,D5,G5,H3,C1,B1,E5,N2	70/100 x 100/100 x 90/100 x 90/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100 =0.175	17.50
3	Mannar	T2,R5,S1,D4,G5,H5,C1,B1,E5,N2	70/100 x 90/100 x 90/100 x 100/100 x 100/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.194	19.40
4	Thrikkunnapuzha	T2,R4,S1,D2,G5,H3,C1,B1,E5,N3	70/100 x 100/100 x 90/100 x 60/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 80/100= 0.133	13.30
5	Mahadevikad	T2,R3,S1,D3,G5,H3,C1,B2,E5,N2	70/100 x 90/100 x 90/100 x 90/100 x 100/100 x 100/100 x 70/100 x 90/100 x 100/100 x 70/100=0.225	22.50
6	Attuva	T2,R4,S2,D3,G5,H4,C1,B2,E5,N3	70/100 x 100/100 x 100/100 x 90/100 x 100/100 x 70/100 x 70/100 x 90/100 x 100/100 x 80/100= 0.222	22.20
7	Kollaka	T2,R5,S2,D4,G5,H2,C1,B1,E5,N2	70/100 x 90/100 x 100/100 x 100/100 x 100/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100=0.216	21.60
8	Alappuzha	T1,R5,S1,D5,G5,H5,C1,B1,E5,N3	50/100 x 90/100 x 90/100 x 90/100 x 100/100 x 100/100 x 70/100 x 70/100 x 100/100 x 80/100=0.143	14.30
9	Pallipad	T2,R5,S2,D3,G5,H4,C1,B2,E5,N2	70/100 x 90/100 x 100/100 x 90/100 x 100/100 x 100/100 x 70/100 x 90/100 x 100/100 x 70/100=0.250	25.00
10	Mynagapally	T7,R4,S3,D4,G3,H2,C1,B2,E5,N3	100/100 x 100/100 x 90/100 x 100/100 x 80/100 x 70/100 x 70/100 x 90/100 x 100/100 x 80/100=0.254	25.40

Sl no	*Soil series*	*Productivity index code*	*Productivity calculation*	*Rating percentage*
11	Kattanam	T2,R5,S2,D3,G5,H3,C1,B2,E5,N2	70/100 x 90/100 x 100/100 x 90/100 x 100/100 x 90/100 x 70/100 x 90/100 x 100/100 x 70/100=0.225	22.50
12	Palamel	T3,R4,S3,D4,G4,H4,C1,B2,E5,N3	90/100 x 100/100 x 90/100 x 100/100 x 90/100 x 100/100 x 70/100 x 90/100 x 100/100 x 80/100=0.367	36.70
13	Sooranad	T3,R4,S2,D2,G4,H4,C1,B1,E5,N2	90/100 x 100/100 x 100/100 x 60/100 x 90/100 x 100/100 x 70/100 x 70/100 x 100/100 x 70/100= 0.167	16.70
14	Vallikunnam	T7,R4,S3,D4,G3,H3,C1,B1,E5,N3	100/100 x 100/100 x 90/100 x 100/100 x 80/100 x 90/100 x 70/100 x 90/100 x 100/100 x 80/100=0.327	32.70
15	Kottakakam	T3,R3,S1,D2,G5,H2,C1,B2,E5,N3	90/100 x 90/100 x 90/100 x 60/100 x 100/100 x 70/100 x 70/100 x 90/100 x 100/100 x 80/100 = 0.154	15.40
16	Pathiyoor	T8,R5,S2,D2,G5,H2,C1,B2,E5,N3	80/100 x 90/100 x 100/100 x 60/100 x 100/100 x 70/100 x 70/100 x 70/100 x 100/100 x 80/100=0.119	11.90
17	Cherukol	T2,R4,S2,D3,G5,H3,C1,B1,E5,N2	70/100 x 100/100 x 90/100 x 90/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.175	17.50
18	Vettikode	T12,R4, S2,D2,G5,H3,C1,B1,E5,N5	40/100 x 100/100 x 100/100 x 60/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 100/100=0.106	10.60
19	Keerikkad	T2,R5,S1,D2,G5,H3,C1,B1,E5,N2	70/100 x 90/100 x 90/100 x 60/100 x 100/100 x 90/100 x 70/100 x 70/100 x 100/100 x 70/100=0.105	10.50
20	Chunad	T3,R4,S2,D2,G5,H2,C1,B2,E5,N2	90/100 x 100/100 x 100/100 x 60/100 x 100/100 x 70/100 x 70/100 x 90/100 x 100/100 x 70/100=0.167	16.70

4.9.2.2. Productivity rating for coconut

Among the thirteen gardenland soils, Palamel series with a rating of 36.3 percent ranks first with *very good* productivity class and Thrikkunnapuzha series ranks least with a raring of 12 percent.

4.9.2.3. Productivity rating for sesamum

Attuva and Mahadevikad soil series with rating of 26.1 and 25.4 percent respectively fall in the *good* productivity rating class. Neendakara with a rating of 9.9 percent ranks least in the *poor* productivity class.

4.9.2.4. Productivity rating for cassava

Among the twenty soil series, Palamel series with a rating of 45.3 percent ranks first, falling in the *very good* rating class and Keerikkad series, ranks least with 8.1 percent rating falling in the *poor* rating class.

4.9.2.5. Productivity rating for banana

Palamel series with a rating of 36.7 percent ranks top falling in the *very good* productivity class and Keerikkad series ranks least with only 10.5 percent rating.

4.10. Proposed land use

After studying in detail the various soil characteristics, their capabilities, fertility status and socio-economic considerations of the farmers, the following land use is proposed for the twenty soil series of Onattukara region. The suitability of the soil series for the five important crops has been arrived based on productivity calculation and productivity rating.

4.10.1. Crop suitability for rice

Seven wetland soils, viz., Kottakakam, Vettikode, Pathiyoor, Sooranad, Cherukol, Keerikkad and Chunad have been identified during the course of soil survey. As per the productivity rating, Kottakakam soils are best suited for rice followed by Vettikode and Pathiyoor. Cherukol soils, which is the major wetland soil of the region, ranks least in productivity rating for rice and have to be properly managed for sustained rice production.

Crop suitability map for rice is presented in Figure 18.

4.10.2. Crop suitability for coconut

Thirteen gardenland soil series have been identified in Onattukara region. The productivity rating reveals that Palamel series is best suited for coconut cultivation followed by Attuva, Mannar, Pallipad, Mynagapally and Vallikunnam. Neendakara, Kandallur, Thrikkunnapuzha, Mahadevikad, Kollaka, Alappuzha and Kattanam soils which fall in the poor rating class have to be managed properly for better economic returns. In all gardenlands, coconut is grown as a main crop, arecanut and fruit crops as mixed crops and banana, cassava, vegetables and yams as intercrops.

The crop suitability map for coconut is presented in Figure 19.

4.10.3. Crop suitability for sesamum

All the twenty soil series identified in the region were studied for the suitability of sesamum. The study shows that Attuva and Mahadevikad soils are the best suited for sesamum cultivation followed by Mannar, Pallipad, Kattanam, Palamel and Vallikunnam. The remaining thirteen soils are poorly suited for cultivation of sesamum.

Crop suitability map for sesamum is presented in Figure 20.

4.10.4. Crop suitability for cassava

Studies reveal that Palamel and Vallikunnam series are best suited for cassava cultivation. Among the twenty soil series, Keerikkad soils is the least suited. Mynagapally and Attuva soils are also good for cassava. The remaining soils are poorly suited for cultivation of cassava.

The crop suitability map for cassava is presented in Figure 21.

4.10.5. Crop suitability for banana

Studies reveal that Palamel series is best suited for growing banana followed by Pallipad, Mynagapally and Vallikunnam. The soil series, viz., Mahadevikad, Attuva, Kollaka and Kattanam are also good for cultivation of banana. The remaining soils are poorly suited.

The crop suitability map for banana is presented in Figure 22

DISCUSSION

5. DISCUSSION

Soil survey information forms the major basis for land evaluation. The demand for land evaluation arose when it was appreciated that mapping of the natural resources alone did not provide sufficient guidance on how the land could be used and what would be the likely consequences of a particular use. Interpretation of soil survey data for land evaluation is required because, even if the potential of the land can be gauged from the study of a soil map by a soil surveyor, it may not be well understood by planners, administrators and various user agencies.

The results of the study are discussed on the basis of morphological, physical and chemical studies of the profile, each from the twenty identified soil series of Onattukara region. The climatological data of Onattukara region collected for 10 years from 1988 to 1997 have been analyzed for interpretation.

The results of the studies are discussed in detail under the following captions:

- Interpretation of climatological data
- Soil classification
- Land capability classification.
- Land irrigability classification
- Productivity rating and
- Proposed land use

5.1. Interpretation of climatological data

The climatological data of Onattukara region for ten years from 1988 to 1997 has been collected and interpreted.

Onattukara region, in general, has a humid tropical climate.

5.1.1. Rainfall

Rainfall data shows that the region received an average annual rainfall of 2605 mm. Rainfall is received from both southwest (June to September) and northeast monsoons (October to November) with 60percent of the rainfall from the former. Very little rain is received in the driest months of December, January, February and March. The analysis of the mean monthly rainfall shows that maximum rainfall of 554.30 mm is received during June and minimum rainfall of 10.47 mm in January. The analysis of mean number of rainy days shows that maximum number of rainy days of 23.5 has been received in the month of July and minimum number of rainy days, of 6, in January. Year wise rainfall pattern studies also reveal that the maximum rainfall of 2972.6 mm is received during 1997. The average annual rainfall, in general, ranges between 2300 mm and 2900 mm.

5.1.1.1. Soil moisture regime

The soil moisture regime over the region is *ustic* with the soil moisture control section being dry in some or all the parts for 90 cumulative days or more in most years and moist in some part for more than 180 cumulative days.

5.1.2. Temperature

Temperature data recorded from 1988 to 1997 shows that the highest mean monthly temperature of 28.40°C is recorded in April and the lowest mean monthly temperature of 25.39°C in July. The mean monthly temperature is 26.45°C. The decreasing trend of temperature from the month of June is attributed to the incidence of heavy monsoon showers.

5.1.2.1. Soil temperature regime

The soil temperature regime of Onattukara region is *isohyperthermic* because the mean annual soil temperature at a depth of 50 cm is 22°C (or more) and the difference between mean summer (June to August) and mean winter (December to February) temperature is less than 5°C.

5.1.3. Humidity

Analysis of the data on humidity shows that mean humidity of the region is 92.5 percent. Highest mean monthly humidity of 95.1 percent is recorded in July and August and minimum monthly humidity of 90.3 percent is recorded during January.

5.1.4. Sunshine hours

A study of the sunshine hours reveals that mean monthly hours of sunshine is 221.68. Maximum mean monthly sunshine of 300.9 hours is recorded during March and a minimum monthly sunshine of 121.3 hours in July.

5.1.5. Wind velocity

Wind velocity for the period from May to September shows very little variation. Maximum wind velocity of 2.2 km/hr and minimum of 1.4 km/hr are recorded in April and December respectively. Mean wind velocity is 1.8 km/hr.

