National Agricultural Research Project

STATUS REPORT

OF THE

HIGH RANGE ZONE

Vol. I

KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA, THRISSUR - 680654

English

NARP
STATUS REPORT
High Range Zone
Vol. I

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FOREWORD

The National Agricultural Research Project was launched in the early 1980's to strengthen the research capabilities of the State Agricultural Universities. The development of regional research stations in the different agroclimatic zones in terms of research manpower and infrastructure facilities was the essential feature of the NARP. The eligibility of the Kerala Agricultural University to the project was approved by the ICAR in May, 1980. The project has completed its first phase in all the five agroclimatic zones of the state. The second phase of the project was launched in March, 1989.

The essential pre-requisite for starting the NARP is the preparation of the Status Report. It is a basic document embodying all the valuable information on the agricultural sector of the state in general and the specific agroclimatic zones in particular. The first status report of the State was published in May, 1984 in 5 volumes, each volume pertaining to one agroclimatic zone. Since then, several changes have taken place both in the area and production of crops and new field problems have cropped up necessitating the revision of the Status Report.

The present revised Status Report is published in 3 volumes for each of the five agroclimatic zones in Kerala State. The volume-I gives a comprehensive account of the general agricultural characteristics of the state and the concerned zone, in addition to the research extension linkages and research priorities and strategies of the zone. The volume II embodies the conclusions drawn from the field surveys on the adoption patterns and production constraints of improved agricultural technologies. The data referred to in the narrative part of the Status Report viz., vol. I, are presented in vol. III.

A number of State Departments and organisations have collaborated with the Kerala Agricultural University in the revision of the Status Report. The Zonal Associate Directors and their teams of scientists have spent considerable time and energy in collecting the details and pruning the information to the present form. I congratulate them for their sincere and devoted efforts.

The status report is perhaps the first of its kind bringing together a wealth of information on Kerala Agriculture. I trust that this will be of immense use to all those who are concerned with agriculture and planning, especially as we are in the midst of formulating the VIIIth Five Year Plan as the perspectives for 2000 A. D.

E. G. SILAS
Vice-Chancellor
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PREFACE

The first Status Reports of all the Five Agro-climatic Zones of Kerala were prepared in the year 1984. The Kerala Agricultural University has successfully implemented the Phase-I of the NARP. The NARP Phase-II was sanctioned by the Indian Council of Agricultural Research in the year 1988 and the sub-projects started functioning with effect from 20-4-1988.

The necessity for the revision of the Status Report prepared earlier was emphasised by the ICAR and the World Bank, incorporating further details. The revision of the Status Reports of the five regions was therefore taken up and the present publication incorporates the details collected as per the guidelines of ICAR/World Bank. The revised Status Report consists of three volumes. The Volume I contains details on the general agricultural characteristics of the State, the Zones, Agro-ecological situations, research and extension linkages and research priorities and strategies. The Volume II is mainly concerned with the adoption pattern and production constraints of different crops, while statistical data are presented in the volume III. Considerable efforts have been made by several scientists of KAU to collect data available on the agricultural scenario of the State from all available sources and to present in an informative manner.

It is hoped that this publication will be of considerable use to the scientists working in the five agro-climatic zones of the KAU as well as in evolving strategies for agricultural research and development in the State of Kerala.

The Associate Directors of Research of the five regions and their teams of scientists and other staff deserve appreciation for the painstaking efforts, they have made to bring out this compilation. The encouragement given by Dr. E.G. Silas, Vice-Chancellor, KAU and the guidance given by Dr. A. R. Sheshadri, Consultant, World Bank in the preparation of the Status Report, is gratefully acknowledged.

Our sincere thanks are due to Dr. A. G. G. Menon, Director of Extension, Shri. K. Rajappan, Press Manager and all the members of the staff of the KAU Press for their co-operation in arranging the printing of the publication in record time.

(Sd/-)
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CONTENTS

CHAPTER I

General Agricultural Characteristics of the State

1.1 General description of the State: Delineation, population

Kerala state lies between 8° 18' and 12° 48' North latitudes and 74° 52' and 77° 22' East longitudes, in the South-West corner of the Indian peninsula as a long narrow strip of land, 32 to 130 km wide, between the Western Ghats in the East and the Arabian Sea in the West. The coastal line of the state has a length of 580 km. The state is bounded by Tamil Nadu in the South and Karnataka in the North. Though Kerala is the smallest state in India with a geographical area of 38863 sq. km, it supports a population of 254 lakhs, which is 3.7 percent of the country's population as per 1981 census. The land mass of Kerala has an undulating topography stretching from the East with a series of hills and valleys intersected by numerous rivers and streams flowing into Arabian Sea on the West. The large number of lakes and backwaters provide a unique scenic beauty to the land.

Administratively, Kerala is divided into 14 districts spread over 61 taluks covering 1557 villages (Fig. 1). There are 1000 panchayats, three corporations, 43 municipalities, three townships/cantonments, 197 census towns and 151 development blocks in the state. (Annexure I.)

1.2 Physiography

Kerala is highly diversified in its physical features and agro-ecological situations. The undulating topography ranges in altitude from below the mean sea level (MSL) to 2694 m. above MSL (Fig. 2).

The land is exquisite with a panoply of evergreen forests, picturesque landscapes and backwaters. The details of the rivers flowing within the state, their catchment areas etc. are given in Annexure 2. Among the 44 rivers originating from the Western Ghats, 41 flow towards the West into the Arabian Sea and the remaining three towards the East in to the Bay of Bengal. The rivers are typically monsoon-fed and fast flowing. The principal West-flowing rivers of the State are Bharathapuzha, Periyar, Pampa and Chaliyar. The East-flowing rivers are Kabani, Bhavani and Pambar.

Based on the topography, the land resources of the state fall generally into four well-defined natural divisions, each running almost parallel in the North-South orientation. These are:

1.2.1 High Ranges (> 750 m above MSL)

The mountainous land (elevation: 750 m to 2500 m above MSL) along the Western Ghats with jutting rocks and loamy soils constitutes the High

Fig.1.

MAP OF KERALA

ADMINISTRATIVE DIVISIONS

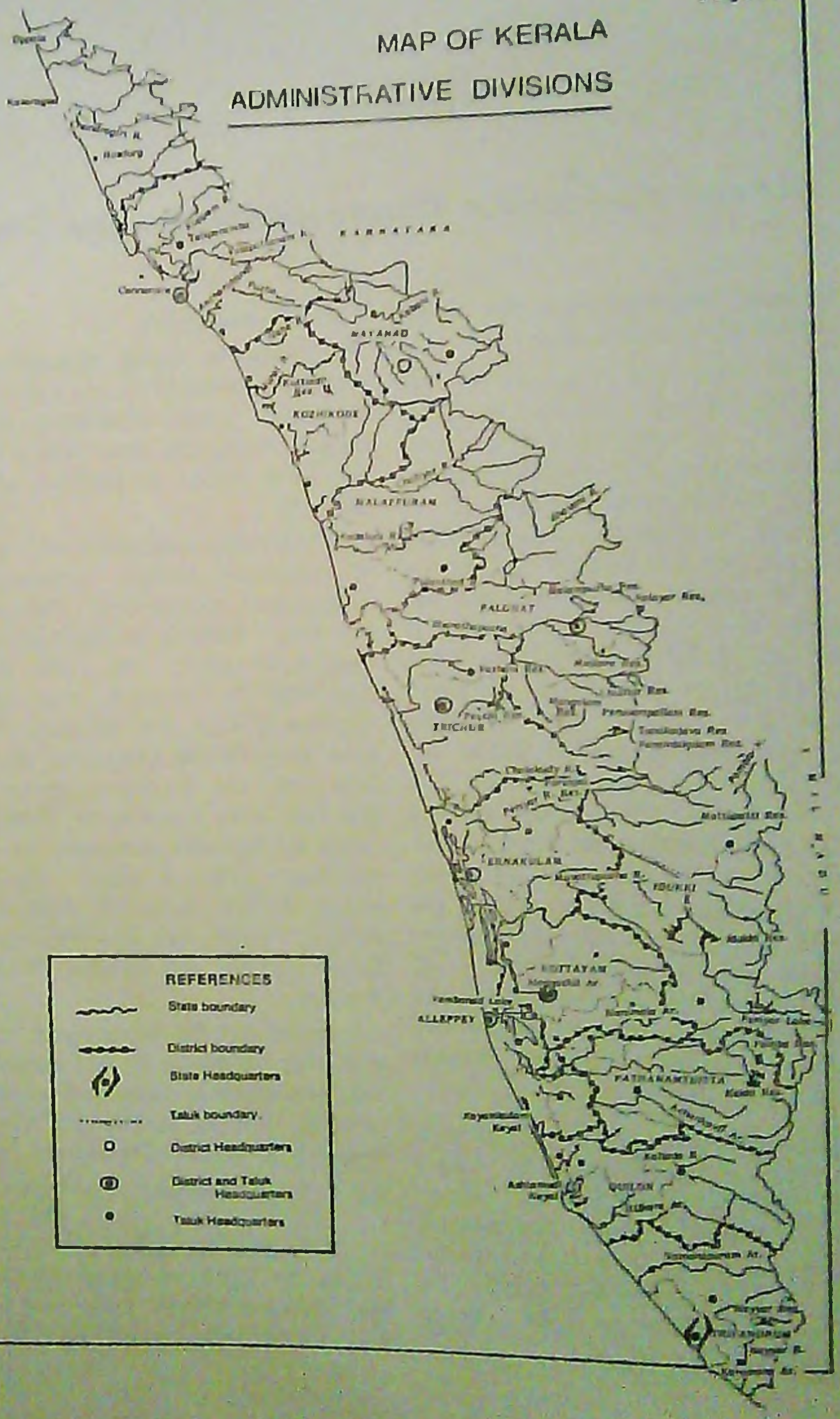
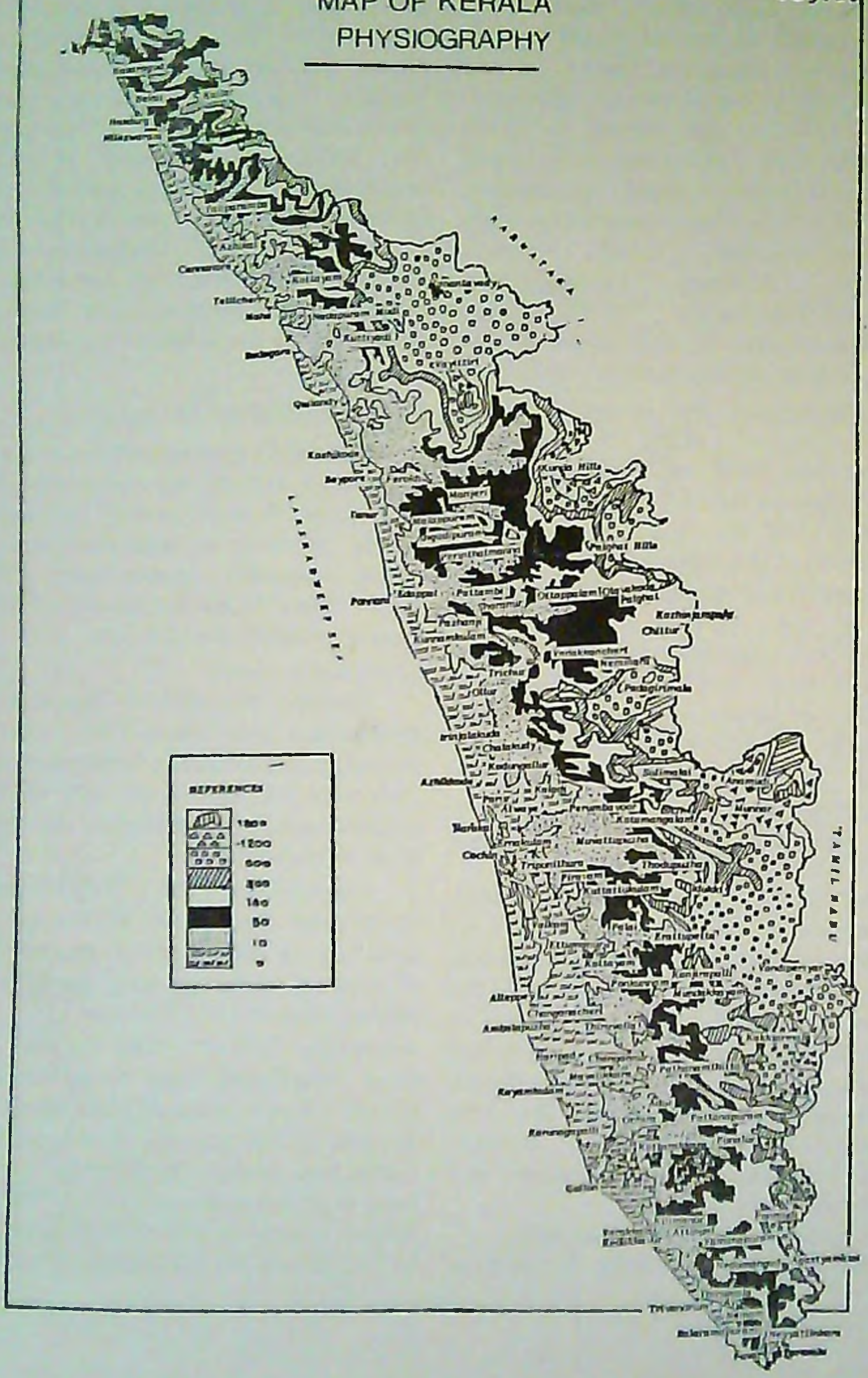


Fig.2.

MAP OF KERALA
PHYSIOGRAPHY



Ranges. The two districts of Wynad and Idukki and the eastern parts of the other districts bordering the Western Ghats come under this. Most of the reserve forests of the State are in this tract. The important peaks in the Western Ghats are Anamudi (2690 m), Mukunti (2550 m) and Nilgiris (2470 m): The 32-km wide Palghat gap is the largest pass in the Western Ghats. In addition, there are a few other passes inthe Ghats such as Aramboli, Kumili, Kambam, Thevaram, Karkken, Bodinaikannur, Periya and Perambadi. The High Range zone is dominated by plantations of tea, coffee, rubber and cardamom.

1.2.2 Highland (75 to 750 m above MSL)

This hilly tract on the western side of the Western Ghats, comprising about 43 per cent of the land and supporting 14 per cent of the population, is covered with forests and small streams. Plantations of tea, coffee, cardamom and rubber are common. The soils are generally forest loams which show wide variation in depth with a very high content of organic matter. A large percentage of the population of hill tribes live in this region.

1.2.3 Midland (7 5 to 75.0 m above MSL)

The midland plains covering about 42 per cent of the land mass have an undulating terrain traversed by numerous rivers, small hills and valleys. Of the State's population, 59.0 per cent live in this tract. The soil is mainly laterite and supports an intense diversity of seasonal, annual and perennial crops like rice, coconut, sugarcane, tapioca, banana, ginger, arecanut, pepper, cashew and rubber.

1.2.4 Lowland (<7.5m from MSL)

The lowland bordering the Arabian Sea is a strip of land running along the coast. This region, comprising about 10 per cent of the total area, supports 26 per cent of the population and is characterised by marine land forms consisting of beach ridges and beaches with swamps and lagoons. During the monsoons, several places are liable to be flooded, particularly the "Kuttanad" area which is situated below the sea level. This region is noted for its picturesque backwaters with extensive paddy fields interspersed with plantations of coconut and arecanut. The soil is generally sandy to sandy loam; but alluvial along the banks of the rivers.

1.3 Soil

1.3.1 Geological formations

Three main geological formations are recognised, namely, the Archaeans (oldest rocks), the Warkalli beds of Tertiary Age (upper miocene to pliocene) and the recent deposits (quarternary). These have North-South alignment (Fig. 3). They are identified as follows:-

Crystalline rocks

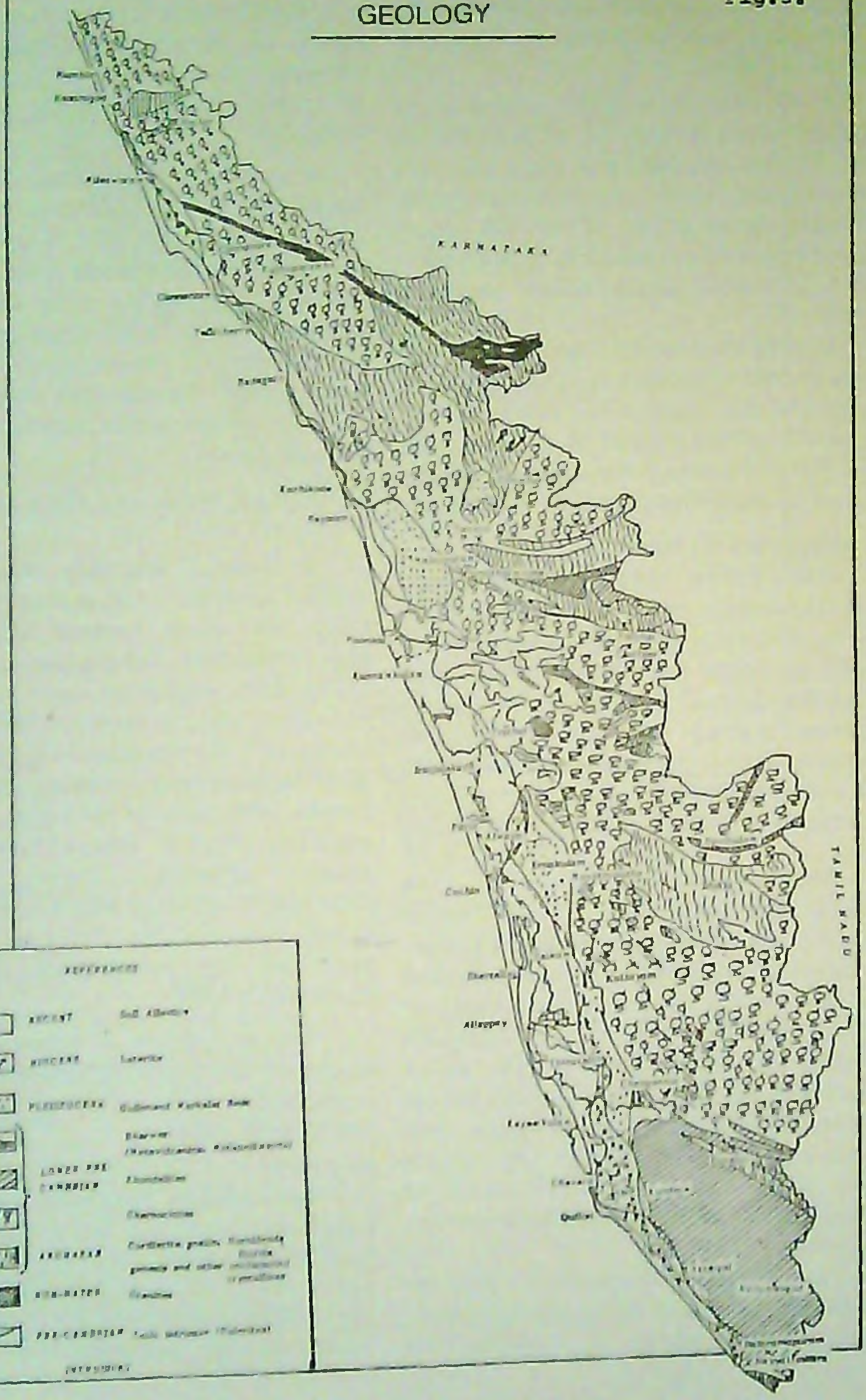
Dharwar formation: These occur in the Malabar area only. They are represented by garnetiferous-ferruginous-quartzites mica, talc, schists etc. and are found exposed in South-East Wynad and North-West of Gudalur.