5.1.6. Evaporation

The analysis of mean monthly evaporation for the period from 1988 to 1997 shows that the mean evaporation is high between

February to April. Maximum evaporation of 4.8 mm is recorded in the month of March and the minimum evaporation of 2.4 mm for July. The mean monthly evaporation is 3.6mm.

5.1.7. Climatic requirements for crops

The five important crops, namely rice, coconut, sesamum cassava and banana are considered in this study. Climatic requirements for these crops are discussed (Sys *et al.*, 1993).

Rice can be grown under a wide range of climatic conditions, both in temperate and humid tropical climate, from sea level to high altitudes. Long periods of sunshine are essential for high yields. Growth is optimal at air temperatures between 24 and 36°C. No sudden temperature drop or strong wind should occur. Rice is sensitive to frost. The optimum precipitation for rainfed rice is more than 1600 mm per year.

Coconut requires warm and sunny conditions without too much variation in temperature. The mean annual temperature requirement is approximately 29°C. The crop does not flourish if the mean annual temperature is below 20°C. The annual total precipitation should exceed at least 1000 mm. The optimal mean annual relative air humidity should be 60 percent or above.

Sesamum seeds do not germinate at soil temperature below 20°C. The optimal temperature range for growth is 25 to 29°C. The crop should receive 300 to 800 mm of precipitation in the growing cycle. Sesamum needs moderate to low air humidity. A high insolation is required at flowering. High winds can cause damage.

The temperature range for growth of cassava is 12 to 35°C. At less than 15°C, there is premature leaf shedding and slow growth. The required total precipitation ranges from 500 to 5000 mm per year. Optimum amount of rainfall required is 1400 to 1800 mm per year. The crop can survive prolonged period of drought during the growing season.

The mean monthly air temperature for the growth of banana is 25 to 28°C. The optimal precipitation amounts to 1500 to 2500 mm per year. It can also be grown in areas with a pronounced dry season. A high relative air humidity of more than 60 percent is desirable. A maximum of sunshine is required. High wind velocity can cause damage. Total crop loss occurs at wind speeds above 100 km/hr.

5.2. Soil classification

Soil classification is a method of organizing and communicating the knowledge and perceptions about the attributes of a soil. It forms the basis for national or regional planning. When soil information is communicated through a common international system such as United States Department of Agriculture (U.S.D.A.) Soil Taxonomy, it provides a strong basis for transferring information from other parts of the world where important research results are available to similar soils. Soil taxonomy is also an effective vehicle for technology transfer from research stations to the farmers field.

Soils of Onattukara region have been classified as per the comprehensive soil classification system - Soil Taxonomy (U.S. Soil Survey Staff, 1975) and Keys to Soil Taxonomy (U.S. Soil Survey Staff, 1994 and 1996).

The primary basis for identifying different classes in the system are the properties of the soil, properties that can be measured quantitatively either in the field or in the laboratory. All the physical and chemical properties of the soils are used in this system. Among the most significant of the properties used as a basis for classification is the presence or absence of certain diagnostic soil horizons which may help to determine the placement of a soil in the classification system. Based on the studies, the soil map showing distribution of the identified twenty soil series in Onattukara region has been prepared.

The soil classification of the identified twenty soil series of Onattukara region are discussed in detail hereunder.

5.2.1. Neendakara series

Neendakara series represents the very deep, light textured marine alluvium located adjoining beach sand.

The surface layer, even though highly sandy, has a dark grey colour due to the presence of opaque minerals found in the locality. Since the surface does not possess any diagnostic characters other than absence of rock structures or finely stratified fresh sediments, the epipedon is recognized as *ochric*. The subsoil shows no diagnostic characters other than a continuous sandy textural grade with very little clay. So it is placed under the order *Entisols*.

Since the subsoil contains more than 92 percent sand, the soil is placed under the suborder *Psamments*. The soil possess an *ustic* moisture regime and hence the soil is placed under the great group *Ustipsamments*. At the subgroup level, the soil does not possess a lithic, aquic, oxyaquic or agric characteristics and hence the soil is placed under *Typic Ustipsamments*. Since the soil control section contains more than 90 percent sand and are grouped under the suborder Psamments, the particle size class is not mentioned. The soil is having a *mixed* mineralogy with an *isohyperthermic* temperature regime and hence the soil is placed under the family *mixed, isohyperthermic*.

The Neendakara series is classified under *Mixed, isohyperthermic, Typic Ustipsamments*.

5.2.2. Kandallur series

Kandallur series represents the very deep, coarse textured, marine alluvium of recent origin located on level to very gently sloping marine terraces. These very young soils show very little profile development.

The 'Ap' horizon is too thin with high colour value and chroma and low in organic matter which qualifies the epipedon as *ochric.* The soils are uniformly sandy without any profile development such as alteration in structure, texture or colour In general, clay content decreases with depth which shows the immature condition of the soil with no clay movement down the profile. Hence, no diagnostic subsurface horizon is identified, thereby placing the soils in the order *Entisols.*

The soil is placed under the suborder *Psamments* since the particle size control section contains only sand and loamy sand. The *ustic* moisture regime identified places the soil under the great group *Ustipsamments.* These soils do not have characters of lithic, aquic, oxyaquic, aridic or agric which places the soil under the subgroup *Typic Ustipsamments.* Since these Psamments contain only sand and loamy sand textural grades, the particle size class is not mentioned in family. *Mixed* mineralogical composition along with *isohyperthermic* temperature regime qualifies the soil to be placed under the family *mixed, isohyperthermic.*

The Kandallur series is classified as *Mixed, isohyperthermic, Typic Ustipsamments.*

5.2.3. Mannar series

Mannar series represents the very deep, coarse textured, coastal alluvial soils located on very gently sloping plains adjoining the coastal sandy belt distributed throughout Onattukara region. These soils are very young in origin and show very little profile development.

The soils have a uniform sandy textural grade without any evidence of profile development since there are no alterations like development of structure or colour or illuvial movement of clay. The soil does not have any diagnostic characters other than an 'Ap' horizon which has low colour value and chroma, but too thin to be recognized as mollic or umbric epipedon. The 'Ap' horizon is therefore identified as *ochric*. The subsurface soils are characterized by uniformly sandy textural grades with no evidence of any profile development. Hence the soil qualifies to be placed under the order *Entisols.*

The soil is having a textural grade of sand to loamy sand in the control section and is placed in the suborder *Psamments.* These soils possess an *ustic* moisture regime and hence placed under the great group *Ustipsamments.* Since the soils do not qualify under lithic, aquic, oxyaquic, aridic or argic, these soils are placed under the subgroup, *Typic Ustipsamments.* The soils have only sandy textural grade and classified under Psamments. Hence the particle size class is not mentioned. The mineralogical composition of fine earth fraction is *mixed* and the temperature regime is *isohyperthermic.* Therefore the soils are placed under *mixed, isohyperthermic* family.

The Mannar series is classified under *Mixed, isohyperthermic, Typic Ustipsamments.*

5.2.4. Thrikkunnapuzha series

Thrikkunnapuzha series represents very deep, imperfectly drained, highly gleyed, very dark grey soils developed from marine and lacustrine deposits of recent origin. These soils are submerged for a considerable period of time during monsoons and are mainly located in depressions adjoining backwaters.

The soils are very young with contrasting structural grades. The surface layer shows the evidence of slight structural development with very dark grey colour but it is too thin and contains too little organic matter to be placed under any other diagnostic surface horizon other than an *ochric* epipedon. The subsurface horizon is highly gleyed and the texture ranges from loamy sand to clay with an irregular distribution of organic carbon. Since these soils are very young in origin, no diagnostic characters have developed in the subsurface. With only an *ochric* epipedon and no diagnostic subsurface horizon, these soils are placed under the order *Entisols.*

The soil shows aquic conditions for considerable period of time in most years as evidenced by the presence of highly gleyed subsurface horizon with a chroma of two or less with redox concentrations and depletions. Hence the soil is placed under the suborder *Aquents.* Since the soil column shows an irregular distribution of organic carbon and remains more than 0.2 percent at a depth of more than 125cm, the soil is placed under the great group *Fluvaquents.* The soil does not show any characteristics for placing the soil under sulphic, vertic, histic but have a difference of less than 5°C between mean summer and mean winter soil temperatures at a depth of 50 cm from the soil surface and hence the soil is placed under the subgroup *Tropic Fluvaquents.* In the soil control section, the percentage of clay is 28.6 with a *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is less than 0.24 and hence the cation exchange activity class is *subactive.* Hence the soil is placed under *fine-loamy, mixed, isohyperthermic, subactive* family.

The Thrikkunnapuzha series is classified under *Fine-loamy, mixed, isohyperthermic, subactive, Tropic Fluvaquents*

5.2.5. Mahadevikad series

Mahadevikad series represents the very deep, coarse textured marine alluvium occurring on gently sloping plains adjoining the coastal belt. These are very young soils with ill defined horizons.

Uniformly sandy textural grades, without alterations in structure, texture or colour and without movement of clay show the highly immature nature of these soils. However, an *ochric* epipedon is identified in the surface since the surface soil is too thin with very little organic matter even though the chroma is low. In the subsoil, the distribution of clay, along with low cation exchange capacity and the irregular decrease of organic carbon does not qualify the horizon to be placed under kandic, argillic or oxic. There is not even the development of structure or colour in these immature soils to qualify the diagnostic horizon as cambic. Hence the soil is placed under the order *Entisols*.

The soil is grouped under the suborder *Psamments* since the particle size control section is sandy. The soil is having an *ustic* moisture regime and hence classified under the great group *Ustipsamments*. These soils show the typical character of Ustipsamments leaving behind lithic, aquic, oxyaquic, aridic or agric which places the soil under the subgroup *Typic Ustipsamments*. Since Psamments contain only sand and loamy sand textural grades, the particle size class is not mentioned under family. *Mixed* mineralogical composition along with *isohyperthermic* temperature regime places the soil under *mixed, isohyperthermic* family.

The Mahedevikad series is classified under *Mixed, isohyperthermic, Typic Ustipsamments.*

5.2.6. Attuva series

Attuva series represent the very deep, coarse textured, alluvial soils located between coastal plains and laterite belt. Even though these soils are young in origin, profile development is noticed.

The surface soil is too thin, low in organic matter and being dark in colour, does not meet the colour requirements of any other epipedon except *ochric*. The development of structure and absence of rock structure is noticed in the subsoil. The identifying properties of an argillic, kandic, an oxic or a spodic horizon are not met with here.

The organic carbon content decreases regularly with depth. Hence the subsurface horizon is diagnosed as *cambic*. The ochric epipedon and cambic subsurface horizon places these soils under the order *Inceptisols*.

Since the soil has *isohyperthermic* temperature regime, it is placed under the suborder *Tropepts*. The soil qualifies to be placed under the great group *Dystropepts* since the organic carbon content, moisture regime and base saturation values do not categorize the soil otherwise. The organic carbon content of more than 0.2 percent and slope of less than 25 percent puts this series under the subgroup *Fluventic Dystropepts*. The soil control section contains 11.9 percent clay with a *mixed* mineralogy and *isohyperthermic* temperature regime. The CEC to clay ratio of 0.49 qualifies the soil to be placed under the cation exchange activity class, *active*. Hence the soil is placed under *coarse-loamy, mixed, isohyperthermic. active* family.

The Attuva series is classified under *Coarse-loamy, mixed, isohyperthermic, active, Fluventic Dystropepts*.

5.2.7. Kollaka series

Kollaka soils represent the very deep, light textured, strong brown to red, marine alluvial deposits located on gently to moderately sloping undulating plains on the eastern portion of Onattukara region. These soils are uniformly sandy without any profile development.

The 'Ap' horizon is too thin with high value and chroma and low in organic matter which qualifies the epipedon to be placed under *ochric*. In the subsoil, no alteration in the form of development of structure, texture or colour are noticed. In general, clay content decreases with depth with no movement of clay which shows the immature condition of the soil. Thus, no diagnostic subsurface horizon could be identified. Hence the soil is placed in the order *Entisols*.

The soil is grouped under the suborder *Psamments* since the particle size control section contains only sand and loamy sand. The *ustic* moisture regime identified places the soil under the great group *Ustipsamments*. These soils do not have characters of lithic, aquic, oxyaquic, aridic or agric which places the soil under the subgroup *Typic Ustipsamments*. Since these Psamments contain only sand and loamy sand textural grades, the particle size class is not mentioned in family. *Mixed* mineralogical composition along with *isohyperthermic* temperature regime places the soil under *mixed, isohyperthermic,* family.

The Kollaka series is classified under *Mixed, isohyperthermic, Typic Ustipsamments*.

5.2.8. Alappuzha series

Alappuzha series represent the very deep, coarse textured, marine alluvium deposited over a black, dark brown coloured iron oxide and organic matter rich sand, locally called *Kalashi*.

These soils are very young in origin and show very little profile development other than a light coloured *ochric* epipedon. The subsoil shows no evidence of profile development and the textural grade is always sandy and hence these soils are placed under the order *Entisols.*

In the control section, the textural grade is sand to loamy sand and hence the soil is placed under the suborder *Psamments.* Within the particle size control section, there is more than 90 percent silica which qualifies the soil to be placed under the great group, *Quartzipsamments.* The area possess an *ustic* moisture regime and hence these soils are placed under the subgroup *Ustic Quartzipsamments.* The particle size class is not mentioned under family since this is classified under Psamments. A *mixed* mineralogical composition with *isohyperthermic* temperature regime places the soil under *mixed, isohyperthermic* family.

The Alappuzha series is classified under *Mixed, isohyperthermic, Ustic Quartzipsamments.*

5.2.9. Pallipad series

Pallipad series represents very deep, alluvial soils with initial stages of laterization in deeper layers. These soils occur on gently to moderately sloping plains.

The surface soil is characterized by the presence of an *ochric* epipedon since no characteristics of the other six epipedons are observed. Even though the soils are young in age, the subsoils show considerable profile development in the form of significant accumulation of illuviated layer lattice silicate clay. The 'Bw' horizon contains 12 percent clay and the underlying argillic horizon contains more than 24 percent clay. Thus, there is an increase of more than three percent (absolute) clay than the eluvial horizon. This clay increase satisfies the criteria for an *argillic* horizon. Base saturation is more than 35 percent and hence the soil is placed under the order *Alfisols.*

The soil possess an *ustic* moisture regime and hence it is placed under the suborder *Ustalfs.* Since this soil does not have a duripan, plinthite within 150cm, natric horizon, CEC of less than 16 cmol/kg and a hue not redder than 2.5 YR, it is placed under the great group *Haplustalfs.* The cation exchange capacity of less than 24 cmol/kg clay is observed in the argillic horizon and hence the soil is placed under the subgroup *Kanhaplic Haplustalfs.* The control section contains less than 18 percent clay with a *mixed* mineralogical composition. The soil temperature regime is *isohyperthermic* which enables the soil to be placed under *coarse-loamy, mixed, isohyperthermic* family.

The Pallipad series is classified under *Coarse-loamy, mixed, isohyperthermic Kanhaplic Haplustalfs.*

5.2.10. Mynagapally series

Mynagapally series represents the very deep, well drained, gravelly, laterite soils occurring on moderately sloping to strongly sloping low mounds on the eastern periphery of Onattukara region.

The 'Ap' horizon is red to yellowish red, gravelly sandy clay loam with slight profile development. Hence 'Ap' horizon is identified as the *ochric* epipedon. The subsoil is characterized by gravelly sandy clay to gravelly clay illuvial horizon with low CEC and an increase in clay content of more than 20 percent than in the surface horizon. Hence the 'Bt1' and 'Bt2' horizons qualify for placement under *kandic* horizon. Since the soil is having a *kandic* horizon and an *ochric* epipedon with a base saturation of less than 35 percent from 98cm downwards, this soil is placed under the order *Ultisols.*

The soil is having an *ustic* moisture regime and hence the soil is placed under the suborder, *Ustults.* Plinthite forms a continuous phase at a depth of 113 cm from the mineral soil surface and hence the soil is placed under the great group, *Plinthustults.* All *Plinthustults* are provisionally classified in the subgroup *Typic Plinthustults.* The soil control section is characterized by the presence of more than

35percent by volume of coarse fragments and contains more than 40percent of clay with *mixed* mineralogical composition. The soil enjoys an *isohyperthermic* temperature regime. The CEC to clay ratio is less than 0.24 and hence the cation exchange activity class is *subactive*. Hence the soil is placed under *clayey-skeletal, mixed, isohyperthermic subactive* family.

The Mynagapally series is classified under *Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults.*

5.2.11. Kattanam series

Kattanam series represents alluvio-colluvial soils resting over sandy marine deposit on gently sloping plains adjoining undulating laterite belt. Even though the soils are young in origin, slight profile development is noticed in the upper part of the subsoil.

The 'Ap' horizon is *ochric* since it is too thin and low in organic matter, even though, low in colour value and chroma. The 'Ap' horizon does not contain rock structure and fine stratification. The subsoils do not have sufficient clay increase or movement of clay to qualify for kandic, argillic or oxic horizons. But evidence of alteration in the form of structural development along with the absence of rock structure shows the presence of *cambic* subsurface horizon. Since the soil is having an ochric epipedon and cambic subsurface horizon, this soil series is placed in the order *Inceptisols.*

The *isohyperthermic* temperature regime places the soil in the suborder *Tropepts*. The great group is identified as *Ustropepts* due to *ustic* moisture regime and a base saturation of more than 50 percent between 25 to 100 cm of soil depth. Lithic, vertic, aquic or oxic characteristics are not identified in the soil except fluventic character of irregular decrease in organic carbon content and a slope of less than 25 percent. Hence the soil is placed under the subgroup *Fluventic Ustropepts.* The particle size control section of the soil has less than 18 percent clay with a *mixed* mineralogical composition and an *isohyperthermic* temperature regime. The CEC to clay ratio is 0.39, enabling the soil to be placed under the cation exchange activity class *semiactive*. Hence the soil is placed under *coarse-loamy, mixed, isohyperthermic semiactive* family.

The Kattanam series is classified under *Coarse-loamy, mixed, isohyperthermic, semiactive, Fluventic Ustropepts.*

5.2.12. Palamel series

Palamel series represents the light to medium textured, recent to subrecent, alluvio-colluvial soils occurring on undulating to rolling land forms on the north eastern part of Onattukara region. These soils are deposited over a continuous layer of plinthite which are soft and quarriable. Even though they are young in origin, these soils show certain amount of profile development due to their physiographic position and climatic conditions.

The surface layer is dark brown, gravelly sandy loam, highly disturbed due to regular cultivation practices. Even though organic matter is high, this epipedon does not qualify for placement under anthropic, histic, melanic or mollic epipedons due to unsatisfactory compliance with specific requirements. However, the epipedon of Palamel series is identified as *ochric* since it satisfies the conditions of colour and other characteristics like thickness. The subsurface horizon shows high amount of clay. But there is no evidence of illuvial movement of clay which invariably rules out the presence of an argillic or kandic horizon. Even though CEC is low, this horizon does not satisfy the conditions laid down for an oxic horizon. However the subsurface horizon shows slight profile development by way of alterations like development of structure and colour. Hence it can be seen that the subsurface horizons, namely 'Bw1' and 'Bw2', represent a *cambic* subsurface horizon. Hence the soil is placed under the order *Inceptisols.*

Since Palamel soils have an *isohyperthermic* temperature regime, the soil qualifies for placement under the suborder *Tropepts.* These soils have less than 50 percent base saturation as well as more than 12kg/m^2 organic carbon and no sombric horizon and hence they are grouped under the great group *Humitropepts.* Palamel soils have a CEC of less than 24 cmol/kg. clay and hence they are grouped under the subgroup of *Ustoxic Humitropepts.* As per the climatological data attached, it can be seen that the soil possess an *ustic* moisture regime and an *isohyperthermic* temperature regime. The control section for particle size shows an average distribution of 34 percent clay with a *mixed* mineralogical composition. The CEC to clay ratio is less than 0.24 and hence the cation exchange activity class is *subactive.* Hence the soil is grouped under *fine-loamy, mixed, isohyperthermic, subactive* family.

The Palamel series is classified as *Fine-loamy, mixed, isohyperthermic, subactive, Ustoxic Humitropepts.*

5.2.13. Sooranad series

Sooranad series represent the very deep, fine textured colluvium over laterite occurring on gently sloping depressions of lowland plains.

Ochric epipedon is the diagnostic epipedon identified in the surface soil since the epipedon fails to meet the requirements for any of the other six epipedons because it is too thin or too dry and has too high colour value or chroma and contains too little organic matter. The 'Bt1' horizon is identified as the *kandic* horizon which is a vertically continuous subsurface horizon underlying a coarse textured surface horizon. The 'Bt1' horizon satisfies the clay and CEC requirements for placing the soil under *kandic* horizon. Since the soil has a *kandic* horizon and an *ochric* epipedon and a base saturation of less than 35 percent, the soil is placed under the order *Ultisols.*

The soil is having an *ustic* moisture regime and hence the soil is placed under the suborder *Ustults.* Plinthite forms a continuous phase at 120 cm from the mineral soil surface and hence the soil is placed under the great group *Plinthustults.* All Plinthustults are provisionally classified in the subgroup *Typic Plinthustults.* The soil control section contains more than 35 percent clay with a *mixed* mineralogical composition and an *isohyperthermic* temperature regime. The CEC to clay ratio is less than 0.24 enabling the soil to be placed under the cation exchange activity class, *subactive.* Hence the soil is placed under *fine, mixed, isohyperthermic, subactive* family.

The Sooranad series is classified under *Fine, mixed, isohyperthermic, subactive, Typic Plinthustults.*

5.2.14. Vallikunnam series

Vallikunnam series represents the very deep, medium textured, gravelly soils occurring on gently to moderately sloping low mounds. They are developed from gneissic materials and rests over plinthite.