Champion gneiss: They are seen in South and South-East Wynad and have gold bearing veins. Rocks appear to be of post peninsular age and resemble the champion gneiss of Kamataka.

Peninsular gneiss: This is one of the most widespread rock types found in Kerala. The important minerals that go to make up the rocks are quartz, feldspars, biotite and garnet. In Cochin area, they form the most extensive rocks. The types present are biotite and hornblende gneiss. In Trivandrum area, the gneiss belongs to

MAP OF KERALA
GEOLOGY

Fig.3.



the Peninsular suite and are made of quarts, orthoclase, mica and hornblende. Charnockite and lettynites are the most common gneisses in this are.

Charnockite: A good portion of the Western Ghats is made up of this rock. In the Travancore area, the rocks are well foliated and show intrusive relationship with peninsular gneiss. They are highly garnetiferous as compared to the Charnokites of North Kerala where garnet is absent.

Closepet granite: Archaean intrusives of post Charnockite age are found in the Malabar region. The two intrusions of biotite granite found in Kalpetta hills and Sultan's Battery, have strong resemblance to the Dornegneiss of Hazaribagh.

Precambrian system

Basic dykes: These rocks are fresh; but fractured and mylonitised. They approach dolerite in composition and are found to occur in South Malabar area. The basic dykes of Cochin area are fine to medium grained and free from olivine. The more coarse grained crystalline phases are represented by gabbros Several exposures of gabbros are found in Cochin area.

Residual laterites: A narrow zone of lateritised rock exists to the West of crystalline rocks that constitute the eastern boundary of the State. The rock exposed on the surface in this zone is a type of laterite which exhibits characteristics different from those of the laterite which caps the Warkalli formation. The laterite preserves the structure of the parent rock and is less compact. Below the laterite layer is the kaolin layer, the depth of which to the undecomposed rock shows gradation.

The Warkalli formation: This represents the most conspicuous sedimentary bed occurring in Varkala. They are best exposed at Varkala in the cliffs near the seashore. They consist of clayey sandstone, white and variegated clay and carbonaceous clay containing thin lenses of lignite. Most of these areas are lateritised.

Recent deposits: They are mainly developed North of Quilon and are made up of sand and silt. The lacustrine deposits of the backwater tracts of Kerala, the mud banks of the coast of Alleppey and the marine beach deposits all along the sea shore of Kerala come under the group. From the economic point of view, the area is important as it contains valuable mineral sands.

1.3.2 Soil types and their characteristics

In general, the soils of Kerala are acidic, kaolinitic and gravelly with low CEC, low water holding capacity and high phosphate fixing capacity. Climate, topography, vegetation and hydrological conditions are the dominant factors of soil formation. On the basis of the morphological features and physico-chemical properties, the soils of the State have been classified (Fig. 4) into red loam, laterite, coastal alluvium, riverine alluvium, *Onattukara* alluvium, brown hydromorphic, saline hydromorphic, *Kuttanad* alluvium black soil and forest loam, which are discussed below:

The soil types of Kerala and their corresponding tentative taxonomic classification upto the great soil group level are given in Table 1.

Red loam

Red loams of Kerala are localised in occurrence and are found mostly in the southern parts of Trivandrum district. These soils occur in catenary sequence along with laterites and are found mainly as deposits by colluviation in foot-hills

Fig.4.

MAP OF KERALA
SOIL

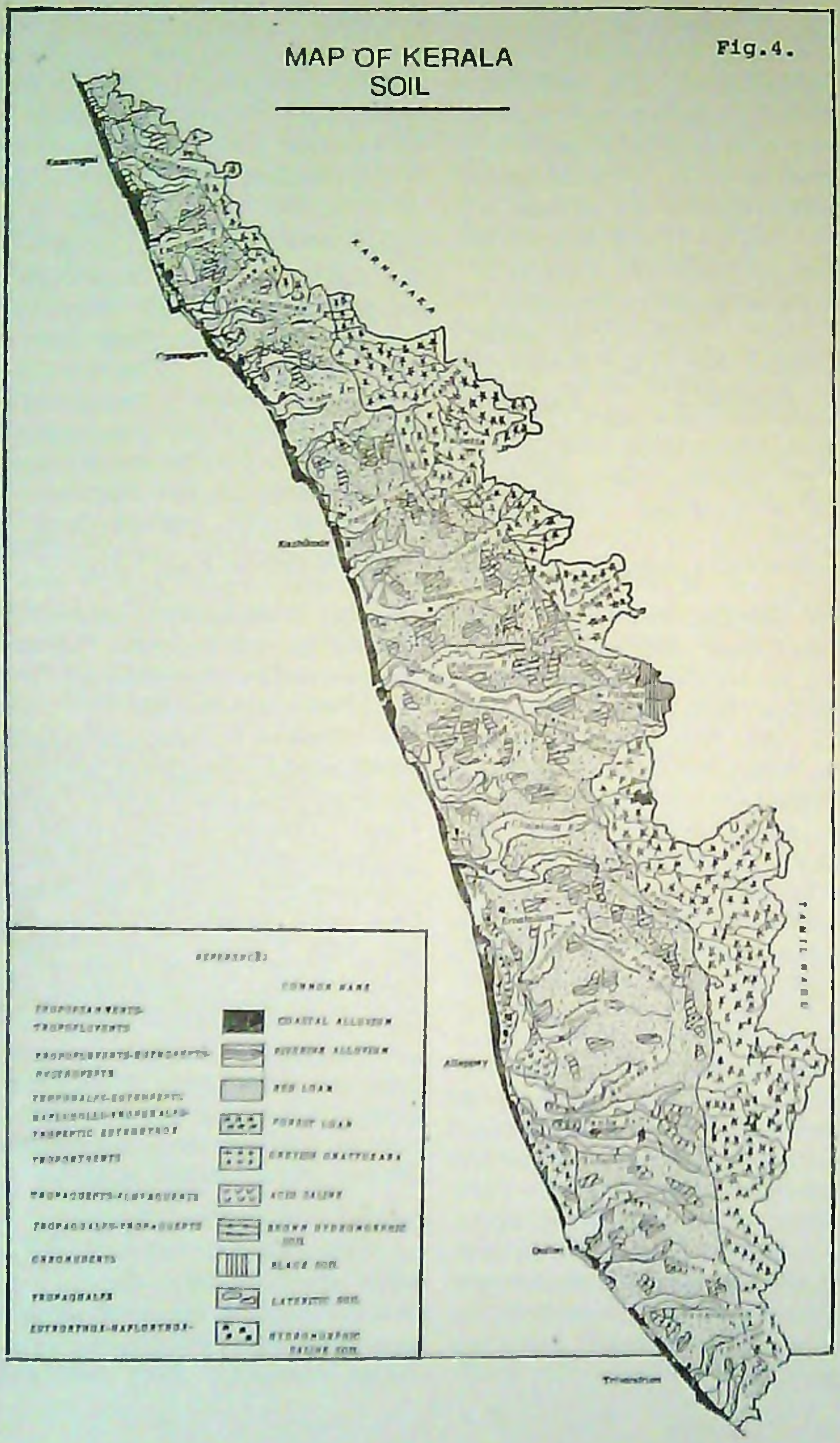


Table 1 Soil types of Kerala and their tentative taxonomic classification

Soil type	Order	Suborder	Great soil group
Red loam	Alfisol	Udalf	Troupudalf
Laterite	Oxisol	Orthox	Eutrorothox
Coastal alluvium	Entisol	Psamment	Tropopsamment
Riverine alluvium	Entisol	Fluvent	Tropofluvent
	Inceptisol	Tropept	Eutropept
Onattukara alluvium	Entisol	Orthent	Troporthent
Brown hydromorphic	Alfisol	Aqualf	Tropaqualf
	Inceptisol	Aquept	Tropaquept
Saline hydromorphic	Alfisol	Aqualf	Tropaqualf
Kuttanad alluvium	Inceptisol	Aquept	Tropaquept
	Entisol	Aquept	Fluvaquent
Black soil	Vertisol	Udert	Chromudert
Forest loam	Mollisol	Udoll	Tapludoll
	Alfisol	Udalf	Tropudalf

Source: Soils of Kerala, Soil Survey Branch, Department of Agriculture, Kerala (1976)

and small hillocks. The rapid permeability of the surface soils also has been responsible for the characteristic development of these loamy soils which are very deep and homogeneous without much expression of horizons. The soils have red colour which has been attributed to the presence of haematite or anhydrous ferric oxides. These soils are essentially kaolinitic in nature, acidic in reaction, highly porous and friable. They are low in organic matter content as well as in all the essential plant nutrients.

Laterite

Laterites of Kerala are typical kaolinitic weathering products of gneissic and granitic rocks developed under humid tropical conditions. Heavy rainfall and high temperature prevalent in the State are conductive to the process of laterisation. The surface soil, which is reddish brown to yellowish red, is mostly gravelly loam to gravelly clay loam in texture. The profiles have well-developed B horizon with abundant ferruginous and quartz gravels. The plinthite is characterised by a compact vesicular mass below the B horizon, composed essentially of a mixture of hydrated oxides of iron and aluminium. The plinthite includes quarriable type which breaks into blocks and also non-quarriable type which breaks into irregular lumps. Laterites are in general poor in available nitrogen, phosphorus and potassium and are low in the bases. They have poor water-holding capacity, CEC and high P fixing capacity with low organic matter content. They are generally acidic with the pH ranging from 4.5 to 6.2.

They cover about 65 per cent of the total area of the State, occupying a major portion of the midland and mid-upland regions and are the most extensive of the soil groups found in Kerala.

Coastal alluvium

These soils are seen in the coastal tracts along the West as a narrow belt with an average width of about 10 km and have been developed from recent marine deposits. They show incipient

development. The texture is dominated by sand fraction with very rapid permeability. The A horizon is usually thin and the surface textures observed are loamy sand and sandy loam. These soils are acidic and of low fertility level. They are also low in organic matter, clay and CEC.

Riverine alluvium

These soils occur mostly along the banks of rivers and their tributaries. They show wide variation in their physico-chemical properties depending obviously on the nature of the alluvium that is deposited and the characteristics of the catchment area through which the river flows. Horizon differentiation is not well expressed. They are very deep soils with surface texture ranging from sandy loam to clay loam. They are moderately supplied with organic matter, nitrogen and potassium. They are acidic and poor in phosphorus and lime.

Onattukara alluvium

These soils are confined to the *Onattukara* region comprising the Karunagapally, Karthikapally and Mavelikkara taluks of Quilon and Alleppey districts. They occur as marine deposits extending to the interior upto the lateritic belt. The soils are, in general, coarse textured with immature profiles. In low lying areas, the water table is high and drainage is a problem. These soils have very rapid permeability. They are acidic in reaction and are extremely deficient in all the major plant nutrients.

Brown hydromorphic

Hydromorphic soils, as a group, occur extensively in the State. These soils are mostly confined to valley bottoms of undulating topography in the midland and to low lying areas of coastal strip. They have been formed as a result of transportation and sedimention of material from adjacent hill slopes and also through deposition by rivers. They exhibit wide variation in physico-chemical properties and morphological features. The development of the soil profiles has occurred under impeded drainage conditions. These soils, therefore, exhibit characteristic hydromorphic features like gley horizons, mottling streaks, hard pans, organic matter depositions, iron and manganese concretion, etc. Drainage is the major problem. They are moderately supplied with organic matter, nitrogen and potassium and are deficient in lime and phosphorus. Acidity is a problem in some areas.

Saline hydromorphic

These soils are usually seen within the coastal tracts of the districts of Ernakulam, Alleppey, Trichur and Cannanore. The origin, genesis and development of these soils have been under peculiar physiographic conditions. They are, therefore, not comparable with the saline soils occurring in the other parts of the Country. The network of backwaters and estuaries bordering the coast serves as inlet of tidal waters to flow into these areas, causing salinity. Wide fluctuation in the intensity of salinity has been observed. During the rainy season, the fields are flooded and most of the salt is leached out, leaving the area almost free of the salts. Electrical conductivity of the soil during this season ranges from 0.1 to 2.0 mmhos/cm^2. The maximum accumulation of toxic salts is observed during the summer months from March to April when electrical conductivity rises to the range of 10 to 15 mmhos/cm^2. These soils are in general brownish, deep and imperfectly drained. The profiles how wide variation in

texture, as is common in most of the alluvial soils. Being developed in areas with relatively high ground water table, these soils show aquic properties. In some areas, undecomposed organic matter is observed in the lower layers, causing problems of acidity. The *Pokkali* (Ernakulam district) and *Kaipad* (Cannanore district) soils come under this category.

Kuttanad alluvium

The *Kuttanad* region covering about 875 km^2 is an unique agricultural area in the World. A good portion of this area lies one to two metres below the MSL and is submerged for major parts of the year. The area is susceptible to seasonal ingress of saline water as a result of tidal inflow from the sea. During the monsoons, the rivers and revulets pour fresh water into the area. As the North East monsoon recedes, sea water again enters the Vembanad lake and the whole area becomes saline. Hence, the soils of *Kuttanad* area are faced with the serious problems of hydrology floods, acidity and salinity. Consequent on the construction of the Thanneermukkum bund, salinity hazards have been considerably reduced. The soils of *Kuttanad* form the typical waterlogged soils and are entirely different from normal well-drained soils in their morphological, chemical and physical characteristics. They can be grouped into three categories, the *Kayal* soils, the *Karappadam* soils and the *Kari* soils which are dealt with in the Zone of Problem Areas.

Black soils

Black soils are restricted in their occurrence to Chittoor taluk of Palghat district. They are found to occur in patches and are considered as extensions of the black cotton soils observed in the adjacent Coimbatore district of Tamil Nadu. These soils are dark, low in organic matter, calcareous, neutral to moderately alkaline(pH 7.0 to 8.5) and high in clay content and CEC. Hence, they exhibit the characteristic cracking during the dry periods. They are usually located in gently sloping to nearly level lands. The levels of potassium and calcium are moderate and those of nitrogen and phosphorus, low.

In a relatively small area of 1000 ha in Chittoor block, a highly dispersed soil termed as *"Poonthalpadam"* soil, is seen. This soil occurs as a slushy layer to a depth of about 0.5m to 1.5m. A bed of limestone is seen beneath the slushy layer. The physical properties like plasticity, cohesion, expansion and shrinkage are similar to those of the regur soils of the Deccan.

Forest loam

Being the products of weathering of crystalline rocks under forest cover, they are restricted in occurrence to the eastern parts of the State. They have immature profiles with shallow soils, followed by gneissic parent material in various stages of weathering. In areas with lesser canopy cover, signs of laterisation have been observed in the profiles. They generally show wide variation in depth and are dark reddish brown to black, with loam to silty loam texture. In denuded areas, leaching and deposition of humus in the lower layers are observed. The B horizon usually contains gneissic gravels and boulders. These soils are generally acidic with the pH ranging from 5.5 to 6.3. They are rich in nitrogen; but poor in the bases because of heavy leaching.

The important characteristics of the surface soil (A horizon) of the different soil types of Kerala described above are given in Annexure 3.

1.3.3 Soil testing facilities in Kerala

At present, there are 13 soil testing laboratories in the State run by the Department of Agriculture (Table 2) and nine, by other agencies (Annexure 4).

1.3.4 Fertility status of Kerala soils

The soils of the State are grouped into ten fertility classes numbering from 0 to 9 for the purpose of giving fertilizer recommendations based on soil test values. A soil with 10 kg of Bray No. 1 extractable (available) phosphorus per hectare is considered to be 'average' in phosphorus status and will, therefore, require 100 per cent of the general fertilizer recommendation of phosphorus. The potassium status of the soil will be considered as 'average' when the soil contains 115 kg of available (1 *N* ammonium acetate extractable) potassium per hectare. The average fertility values for total nitrogen are 0.03 per cent (organic carbon 0.3%) for sandy soils and 0.05 per cent (organic carbon 0.5%) for clayey or loamy soils. The details of the soil fertility classes and the recommendation of N, P and K for each class as percentage of the general recommendations, currently followed by the soil testing laboratories of the State are given in Annexure 5.

1.3.5 Fertilizers consumption in the State

Except the small patch of black soil, the soils of the State are acidic in nature with kaolinite as the most important clay mineral. The abundance of iron and aluminium oxides results in a large percentage of gravel in the soil. As a result, the soils possess the least CEC, water holding capacity and nutrient retentivity. In other words, the soils are not inherently fertile. The phosphate fixation is very high.