The surface soil is too thin and low in organic matter. The colour of this horizon, base saturation percentage and organic carbon content do not agree these soils to be placed under any diagnostic epipedon other than *ochric.* The subsoil is characterized by the gravelly sandy clay loam to gravelly clay illuvial horizon with low cation exchange capacity. An increase in clay content down the profile with more than 20 percent increase in clay than the surface horizon is noticed in 'Bt1' and 'Bt2' horizons. Organic carbon content decreases regularly. The 'B' horizon qualifies for placement under *kandic* horizon. Since the soil is having an *ochric* epipedon, *kandic* subsurface horizon and base saturation of less than 35 percent at lower most depth, the soil is placed under the order *Ultisols.*

The soil has an *ustic* moisture regime and is placed in the suborder *Ustults.* Plinthite forms a continuous phase below a depth of 113 cm from the mineral soil surface which qualifies the soil for placement under the great group *Plinthustults.* All the *Plinthustults* are provisionally classified in the subgroup *Typic Plinthustults.* The soil control section has more than 35 percent by volume of coarse fragments, more than 35 percent clay with *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is less than 0.24 and hence the cation exchange activity class is *subactive.* Hence the soil is placed under *clayey-skeletal, mixed, isohyperthermic, subactive* family.

The Vallikunnam series is classified under *Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults.*

5.2.15. Kottakakam series

Kottakakam series represents the very deep, medium textured, alluvial soils occurring in the depressions of coastal plain in Karthikapally taluk.

Ochric epipedon is identified in the surface soils since it does not comply to the requirements of any of the other diagnostic horizons. The subsoil shows little profile development in the form of alteration in the development of structure and colour. Further, clay increase is seen, but does not show evidence of illuvial clay movement. So these soils do not qualify for the kandic or argillic horizon. The CEC is more than 16 cmol/kg and hence do not qualify for an oxic horizon. These soils have a *cambic* diagnostic subsurface horizon and hence the soil is placed under the order *Inceptisols.*

The soils are submerged during monsoons and the profiles show redoximorphic concentrations and depletions and chroma of two between 20 cm and 54 cm depth. Hence, the soil is placed under the suborder *Aquepts.* The soil is having an *isohyperthermic* temperature regime and hence placed in the great group, *Tropaquepts.* The soil is having a colour of 7.5 YR, a value of three and chroma two between depth of 25 and 75 cm and hence it is placed under the subgroup *Aeric Tropaquepts*. The soil control section contains less than 18 percent of clay with a *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is less than 0.24 and hence the cation exchange activity class is *subactive.* Hence the soils are placed under *coarse-loamy, mixed, isohyperthermic, subactive* family.

The Kottakakam series is classified under *Coarse-loamy, mixed, isohyperthermic, subactive, Aeric Tropaquepts.*

5.2.16. Pathiyoor series

Pathiyoor series represents the very deep, imperfectly drained, fine textured, alluvial soils in gently sloping depressions of lowland plains.

The colour, organic carbon content, thickness of the horizon and absence of rock structure and stratification of 'Ap' horizon qualifies the surface soil to be placed under *ochric* epipedon. The subsoil shows slight profile development in the form of development of structure and absence of rock structure in addition to aquic conditions and colour requirements of the cambic horizon. Even though there is clay increase in the first half of the subsoil, the subsoil does not qualify for kandic, argillic, or oxic horizon due to higher CEC of more than 16 cmol/kg and absence of translocated clay films. Hence the subsoil is identified as *cambic.* The *ochric* epipedon and *cambic* subsurface horizon qualifies the soil to be placed under the order *Inceptisols.*

The soil is submerged during monsoons and the profiles show redoximorphic concentrations and depletions with a chroma of two, the soil is placed under the suborder *Aquepts.* These soils have an *isohyperthermic* temperature regime and qualifies for placement under the great group *Tropaquepts.* The soil has a colour of hue 10 YR and value of less than five and chroma two between a depth of 25 cm and 75 cm . Hence the soil qualifies for the subgroup *Aeric Tropaquepts.* The soil control section contains more than 35 percent clay with *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is 0.24 and hence the cation exchange activity class is *semiactive.* Hence the soil is placed under *fine, mixed, isohyperthermic, semiactive* family.

The Pathiyoor series is classified under *Fine, mixed, isohyperthermic, semiactive, Aeric Tropaquepts.*

5.2.17. Cherukol series

Cherukol soils are observed in narrow depressions with very gentle slopes. Soils are very deep, coarse textured, coastal alluvium of recent origin with ill defined horizons.

The 'Ap' horizon is dark greyish brown, loamy sand with slight structural development. No diagnostic characters other than colour value of four or more, this horizon is too thin to be recognized as mollic or umbric. Hence the 'Ap' horizon is identified as *ochric* epipedon. The subsurface layers are light yellowish brown to yellowish brown, light textured with no evidence of profile development. Even though clay is high in the lower horizon, there is no evidence of illuvial movement and the organic carbon decreases irregularly with depth. Hence this soil cannot be assumed to have a cambic horizon. Even though the CEC is low and there is no evidence of clay movement, this soil cannot be placed under oxic, kandic or argillic horizons. From the above discussion, it is seen that no diagnostic horizon other than an *ochric* epipedon is present. Hence the soils are placed under the order *Entisols.*

These soils are located in areas where the slope is less than three percent and the organic carbon content of the soil decreases irregularly with depth. Hence the soil is placed under the suborder *Fluvents.* The soil is having an *isohyperthermic* temperature regime, and hence placed in the great group, *Tropofluvents*. The particle size classification shows that the soil control section contains less than 18 percent clay with *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is below 0.24 and hence the cation exchange activity class is *subactive*. Hence the soils are classified under *coarse-loamy, mixed, isohyperthermic, subactive* family.

The Cherukol series is classified under *Coarse-loamy, mixed, isohyperthermic, subactive, Typic Tropofluvents.*

5.2.18. Vettikode series

Vettikode series represents the very heavy, imperfectly drained, very deep, alluvial soils located in the shallow depressions of the undulating coastal plains of Onattukara region.

The diagnostic epipedon is *ochric,* since the epipedon fails to meet the requirements of any of the other six epipedons. The subsurface horizon does not show any significant profile development. Even though organic carbon is high, the soils are of very recent origin and since there is no diagnostic subsurface horizon, the soil is placed under the order *Entisols.*

In the layer between 40 and 50 cm from the mineral soil surface, the soil shows aquic conditions, a chroma of one and a colour value (moist)of five. Hence the soil is placed under the suborder *Aquents.* Since the organic carbon content is more than 0.2 percent at a depth of 125 cm from the mineral soil surface, the soil is placed under the great group *Fluvaquents*. The soil is having a difference of less than 5°C between mean summer and mean winter soil temperatures and hence placed under the subgroup *Tropic Fluvaquents*. The soil control section is having more than 60 percent clay with a *mixed* mineralogical composition and *isohyperthermic* temperature regime. The CEC to clay ratio is below 0.24 and hence the cation exchange activity class is *subactive*. The above characters qualify the soil to be placed under *very fine, mixed, isohyperthermic, subactive* family.

The Vettikode series is classified under *Very fine, mixed, isohyperthermic, subactive, Tropic Fluvaquents*.

5.2.19. Keerikkad series

Keerikkad series represents the very deep, imperfectly drained, coarse textured, coastal alluvium developed in the depressions of the two subdued sand dunes of the coastal belt. These soils are very young.

These soil are uniformly sandy without any profile development. There is no alteration like structure or colour or illuvial movement of clay. There are no diagnostic characteristics in the 'Ap' horizon that has a colour value and chroma and organic matter content that meet the requirements for any diagnostic surface horizons other than an *ochric* epipedon. The subsoil is uniformly sandy with stratification below 100 cm. There is no evidence of clay movement or alteration in structure or colour other than stratification in the subsoil. Since there is no diagnostic subsurface horizon, the soil is classified under the order *Entisols.*

In the layer between 40 and 50 cm from the mineral soil surface the soil shows aquic conditions and chroma of one and colour value of four. Hence the soil is placed under the suborder *Aquents.* The soil has a sandy particle size in all horizons between 25 and 100 cm from the mineral soil surface which qualifies the soil to be placed under the great group, *Psammaquents.* These *Psammaquents* do not qualify to be placed under any subgroups other than *Typic* and hence the subgroup is *Typic Psammaquents.* These soils have only sandy textural grades and hence the particle size class is not mentioned at family level. The mineralogical composition of the fine earth fraction is *mixed* and possess an *isohyperthermic* temperature regime. Hence the soil is placed under *mixed, isohyperthermic* family.

The Keerikkad soils are classified under *Mixed, isohyperthermic Typic Psammaquents.*

5.2.20. Chunad series

Chunad series represents the very deep, imperfectly drained, medium textured soils occurring on level to gently sloping depressions of lowland plains . Even though these soils are young in origin, profile development is noticed.

The surface horizon is too thin with colour value (moist) of four and have less amount of organic carbon which qualifies the horizon as *ochric.* The subsoil shows profile development. Aquic conditions, chroma of two or less along with redox concentrations and depletions within 50 cm of mineral soil surface and a regular decrease in organic carbon content enables the soil to be placed under *cambic* subsurface horizon. Ochric epipedon along with cambic subsurface horizon places the soil under the order *Inceptisols.*

The soil is submerged during monsoon season and the profile shows redoximorphic concentrations and depletions with a chroma of two which places the soil under the suborder *Aquepts.* These soils have an *isohyperthermic* temperature regime which qualifies for the great group *Tropaquepts.* The soil has a colour of hue 10 YR and a value of less than five and chroma of two between a depth of 25 and 75 cm. Hence the soil qualifies for placement under the subgroup *Aeric Tropaquepts.* The soil control section contains 34 percent clay with a *mixed* mineralogy and *isohyperthermic* temperature regime. The CEC to clay ratio is 0.31 and hence the cation exchange activity class is *semiactive.* Hence the soil is placed under *fine-loamy, mixed, isohyperthermic, semiactive* family.

The Chunad series is classified under *Fine-loamy, mixed, isohyperthermic, semiactive, Aeric Tropaquepts.*

Soil taxonomic classification of the identified twenty soil series were not attempted earlier. But, classification of sandy soils in other parts of India have been attempted like that of the Gangetic plains of Bihar (Divakar and Singh, 1994), Soan river valley soils (Sharma *et al.*, 1994) and of riverine alluvial plains of Arunachal Pradesh (Walia and Chamuah, 1994). Patel and Dasog(1997) classified the lowland soils associated with laterite in the Western Ghat region under Inceptisols.

Soil survey staff (1997 and 1998) have made soil taxonomic classification of the soils of the soils of the Kuriarkutty Karappara Irrigation Project and soils of Dharmadam panchayat and placed the soils under the orders, Entisols and Inceptisols, Alfisols and Ultisols.

5.3. Land capability classification

Land capability classification is an interpretative grouping of soils mainly based on the inherent soil characteristics, external land features and environmental factors that limit the use of land. Classification of soil units into capability groups enable us to understand the potential and hazards of the soil to various land use for sustained productivity.

Scientific survey and classification of soils are the primary requirements for grouping soils according to their capability for uses of varying intensity, (Soil Survey Manual, 1971). Land capability classification shows in a general way the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations for field crops, the risk of damage and the way they respond to management.

The criteria used in grouping the soils do not include major and generally expensive land forming that would change slope, depth or other characteristics of the soils nor do they include possible but unlikely major reclamation projects.

In the capability system, soils are generally grouped at three levels, viz., capability class, subclass and unit (Soil Survey Manual,1970). Only class and subclass are used in this study.

5.3.1. Capability class

Capability classes, the broadest group, are designated by roman numerals I to VIII (Soil Survey Manual, 1970). The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows.

5.3.1.1. Class I

These soils have few limitations or hazards that restrict their use.

5.3.1.2. Class II

Class II soils have moderate limitations or hazards that reduce the choice of plants or that require moderate conservation practices.

5.3.1.3. Class III

Class III soils have severe limitations or hazards that reduce the choice of crops or that require special conservation practices or both.

5.3.1.4. Class IV

Class IV soils have very severe limitations or hazards that reduce the choice of plants or that require very careful management or both.

5.3.1.5. Class V

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

5.3.1.6. Class VI

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

5.3.1.7. Class VII

Class VII soils have very severe limitations that make them unsuitable for cultivation.

5.3.1.8. Class VIII

Class VIII soils are miscellaneous areas that have limitations which nearly preclude their use for commercial crop production.

5.3.2. Land capability subclass

Under land capability classes, there are subclasses which show the dominant limitations such as erosion (e), excess water (w), soil limitation (s) and climatic limitation (c). The subclasses provide information as to the kind of problem or limitation involved. Climatic limitations of uneven rainfall and high temperature being general to the area have not been indicated in each land capability class. In class I, there are no subclasses, because the soils of this class have few limitations.

5.3.3. Land capability class and subclasses identified

Based on the characteristics of the soils identified in Onattukara region, land capability classification has been made and mapped. Soils of Onattukara region have been grouped into three land capability classes, viz., class II, III and IV. The land capability subclasses identified are IIe, IIw, IIIe, IIIes, IIIw, IIIs, IIIws, IVs and IVws.

5.3.3.1. Class IIe

Kattanum soils with an extent of 65 ha falls under this class. These are good arable lands having very deep, moderately well drained, loamy sand to sandy loam textured soils occurring on gently sloping plains adjoining the undulating laterite belts. These soils are subject to slight to moderate erosion. By adopting contour cultivation, soil erosion can be checked.

5.3.3.2. Class IIw

Sooranad and Chunad soils falls under this class covering an area of 1683 ha of the Onattukara region. These soils occur in level to gently sloping depressions of low land plains. They are imperfectly to poorly drained and are subject to flooding during monsoon. Excessive moisture due to impeded drainage and water logging during monsoon period are the major problems of these soils. Deepening of the existing drainage channels and construction of permanent drainage channels are required to drain excess water collected during monsoons.

5.3.3.3. Class IIIe

Mynagapally, Vallikunnam and Palamel soils fall under this class covering an area of 1331 ha. These are moderately good cultivable lands having deep to very deep, well drained, medium to heavy textured, gravelly soils developed over laterite. These soils occur on gently to moderately sloping low mounds along the eastern boundary of Onattukara region. These soils are subject to moderate erosion due to moderately high runoff potential. Contour cultivation and earthen contour bunds protected with vegetative cover will check hazards of soil erosion.

5.3.3.4. Class IIIes

Attuva soils with an extent of 1300 ha fall under this class. These soils are very deep, coarse textured alluvium located between coastal plains and the laterite belt slightly above the general elevation of Onattukara region. Due to sandy textural grades, these soils have poor water holding and nutrient holding capacity. These soils are subject to slight erosion. Application of heavy dozes of organic manure will improve soil structure, water holding capacity and nutrient status of these soils. Controlled irrigation is required due to low available water content.

5.3.3.5. Class IIIw

Pathiyoor and Vettikode soils covering an area of 843 ha are grouped under this class. These are very dèep, imperfectly drained, heavy textured, alluvial soils occurring on level to gently sloping depressions of lowland plains. These soils are moderately wet and subject to overflow and submergence during monsoons. Construction of permanent drainage channels are required to drain off excess water.

5.3.3.6. Class IIIs

Neendakara, Mannar, Pallipad, Mahadevikad and Kollaka soils with an extent of 25715 ha are grouped under this class covering the major potion of Onattukara region. These are very deep, moderately well drained to well drained, sandy, marine alluvial soils occurring on gently to moderately sloping plains of Onattukara region. Medium textured soils are also noticed in the deeper layers. These soils have poor water holding capacity and nutrient holding capacity. Application of high amount of organic manures will improve the soil structure, water holding capacity and nutrient status of these soils. Controlled irrigation may be provided due to very low available water content.

5.3.3.7. Class IIws

Kottakakam, Cherukol and Keerikkad soils fall under this class covering an area of 2156 ha. These soils are very deep, coarse textured, coastal alluvium of recent origin. They are located on very gently sloping depressions of coastal plains.The major limitation of these soils are poor drainage, overflow and flooding. Adequate drainage, addition of organic manures and controlled irrigation are the general management recommendations.

5.3.3.8. Class IVs

Alappuzha and Kandallur soils with an extent of 3162 ha are grouped under this class. These are very deep, marine alluvium located on coastal plains.Compared to other soils, textural grades of these soils is characteristically, sand. This is the major limitation of these soils. Application of heavy dozes of organic manures, coconut husk burial and addition of soil amendments are some of the general management recommendations.

5.3.3.9. Class IV ws

Thrikkunnapuzha soils with an extent of 998 ha falls under this class. These are very deep, imperfectly drained, highly gleyed soils developed from marine and lacustrine deposits occurring adjacent to the Kayamkulam kayal. The subsoil is clayey and massive. Water table is very high and flooding is common during monsoon. This is the most problematic area of Onattukara region due to impeded drainage. Adequate drainage facilities should be provided.

Land capability classification of Mannar panchayat was undertaken earlier by Soil survey staff (1998) and is in agreement with the present observation on Mannar series.

Land capability classification on similar lines was attempted earlier in Thiruvananthapuram district by Joseph (1982). Soil survey staff(1996) conducted land capability classification of Kalluvathukkal panchayat and identified five land capability classes. Similarly, land capability classification of the soils of Kuttanad was attempted by Soil survey staff (1997).

Challa *et al.* (1989) conducted a case study in land evaluation for irrigation in Kanedi village, Dadra and Nagar Haveli, Maharashtra. Singh and Mishra (1996) made land capability classification of the soils of Chota Nagpur. These studies were in conformity with the present land capability classification.

5.4. Land irrigability classification

Soil irrigability classes are useful to make groupings of soils according to their suitability for sustained use under irrigation. The classes are defined in terms of degree of soil limitations. The soil irrigability classes are further interpreted into land irrigability classes based on topography, drainage and cost of land development.

5.4.1. Land irrigability classes

Six irrigability classes of land have been generally recognized (1 to 6). Class 1 lands have practically no limitations and can be irrigated without any difficulty. As the class number increases, limitations also increase. Class 4 lands are marginal for sustained use under irrigation due to very severe limitations. Class 5 lands are provisionally not suitable for sustained irrigation and class 6, unsuitable for irrigation.

5.4.2. Land irrigability subclasses

The land irrigability classes are further subdivided into subclasses to indicate he nature of limitation requiring attention by adding a suitable lowr case letter for the concerned limitation such as 's' for soil factor, for topography and 'd' for drainage requirement.

5.4.3. Lanαigability classes and subclasses identified.

The coming in Onattukara region are grouped into four land irrigat classes, namely, class 2, 3, 4 and 6. Land irrigability subclasses iGed are 2d, 2t, 3d, 3s, 3t, 4s, 4sd and 6d.

5.4.3.1. Class 2d

These lands have moderate limitation for sustained use under irrigation. Sooranad and Chunad series covering an area of 1683 ha are identified under this irrigability subclass. These soils occur on level to gently sloping depressions of lowland plains. They are imperfectly to poorly drained and are subject to flooding during monsoons. These soils have light to medium textured surface followed by medium to heavy textured subsurface. The physiographic position of the soils along with soil texture limits drainage of the area, mainly during rainy season, leading to anaerobic conditions. Sufficient drainage facilities should be provided to drain off excess water to reduce crop loss. During summer, irrigation is required to raise crops.

5.4.3.2. Class 2t

The lands under this class have only moderate limitation for sustained use under irrigation due to topography. Kattanam series which are located on very gently to gently sloping lands near the laterite belt are subject to slight to moderate erosion. These soils cover an area of 65 ha. Proper levelling and bundling are required before irrigating these lands.

5.4.3.3. Class 3d

The lands under this class have severe limitations for sustained use under irrigation. Kottakakam, Pathiyoor, Vettikode, Cherukol and Keerikkad soils included in this class cover an area of 2999 ha. These soils occur on depressions of Onattukara region. The soils are generally medium to heavy textured with moderately slow to slow permeability. The area is poorly to imperfectly drained due to their low physiographic position. In addition, the area is subject to occassional flooding. The drainage facilities available at present have to be improved before introducing irrigation in these lands.

5.4.3.4. Class 3s

Lands under this class have severe limitation for sustained use under irrigation. Neendakara, Mannar, Kollaka, Mahadevikad and Pallipad series on very gently to gently sloping lands are included under this class. This class covers an area of 25,715 ha which constitute the major portion of Onattukara region. Sandy texture with low water holding capacity and nutrient status are the major limitations of these soils. In addition, these soils have rapid permeability. These soils require low volume, high frequency irrigation such as sprinkler or drip irrigation. The addition of organic matter, coconut husk and clay in the crop basins of these sandy soils are recommended to improve their water holding capacity. This will also increase irrigation efficiency of these soils.

5.4.3.5. Class 3t

The lands under this class have severe limitation for sustained use under irrigation. Soils of Mynagapally, Attuva, Vallikunnam and Palamel, which occur on gently to moderately sloping lands, are included in this class. It extends over an area of 2631 ha. These soils have medium to heavy texture with moderate to moderately slow permeability. The runoff potential is moderately high. Topography of the area which leads to fast surface flow of water forms the major limiting factor. Levelling of land and bunding are required before irrigating for maximum irrigation efficiency.

5.4.3.6. Class 4s

An area of 2982 ha under Kandallur series on level to very gently sloping lands are included in this class. The area under this class is marginally suitable for irrigation due to sandy texture, low water holding and nutrient holding capacity. The soils of the area require low volume, high frequency irrigation such as sprinkler or drip irrigation. Addition of organic matter and coconut husk in crop basins are required to increase the water holding capacity of the soils.

5.4.3.7. Class 4sd

Lands under this class are marginally suitable for irrigation. Alappuzha series which occur on level to gently sloping lands are grouped in this class and covers an area of 180 ha. Soils are sandy but a high water table is maintained during rainy season due to the presence of the impermeable *Kalashi* in the subsoil. This leads to drainage problems in the area during rainy season. The low water holding and nutrient holding capacity of the soils and drainage problem during rainy season puts the soil under this class. Low volume, high frequency irrigation techniques are required during summer months in these sandy soils.