Due to high rainfall during the South-West monsoon, a major part of

Table 2. Soil Testing Laboratories of the State Department of Agriculture

Location	Capacity (No. of samples per year)
Stationary Soil Testing Laboratories	
Trivandrum (Trivandrum)	20,000
Quilon (Quilon)	18,000
Ettumanoor (Kottayam)	16,000
Alleppey (Alleppey)	20,000
Vyttila (Ernakulam)	16,000
Thodupuza (Idukki)	16,000
Trichur (Trichur)	10'000
Pattambi (Palghat)	20.000
Malappuram (Malappuram)	18,000
Tikkoti (Kozikode)	16,000
Cannanore (Cannanore)	18,000
Mobile Soil Testing Laboratories	
Alloppey (for southern districts)	10,000
Pattambi (for northern districts)	10,000

Note: A new soil Testing Laboratory with a capacity of 18,000 samples has been sanctioned for Wynad district. Source: Farm Guide, 1986

the applied N and K is lost due to run off and leaching. The fertilizer use efficiency is only 30-35 per cent for N and 50 to 60 per cent for K in weilands. Toxicity due to higher concentrations of soluble iron and aluminium occurs in low lying areas subject to rice culture. Lack of irrigation during the summer months is another limiting factor for increasing the fertilizer use efficiency.

In spite of the climate and soil fertility constraints, the fertilizer consumption in the State on an average is on the increase, mainly due to the awareness of the farmers through extension and fertilizer promotion activities. Annexure 6 shows the actual consumption of N, P_2O_5 and K_2O during the period from 1960-61 to 1985-86. The average fertilizer consumption in the State (1985-86) is 20.71 kg N, 12.02 kg P_2O_5 and 16.65 kg K_2O per ha making the total NPK fertilizer consumption 49.38 kg/ha. The present total consumption of fertilizers is 1.41 lakh tonnes and assuming the same rate of growth experienced during the last 26 years, the consumption is expected to touch 2.56 lakh tonnes by 2000 AD. (Table 3).

The projected crop-wise fertiliser requirement is given in Table 4. The price of fertilisers relative to that of agricultural products might have considerably influenced the consumption of fertilisers in the state.

The NPK consumption ratios for the last few years are given in Table 5.

The ratio is not sufficiently balanced and the consumption of P and K is much less than that of N. This is mainly because of the fact that the consumption of fertilizer in the State is mainly for rice whose NPK recommendation is in a 2:1:1

Table 3. Fertilizer consumption in Kerala predicted upto 2000 AD based on linear regression models fitted to actual fertilizer consumption data (in tonnes) for the period 1960-61 to 1985-66

Year	N	P_2O_5	K_2O	Total
1986—87	64434	31931	47727	144092
1987—88	67612	33140	50247	150999
1988—89	70867	34370	52832	158069
1989—90	74198	35623	55481	165302
1990—91	77605	36898	58195	172698
1991—92	81089	38196	60974	180259
1992—93	84649	39516	63818	187983
1993—94	88286	40859	66726	195871
1994—95	92000	42224	69699	203923
1995—96	95790	43612	72737	212139
1996—97	99656	45022	75840	220518
1997—98	103599	46554	79008	229061
1998—99	107618	47909	82240	237767
1999—2000	111714	49386	85538	246638
2000—2001	115887	50886	88900	255673

Source: Strategy for meeting fertilizer use targets in Kerala by 2000 AD. Conference on Fertilizer Technology, ICAR, New Delhi, 1986.

ratio. For other crops (the next important crop being coconut), the requirement of K_2O is more and hence, the ratio indicates application of fertilizers at rates less than those recommended.

1.4 Climate

The State of Kerala falls under per-humid and humid climatic types except the southern most pockets of the State and the eastern part of the Palghat region which come under moist sub-humid climatic type. The State as a whole experiences megathermal climate which indicates that the crop growth is not inhibited by temperature; but governed by rainfall alone.

Table 4. Projected (potential) fertilizer requirement of crops in Kerala (1983–84) assuming 100 per cent adoption of recommended doses of fertilizers (in '000 tonnes)

Crop	N	P_2O_5	K_2O	Total
Rice	44.4	22.2	22.2	88.8
Coconut	60.7	38.9	146.0	245.6
Rubber	24.4	24.4	24.4	73.2
Tapioca	11.7	11.7	11.7	35.1
Cashew	5.4	2.7	2.7	10.8
Pepper	11.7	4.7	16.3	32.7
Coffee	6.8	4.6	6.2	17.6
Arecanut	8.2	3.3	11.4	22.9
Cardamom	4.1	4.1	8.2	16.4
Banana and Plantains	7.4	7.4	14.8	29.6
Pulses	0.6	0.9	0.3	1.8
Cocoa	0.6	0.3	0.9	1.8
Vegetables	3.1	1.6	1.6	6.3
Sesamum	0.4	0.2	0.4	1.0
Ginger	1.1	0.7	0.7	2.5
Groundnut	0.1	0.7	0.7	1.5
Sugarcane	1.2	0.6	0.6	2.4
Other crops	5.0	3.0	4.0	12.0
Total	196.9	132.0	273.1	602.0
Actual consumption (1983-84)	62.4	31.1	35.8	129.4
%Adoption	31.7	23.6	13.1	21.5

Source: Strategy for meeting fertilizer use targets in Kerala by 2000 AD. Conference on Fertiliser Technology, ICAR, New Delhi, 1986.

Table 5. NPK consumption ratios in Kerala

Year	N	P_2O_5	K_2O
1981-82	1	0.57	0.76
1982-83	1	0.58	0.84
1983-84	1	0.50	0.57
1984-85	1	0.57	0.65
1985-86	1	0.58	0.80

Source: Department of Soil Science and Agricultural Chemistry, College of Horticulture, Kerala Agricultural University, Vellanikkara

The classification of Moisture Availability Regimes (MAR) of Kerala is given in Table 6.

Table 6. Moisture availability regimes in Kerala

Criterion	MAR	Symbol
6 or more months with MAI in the range 0-0.33	Dry	A
5 or more consecutive months with MAI in the range 0.33—0.67	Semi-dry	B
5 or more consecutive months with MAI in the range 0.67—0.99	Sub-humid	C
5 or more consecutive months with MAI in the range 0.99—1.33	Humid	D
5 or more consecutive months with MAI in the range 1.33—1.67	Per-humid	E
5 or more consecutive months with MAI above 1.67	Wet	F

1.4.1. Rainfall

The rainfall distribution in Kerala is bimodal. The state gets heavy rains during both monsoons (South-West and North-East). The mean date of onset of the South-West monsoon varies from 25th May to 1st June. The North-East monsoon starts by the middle of October.

The annual rainfall of the State is 2963 mm. The highest rainfall (5883.8 mm) is recorded at Neriamangalam (Ernakulam district) and the lowest (651.3 mm), at Chinnar (Idukki district). The annual rainfall increases from 1479 mm at Parassala in the South to 3562 mm at Hosdurg in the North. July is the most rainy month in the northern districts. The southern parts extending from Ponnani to Trivandrum (except Devikulam) show two peaks in the months of June-July and October during the South-West and North-East monsoons, respectively. The northern districts, especially Kasaragod and Cannanore, experience a prolonged dry spell if the pre-monsoon showers fail. In general, the rainfall increase from the coast to the foot hills and then decreases on the hill tops. This trend is partially disrupted in the Palaghi region. Though the annual rainfall in the northern region is more, the effective rainfall is only about 40 per cent. The effective rainfall is 80 percent in the southern region. The mean annual number of rainy days over the State is 126 (Fig.5) with the minimum (45 days) at Chinnar and the maximum (172 days) at Neriamangalam. Nearly 60 per cent of the annual rainfall is received during the South-West monsoon (June to September). Around 25 days are observed in July. Most parts of the Western Ghat region receive less rainfall (Fig. 6).

The distribution pattern of rain during the North-East monsoon (October to December) is quite different from that during the South West monsoon, as the northern parts of Kerala receive less amount of rainfall compared to the South (Fig.7). The number of rainy days are more in October and thereafter, a sharp decline occurs. The pattern of rainfall other than monsoon rains is depicted in Fig. 8.

Fig.5.

MAP OF KERALA

CLIMATE : RAINFALL

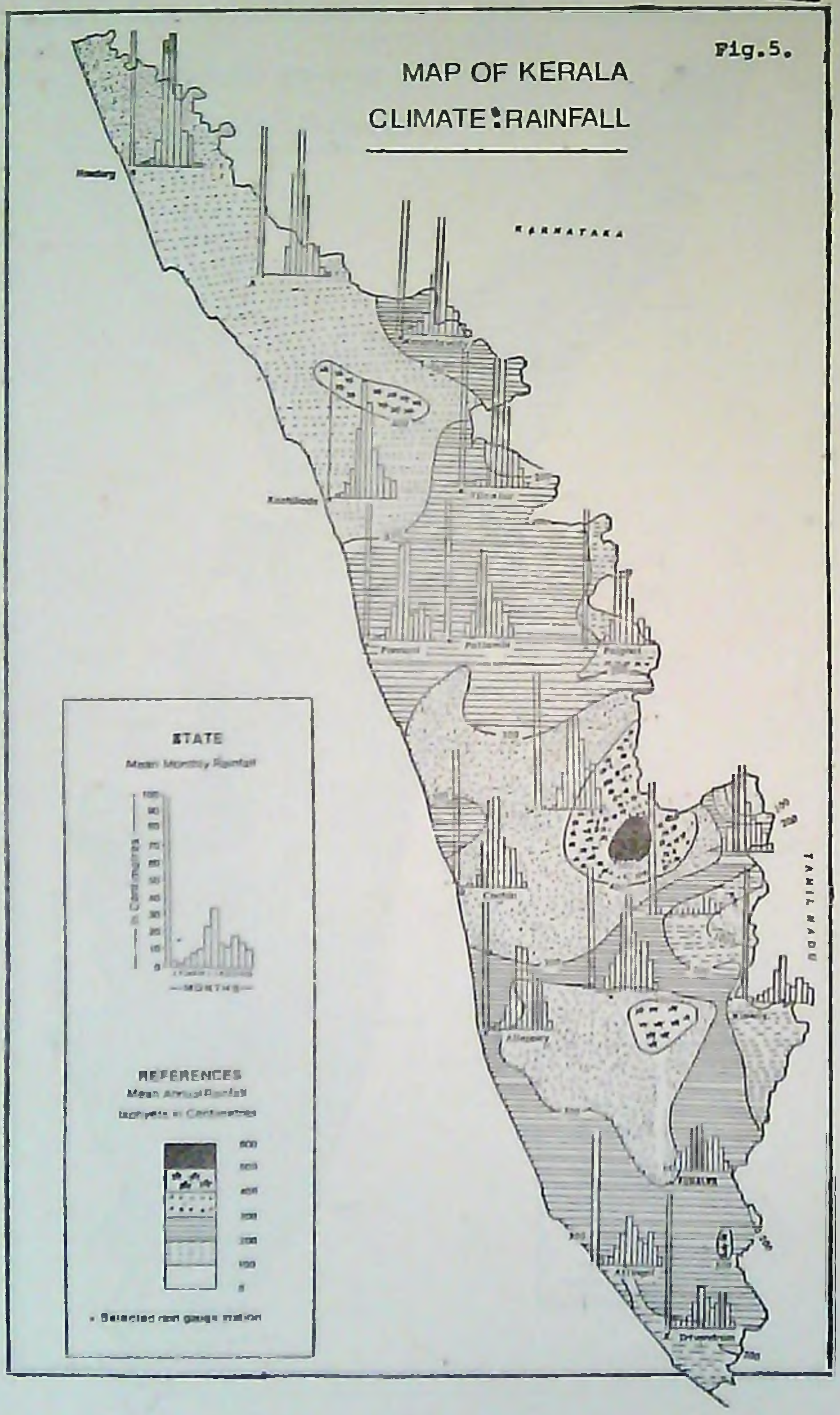
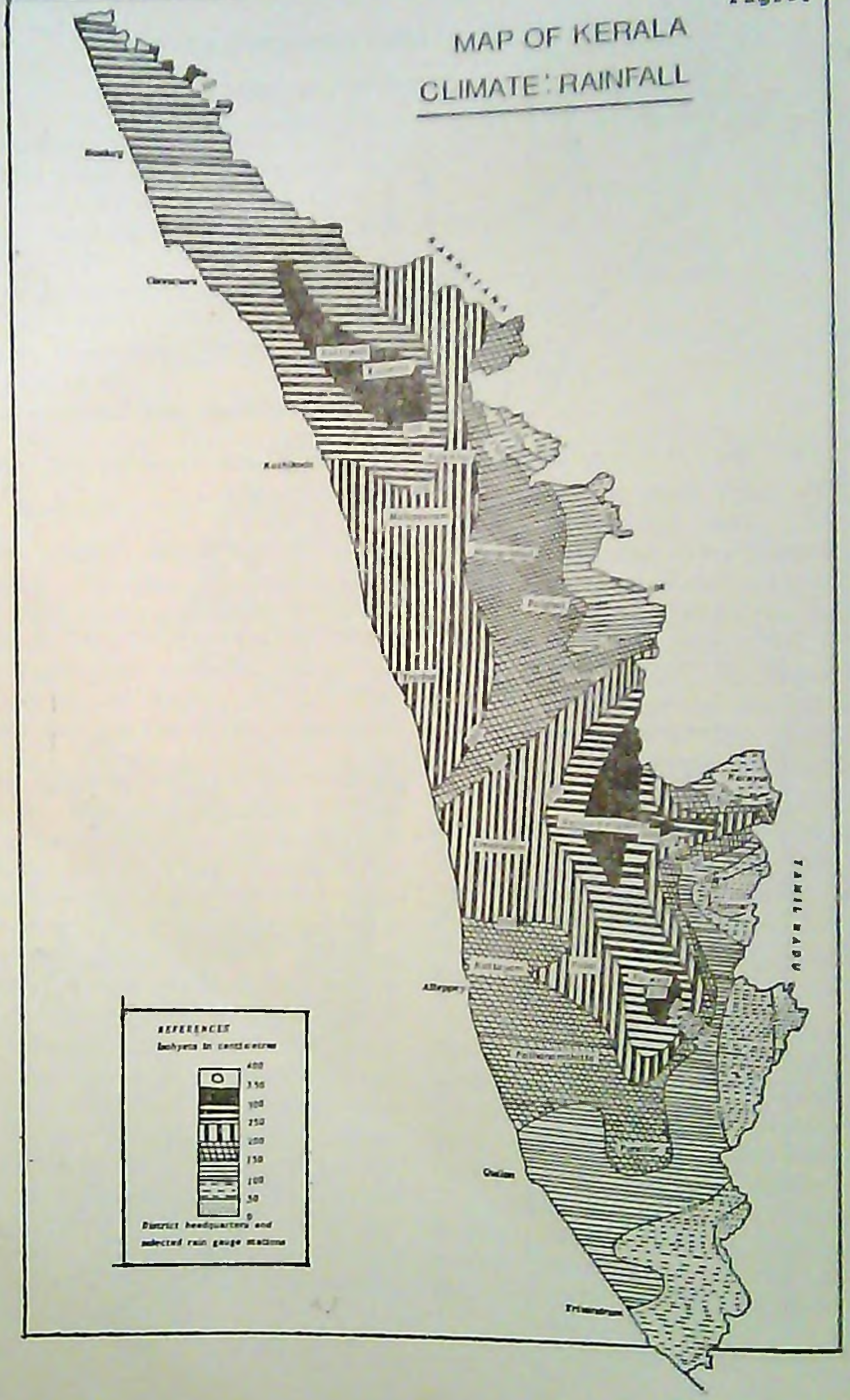


Fig.6.

MAP OF KERALA

CLIMATE: RAINFALL



MAP OF KERALA
CLIMATE : RAINFALL

Fig.7.