5.4.3.8. Class 6d

Bottom lands of Onattukara region are put in this class. The area under this class is not suitable for irrigation. Thrikkunnapuzha series covering an area of 998 ha is identified under this class. These soils occur on level to gently sloping lands adjacent to the kayal. The heavy textured subsoil, slow permeability, high water table and impeded drainage are the major limitations of these soils. Water level in the kayal is the general ground water level.

Land irrigability classification of Mannar panchayat undertaken by Soil survey staff (1998) is in line with the observations of the present study.

Irrigability classification and identification of various associated soil limitations made in the soils of Bihar by Singh and Mishra (1997) in conformity with the present observations made for the identified major soils.

Similar land irrigability classification of the ayacut of Aralam irrigation project area was made by Soil survey staff (1992) and identified four land irrigability classes such as 2d, 2t, 3t and 4t. Similar observations were also reported by Soil survey staff(1996) in the soil survey report of Kalluvathukkal panchayat.

5.5. Productivity rating of soils

The five important crops, namely, rice, coconut, sesamum, cassava and banana are considered for productivity rating and subsequently for suitability rating. The rating of the soil properties against the productivity index showed the following pattern.

5.5.1. Productivity rating for rice

Productivity rating shows that Kottakakam series having a rating of 25.4 percent ranks first in the *good* rating class among the seven wetland soil series class and Cherukol ranks least with only 9.3

percent in the *poor* rating class. Vettikode series, ranking second with a rating of 22.2 percent, is included in the *average* productivity class. Pathiyoor series also falls in the *average* productivity class. All the other four wetland soil series are grouped in the *poor* rating class.

5.5.2. Productivity rating for coconut

Palamel series having a rating of 36.3 percent ranks first in the *very good* productivity class among the thirteen gardenland soils and Thrikkunnapuzha series ranks least with a rating of 12 percent. Attuva series with a rating of 25.4 percent fall in the *good* productivity class. Mannar, Pallipad, Mynagapally and Vallikunnam series fall in the *average* productivity class with a rating percentage of 19.5, 20.0, 20.6 and 23.2 respectively. Neendakara, Kandallur, Thrikkunnapuzha, Mahadevikad, Kollaka, Alappuzha and Kattanam fall in the *poor* rating class.

5.5.3. Productivity rating for sesamum

Attuva and Mahadevikad series with ratings of 26.1 and 25.4 percent respectively falls in the *good* productivity rating class for sesamum. Among the twenty soil series, Neendakara with a rating of 9.9 percent ranks least in the *poor* productivity class. Mannar, Pallipad, Kattanam, Palamel and Vallikunnam soils fall in the *average* productivity rating class for sesamum. The remaining thirteen soil series fall in the *poor* rating class for sesamum.

5.5.4. Productivity rating for cassava

Palamel series with a rating of 45.3 percent ranks first in *very good* rating class and Keerikkad ranks least with only 8.1 percent rating. Vallikunnam series with a rating of 36.3 also falls in the *very good* productivity class. Mynagapally with a rating of 28.2 falls in the *good* productivity rating class. Attuva series with a rating of 23.8 percent falls in the *average* productivity rating class. Except Palamel, Vallikunnam, Mynagapally and Attuva, the rest of the soil series fall under the *poor* rating class for cassava.

5.5.5. Productivity rating for banana

Among the twenty soil series of Onattukara region, Palamel series with a rating of 36.7 percent ranks first and falls in the *very good* productivity rating class. Keerikkad series ranks least with only 10.5 percent rating. Pallipad, Mynagapally and Vallikunnam soils fall in the *good* productivity class for banana with ratings of 25.0, 25.4 and 32.9 percent respectively. Mahadevikad, Attuva, Kollaka and Kattanam soils fall in the *average* productivity class. The remaining twelve soil series fall in the *poor* productivity rating class for banana.

In Onattukara region, sesamum is cultivated as third crop in rice lands. Among the wetland series, Kotttakakam series ranks best for rice cultivation while Cherukol series, which covers the major rice tract, ranks last. But Cherukol series is best suitable for sesamum cultivation among the seven wetland soil series. Kottakakam series which ranks first for rice, ranks second for sesamum. Pathiyoor series which falls in the third position for rice ranks last for sesamum. The other wetland series are average to poor for both rice and sesamum

In this region, one of the most important observations recorded is that sesamum is cultivated in gardenland series also apart from the unique rice-rice-sesamum sequence of Onattukara wetland. The study shows that among the gardenland series, Attuva series is best suited for sesamum and Neendakara, the least. From among the thirteen gardenland series, Mannar, Pallipad, Kattanam, Palamel and Vallikunnam fall in the average productivity rating class and the other in the poor rating class.

Joseph (1982), Anilan (1983) and Premachandran (1992) made similar studies in other regions of the State and reported the comparative suitability of rice for different soil series studied by them. Soil series suitability of sesamum crop was not attempted earlier in the State other than in the present study.

In Onattukara region, a coconut based farming system is prevalent in gardenlands with banana and cassava as intercrops. The study reveals that Palamel series is equally best suited for coconut, banana and cassava. Similarly, Vallikunnam and Mynagapally are also equally good for these crops. Thrikkunnapuzha ranks last among gardenland soils for coconut and banana cultivation. Keerikkad, the wetland series is found to be poor for banana and cassava cultivation.

Banana and cassava are also found to be cultivated in wetland soils. Cherukol series which is the major wetland rice soils of the region ranks best for banana and good for cassava among the seven wetland soils. Sooranad , Kottakakam and Chunad are almost equally good for banana and cassava while Keerikkad series stands last for both banana and cassava. No earlier attempts were made to study the soil series suitability of coconut with banana and cassava as intercrops in gardenlands and the probable performance of banana and cassava in wetland soil series of the State

The present observations of existing land use and cropping systems on the basis of soil series productivity is of vital importance for future regional and microlevel planning

5.6. Proposed land use

Onattukara region is predominantly an agricultural tract with 77 percent of the population depending on agriculture for their livelihood. In general, the holdings are fragmented and small. A variety of crops like rice, coconut, sesamum, cassava, banana, arecanut, yams, vegetables and pulses are grown in the area. Five major crops , viz., rice, coconut, sesamum, cassava and banana are considered in the present study.

Reconnaissance soil survey of the region was undertaken to understand the characteristics, extent and distribution of soils for soil classification and subsequent land evaluation. The soil limitations observed are low fertility status, low to medium available water content, slight erosion, slightly to strongly acidic conditions and in some cases, coarse textural grade and excessive moisture as a result of impeded drainage. A certain degree of changes in the physical and chemical properties of the soils can be expected in the altered regime brought about by the introduction of irrigation.

The land use proposed based on the studies is discussed in detail hereunder.

5.6.1. Crop suitability for rice

Productivity studies show that Kottakakam soils are best suited for rice followed by Vettikode and Pathiyoor. Though Cherukol soils, which is the major wetland soil of the region, ranks least in the productivity rating for rice, these soils have to be properly managed for sustained rice production.

The main constraints that limit rice production in the region are intermittent floods during southwest monsoon and severe drought during summer months. Viruppu crop is affected by floods and Mundakan by dry spell from December to February. Frequent floods and impeded drainage make difficult application of inorganic fertilizers to Viruppu crop. Application of organic manures to these soils is indispensable to improve the soil structure and the nutrient status. Non availability of organic manures and their high cost stand in the way of full adoption of this technology. Pest and diseases, particularly earhead caterpillar and sheath blight are serious problems faced by the farmers in the region.

Wetland soil series which fall in the poor rating class, viz., Sooranad, Cherukol, Keerikad and Chunad have to be properly managed for better returns.

5.6.2. Crop suitability for coconut

Detailed study reveals that Palamel series is best suited for coconut cultivation followed by Attuva, Mannar, Pallipad, Mynagapally and Vallikunnam. Neendakara, Kandallur, Thrikkunnapuzha, Mahadevikad, Kollaka, Alappuzha and Kattanam soils which fall in the poor rating class have to be managed properly for better economic returns. In all gardenlands, coconut is grown as a main crop, arecanut and fruit crops as mixed crops and banana, cassava, vegetables and yams as intercrops.

Root(wilt) disease of coconut is the main problem being experienced by the farmers of this region. Attack of diseases and pests including nematodes, lack of high yielding coconut cultivars with resistance/tolerance to root(wilt) and low income from diseased coconut gardens are some of the other constraints confronted by the farmers. Management practices already evolved will have to be popularized. The use of coconut seedlings obtained from disease affected area has to be discouraged. Recommended control measures of disease and pest have to be popularized among the farmers. Intercropping, mixed cropping and mixed farming systems will have to be popularized for increasing the income of the farmers.

5.6.3. Crop suitability for sesamum

Attuva and Mahadevikad soils are the best suited for sesamum cultivation followed by Mannar, Pallipad, Kattanam, Palamel and Vallikunnam. The remaining thirteen soils are poorly suited for cultivation of sesamum.

Sesamum crop is usually cultivated after Viruppu and Mundakan rice, utilizing the residual moisture in the fields. Non-availability of soil moisture and lack of detailed information on water management practices are the major production constraints. Addition of organic manures in large quantities may be made to improve soil properties. Sprinkler method of irrigation has to be popularized for providing irrigation facilities.

5.6.4. Crop suitability for cassava

The present study reveals that Palamel and Vallikunnam series are best suited for cassava cultivation. Among the twenty soil series, Keerikkad soils is the least suited. Mynagapally and Attuva soils are also good for cassava. The remaining soils are poorly suited for cultivation of cassava.

Lack of short duration and shade tolerant varieties, incidence of rodent attack and non adoption of recommended spacing are some of the production constraints for cassava. Research work has to be intensified for the development of short duration and shade tolerant varieties for growing as an intercrop in coconut gardens. Awareness has to be created among the farmers about the need for integrated rodent control measures. On farm demonstrations will have to be conducted for the adoption of the recommended spacing.

5.6.5. Crop suitability for banana

Palamel series is best suited for growing banana followed by Pallipad, Mynagapally and Vallikunnam. The soil series, viz., Mahadevikad, Attuva, Kollaka and Kattanam are also good for cultivation of banana. The remaining soils are poorly suited for growing banana

Lack of sufficient number of ideal planting material is the major production constraint for banana. The seed multiplication and distribution has to be taken up by any one of the government agencies.

Productivity calculations and crop suitability ratings were made earlier by Joseph (1982), Anilan (1983) and Premachandran (1992) respectively in the soils of Thiruvananthapuram district, rice soils of Thiruvananthapuram district and in major soil series of Kallada Irrigation Project ayacut area. Premachandran (1992) also prepared crop suitability maps for the major crops such as rice, coconut, cassava and banana from the project area

The importance of productivity parameters considered in the present investigation, have been stressed by Storie (1933), Riquier *et al.*(1976), Bali and Karale (1978), Richard and Protz (1981) and Sys *et al.* (1991).

Onattukara region enjoys a humid tropical climate with an annual average annual rainfall of 2605 mm, mean annual temperature of 26.45°C, 92.5 percent humidity, 221.68 hours mean monthly sunshine, 1.8 km/hr mean wind velocity and 3.6 mm of mean monthly evaporation.

The climatic requirements (Sys *et al.*,1993) for the five major crops in the present study and the prevalent climatic parameters of the region indicate that the region is suitable for cultivation of rice, coconut, sesamum, cassava and banana. But the serieswise probable performance variation rating of these crops confirm the role played by soil requirements over the climatic suitability.

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

Development and utilization of various natural resources involves survey, investigation, planning, implementation and subsequent evaluation. Soil being a natural resource which supports life, its study is important for development and optimum use. A systematic survey and evaluation of the soils of Onattukara region was carried out to study, interpret, classify and to show their location and extent on base maps. The data generated were used for evaluating the soils based on productivity rating. The salient findings of the study are summarized below

1. A reconnaissance soil survey of Onattukara region was carried out according to the principles envisaged in the Soil Survey Manual (1970) using Survey of India toposheets and Landsat imageries (1 : 50,000) as base maps. Traversing of the entire region was carried out and soils examined for physical and chemical characteristics.

2. On the basis of the differentiating characteristics, the soils have been grouped into twenty soil series. The photographs of the typical profiles and present land use were taken for visual interpretation. Detailed examination of the profiles were carried out in the field and the description of the pedomorphic characters of the soils series were made.

3. The delinated soil boundaries were transferred planimetrically to accurate topobases and the extent of each identified soil series were worked out using digital planimeter. Detailed studies indicate that Onattukara region extends over an area of 40,948 ha.

4. The names of the twenty soil series identified with their extent are given below.

Name of soil series	*Area(ha)*
Neendakara	440
Kandallur	2982
Mannar	22325
Thrikkunnapuzha	998
Mahadevikad	1580
Attuva	1300
Kollaka	355
Alappuzha	180
Pallipad	1015
Mynagapally	325
Kattanam	65
Palamel	553
Sooranad	725
Vallikunnam	453
Kottakakam	698
Pathiyoor	350
Cherukol	1058
Vettikode	493
Keerikkad	400
Chunad	958

5. Based on systematic survey, the soil map showing the distribution of the identified twenty soil series in Onattukara region has been prepared along with the mapping legend.

6. The climatological data of Onattukara region has been collected, tabulated and interpreted for soil classification. The interpretation of climatological data shows that the soil moisture regime and soil temperature regime are ustic and isohyperthermic respectively.

7. The soils identified in the region have been classified as per the comprehensive Soil Classification System - Soil Taxonomy (U.S Soil Survey Staff, 1975) and Keys to Soil Taxonomy (U.S. Soil Survey Staff, 1994 and 1996) and presented below.

Name of series	*Suborder*	*Order*
Neendakara	Psamments	Entisols
Kandallur	Psamments	Entisols
Mannar	Psamments	Entisols
Thrikkunnapuzha	Aquents	Entisols
Mahadevikad	Aquents	Entisols
Attuva	Tropepts	Inceptisols

Name of series	*Suborder*	*Order*
Kollaka	Psamments	Entisols
Alappuzha	Psamments	Entisols
Pallipad	Ustalfs	Alfisols
Mynagapally	Ustults	Ultisols
Kattanam	Tropepts	Inceptisols
Palamel	Tropepts	Inceptisols
Sooranad	Ustults	Ultisols
Vallikunnam	Ustults	Ultisols
Kottakakam	Aquepts	Inceptisols
Pathiyoor	Aquepts	Inceptisols
Cherukol	Fluvents	Entisols
Vettikode	Tropepts	Inceptisols
Keerikkad	Psamments	Entisols
Chunad	Aquepts	Inceptisols

8. Out of the twenty soil series, ten series, viz., Neendakara, Kandallur, Mannar, Thrikkunnapuzha, Mahadevikad, Kollaka, Alappuzha, Cherukol, Vettikode and Keerikkad were classified under Entisols, six series, viz., Attuva, Kattanam, Palamel, Kottakakam, Pathiyoor and Chunad under Inceptisols, three series, viz.,

Mynagapally, Sooranad and Vallikunnam under Ultisols and Pallipad series under Alfisols.

9. Based on inherent soil characteristics and landscape features, land capability classification of the soils have been made and presented below

Land capability class & subclass	*Soil series mapped*	*Area (ha)*	*Total area(ha)*
IIe	Kattanam	65	65
IIw	Sooranad	725	
	Chunad	958	1683
IIIe	Mynagapally	325	
	Vallikunnam	453	
	Palamel	553	1331
IIIes	Attuva	1300	1300
IIIw	Pathiyoor	350	
	Vettikode	493	843
IIIs	Neendakara	440	
	Mannar	22325	
	Pallipad	1015	
	Mahadevikad	1580	
	Kollaka	355	25715
IIIws	Kottakakam	698	
	Cherukol	1058	
	Keerikkad	400	2156

Land capability class & subclass	*Soil series mapped*	*Area (ha)*	*Total area(ha)*
IVs	Alappuzha	180	
	Kandallur	2982	3162
IVws	Thrikkunnapuzha	998	998

The soils have been grouped into three land capability classes and nine capability subclasses. The land capability classes and subclasses identified are IIe, IIw, IIIe, IIIes, IIIw, IIIs, IIIws, IVs and IVws. Maps showing the distribution of different land capability classes and subclasses have been prepared.

10. For grouping soils according to their suitability for sustained use under irrigation, soils identified in the region were classified into five land irrigability classes and eight land irrigability subclasses. The land irrigability classes and subclasses identified are 2d, 2t, 3d, 3s, 3t, 4s, 4sd and 6d. Based on the studies, map showing the distribution of different land irrigability classes and subclasses has been prepared. The details of land irrigability classification are presented below

Land irrigability class and subclass	*Soil series mapped*	*Area (ha)*	*Total area(ha)*
2d	Sooranad	725	
	Chunad	958	1683
2t	Kattanam	65	65

Land irrigability class and subclass	*Soil series mapped*	*Area (ha)*	*Total area(ha)*
3d	Kottakakam	698	
	Pathiyoor	350	
	Vettikode	493	
	Cherukol	1058	
	Keerikkad	400	2999
3s	Neendakara	440	
	Mannar	22325	
	Kollaka	355	
	Mahadevikad	1580	
	Pallipad	1015	25715
3t	Mynagapally	325	
	Attuva	1300	
	Vallikunnam	453	
	Palamel	553	2631
4s	Kandallur	2982	2982
4sd	Alappuzha	180	180
6d	Thrikkunnapuzha	998	998

11. The soils series have been evaluated on the basis of land evaluation and rating of productivity parameters. The productivity parameters considered in the present study include, soil texture, depth, slope, drainage, coarse fragments, soil reaction, cation exchange capacity, base saturation percentage, total soluble salts and organic carbon. For each parameter, a range of scale was prepared and numerical values assigned based on the principles of land evaluation. The productivity of the soils were calculated by multiplying the

ratings of the individual parameters and expressed as percentage. The five important crops , viz., rice, coconut, sesamum, cassava and banana grown in Onattukara region were considered for suitability rating.

12. The productivity rating of the soil series against the productivity index for rice, coconut, sesamum, cassava and banana showed the following results.

12.1. The productivity rating for rice shows that Kottakakam series having a rating of 25.4 percent ranks first falling in the good rating class among the seven wetland soils and Cherukol ranks last with 9.3 percent in the poor rating class. Vettikode soils which fall in the average productivity class ranks second with a rating of 22.2 percent. The remaining wetland soils fall in the poor rating class for rice.

12.2. The productivity rating for coconut shows that Palamel series with a rating of 36.3 percent ranks first among the thirteen gardenland soils ands Thrikkunnapuzha ranks last with a rating of 12 percent. The study shows that Attuva series fall in the good productivity rating class, Mannar, Pallipad, Mynagapally and Vallikunnam series fall in the average productivity class and the remaining series in the poor rating class.

12.3. Attuva and Mahadevikad soil series with ratings of 26.1 and 25.4 percent fall in the good productivity rating class for sesamum and Neendakara with a rating of 9.9 percent ranks last in poor productivity class. The remaining soil series fall in the poor rating class.

12.4. The study reveals that Palamel and Vallikunnam series with ratings of 45.3 and 36.3 percent fall in the very good rating class and Keerikkad with a rating of 8.1 percent ranks last for cassava. Mynagapally series with a rating of 28.2 percent fall in the good productivity rating class. Attuva series fall in the average productivity rating class with a rating of 23.8 percent. The remaining soil series fall under the poor rating class for cassava.

12.5. Productivity rating for banana shows that Palamel series with a rating of 36.7 percent ranks top falling in the very good rating class and Keerikkad series ranks last with 10.5 percent rating. Pallipad, Mynagapally and Vallikunnam soils fall in the good productivity class and Mahadevikad, Attuva, Kollaka and Kattanam soils fall in the average productivity class. The remaining soil series fall in the poor productivity class.

13. After studying in detail, the various soil characteristics, its capabilities, fertility status, crop suitability and socio-economic

conditions of the farmers, a land use is proposed for the identified twenty soil series of Onattukara region as follows

13.1. The study shows that Kottakakam series is best suited for rice followed by Vettikode and Pathiyoor. Cherukol series, which is the major wetland soil of the region has to be properly managed for sustained rice production.

13.2. Palamel series is best suited for coconut cultivation followed by Attuva, Mannar, Pallipad, Mynagapally and Vallikunnam. The soils which fall under the poor rating class for coconut have to be managed properly for better economic returns.

13.3. Attuva and Mahadevikad series are the best suited for sesamum followed by Mannar, Pallipad, Kattanam, Palamel and Vallikunnam.

13.4. Palamel and Vallikunnam series are best suited for cassava. Mynagapally and Attuva series are also good for cassava. The remaining soils are poorly suited for cassava.

13.5. Palamel series is best suited for banana followed by Pallipad, Mynagapally and Vallikunnam. The soil series, viz., Mahadevikad, Attuva, Kollaka and Kattanam are also good for banana.

The systematic survey and evaluation of the soils of Onattukara region provided necessary data for interpreting the soils in terms of their suitability for optimum land use planning in respect of their land capability, crop suitability and suitability for irrigation. This study will help the farmers, administrators and policy makers to make best and immediate use of the soil resource data for arriving at optimum land use recommendations for the region as well as for rational resource allocation.

The present work forms a base line study in land evaluation of Onattukara region which gives an overview of the soils of the area with their limitations and potentialities. The present study will form the basis for microlevel planning which is aimed at integrated and sustainable development of each unit of the region under the *Peoples Planning Program* which is gaining ground at the panchayat level.

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* originals not seen.

LAND EVALUATION AND SUITABILITY RATING OF THE MAJOR SOILS OF ONATTUKARA REGION

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ABSTRACT OF A THESIS

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ABSTRACT

The need for a scientific approach in inventorying and utilizing land resources most economically and efficiently is now universally accepted. Agricultural prosperity, to a great extent, depends on judicious use of soils and rational application of soils data. A reconnaissance soil survey of Onattukara region was undertaken to study the extent and distribution of the different soils for soil classification, land capability and irrigability classification and for subsequent land evaluation. The study reveals that Onattukara region extends over an area of 40,948 ha. The soil map showing the distribution of the identified twenty soil series has been prepared.