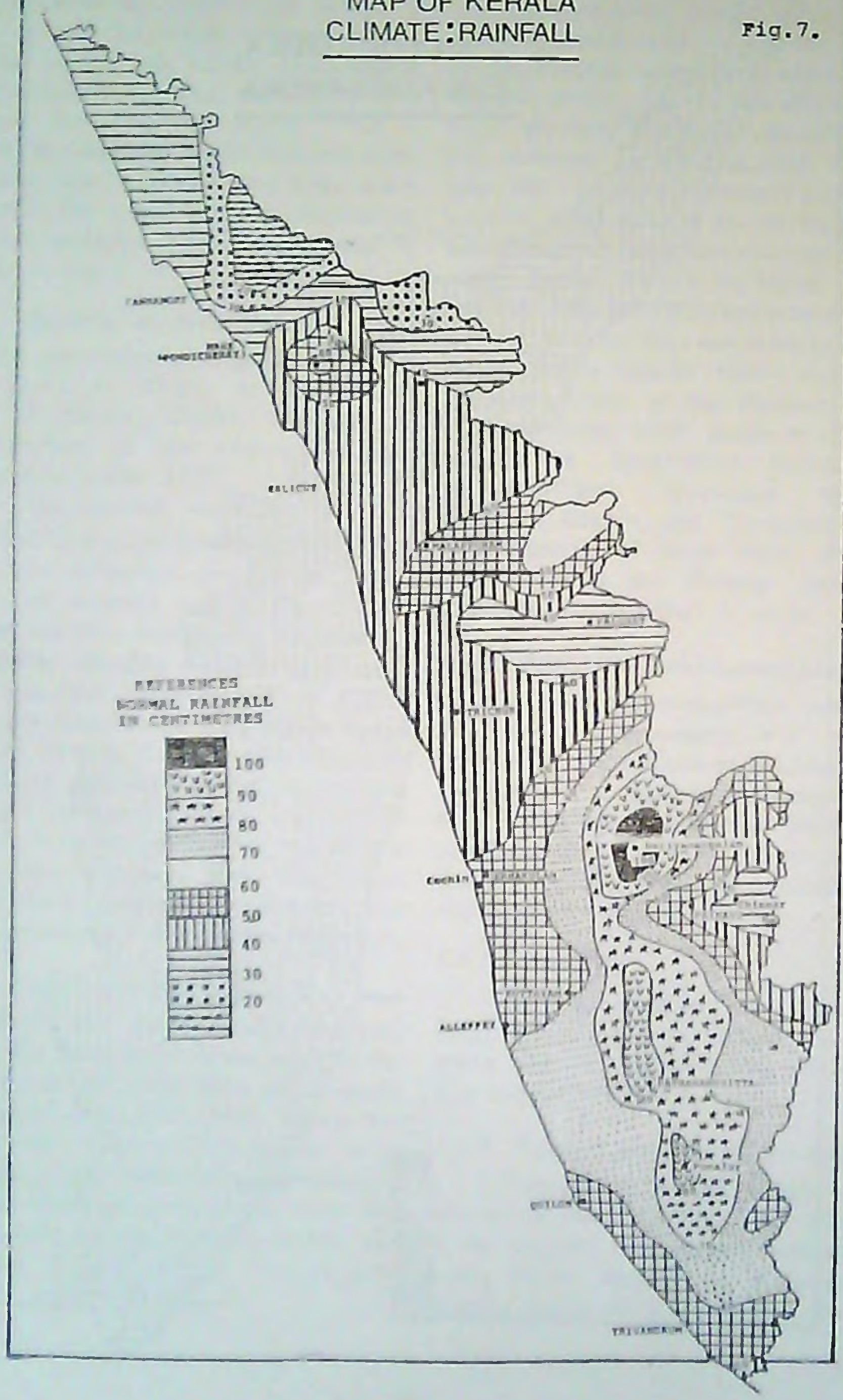
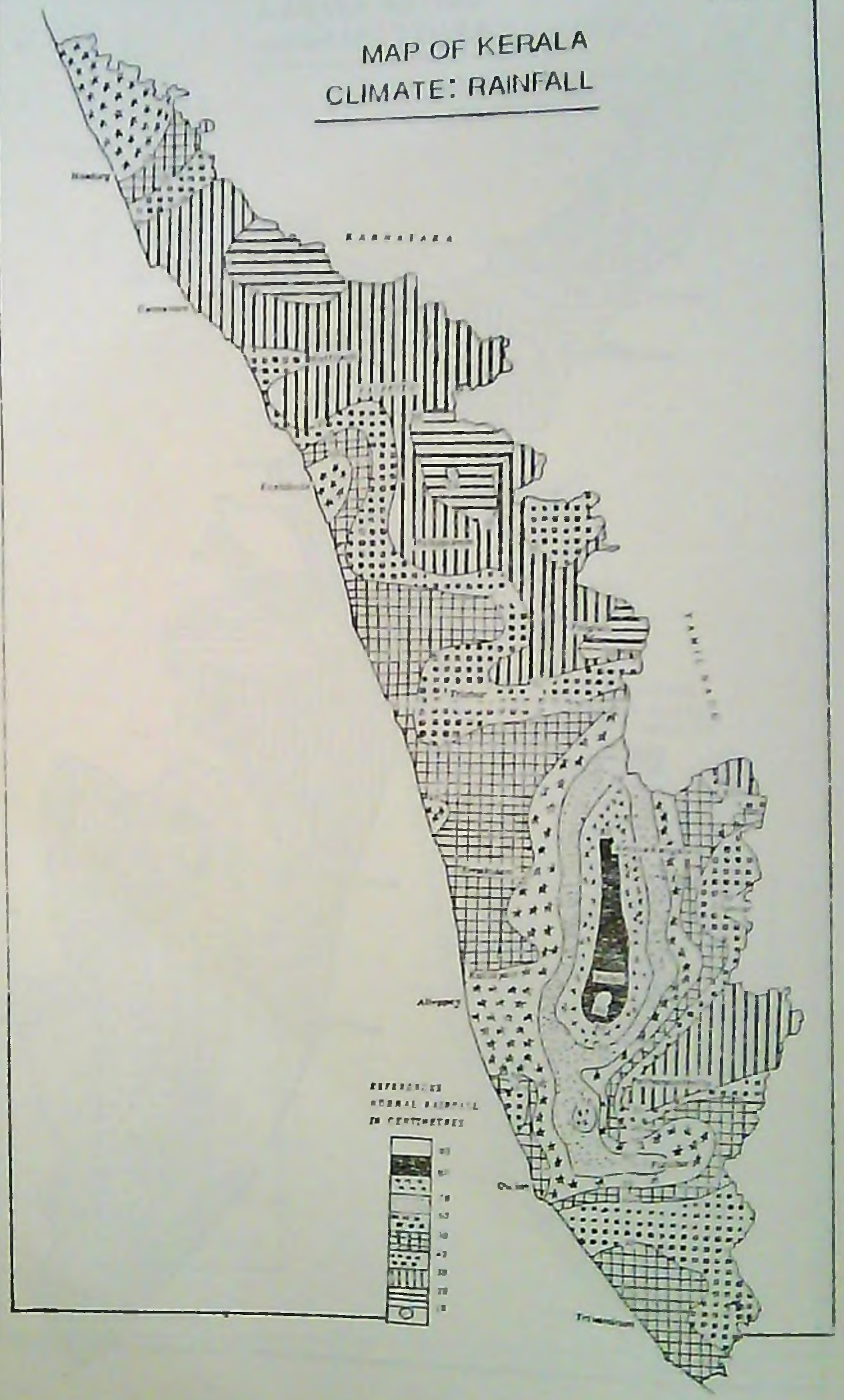


Fig.8.

MAP OF KERALA
CLIMATE: RAINFALL



1.4.2. Water balance of Kerala

Unlike the southern zone, deficit of water is seen for longer duration in the northern region of Kerala (Kasaragode and Cannanore districts), especially in the lowland and midland regions. This is mainly because the North-East monsoon is erratic over Cannanore and Kasaragode districts. The water balance which gives the soil moisture status in general is shown in Fig. 9.

1.4.3. Surface air temperature

The mean annual temperature varies from 25.4°C to 31.0°C in the central parts of Kerala (Fig.9). However, a major portion of the midland records temperature under 27.5°C (Annexures 7, 8, 9). The diurnal variations are not high (5-7°C),e xcept in the highland zones where the difference goes up to 15°C. This is an example where the tropical climate has been remarkably modified by the higher altitudes. March, April and May are the summer months during which the mean annual temperature varies between 29 to 31°C. The daily maximum may shoot upto 40°C in summer and the minimum may come down to 16°C in winter. Due to high rainfall during the South-West monsoon, the temperature comes down during July-August and starts increasing from October onwards.

1.4.4 Cloudiness and humidity

Cloudy and overcast skies are seen during the South-West monsoon. Moderately cloudy to cloudy skies are observed in October and November. During the rest of year clear or partly cloudy skies are seen. The mean monthly relative humidity varies between 85 per cent and 95 per cent during June-September and is about 70 per cent in January over different parts of Kerala.

1.4.5 Surface winds

North-westerly winds occur in the entire northern zone of Kerala. Interestingly, Palghat experiences easterly and westerly winds due to the effect of the Gap. Westerly and North-westerly winds are observed in Cochin and Alleppey (Fig. 10). In general, easterly and North-easterly winds occur in the morning hours while westerly and North-westerly winds occur during the evening hours. This is because of the land and sea breezes. The number of calm days are more in inland region than in coastal region due to the sheltering effect of the Western Ghats. The maximum wind speed is observed during the South-West monsoon. It decreases from November onwards. Alleppey, Cochin and Trivandrum have wind speeds of more than 20km/hr, while Palghat and Punalur experience wind speed of less than 5 km/hr.

1.4.6 Potential evapo-transpiration

The mean pan evaporation per day is 4.8 mm at Kasaragod, 4.5 mm at Trivandrum and 5.8 mm at Ollukkara and Pattambi. The pan evaporation is less than 3 mm/day during the South-West monsoon and starts increasing from October onwards, often exceeding 6mm/day during the summer months.

1.4.7 Sunshine

Due to overcast skies during the South-West monsoon, bright sunshine hours are less than 4 hr/day. In winter, it is about 10 hr/day.

1.4.8 Special weather phenomenon

Depression storms which are not uncommon during October and November in the Arabian Sea, cause rains over the entire State. Thunder is observed frequently during the pre-monsoon period.

Fig.9.

MAP OF KERALA
CLIMATE : TEMPERATURE

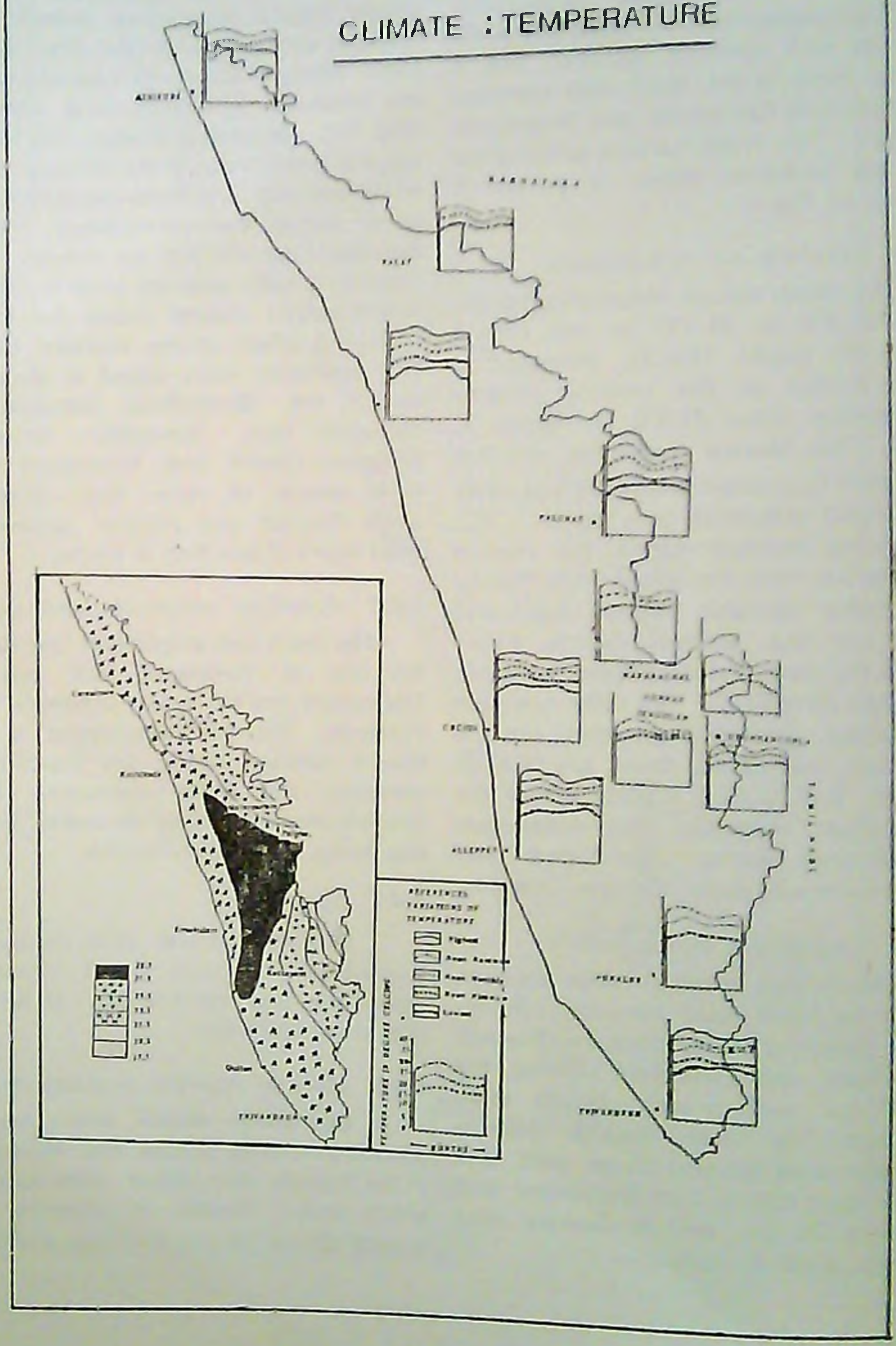
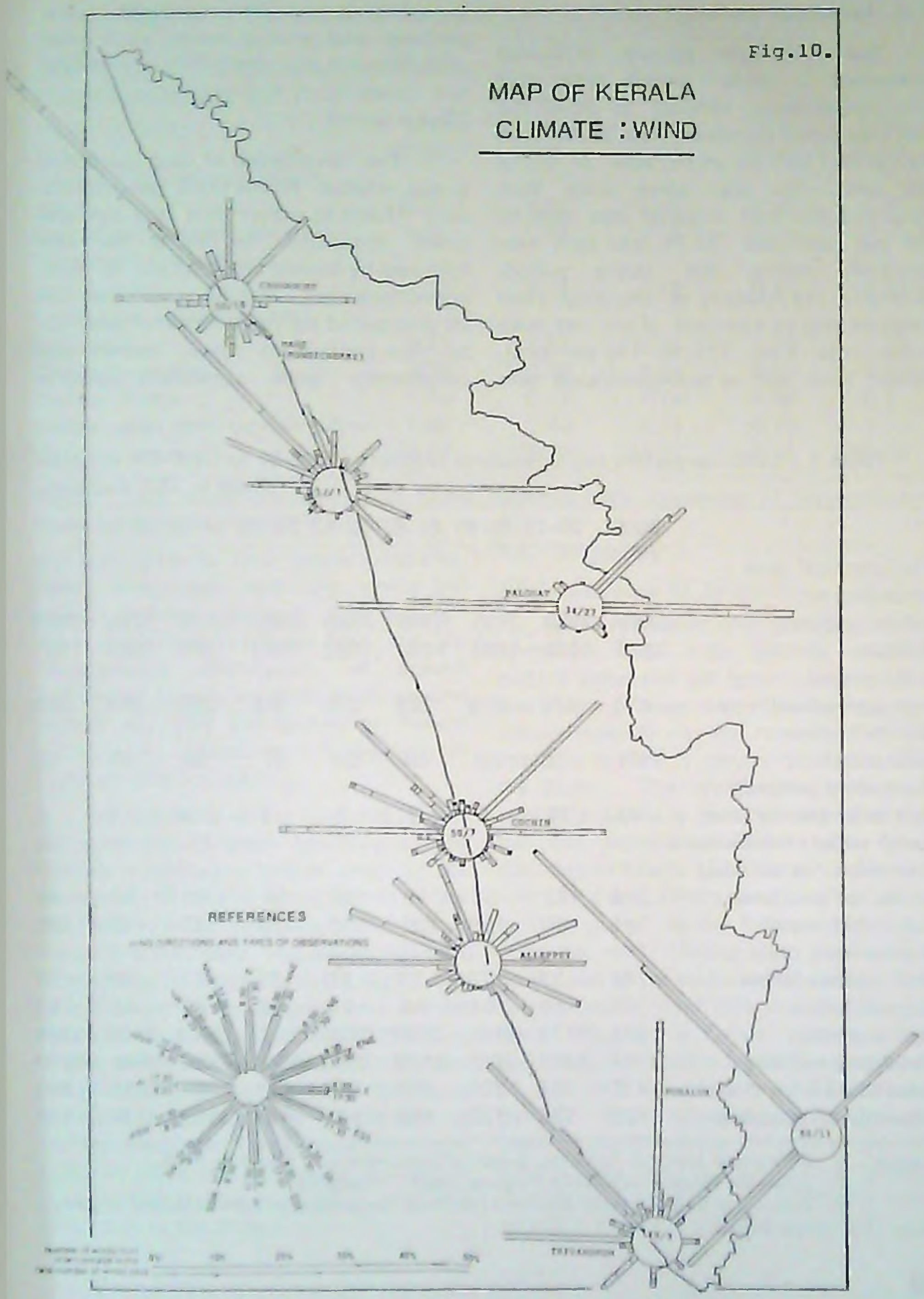


Fig.10.

MAP OF KERALA
CLIMATE : WIND



1.5 Land use pattern

The land use pattern of Kerala presented in table 7 shows that over the period from 1960-61 to 86-87 the net area sown increased from 23.49 lakh ha. to 28.7 lakh ha. an increase of 22.18 per cent. The area sown more than once and the total cropped area rose by 56 per cent and 22.18 per cent respectively during the above period. Similarly the intensity of cropping, total cropped area as a percent of the net area sown, rose from 122 to 130 per cent. While land put to non-agricultural uses increased, barren and uncultivable lands, pastures and grazing lands, land under miscellaneous tree crops, cultivable wastes and fallow lands declined during the last 26 year period.

The distribution of land according to use, relative to the total geographical area (Table 8) shows that the net area sown accounted for 56.78 per cent followed by forests and land put to non-agricultural uses. Notably, over the last 26 year period the proportions of land put to non-agricultural uses, barren and uncultivable lands permanent pastures

Table 7. Land use pattern and intensity of cropping (1960-61 to 1986-87) in Kerala
(Area in '000 hectares)

	60-61	70-71	80-81	81-82	82-83	83-84	84-85	85-86	86-87
Geographical area according to village papers	3885	3885	3885	3885	3885	3885	3885	3885	3885
Forests	1056	1055	1082	1082	1082	1082	1082	1081	1081
Land put to non-agricultural use	205	275	270	266	276	278	280	278	263
Barren and uncultivable land	151	72	86	86	86	87	86	83	82
Permanent pastures and other grazing land	45	28	5	5	5	5	4	4	3
Land under miscellaneous tree crops not included in the net area sown	204	132	64	55	55	55	51	50	46
Cultivable waste	144	80	129	130	130	129	130	125	129
Fallow land other than current fallow	62	23	27	27	27	28	27	28	27
Current fallow	67	24	44	44	44	43	42	43	44
Net area sown	1924	2172	2180	2190	2180	2180	2184	2190	2206
Total cropped area	2349	2933	2885	2905	2862	2862	2875	2866	2870
Area sown more than once	425	761	705	715	682	681	690	676	663
Intensity of cropping	122	135	132	133	131	131	132	130	130

Source : 1. Agricultural Statistics in Kerala, Bureau of Economics and Statistics, 1975.
2. Economic Review 1985, State Planning Board, Trivandrum.
3. Progress of Kerala in three decades 1956-1985, Department of Economics and Statistics Trivandrum.

Table 8. Percentage distribution of land in Kerala according to use

Land use classification	60—61	70—71	80—81	84—85	86—87
Total area according to village papers	100	100	100	100	100
Forest	27.37	27.35	28.04	28.04	27.82
Land put to non-agricultural use	5.31	7.17	7.00	7.26	6.77
Barren and uncultivable land	4.02	1.87	2.23	2.23	2.12
Permanent pastures and grazing land	1.17	0.73	0.13	0.10	0.08
Land under miscellaneous tree crops	5.29	3.42	1.66	1.32	1.18
Cultivable waste	3.73	2.08	3.34	3.37	3.32
Current fallow	1.74	0.62	1.14	1.06	0.7
Fallow other than current fallow	1.60	0.60	0.70	0.70	1.13
Net area sown	49.87	56.30	56.51	56.61	56.78

Source : Land Resources & Land use in Kerala, December 1980, Directorate of Economics and Statistics, Trivandrum.

and grazing lands, land under miscellaneous tree crops, cultivable waste and current fallows declined. The district-wise distribution of forest area and the division-wise distribution of reserve and vested forests are given in Annexures 10 and 11. The distribution of forests in Kerala by functional and vegetational types are given in table 9.

The suitability of the land and climate for a number of crops has tempted the farmers to cultivate a host of crops in the same piece of land in mixed stands. This has resulted in an intensive cultivation of dry land in the State. The overall intensity of cropping in Kerala is fairly high. The ratio between gross cropped area and net area sown is 1.30 in Kerala (1986-87) as against the national figure of 1.18. But this parameter, in the context of Kerala, is deceptive because nearly 45 per cent of the net area sown is under perennial crops. Table 10 gives the per capita availability of geographical area, cultivable area and forest area in the State.

1.6 Irrigation

1.6.1 Sources of irrigation

Kerala is blessed with abundant water resources. The main sources are the surface water and the ground water. The availability of water from these two sources mainly depends on the rainfall. Rainfed cropping system is generally followed in the State. The distribution pattern of rainfall in Kerala is not uniform and during the two monsoons, heavy rains occur resulting in floods. The State is blessed with 44 rivers (Annexure 2). The water in these rivers can be fully exploited for irrigation and raising the agricultural production to the maximum possible. The total extent of land that can be brought under irrigation in Kerala through major and medium irrigation projects is estimated at 6.0 lakh ha (net) or 14.0 lakh ha (gross). Seven ongoing projects, through partial commissioning, irrigate an area of 0.65 lakh ha (net) or 1.53 lakh ha (gross). During the Sixth Plan, an additional area of 24558 ha (net) or 57085 ha (gross) was

Table 9 : Percentage distribution of forests in Kerala by functional type and vegetational type (1980)

	Percentage
A. Functional type	
Forest area available for timber production	86.5
Forest area under cardamom	2.8
Forest area set apart as wild life sanctuary	8.3
Forest area not suitable for timber production	2.4
Total	100.0
B. Vegetational type	
Evergreen and semi evergreen	50.5
Moist deciduous	33.4
Dry deciduous	1.8
Montane sub tropical and temperate	1.7
Plantations	12.6
Total	100.0

Source : Land Resources & Land use in Kerala, December 1980. Directorate of Economics and Statistics, Trivandrum.

Table 10 : Per capita availability of land (in ha.) in Kerala

Category	Year		
	1961	1971	1981
Per capita availability of geographic area	0.23	0.19	0.15
Per capita cultivable area	0.14	0.14	0.09
Per capita forest area	0.06	0.05	0.04

Source : Land Resources & Land use in Kerala 1980. Directorate of Economics & Statistics, Trivandrum.

irrigated in the State. Thus the gross irrigated area covered by the major and medium irrigation projects till June 1985 was 3.57 lakh ha. A list of ongoing major and medium irrigation projects and their cumulative achievements at the end of 1984-85 are given in Annexures 12 and 13.

In 1984-85, there were 12 ongoing major irrigation projects and six ongoing medium irrigation projects under different stages of construction. Of these, the major works at Kuttiady, Chitturpuzha, Pampa, Pazhassi and Periyar Valley are almost over. During 1984-85, Rs. 670 lakhs were spent on minor irrigation schemes to extend the benefits of irrigation to 7163 ha (net) or 8993 ha (gross). The sub head-wise outlay and expenditure as well as physical targets and achievements during 1983-84 and 1984-85 are furnished in Annexure 14. The number of minor irrigation schemes proposed and completed during 1984-85 under each category are given in Annexure 15.

1.6.2 Irrigation potential

According to a study of the Planning Commission, the irrigation potential of Kerala was estimated at 2.5 million ha approximately. Out of this, only 1.5 million ha can be covered under major and medium irrigation projects. This calls for finding out alternate sources so that irrigation facilities can be extended to the remaining 1.0 million ha of cropped area also. It can be seen that the surface water resources of the State alone are not capable of bridging this gap and that the utilisation of under developed ground water resources of the State only provide the practical means to bridge this wide gap that exists between the demand and the supply of water for irrigation.

1.6.3. Ground water availability

Compared to that in the other parts of India, ground water development in Kerala State is in its infancy. However, ground water had been extensively used for drinking and other domestic purposes through the 30 lakhs of domestic wells in the different panchayats of the state. The 12 existing major irrigation projects along with the six medium projects under different stages of investigation and execution could cover hardly 50 per cent of the total area under crops. This lacuna along with the vagaeris of the recent drought in 1983, has been on eye-opener to the farmers. They have realised that tapping of ground water is essential for the survival of crops as well as for increasing the production of the cash crops like coconut, arecanut, cocoa and banana. In addition, there has been an attempt to convert lands which were traditionally used for raising two rainfed crops of paddy into tripple cropped lands using ground water.

The systematic hydrological studies by the State Groundwater Department and the Central Groundwater Board have indicated the presence of a number of sandy belts composed of medium to coarse grained sands. These sandy pockets are found to be potential ground water resources and suitable for development by way of shallow filter point wells. From 1982 to the end of March 1936, 548 filter point wells in Trivandrum, Quilon, Alleppey, Trichur, Ernakulam, Malappuram, Calicut and Cannanore districts have been sunk. Besides these, suitable sites were cleared and appropriate designs given for 686 open irrigation wells, 869 tube bore wells and 233 shallow bore wells to a depth of 60 m in various parts of the State for irrigating the agricultural land. The Ground water Department also dug 286 borewells and 18 tube wells for providing drinking water to Harijan/Girijan colonies. The present ulilisation of ground water through dug wells, dug-cum-bore wells is rather limited to certain areas. The wells are tapping the near surface aquifers in Malappuram, Kozhikode, Palghat, Cannanore and Ernakulam districts. In the other districts, it is yet to catch up. The department have so far cleared sites for 7113 open wells throughout the state. The district-wise break up of irrigation wells in the state is given in Table II.

1.6.4. Inland navigation system

Kerala is placed in a very favourable position with regard to inland water transport. The waterways of Kerala connect several minor ports as well as the major port of Cochin. A number of industrial units are situated close to them. This state enjoys a regular navigation system because of several west-flowing rivers and a coastline interspersed with backwaters.

Long before the development of road and railways, the coastal and inland waterways provided the main transport base in Kerala. The canal system, navigable all round the year, extends from Trivandrum in the south to Badagara in the North and

Table II. District wise break up of irrigation wells

Districts	Number of wells with pumpsets	
	Diesel	Electrical
Trivandrum	175	3889
Quilon and Pathanamthitta	215	2108
Alleppey	1732	1205
Kottayam and Idukki	777	7174
Trichur	3455	67368
Ernakulam	3674	22695
Palghat and Malappuram	3550	27430
Calicut and Wayanad		3079
Cannanore and Kasaragodo		10831
Total	13578	145779
Overall total of irrigation wells		159357

is interlinked by backwaters and rivers through artificial canals. The total length of the navigable route in Kerala is 1895 km accounting for about 20 per cent of the total inland water route in India. This can be categorised under the interior coastal canal system, the river navigation system and the inland cross canal system. The 83 km long vembanad lake constitutes the centre of these inland waterways.

Kerala's main waterway is made up of the West coast canal system of 558 km length, formed by linking a series of backwaters and lakes. It extends from Trivandrum to Cochin and further to Badagara by the Cochin-Ponnani-Badagara canal system. It is the principal means of communication in the areas through which it passes. The West coast canal enables not only the distribution of agricultural procuce from the areas lying around the canal; but also meets the needs of the industries such as tile, timber, coir, fertilizer, aluminium, rayon, cashew and titanium.

Cochin-Quilon section, having a length of 146 km, is the most important section of the West coast canal and carries about 60 per cent of the total tonnage of cargo carried by the inland waterways of the State. At its centre, it has the important industrial and commercial town of Alleppey and at the southern end, Quilon town. The Vembanad lake extending over an area of 205 km^2 has Cochin at the northern end and Alleppey near its southern end. Five rivers drain into this lake and these rivers are navigable for a length of about 30 km upstream from their points of outfall. The low lying area of *Kuttanad* which is known as the rice bowl of Kerala, is contiguous with this lake and is connected by a system of canals and rivers with the main inland water route. Alleppey is the main point of exit for agricultural produce from *Kuttanad*, besides being an important market of coir products. The waterway between Alleppey and Quilon passes through important coir producing areas of the Ashtamudi lake (52 km^2 in area). The Kayamkulam lake, Vembanad lake and Ashtamudi lake are

connected by backwaters and Chavara Canal. Chavara is the most important mining centre for rare earths in India. A project, costing Rs. 1000 million, for deep mining of rare earth and for establishing industries based on the mined material is being planned to be established here.

Of the 44 rivers which run across the State, the West-flowing 41 rivers, providing 840 km of navigable routes are fit for boats only during the monsoons. During the rest of the year the navigation is possible only in the lower reaches. Besides the above, a series of backwaters of irregular shape and width run along the Kerala coast. These form continuous navigable waterways over long stretches with intermittent gaps. The backwaters are navigable by country crafts and powered crafts during all seasons of the year. The aggregate length of navigable backwaters is approximately 350 km.

The inland cross canals inter-connect the rivers on the banks of which are located many of the important commercial and industrial centres of the State. There are about 500 km of inland cross canals which lie mostly in the Travancore-Cochin area of the State.

The Inland Water Transport (IWT) system in Kerala with all its limitations' carried as much as 4.0 million tonnes of freight traffic in the year 1970 and 26.6 million passengers in the year 1976. As the inland water ways connect many villages *en route*, they provide stimuli to develop small scale cottage industries in the rural areas. The State of Kerala being mostly rural, the inland water ways play an important role in the economic uplift of rural areas by providing transport connection, better irrigation, augmentation of fish culture and development of tourism.

Realising the need for the development of this mode of transport, the State Government set up a Task Force to study the limitations in the present IWT system in the State. The Task Force submitted proposals during the Sixth Five year Plan amounting to Rs. 154.4 million. The details of the proposed schemes are given in Table 12. The plen schemes under the IWT are being implemented by four agencies viz., the Public works Department, the State Water Transport Department, the Kerala State Road Transport Corporation and the Kerala Inland Navigation Corporation.

1.7. Socio-Economic characteristics, Land holding pattern

1.7.1. Area, population and literacy

Kerala ranks 17th in respect of area (38863 km^2) and 12th with respect to population (254.5 lakhs according to 1981 census, which accounts for 3.71 per cent of the national population). The population density of Kerala is 655 per km^2 as against the national average of 221. The total rural population is 207 lakhs while urban population is only 47 lakhs. The percentage of rural population to the total population diminished from 83.76 in 1971 to 81.22 in 1981. The total male population of 125 lakhs and the total female population of 129 lakhs in 1981 represent an increase of 19 lakhs and 22 lakhs, respectively over the 1971 census (Annexure 16).

The sex ratio is 1032 females per 1000 males. The female pspulation is found to be increasing at a faster rate than the males. There has been a steady fall in the birth and death rates in the recent past. Table 13 shows the projected population for 1986.

Table 12. Scheme-wise outlays (in million rupees) for the development of Inland water Transport in Kerala

Scheme	Fifth Plan Outlay 1974-1979	Outlay proposed 1978-1983
Direction and Administration		
Establishment of a Dredger Organisation (PWD)	—	25.00
Assistance to Transport Services		
Completion of existing and a few new canal schemes in State Sector (PWD)	5.50	80.00
State water Transport Department Schemes		
Terminal facilities Crafts (Augmentation of ferry services) Equipment and workshops Training of staff	1.80	9.90
Ferry services of the KSRTC		
Acquisition of fleet	—	7.50
Workshop machinery and slipway construction	—	3.50
Training and Research		
Traffic studies, Hydrographic Survey Unit etc.	—	3.50
Other facilities		
Preparation of master plan	0.20	—
Deepening and improving existing boat routes operated by the SWT Department	—	5.00
Kerala Inland Navigation Corporation Scheme	—	20.00
Total	7.50	154.40

Source: Proceedings of the National Seminar on Inland Water Transport Future Perspectives. Trivandrum, 10-12, November, 1982.

Table 13. Growth of population over the last decades

Year	Population in lakhs		
	Male	Female	Total
1951	66.82	68.67	135.49
1961	83.62	85.42	169.04
1971	105.88	107.59	213.47
1981	125.27	129.27	254.54
1982*	127.01	130.90	257.91
1983*	128.78	132.57	261.35
1984*	130.59	134.27	264.86
1985*	132.42	135.99	268.41
1986*	134.28	137.74	272.02

*Projected population

Source: Progress of Kerala in three decades 1950–1985. Department of Economics and Statistics, Trivandrum

There are 25 lakhs scheduled castes and 2.6 lakhs scheduled tribes in the State. The percentages of scheduled castes and scheduled tribes to the total population are 10.02 and 1.03, respectively (1981). The district-wise distribution of scheduled caste/scheduled tribe population is given in Annexure 17.

The total working population in the State is 78 lakhs which is 30.7 per cent of the total population of the State. Out of this, 27.9 lakhs of people are engaged in Agriculture. It is also seen that about 13.18 per cent of the main workers are cultivators and 28.19 per cent, agricultural labourers. The population engaged in agriculture including livestock farming,

fishing and forestry is 55 per cent which includes cultivators, landless labourers and fishermen (Annexure 18). The fishermen population during 1984-85 was 8.64 lakhs constituting 3.2 per cent of the State's population. The district-wise distribution of fishermen population in Kerala is given in Annexure 19.

The number of occupied residential houses in the State is 43 lakhs and the number of households is 44 lakhs.

Kerala leads all the other states in India in literacy with 70.4 per cent, the national average being 36 17 per cent. Male literacy is 75.3 per cent while female literacy is 65.7 per cent. Among the districts, Kottayam has the highest literacy with 81.7 per cent and Palghat, the lowest with 58 per cent. The district-wise literacy rate is given in Annexure 20.

1.7.2. Infant mortality rate and life expectancy

The infant mortality rate (IMR) in Kerala is 37 according to 1981 census. The rural IMR is 40 while the urban IMR is only 24 (Annexure 21) The IMR during the last four decades are given in Table 14.

Table 14. Infant mortality rates in Kerala

Year	IMR
1951	120.0
1966	68.3
1970	52.6
1975	57.3
1980	42.5
1981	39.1
1982	36.3
1983	38.9

Source: Economic Review, 1935. Directorate of Economics and Statistics.

During the fifties, about one-eight of the infants born would die before attaining one year, showing an IMR of 120 per 1000 births. There was a two-third decrease in IMR during the last quarter of the Century and the IMR reported in 1983 is only 38 9. A comparison of the infant mortality rates in 1981 among the major states shows that Kerala had the lowest rate, both in the rural and urban areas (Annexure 21).

As a result of the success achieved by the State in reducing IMR, the life expectancy rose to 68 years in 1982, with 66 years for males and 70 years for females. Table 15 shows the life expectancy for Kerala and India.

Among the states, longevity is the highest in Kerala, both for males and females (Annexure 22).

The above socio-economic indicators show that albeit the primary and secondary sectors of the economy are in general stagnating in the recent past, the state has achieved high physical qualities of life even comparable with those in the developed world. Such a type of development is oft-quoted as the "Kerala model" by planners and development thinkers.

Table 15. Life expectancy in Kerala and India

Kerala			India		
Year	Males	Females	Year	Males	Females
1982	66.33	70.71	1976-80	52.50	52.10

Source: Economic Review, 1985

1.7.3. Unemployment and educational status

Kerala has a very high level of unemployment. According to a survey on unemployment conducted in 1980, about 18 per cent of the labour force numbering 14 lakhs were chronically unemployed. Annexure 23 shows the educational status of the state. The number of students at high school stage in 1984-85 was 13.68 lakhs. There were 2.98 lakh of students studying in the Arts and Science Colleges of the state. The students' statistics for 1983-84 and 1984-85 in the Kerala Agricultural University are also given in Annexure 24. There were 1253 graduates on the rolls in 1984-85.

1.7.4. Income of the state

The Net State Domestic product amounted to Rs. 5965 crores in 1984-85 at current prices. It is estimated that the primary sector contributed 40.17 per cent of the net domestic product in the year 1984-85. The contribution of the primary sector during 1981 was 38.88 per cent at 1971 prices and 38.14 per cent at current prices. The per capita income of the state in the year 1984-85 was Rs. 645.00 at 1970-71 prices and it was Rs. 2196.00 at current price. The details are given in Annexure 25.

1.7.5. Land holding pattern

It is reported that the revenue settlement of 1911 identified as many as 455 different tenures in Travancore and Cochin states. But intermediaries like Zamindars Mahalwaries etc. found in North India, never existed in Kerala. The Kerala Agrarian Relations Act, 1960 was the first identified legislation which embodied the broad principles of land reforms. With the enactment of the land Reforms Amendment Act of 1969, landlordism has been abolished in the state and ownership rights have been conferred on the tenants. According to this Act, the ceiling area was fixed as five standard acres (2.02 ha) in the case of adult married men or a family. The 1969 Amendment exempted the private forests and the plantation lands belonging to religious, educational and charitable institutions from the purview of the Act. It is noteworthy that Kerala has the lowest ceiling limit among the states in India.