The climatological data reveals that the soil moisture regime is ustic and the soil temperature regime is isohyperthermic.

The soils have been classified as per Soil Taxonomy (U.S. Soil Survey Staff, 1975) and Keys to Soil Taxonomy(U.S. Soil Survey Staff, 1994 and 1996). Ten series were classified under Entisols, six under Inceptisols, three under Ultisols and one under Alfisols.

Based on the inherent soil characteristics and landscape features, the soils have been grouped into three land capability classes, nine capability subclasses and land capability map prepared. The soils were classified into five land irrigability classes, eight land irrigability subclasses and land irrigability map prepared.

The soils were evaluated based on principles of land evaluation and rating of productivity parameters. The productivity rating of the

soil properties against the productivity index for rice, coconut, sesamum , cassava and banana were made and conclusions arrived at.

Productivity rating shows that Kottakakam series is best suited for rice, Palamel, best for coconut and banana, Attuva and Mahadevikad, for sesamum and Palamel and Vallikunnam, for cassava. On the basis of the studies carried out, a land use is proposed for the twenty soil series of Onattukara region based on crop suitability ratings and crop suitability map prepared for the five crops taken for study. A proper soil survey interpretation provides information on soil potential, productivity and limitations in their sustained use.

Soil survey information forms the major basis for land evaluation. A thorough knowledge of the potentialities and limitations of every piece of land is a prerequisite in its efficient utilization. A systematic survey is essential for the evaluation and classification of the soils based on their inherent soil characteristics, land capability, land irrigability and land suitability.

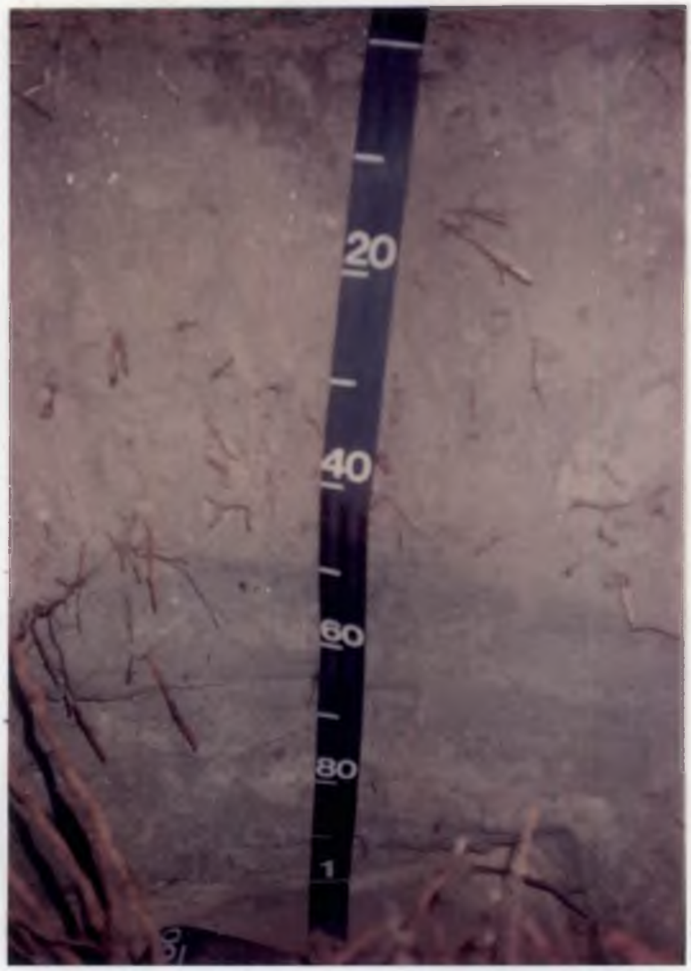
A systematic survey and evaluation of the soils of Onattukara region was taken up to study, interpret, classify and to show their location and extent on base maps. It is hoped that the present study would open up avenues for further investigations on land evaluation, crop suitability and other management aspects for sustained use of soil resource data to the best advantage. This will also form the basis for microlevel planning for integrated and sustainable development of the region under *Panchayat raj.*

APPENDIX

NEENDAKARA SERIES

Classification : Mixed, isohyperthermic, Typic Ustipsamments

Profile



Land use

KANDALLUR SERIES

Classification : Mixed, isohyperthermic Typic Ustipsamments

Profile

Land use

MANNAR SERIES

Classification : Mixed, isohyperthermic Typic Ustipsamments

Profile

Land use

THRIKKUNNAPUZHA SERIES

Classification : Fine-loamy, mixed, isohyperthermic, subactive,
Tropic Fluvaquents

Profile

Land use

MAHADEVIKAD SERIES

Classification : Mixed, isohyperthermic Typic Ustipsamments

v

Profile

Land use

ATTUVA SERIES

Classification : Coarse-loamy, mixed, isohyperthermic, active, Fluventic Dystropepts

Profile

Land use

KOLLAKA SERIES

Classification : Mixed, isohyperthermic, Typic Ustipsamments

Profile

Land use

ALAPPUZHA SERIES

Classification : Mixed, isohyperthermic, Ustic Quartzipsamments

Profile

Land use

PALLIPAD SERIES

Classification : Coarse-loamy, mixed, isohyperthermic, Kanhaplic Haplustalfs

Profile

Land use

MYNAGAPALLY SERIES

Classification : Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults

x

Profile

Land use

KATTANAM SERIES

Classification : Coarse-loamy, mixed, isohyperthermic, semiactive, Fluventic Ustropepts

Profile

Land use

PALAMEL SERIES

Classification : Fine-loamy, mixed, isohyperthermic, subactive,
Ustoxic Humitropepts

Profile

Land use

SOORANAD SERIES

Classification : Fine, mixed, isohyperthermic, subactive, Typic Plinthustults

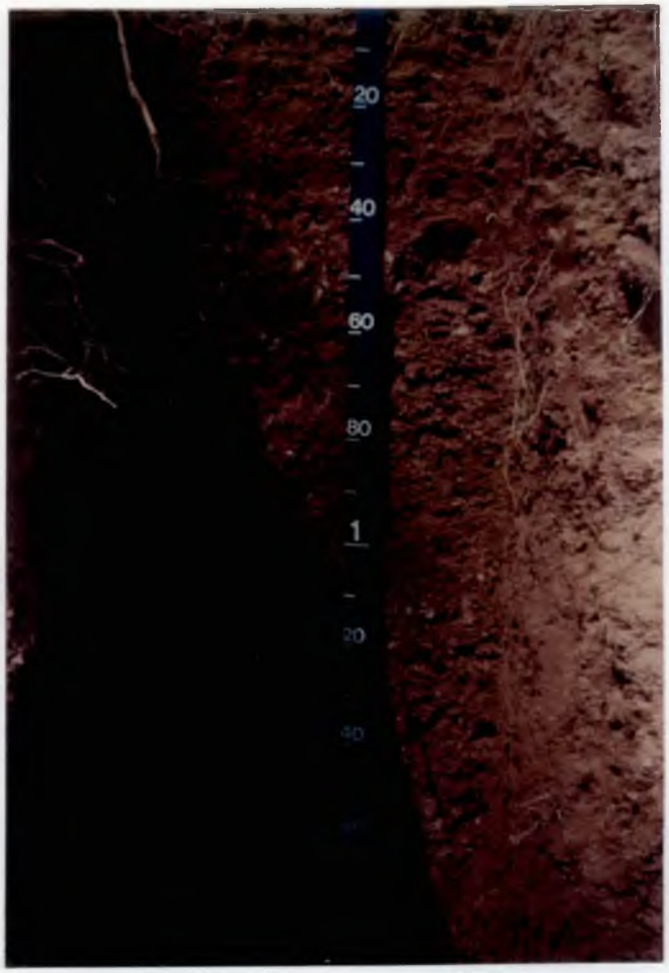
Profile

Land use

VALLIKUNNAM SERIES

Classification : Clayey-skeletal, mixed, isohyperthermic, subactive, Typic Plinthustults

Profile



Land use

KOTTAKAKAM SERIES

Classification : Coarse-loamy, mixed, isohyperthermic, subactive, Aeric Tropaquepts

Profile

Land use

PATHIYOOR SERIES

Classification : Fine, mixed, isohyperthermic, semiactive, Aeric Tropaquepts

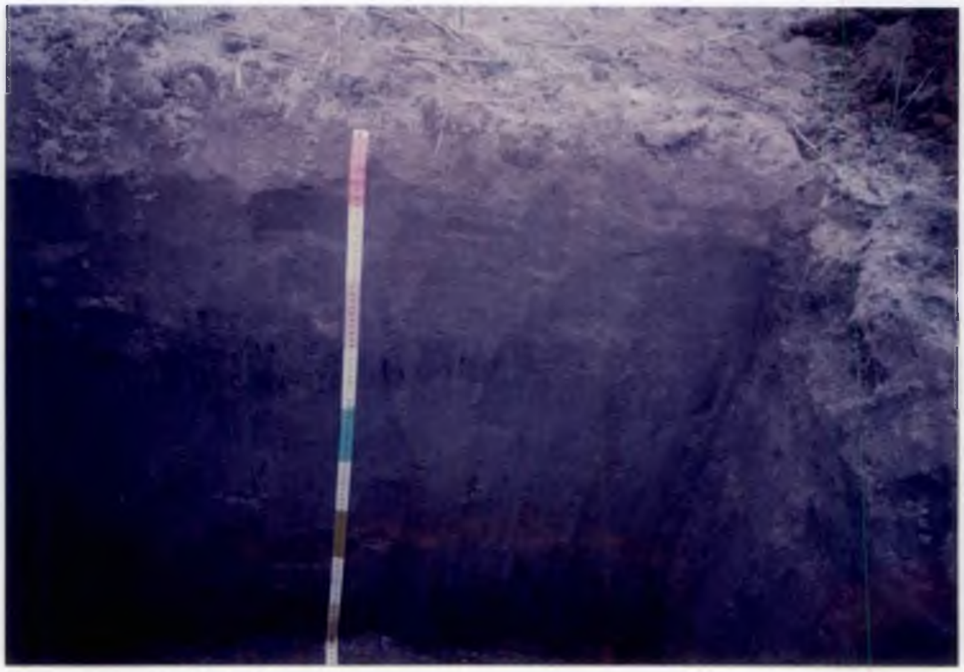
Profile

Land use

CHERUKOL SERIES

Classification : Coarse-loamy, mixed, isohyperthermic, subactive, Typic Tropofluvents

Profile



Land use

VETTIKODE SERIES

Classification : Very fine, mixed, isohyperthermic, subactive, Tropic Fluvaquents

Profile

Land use

KEERIKKAD SERIES

Classification : Mixed, isohyperthermic, Typic Psammaquents

Profile

Land use

CHUNAD SERIES

Classification : Fine-loamy, mixed, isohyperthermic, semiactive,
Aeric Tropaquepts

Profile

Land use