The total number of operational holdings and the total area operated in Kerala, as per 1976-77 agricultural census were 35,01,100 and 17,19,100 ha respectively. According to 1980-81 census, the total number of operational holdings was 41,80,900 and the total area operated became 18,05,300 ha. Between these two census years, the number of operational holdings increased by 19.42 per cent (6,79,800 nos.) while the area operated increased by only 5 per cent (86,200 ha). The details are given in Annexure 26. It may be seen that 89 per cent of the total holdings in Kerala are marginal (ie. less than 1 ha) and that the large holdings (ie. 10 ha and above) occupy only 0.1 per cent (Table 16). The total number of operational holdings in Kerala was 4.68 per cent of the total number of operational holdings in India during the year 1980-81, whereas the total operated area accounted for only 1.11 per cent of the area operated in India.

The medium (between 4 and 10 ha) and the large holdings (10 ha and above) together accounted for only 1.09 per cent of the total holdings in 1976-77. This was reduced to 0.95 per cent in 1980-81. The total area under these classes of holdings was 19.80 per cent of the total operated area in 1970-71 which decreased to 18.02 per cent in 1980-81. For India, the percentage of operational holdings under these classes was 11.46 which accounted for 52.50 per cent of the operated area in 1980-81.

Table 16. Percentage distribution of the number of operational holdings and their size in Kerala and in India, during 1980-81

Class and size of holdings	Number of operational holdings (%)		Average size of operational holdings (ha)	
	Kerala	India	Kerala	India
Marginal (below 1 ha)	89.16	56.55	0.20	0.39
Small (between 1& 2 ha)	6.93	17.99	1.37	1.42
Semi-medium (between 2 & 4 ha)	2.96	14.00	2.68	2.76
Medium (between 4 & 10 ha)	0.85	9.05	5.45	5.98
Large (10 ha and above)	0.10	2.41	35.54	17.27
Total/Average	100.00	100 00	0.43	4.82

Source: 1. State Planning Board, Kerala, Trivandrum
2. Farm Guide, 1985 and 1986, Government of Kerala

The average size of the holdings for the State was 0.49 ha in 1976-77 and 0.43 ha in 1980-81. The average size of the holdings for the Country as a whole was 1.82 ha in 1980-81 (Table 16).

1.7.6 Homesteads

Homesteads form a unique feature in Kerala State. A typical homestead consists of a dwelling house with a small garden in front and variety of annual and perennial crops grown in mixture in a small piece of land. The crops of the homestead may include vegetables, a few coconut and/or arecanut palms, banana or plantains, drumstick, papaya, jack, mango and other fruit trees. In addition to these, the presence of one or two heads of livestock (cows, goats, or buffaloes) with a small unit of poultry consisting of four to five birds is another notable feature of these homesteads. More than 80 per cent of the produce generated in the homestead is consumed in the home itself and the remaining 20 per cent provide subsidiary income to the house owner.

1.7.7 Farm prices

In the absence of a permanent machinery to stabilise prices, farm prices often exhibit marked gyrations. Annexure shows the average farm price of some of the important commodities.

1.7.8 Wages

The average daily wage rate (as per Minimum Wages Rules) of agricultural labour was Rs. 12.74 and Rs. 8.83 for males and females, respectively during the year 1981. The average daily wage rates of carpenters and masons in the agricultural sector during 1981 were Rs. 22.49 and Rs. 22.50, respectively. However, the wages paid in different localities usually exceeded the prescribed minimum wages in the State.

1.8 Major crops and crop sequences

1.8.1 Major crops

Agriculture in Kerala is unique in the sense that homestead system of cultivation is prevalent in almost all parts of the State. The homestead consists of the area

surrounding the farm house. Intensive cultivation of all available crops is the main feature of this system of farming. The nature of crops in the homesteads depends mainly upon the requirements of the farmer and ranges from purely seasonal to perennial crops. One principal feature is that coconut constitutes the base crop in almost every homestead and it is intermixed with other seasonal, annual and perennial crops. Rice is the staple food of Keralites. Tapioca is a subsidiary food crop. The major crops include plantation crops like coconut, arecanut, cashew, pepper, coffee, tea, rubber; annual crops like rice, tapioca, pulses, sesamum, cotton groundnut, ragi, tobacco; fruit crops like mango, banana, pineapple, jack and seasonal crops like cowpea, blackgram, redgram etc. In addition to these, vegetables and tubers are largely grown in the homesteads. Sweet potato, yams, colocasia etc, are some of the important tuber crops. In recent years, cocoa is also cultivated as an intercrop in coconut gardens as well as in homesteads. The area, production and productivity of major crops in Kerala are given in Annexure-28.

1.8.2 Crop sequences

Kerala Agriculture is characterised by a high degree of variability in cropping pattern due to its diverse soil and ecological conditions. Polyculture is the rule in most of the areas. The important crop combinations and crop sequences in the lowland, midland, highland and highranges are given below:-

Lowland

Perennial	—	Coconut
Annual	—	Tapioca and banana
Seasonal	—	Pulses, vegetables, groundnut, sesamum, rice in wet lands

In the wet lands, the crop sequences followed are Rice — Rice — Pulses, Rice — Rice Vegetables, Rice — Sweet potato/Vegetables and Rice — Rice — Fallow.

Midland

Perennial	—	Coconut, rubber, cashew, arecanut, nutmeg, clove, pepper, betelvine and cocoa.
Annual	—	Tapioca, giger, banana, yam, turmeric
Seasonal	—	Pulses, groundnut, vegetables Rice in wet lands

In the wet lands, the crop sequences followed are Rice–Rice–Pulses, Rice–Rice–Sesamum, Rice–Rice–Vegetables, Rice–Banana, Rice–Sugarcane, Rice–Sweet potato and Rice–Tapioca.

Highland

Perennial	—	Pepper, cardamom, coffee, tea, coconut, rubber
Annual	—	Tuber crops, banana, ginger, turmeric
Seasonal	—	Pulses, vegetables, Rice in wet lands

High ranges

Perennial	—	Coffee, tea, rubber, cardamom

While mixed cropping pattern is generally followed in the dry lands, coconut–based mixed cropping system is seen in the low-lands and part of mid-lands. Tapioca based cropping systems are widely practised in the mid-lands. The major crop sequences in the wet land areas, where generally rice-based cropping system is followed are:-

Rice–Rice–Rice
Rice–Rice–Pulses/Vegetables/Oilseeds/Sweet potato
Rice–Banana/Tapioca
Rice–Rice–Fallow

Eventhough a polycropping pattern with mixed stand of various crops is

observed throughout the State, four major farming systems can be identified.

1. Rice-based farming system
2. Coconut-based farming system
2. Tapioca-based farming system
4. Homestead farming system

In certain isolated parts of the State, farming systems based on banana, arecanut and pepper as the main crop also exist. As mentioned earlier, homestead farming is a characteristic feature of the State and crop plus livestock is almost the general rule in such a system.

A list of cultivated crops of Kerala is given in Annexure 29. The peak marketing seasons of principal crops in Kerala along with sowing and harvesting periods are given in Annexure 30.

3.9 Principal crops, area, production and productivity

A wide variety of crops are cultivated in Kerala. The principal crops are plantation crops like coconut, arecanut, cashew pepper, coffee, tea and rubber; annual crops like rice, tapioca, pulses, sesamum and groundnut, and fruit crops like mango, banana, pineapple, jack etc. The area, production and productivity of these crops are given in Table 17 and Annexure 28.

1.9.1 Rice

Rice, the choicest food of Keralites, presents an alarming picture in respect of area and production during the period since 1975-76. From 8.76 lakh ha in 1975-76, the area dwindled to 6.04 lakh ha in 1937-38, a decrease of about 31 percent. However the productivity has increased by 12.4 percent from 1520 kg/ha in 1975-76 to 1909 kg/ha in 1987-88. Hence, it may be noted that the drastic reduction in area is the main reason for the declining production of rice in the State. The production of rice has been almost stagnant during the last few years. Given the growth in population by 1.7 percent annually and declining trend in area under rice, the problem of food deficit is likely to become more grave in the years to come. The current level of production in the State meets only 42 percent of the domestic requirements. It is estimated that by the turn of the century, the population of the State would grow to 33 million and would need 3.99 million tonnes of rice, which is three times the current level of domestic production. If production does not increase substantially, there would be a yawning gap between availability and requirement, necessitating extreme dependence on outside suppliers. This shows the gravity of Kerala's food problem and the need to find urgent measures for increasing rice production through all possible means.

The major constraints that contribute to the low productivity of rice in Kerala are:

i. Rice is cultivated in Kerala under varying condition such as in modan lands, waterlogged and flooded areas, high altitude areas, coastal saline areas etc. These areas, differing in agro-ecological conditions, pose peculiar location-specific problems which come in the way of increasing productivity at economically feasible levels of investment.

ii. Eventhough the annual rainfall in the State is fairly good, its uneven distribution poses certain problems. For example, the first crop of paddy (*Virippu*) suffers from drought in its early stages and floods in its middle or later stages, since the South-West monsoon is concentrated in June and July. Similarly, the

second crop *(Mundakan)* is affected by drought in its later stages.

iii. The undulating topography of the land favours soil erosion and silting up of the natural drains and water sources. Further, toxic proportions of iron and aluminium salts are washed into the low lying rice fields.

iv. High cost of cultivation, low labour productivity and frequent labour problems make rice cultivation less remunerative.

v. About 36 per cent of the gross area under paddy is irrigated according to reported figures. Yet, much need to be done by way of command area

Table 17: Area ('000 ha), production ('000 tonnes) and productivity (kg/ha) of major crops of Kerala (1975-76 to 1987-88)

Crop		1975-76	1980-81	1984-85	1985-86	1987-88
Rice	Area	876	802	730	678	604
	Production	1339	1272	1256	1173	1032
	Productivity	1520	1587	1719	1729	1709
Coconut	Area	693	651	687	687	706
	Production (b)	3439	3296	3453	3149	3173
	Productivity (c)	4963	4617	5023	4584	4494
Tapioca	Area	327	245	217	215	179
	Production	5390	4061	3694	3463	3181
	Producivity	16491	16575	17047	16106	17747
Pepper	Area	108	108	106	106	128
	Production	25	29	17	29	30
	Productivity	227	263	161	274	236
Rubber (d)	Area	205	247	312	326	347
	Production	129	140	172	184	202
	Productivity	768	780	890	879	N. A.
Arecanut	Area	77	61	57	57	60
	Production (b)	13387	10805	9269	5033	5538
	Productivity (c)	174719	176437	162914	88293	92300
Cashew	Area	109	141	137	137	144
	Production	122	82	72	73	71
	Productivity	1122	579	527	533	496
Tea (d)	Area	N. A.	36	35	N. A.	34
	Production	46	51	56	53	50
	Productivity	N. A.	1402	1608	N. A.	1453
Coffee (d)	Area	N. A.	58	64	N. A.	65
	Production	18	24	43	24	23
	Productivity	N. A.	406	672	N. A.	581

Note: (a) Figures for 1985-86 are provisional
(b) Million nuts
(c) Nuts/ha
(d) Commodity board estimates

Source : Directorate of Economics and Statistics, Government of Kerala, Trivandrum

development for effective utilisation of the irrigation potential created.

vi The consumption of fertilisers in the State is quite low. On an average, the quantity of inorganic manures used by cultivators growing HYV is 50.6 kg/ha, whereas for traditional varieties it is only 23.0 kg/ha. With respect to NPK, the consumption amounts to 6.7 kg nitrogen, 1.5 kg phosphorus and 4.3 kg potash per hectare for traditional varieties of rice. The doses of fertilisers for HYV and local varieties according to the recommended package of practices are 90 kg nitrogen, 45 kg phosphorus and 45 kg potash per hectare and 40 kg nitrogen, 20 kg phosphorus and 20 kg potash per hectare, respectively.

To reduce the gap between internal requirement and production, the following measures should be considered:

Increase the coverage of HYV in the different seasons.

Bring more area under *punja* crop (summer) [Irrigation is a major constraint here and to tackle this, ground water resources have to be exploited].

Increase productivity in areas where it is relatively low now and thus bring down the gaps in productivity. Ensure optimum fertiliser use.

1.9.2 Coconut

India is the third largest producer of coconut in the World. The country with 1.1 million hectares under the crop, accounts for nearly 1/8th of the area under coconut in the World. Kerala has nearly 7.96 lakh hectares under coconut cultivation (1987-88).

The production in 1975-76 was 3439 million nuts while it was 3173 million nuts in 1987-88. The productivity has decreased from 4963 nuts/ha to 4494 nuts/ha during the period. Thus although area increased over the period, production declined possibly due to the decline in productivity. The incidence of root wilt disease, extending cultivation to marginal and unproductive lands, sub-optimal levels of input use, unscientific underplanting in existing stands causing overcrowding of palms, inadequate management practices, unfavourable seasonal conditions, inferior genetic base of the cultivars, incidence of pests and diseases, have all contributed to the poor yield.

Coconut is mostly grown in the homesteads and small farms in Kerala. There are about 2.5 million holdings, with an estimated total of 170 million coconut palms, the palm density being 229/ha.

The rural economy of Kerala is closely linked with coconut. It contributes 15 per cent of the annual income of the State. Besides copra and oil, coir and toddy are two other important products of coconut. Export earnings from coir products is around Rs. 130 crores/year.

Coconut is grown in a wide range of soil types. It is mainly a rainfed crop. In high rainfall areas like North Kerala, the dry spell of five to six months affects the growth and productivity of the palms. Irrigation during dry months not only increases the yield of coconut by as much as 50 to 100 per cent; but also ensures stability in production.

There are only two distinct "varieties" in coconut, the tall and the dwarf. The tall, popularly known as West Coast Tall (WCT) occupies most of the area. The dwarf varieties are not cultivated commercially. The hybrids involving tall and dwarf as the parents are popular with the farmers; but they occupy only a small area at present. The root (wilt) disease of

coconut is the major disease which has spread over the entire southern and central parts of Kerala. No preventive/ control methods have been evolved yet.

Three new hybrids Kera Ganga, Laksha Ganga and Ananda Ganga have been released in the State in addition to the earlier hybrid, T X D.

1.9.3 Tapioca

Tapioca (cassava) is a crop of great economic significance to Kerala. It easily fits into the cropping systems prevailing in the State. In spite of this fact, the area and production of tapioca are decreasing at a faster rate. In 1975-76, the total area under cultivation of tapioca was 3.27 lakh ha, whereas in 1987-88 it plumated to 1.79 lakh ha. The production of tapioca also came down by about 31 per cent during the decade 1975-1985 From 53.9 lakh tonnes in 1975-76, the total production came down to 31.81 lakh tonnes in 1987-88. However, the productivity increased from 16,491 kg/ha in 1975-76, to 17,747 kg/ha in 1987-88. Considering the biological and calorific yield, tapioca yields much more than rice from a unit area with less effort and cost. Tapioca is an important staple food, along with fish for the weaker sections in Kerala.

Tapioca is an essential raw material for industries. The starch extracted from cassava is used in the textile industry. Dextrin, a degradation product of starch, is used in the manufacture of dry cell batteries as a stabiliser, binder and adhesive. Sago, dextrose, glucose, fine spirit, alcohol etc. are the other products made out of tapioca flour. Tapioca chips form a major component of cattle, poultry and pig feeds. The major production constraints in the cultivation of tapioca are:

i) Cultivation of low yielding varieties
ii) Slow adoption of modern production technology and lack of awareness of improved package of practices
iii) An uncertain market and fluctuation in price
iv) Poor avenues of alternate use of the produce

1.9.4 Pepper

Pepper is an important export-oriented commodity. Besides being an export earner it provides reasonable returns to the grower and is a crop of the small grower. Now-a-days plantation companies are showing interest in pepper as a companion crop. The area under its cultivation in the State increased from 103,000ha 1975-76 to 1,28,000 ha in 1987-88. The production increased from 25,000 tonnes in 1975-76 to 30,000 tonnes in 1987-88. Similarly productivity recorded marginal increase from 227 kg/ha in 1975-76 to 236 kg/ha in 1987-88. The productivity of pepper in the State is very low when compared with those in the major producing countries. So to face competition in the international market, the domestic productivity has to be increased substantially.

Pepper is essentially a tropical crop. It grows best in deep, well-drained, virgin soil, rich in humus. The crop is vegetatively propagated by means of rooted vine cuttings. When grown as a pure crop, there should be about 1100 vines (standards) in one hectare. The cultivation system followed in pepper even today is largely traditional. Though it is a perennial crop, pepper plantations require planting and underplanting at regular intervals to replace the old, diseased and damaged pepper vines around each standard. Systematic manuring and plant protection are not

practiced by the farmers which is one of the major reasons for the low productivity.

The hybrid Panniyur-1, an early bearing high yielding variety, is becoming popular in the State. The other promising varieties are Karimunda, Kalluvally and Kottanadan. Recently, the Kerala Agricultural University has released three more promising varieties.

1.9.5 Rubber

Rubber is the one crop which has registered substantial increaes in area by about 1.40 lakh hectares over the period 1975-76 to 1987-88, an increase of about 67.6 per cent. In 1987-88, the total area under rubber was 3.47 lakh ha. The total production of rubber also increased over the period, from 1.29 lakh tonnes in 1975-76, to 2.35 lakh tonnes in 1987-88. The productivity increased from 768kg/ha in 1975-76 to 879 kg/ha of tappable area in 1985-86. Hence, it is because of the increase in area, the production of rubber has increased in the State. The replacement of other crops by rubber is obvious. Coconut, cashew and tapioca appear to be the crops replaced by rubber. Probably this may be due to favourable land policy and price situation. The present trend of decreased production in coconut and the attractive returns from rubber are bound to alter the land use pattern in favour of rubber in the remaining areas as well.

1.9.6 Cashew

During the period 1975-1988, the area increased from 109 lakh ha to 144 lakh an increase of about 32 per cent. But, inspite of the increase in area, it is disappointing to note that the production decreased by about 55 per cent during the period. From 1.22 lakh tonnes in 1975-76, the production came down 0.71 lakh tonnes in 1987-88. Adverse weather conditions might be the reason for low levels of production.

The domestic production of raw nuts in the state is far short of demands from processing industries. The raw nut exporting countries are now-a-days resorting to value addition by establishing processing industries to further their export earnings. So there is an urgent need to increase the domestic production through all possible means. As there is no scope of further increase in area under cashew, the emphasis should be on increasing the productivity through better management practices. It is estimated that about 3 per cent of the loss in production could be made up if timely plant protection measures are resorted to.

1.9.7. Arecanut

The area under arecanut has decreased during the period 1975-88. In 1975-76 the total area under arecanut was 0.77 lakh ha whereas in 1987-88 it was only 0.60 lakh ha. The production and productivity have also come down. In 1975-76, the production was 13,387 million nuts whereas in 1987-88 it was 5,538 million nuts, a reduction of 58 per cent. The productivity declined by 47 percent from 1,74,719 nuts/ha in 1975-76 to 92,300 nuts/ha in 1987-88. The drought and other adverse weather conditions might have adversely influenced this crop to such an extent.

1.9.8. Tea

Kerala accounts for 9.5 per cent of tea production in India. The total area under tea was 34,000 ha in 1986-87 and the production, 50,000 tonnes. The productivity reached the highest level in 1984-85 with 1608 kg/ha, but declined to 1453 kg/ha in 1986-87. Since this is mainly a perennial plantation crop, the area adjustments are not possible in the short-run and hence there is no drastic change in area over the years.

1.9.9. Coffee

Coffee is also a commercial plantation crop cultivated in the hilly tracts of the state. The area under coffee in 1986-87 was 65,000 ha. The production of coffee increased from 18,000 tonnes in 1975-76 to 23,000 tonnes in 1986-87. The productivity figures indicated a rise from 406 kg/ha in 1980-81 to 672 kg/ha in 1984-85 which then declined to 581 kg/ha in 1986-87. Such year to year changes in productivity of coffee is not due to a secular trend but possibly due to changes in weather conditions, particularly rainfall during a pre and post-blossom periods.

1.10. Livestock

1.10.1. General status

According to the thirteenth quinquennial livestock census of 1982, Kerala had 56.44 lakh livestock (Fig. 11) and 151 lakh poultry population. There was an increase bf 3.25 lakh (6.12 per cent) livestock and 16.94 lakh (12.65 per cent) poultry over the 1977 census. The district-wise details are given in Annexure 31.

The livestock population was the highest in Quilon district (12.07 per cent) where as the poultry population was the highest in Malappuram district (11.09 per cent) The district with the lowest percentage of both livestock and poultry was Waynad. The district-wise distribution of the major species of livestock and poultry in 1982 is given in Annexure 32. The districts with the largest and the smallest numbers are shown in Table 18.

The changes in the population of the major species of livestock between the consus years 1966 and 1982 are as shown in Annexure 33. Population of buffaloes and other live stock (of which pigs formed the bulk) declined during 1982, whereas cattle and goats showed notable increases over the years. The densities (number per km^2) of livestock and poultry population in each district have been indicated in Annexures 34 to 36. The districts with the highest and the lowest density are given in Table 19.

Idukki district had the lowest density of all the major species of livestock and poultry. The dominance of Alleppey with regard to the overall livestock and poultry population is due to the very high density of cattle and ducks in the district. The density of goats increased in all the districts during the period 1977-1982

Table 18. Dtstricts with the largest and smallest numbers of livestock and poultry in Kerala

Species of livestock/ poultry	Districts with	
	Largest number	Smallest numbers
Cattle	Quilon	Waynad
Baffalo	Palghat	Kozhikode
Goat	Quilon	Waynad
Pig	Kottayam	Malappuram
Fowl	Malappuram	Waynad
Duck	Alleppey	Waynad
Total livestock	Quilon	Waynad
Total poultry	Malappuram	Waynad

Fig.11.

MAP OF KERALA
LIVESTOCK

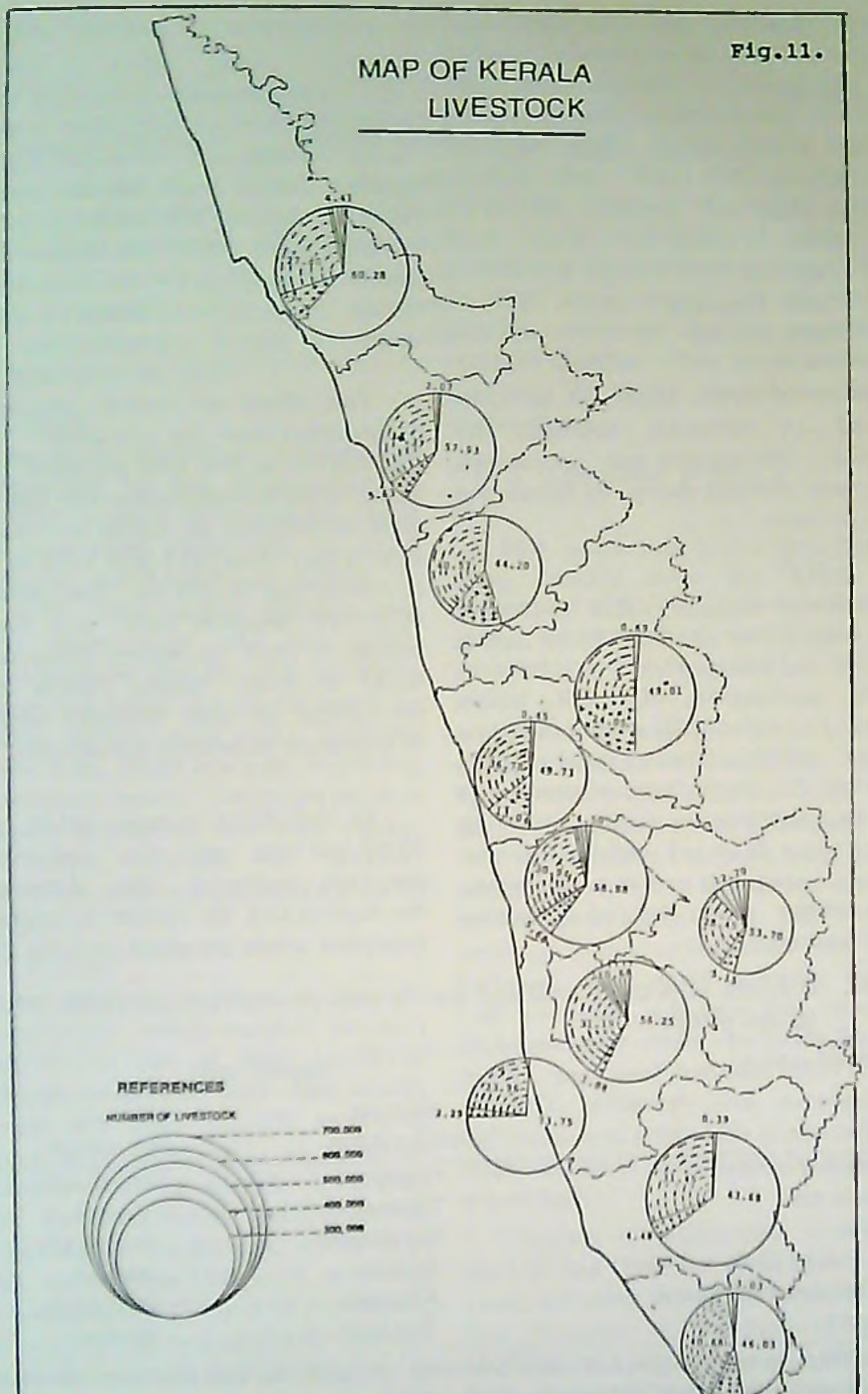


Table 19. Districts with the highest and the lowest density of livestock and poultry (1982)

Species	Districts with	
	Highest density	Lowest density
Cattle	Alleppey	Idukki
Buffalo	Palghat	Idukki
Goat	Trivandrum	Idukki
Pig	Kottayam	—
Total livestock	Alleppey	Idukki
Total poultry	Alleppey	Idukki

Distribution of ducks seems to be concentrated in Alleppey, followed by Ernakulam. The lagoons and backwaters in the two districts seem to favour the rearing of ducks.

1.10.2 Cattle

The distribution of cattle according to age groups, over the four census years from 1966 to 1982 is shown in Annexure 37. The population of adult males declined by about half during the last 15 years which indicates their non-availability for agricultural purposes. It should be noted that the number of young males (3 years & under) remained almost stationary during this period whereas the number of the young and adult female cattle increased.

The effect of cattle improvement programmes can be observed in the distribution of desi and improved (mostly exotic cross breeds) cattle. The age group-wise distribution of cattle between the two census years 1977 and 1982 is shown in Annexures 38 and 39. The proportion of 55:45 between desi and improved breeds in 1977 increased marginally to 53:47 in 1982. Among female calves, the number of desi declined while that of improved increased appreciably.

In the State, among adult males, 92.37 per cent was desi and only 7.63 per cent, improved. The districts with the highest and the lowest percentage of improved cattle are given in Table 20.

Table 20. Districts with the highest and the lowest percentages of cattle according to age groups

Category of cattle	District with	
	Highest percentage	Lowest percentage
Males over 3 years	Kottayam	Ernakulam
Females in milk	Trivandrum	Wynad
Dry cows	Trivandrum	Kozhikode
Female calves (below 1 year)	Quilon	Wynad
Young females (1-3 years)	Alleppey	Kozhikode
Total cattle	Trivandrum	Wynad

Thus, in the progress of cross-breeding programme, the southern districts are far ahead than the central and northern districts.

1.10.3 Buffaloes

Unlike in cattle, adult males in buffaloes outnumber adult females, indicating the preference of male buffaloes for draught purposes. The buffalo population declined by about 47,000 (10 per cent) during 1977-1982 period, as seen from Annexure 40. While there was a decline in male and female adult buffaloes, there was a substantial increase of about 23 per cent in young female buffaloes (under three years of age).

1.10.4 Goats

Although no intensive scheme has been launched for the development of goats, their number increased by about 19 per cent, from 16.83 lakh to 20.04 lakh during 1977-1982 as shown in Annexure 41. The largest increase was in adult male goats (42 per cent), followed by young females (18 per cent). It appears that goats are raised more for the supply of meat than milk. Concrete steps are to be taken towards improving meat yield from goats. Goats are more or less evenly distributed, but their density varied widely between the districts, from 85 to 20, with a State average of 52 per sq. km.

1.10.5 Poultry

The principal species of poultry are fowls and ducks which together account for over 99 per cent of total poultry of 150.83 lakh (Annexure 42). The poultry population has been steadily increasing and there was an increase of 12.66 per cent during 1977-82 period. It is seen that the density of fowls varied from 732 to 110 between the districts, while that of duck varied from 109 to 1, with the State averages of 374 and 14 per sq. km, respectively for the two species. District-wise distribution of poultry is given in Annexures 43 and 44. Among the total fowls in the State, 54.78 per cent belongs to the improved breeds. Malappuram had the largest number of improved fowls (10.81 per cent) and Waynad, the lowest (2.42 per cent). In the case of improved poultry also, the districts South of Ernakulam together had larger numbers. Thus, as in the case of cattle; more accelerated development of poultry appears to have taken place in the southern districts compared to the central and northern districts. Few development programmes for ducks have been initiated in the State.

1.10.6 Livestock products

Milk

Milk production in the State has been rising steadily over the years. Total quantity of milk increased from 7.78 lakh tonnes in 1977-78 to 10.78 lakh tonnes in 1982-83. The production and per capita availability of milk are given in Annexures 45 and 46. It is also seen that milk production in the State increased by 9.29 lakh tonnes (420 per cent) during the two decades between 1964 and 1984. This has enabled the per capita per day availability of milk to increase from 30 g to 117 g, an increase of 290 per cent. Looking at the contribution from cows, buffaloes and goats towards the total milk produced, it is seen that cows have increased their share from 80.2 per cent to 83.1 per cent between 1977-78 and 1982-83. Although the supplies from buffaloes and goats also increased, their share declined by 2.2 and 0.56 per cent, respectively.

Turning to productivity, the per day yield of the species improved over the years, including that of non-descript cows. The increase in productivity between 1977-78 and 1982-83 was 18.91 per cent, 1.79 per cent, 16.46 per cent and 8.35

per cent for the cross bred cow, non-descript cows, buffaloes and goats, respectively. The cross-breeding programme has had its contribution in the yield of cross-bred cows. It is, however, interesting to note that, in spite of the lack of developmental efforts, the yield of buffaloes showed appreciable increase in the five-year period. Milk production in the State during 1983-84 was 3.17 per cent of that of the Country as indicated in Annexure 47.

Eggs

The production of eggs in the State during 1983-84 was estimated to be 1260 million. There was an increase of 978 million eggs or 347 per cent, during the past two decades from 1964 to 1984. This increase has resulted in the per capita availability per year from 15 eggs to 47 eggs, an increase of 213 per cent.

Large quantities of eggs are being transported to the State from the neighbouring states by rail as well as by road. The number of eggs transported by rail was 95.82 lakhs in 1984 and that by road was 1737 lakhs, making a total of 1832.82 lakhs, 14.55 per cent of the production (Annexure 48). This indicates the large demand for eggs in the State and the scope for improving poultry production.

Broiler chicken meat

Another expanding area where there is considerable scope for development and research activities, is broiler chicken production. The 1982 census showed 1.11 lakh broiler chicken in the State. This is a very low figure compared to the development observed. It is true that no effort has yet been made to assess the potential of broiler chicken and to put the industry on scientific footing, although some appreciable growth has taken place. Similarly, attempts have to be made to estimate the production of poultry meat (including broiler meat) in the State, as is done in the case of meat from large and small animals slaughtered.

Meat

Meat production in the State has been steadily rising and was 22,505 tonnes in 1984 (Annexure 49). The estimated meat production in the State during 1977-78 was 16,200 tonnes. The figures indicate that these estimates are underestimates, as the reporting of slaughter statistics is far from satisfactory. In the estimated meat production for 1984, the share of bovines (cattle and buffaloes) was 80.67 per cent while that of goat and sheep was 15.58 per cent, the balance of 3.75 per cent being the share of pigs. Thus, the bulk of the meat consumed in the State is beaf.

The production of this large quantity of beaf was made possible primarily through large scale transport of cattle and buffaloes from the neighbouring states. As much as 6.96 lakh bovines were brought during 1983-84 (Annexure 50). There has been no effort for developing meat animals. The consumption of pork is quite small; but there are piggery development programmes. Hence, there is a larger scope of meat production in the State. Efforts are to be put in this direction (Annexures 51and 52).

Other products

There has been very little attempt at harnessing major byproducts from the livestock sector, particularly those from slaughtered animals. Although hides and skin are salvaged, much of the bones and tissues are not made use of efficiently. Similarly, the potential for the manufacture of milk-based products has not been sufficiently tapped. The scope of the livestock sector to provide considerable

employment opportunities through livestock-based and allied industries has not been realised. Research and development efforts are needed to put the use of livestock products and by-products on scientific lines to cater to the growing consumer demand.

1.10.7 Fisheries

Kerala ranks first in India in fish production. In the year 1984-85. Kerala's marine fish production was 4,26.600 tonnes. Not only in fish production but in fish consumption also, Kerala is ahead of the other states. As per the estimates of 1971, the per capita fish consumption in Kerala was 19.57 kg against a national average of 3.91 kg. The presently exploited fishery wealth accounted for 3.5 per cent of the total income of the State. Twenty per cent of the total export of Kerala is accounted by the fisheries section. Almost 50 per cent of the earning of India through the export of fishery products is contributed by Kerala. In spite of all these, it is a fact the state is unable to meet the domestic demand for fish in full and the gap is filled through imports from the neighbouring States of Tamil Nadu and Karnataka.

The fisheries sector can divided into the marine and inland sectors. Kerala has a coast line of 580 km, with 38,000sq. km area suitable for exploitation. The State has also got 3,55,000 ha of inland water bodies. Thus, potentially Kerala's fisheries sector is one of the richest in the Country. While the State is leading in marine fish production, it is far behind in inland fish production. When Kerala produced 3.8 lakh tonnes of marine fish in the year 1983 contributing to 24.5 per cent of the Country's total marine fish production, it produced 27,011 tonnes of Marine fish, forming only 2.7 per cent of the total inland production of the Country. In the availability of area of inland water, Kerala ranked fifth, while in inland fish production, its position was 10th only. The total fish production potential of the State is estimated to be 12 lakh tonnes. There is ample scope to increase the present marine production by three times and the inland production, by eight times.

1.10.8 Fishing population

According to the census conducted by the Department of Fisheries in 1979, Kerala has a traditional fishermen population of 7,78,883 distributed in 1,18 801 households. This works out to 3.0 per cent of the State's population and 14 per cent of the fishermen population of India, although the State has only 8.0 per cent of India's coast line and 0.7 per cent of India's land area. There are 416 fishing villages in the State, of which 249 are marine and the rest inland. About 35076 fishing boats are operated in the State, including both mechanised and non-mechanised. Of the total Kerala fisherman population, 6,02 467 are marine fishermen and 1,76,416 are inland fishermen. The proportion of women directly involved in fishing is only 1.7 per cent and all of them are employed in the inland sector. The important fishing communities are the Mopilla, Araya, Thiyya, Kukkava, Mogua, Krakka and Valan. Distribution of traditional fishermen households by religion is given in Table 21.

Nine districts of the State have sea coast. The three southern coastal districts, Trivandrum, Alleppey and Ernakulam account for 48 per cent of the fishermen population.

No statistics are available about the fishermen outside the traditional fishing communities, eventhough they operate more mechanised boats and dominate the scene of fish culture.

The income groups of the fishermen as per the 1979 census are shown in Table 22.

Table 21. Religion-wise distribution (%) of fishermen in Kerala

Sector	Religion		
	Hindus	Muslims	Christians
Marine	32.9	29.9	37.2
Inland	59.7	11.4	28.9
Total	39.3	22.5	35.2

Table 22. Percentage distribution of income groups of fishermen

Income groups (Rs. per annum)	Percentage of households
Below 500	11.7
Between 500 and 1000	38.8
Between 1000 and 2000	38.6
Between 2000 and 3000	7.8
Above 3000	3.1

Besides fishing, which forms the main occupation, 3.63 per cent of the fishermen population is engaged in marketing of fish, 0.37 per cent in Government services, 0.46 per cent in Agriculture and 2.73 per cent in other activities, mostly as casual labourers. Nearly 65 per cent of the males and 59 per cent of the females of the fishing community are literate, which is the highest among the fishermen in India and even compares well with the overall literacy rate of the State. The 1979 census show that about 10 per cent of the traditional fisherman of Kerala still do not own any land. Out of 1,18,801 families. 80.4 per cent have their own houses, 4.5 per cent live in rented houses and 15.1 per cent do not have a house. Ninety per cent of the fishermen houses are not electrified. Out of the more than one lakh houses occupied by fishermen, only 6064 have lavatory facilities. Sixty seven per cent of the families do not have drinking water in the ward in which they live.

1.10.9 Fishery development programmes and agencies in the State

Fisheries development in Kerala has witnessed three distinct phases of which the first phase began in 1952 and continued upto 1977-78. During this period, efforts were mainly concentrated on developing mechanised fishing, mechanised processing and fishing harbour facilities. By mid 70's development in the mechanised sector had reached its peak.

During the second phase from 1978 to 1983-84 the State witnessed the process of transition, providing the infrastructure basis for concentrating on the developmental process in favour of the traditional sector. The Kerala Marine Fisheries Regulation Act 1980, the Kerala Fishermen Welfare Societies Act 1980 and Babu Paul Commission Report 1982 were the constituent characteristics of this phase.

The seventh plan beginning from 1985-86 marks the third phase in the field of fisheries development, the main aim being development of policies in favour of the traditional sector. The attempt is to provide means of production to the actual producers and to augment the total fish production and the income of the traditional fishermen through a multipronged strategy of modernisation of the country craft, supply of improved gears, modern beach landing crafts, research and development support for technology to craft/gear mix with World Bank assistance. There is a programme for promoting aquaculture for the benefit of traditional fishermen in the inland sector.

Fisheries activities can be grouped as education, research, development, extension and training. Of these, education and research are now mainly under the Kerala Agricultural University, while the other activities are carried out by the Department of Fisheries and its sister organisation, the "Matsyafed".

Fisheries Department

Fisheries development in Kerala is primarily the function of the Department of Fisheries. Under the Department, there are five Fishermen Training Centres, one each at Vizhinjam, Neendakara, Ernakulam, Beypore and Cannanore. In addition, at Thevara, Chavakad, Thanur and Beypore there are Regional Fisheries Technical High Schools (RFTHS). Three more RFTHS have been sanctioned, one each at Alleppey, Cannanore and Quilon.

For the development of fish culture in freshwater tanks, the Fish Farmers' Development Agency, with central assistance is working in the districts of Palghat, Trichur and Quilon. Under the Fisheries Department, there are seven brackishwater fish farms, one each at Aayiramthengu, Arattupuzha Narakkal, Malippuram, Edakochi, Kadappuram and Eranoli. In addition, a Central Farm has been started in Poyya in Trichur district with central assistance. There is a Pilot Shrimp Hatchery at Azhikode. The freshwater fish farms under the Department are at Malampuzha and Pannivelichira. Four freshwater farms have been sanctioned one each at Polachira, Parappanangadi, Alwaye and Pallom.

Matsyafed

In Kerala, there are three corporations for the development of fisheries, the Kerala Inland Fisheries Development Corporation, the Kerala Fisheries Corporation and the Kerala Fishermen's Welfare Corporation. Recently, these three have been amalgamated to form an apex body called the State Co-operative Federation for Fisheries Development (Matsyafed). its key role in the development of traditional fisheries sector will involve providing adequate credit flow, chalking out a programme to provide intermediate technology, providing the basic infrastructural facilities at grass root level for better processing and marketing to ensure higher returns to fishermen, designing specific welfare programmes such as housing, subsidy for outboard engines etc. for traditional fishermen. initiating schemes for extensive development of inland fish culture and chalking out programmes to tap deep sea resources.

Under the Federation, there are four Ice Freezing Plants at Cannanore, Calicut Cochin and Neendakara, one Nylon Net Factory at Cochin and one Cold Storage Plant at Azhikode. The Federation is implementing several schemes for the development of inland fisheries. The important ones are the collection and distribution of brackishwater fish seed,

brackishwater fish culture demonstration farms at Narakkal and Malipparam, fishery development of Vazhani reservoir and the brackishwater fish and prawn culture farm at Poothotta. The Federation is also carrying out several projects towards the welfare of fishermen.

Kerala Agricultural University

As per the Kerala Agricultural University Act, 1972, Fisheries Education comes under the purview of the University. A Fisheries College was started during the academic year 1979-80, with the approval of ICAR and the Government of Kerala. The College is established for imparting education and practical training in the different aspects of fisheries, in order to produce the much needed professional graduates and post graduates in fisheries. Training of para-technical staff and inservice personnel engaged in development programmes is also envisaged. It is intended to develop, through research, viable technologies for the commercial cultivation of fin-fishes and shell-fishes; for the mixed farming of crops, livestock and fish, and for the large scale hatchery production of fish and prawn seeds. Studies are also envisaged in the fields of Fishery Biology, Ecology, Processing, Craft and Gear Technology, Fishery Engineering and Fishery Management. The research results of practical utility are to be transferred to the fish farmers and the fishermen through extension education. The College offers a four-year Bachelor degree in Fishery Science with an intake capacity of 20 per batch. It also offers a post-graduate degree, M. F. Sc. (Aquaculture), with an admission strength of four.

The University has also got brackishwater fisheries research units at Vyttila and Puduveypu and freshwater fisheries research units at Kumarakom, Moncompu and Vellayani.

In addition to the above, post-graduate courses of two year's duration in Marine Biology and Industrial Fisheries under the Kerala University and in Mariculture under the Cochin University, in Aquatic Biology and Fisheries under the Kerala University and in Mariculture under the Central Marine Fisherie Research Institute are also being offered in the State.

Other organisations

The following central organisations concerned with the development of fisheries are also functioning in the State.

Central Marine Fisheries Research Institute (ICAR)

With its headquarters at Cochin, the CMFRI is mainly concerned with research for the development of the marine fisheries. It has got two research centres, one at Calicut and the other at Vizhinjam. The Institute has a prawn hatchery, a brackishwater farm and a Krishi Vigyan Kendra at Narakkal.

Central Institute of Fisheries Technology (ICAR)

The CIFT is carrying out research in the fields of fishing, fish storage and processing. The headquarters of the Institute is at Cochin. The Institute has a research centre at Calicut.

Marine Products Export Development Authority (Government of India)

This organisation is mainly concerned with export-promotion of marine products. The headquarters of the Authority is at Cochin and it is constructing a prawn hatchery at Vallarpadam.

Integrated Fisheries Project (Government of India)

Formerly known as the Indo-Norvegian Project, it is a fishing complex devoted to the study of fishing, fish storage and fish marketing. Its headquarters is at Cochin and has a unit at Cannanore.

Fishery Survey of India (Government of India)

With its headquarters at New Delhi, the Fishery Survey of India has a Regional Centre at Cochin. Its main objective is to study the various aspects of deep sea fishing.

Central Institute of Fisheries Nautical Engineering and Training (Government of India)

The Institute is located at Cochin. Its main function is to conduct training courses in fishing technology.

Export Inspection Agency (Government of India)

The Agency functions at Cochin with the objective of controlling the quality of marine products for export.

1.10.10 Constraints in fish production

Although Kerala is the foremost State in India in marine fish production, it lags far behind in inland fish production. The fisheries developmental activities in the State were concentrated in the marine sector, which naturally resulted in the staggering of the inland sector. Eighty five per cent of the available inland water resources are either under-utilised or not utilised at all. If these potentially rich resources are brought under scientific fishery management, they can give a big boost to fish production in the State and the related socio-economic aspects. As such, development of inland fisheries should be given top priority in the future planning for fishery development in the State. The major constraints in the development of this sector are:

i) Insufficiency of the stocking material
ii) Feed
iii) The acidic conditions of the fields
iv) High capital investment required for the conversion of the marshy areas into fish farms

1.10.11 Future activities

The natural resources of Kerala offer immense scope for increasing the fish production. In the marine sector, by intensifying fishing in the pelagic area and by the proper exploitation of the deep-sea and off-shore area, a significant increase in the fish harvest can be expected. Fifty per cent of the available 2,42,800 ha of brackishwater area is amenable for fish culture. At a moderate estimate of 1.0 ton/ha/year, it can yield 1,21,400 tonnes of fish annually against the present yield of 16,000 tonnes.

Kerala is perhaps the least developed of the Indian states in the matter of fresh water fisheries for special reasons of her own. The potential resources of the State include 44 rivers with a total length of 3,200 km and a maximum water-spread area of 85,000 ha, 600 km of irrigation canals, 24 reservoirs with a waterspread area of 24,137 ha, 50,00,000 ha of irrigated paddy fields, 3,300 ha of ponds and tanks, and a negligible area under fish farm. If brought under scientific management, the freshwater resources can yield 2,66,160 tonnes of fish per annum.

The State's proposal for the VII Plan has gone into greater details of the fisheries sector considering it as an employment generating sector. The proposed outlay for the VII Plan is 65 crores (Annexure 53) against that of 2000 crores in the VI Plan. The main projects proposed in the fisheries sector during the VII Plan are (i) establishment of fresh and brackishwater fish farms, (ii) riverine fish culture, cage and pen culture, fish culture in ponds, tanks and paddy fields, culture of air breathing fishes, (iii) trout culture, (iv) insurance cover to fish farmers, (v) establishment of a fish feed production unit, (vi) establishment of laboratories and strengthening of the survey unit, (vii) patrolling the

backwaters, (viii) establishment of fishing harbours and landing facilities (ix) organising deep-sea fishing, (x) provision of processing, preservation and marketing facilities, (xi) mechanisation and improvement of fishing crafts, establishment of service centres for outboard engines, (xii) setting up of a resource management cell, (xiii) establishment of Central Fisheries Management Technical Institute and strengthening the Regional Fisheries Technical High Schools and (xiv)providing social amenities to fishermen and strengthening the statistical Unit and the Fisheries Project Cell.

The break-up of the proposed outlay during the VII Plan for the major schemes are given in Annexure 53

1.11. Farm implements and machinery

At present in Kerala, the homestead system of cultivation with a combination of perennial and annual crops as well as the rice cultivation systems use only traditional implements developed in the State. No concerted and systematic effort has so far been made to improve these implements so as to increase their machanical efficiency and to reduce the drudgery associated with their use. This has already started casting its shadow over the various agricultural operations in the state. At a time when the demand for partial mechanization is increasing, selective farm implements and machincry are lagging behind in the requirements. The number of tractors in the state has gradually risen from a mere 400 in 1966 to 2200 in 1980 and to 3500 in 1984. Accordingly, the area cultivated using tractor has also increased.

It can also be seen that the crop production in the State is still done with indigenous implements with low efficiency. Only very few implements are at present available for majority of the important operations. Therefore, a large number of implements have to be obtained from elsewhere, tested and modified, if necessary, to suit the local requirements. Besides, a number of implements have to be developed in the State itself since the problems faced are unique and peculiar to the state of Kerala.

1.12. Agro-climatic zones

The State is divided into five agro-climatic zones taking into consideration its physiography, climate, soil characteristics, sea water intrusion, irrigation facilities, land use pattern and the recommendations of the "Committee on Agro-climatic regions and Cropping Patterns" constituted by the Government of Kerala in 1974. The zones are (i) Northern (ii) Central (iii) Southern (iv) High Range and (v) Problem Areas. A brief account of each zone follows.

1.12.1. Northern zone

This zone consists of the four northern districts of Kerala viz. Kasaragod, Cannanore, Calicut and Malappuram with 12 taluks, 39 development blocks and 295 panchayats, with a total geographical area of 10,94,600 ha. covering 28.2 per cent of the area of the State. The total population of the zone is 74.4 lakhs (1981 census), constituting 29.3 per cent of the population of the state. The percentage literacy of the zone is 64.13 as against 69.17 of the state. Agriculture is the main occupation of the people. Nearly 88 per cent of the population is engaged in farming and allied activities. The zone receives rains during both the monsoons, the South-West and North-East. The annual average rainfall for the zone is 3379 mm. Although the zone is endowed with plentiful rainfall, a prolonged dry spell of four to five months duration does occur every year from December to May. Moisture stress experienced during this period affects the growth and production of perennial crops like coconut, arecanut and pepper. Similarly, the torrential

rains during the months of June and July create crop hazards due to waterlogging. The mean maximum ond minimum temperatures of the zone are 33°C and 23°C, respectively. Westerly and North-westerly winds prevail during the South-West monsoon and easterly winds, during December to March. The maximum wind speed lies between 10 km/hr and 15 km/hr. The major types of soils in the zone are coastal alluvium, laterite and forest loam. Rice, coconut arecanut, pepper, banana, cashew and rubber are the important crops of the zone.

1.12.2. Central zone

The central zone consists of three central districts of Kerala, Palghat, Trichur and Ernakulam, excluding the high ranges, the coastal saline tracts and other isolated areas like kole lands with special soil and physiographic conditions. The zone comprises of 17 taluks, 44 development blocks and 274 panchayats. The geographical area of the zone is 9,73,689 ha covering 25 per cent of the area of the state. The total population of the zone is 70.12 lakh (1981) census) constituting 27.55 per cent of the population of the State. The number of farming families is about 3.8 lakhs. The zone is characterised by comparatively heavier rainfall during the South-West monsoon and less rainfall during the North-East monsoon period, leaving in between a dry spell of six months from December to May. The mean maximum and minimum temperatures of the zone are 31.4°C and 21.1C, respectively. The soil type is mainly laterite. The crops raised are mainly rainfed. This zone is the major rice growing tract of the state and accounts for about 50 per cent of the area under rice and 52 per cent of the production of rice in the State. Coconut, arecanut, groundnut, sesamum, pulses, banana and pineapple are the other important crops of the zone.

1.12.3 Southern zone

The southern zone comprises the districts of Trivandrum, Ouilon, Pathanamthitta, Alleppey and Kottayam with 21 taluks, 47 development blocks and 281 panchayats, with a total geographical area of 6,517 sq.km, covering 16.8 per cent of the area of the State. Total population of the zone is 74.43 lakhs, constituting 29.2 per cent of the population of the State. Nearly 15 lakhs operational holdings exist in the four districts of the zone. Out of these, 49.0 per cent is within the size-range of 0.04ha to 0.25 ha. The zone has a tropical humid climate, with an oppressive summer and plentiful seasonal rainfall. The hot season March to May is followed by the South - West monsoon from June to September. The North - East monsoon occurs from October to November. Unlike in the other zones of the State, rainfall is comparatively well distributed, with the result that the effective annual rainfall is more (80 per cent) than that in the other zones. The annual average rainfall for the zone is 2246 mm. The mean maximum and minimum temperatures of the zone are 34.06°C and 21.7°C, respectively. The soils are lateritic, the texture ranging from sand to sandy loam and clay loam. The major crops of the zone are rice, coconut, tapioca, pepper, cashew, rubber, arecanut sugarcane, pulses and banana.

1.12.4 High Range zone

This zone comprises the districts of Wayanad and Idukki, the Nelliampathy and Attappady hill ranges of Palghat district, Thannithode and Seethathode panchayats of Pathanamthitta districts, Ariyankavu, Kulathupuzha and Thenmala panchayats of Pathanapuram taluk in Quilon district and Perigamala, Aryanad and Vithura panchayats of Nedumangad taluk as well

as Kallikad and Amboori panchayats of Neyyattinkara taluk in Trivandrum district. Thus altogether, the zone comprises nine taluks, 11 development blocks and 84 panchayats, with a total geographical area of 1114067 ha covering 28.67 per cent of the area of the State. Since the districts of the zone are not contiguous, the agricultural characteristics differ widely. The features of the two districts, Wayanad and Idukki are given separately.

Wayanad Range

It is situated at an elevation ranging from 700 to 2100 m above MSL. It has three taluks, three development blocks, and 25 panchayats with a geographical area of 2,13,200 ha and having a population of 5,54,026. The entire population is rural. The scheduled caste and scheduled tribe population in the Wynad range are 21,130 and 95,557, respectively, which is 3.8 and 17.2 per cent of the total population of the district. Agriculture is the main occupation of the people. The average rainfall is 3966.6 mm. The region receives heavy rainfall during the South-West monsoon (June to September). North-East monsoon and pre-monsoon showers account for the major portion of the remaining precipitation. Dry spell occurs during December to March. The mean maximum and minimum temperatures are 29.6°C and 19.6C°, respectively. The soil type is forest loam, characterised by a surface layer of humus and other organic matter at various stages of decomposition. This region is famous for plantation crops and spices. Coffee, the most widely cultivated crop, is the main source of income to the vast majority of small farmers. Pepper, cardamom, ginger, tea, etc. are the other important crops of this region

Idukki Range

It is situated at an elevation ranging from 800 to 1100 m above MSL. There are 14 peaks which exceed a height of 2000m. Idukki district, formed in January 1972, has four taluks, eight development blocks and 51 panchayats. The geographical area of the district is 5,06,100 ha, covering 13.25 per cent of the area of the State. The population is 9,71,636 which accounts for 3.82 per cent of the population of the State (1981 census). Agriculture and animal husbandry are the main occupations of the people. The district receives both South-West and North-East monsoon rains. The average annual rainfall is 3375 mm. Very heavy rainfall occurs during the months of June, July and August, while the rainfall is very low during December to March. The western parts of the Deviculam taluk get the maximum rainfall of 5000 mm. The high range areas experience bracing cold. The period from November to January is the coldest with temperature varying between 1°C and 15°C. Mainly, two types of soils, forest loam and laterite, are seen in the district. Plantation crops like tea, cardamom and rubber are largely grown in these soils. The other important crops are coconut, arecanut, pepper, coffee, banana and vegetables

1.12.5. Special zone of Problem Areas

This zone comprises five areas, Onattukara, Kuttanad, Pokkali, Kole and Sugarcane lands spread over six districts of Kerala, Alleppey Quilon, Kottayam, Ernakulam, Trichur and Malappuram. There are 23 taluks and 39 development blocks in this zone. The details of each of the above areas are furnished below:

Onattukara

This area falls in Quilon and Alleppay districts, covering three taluks and eight development blocks, with a total geographical area of 72,550 ha. In olden days

Onattukara area was considered as the rice grannery of the erstwhile Travancore state. But recently due to various reasons it has become a problem area with low levels of production and productivity. The total population of the area is 10, 94, 432. Of this, about 77 per cent 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 area.

Kuttanad

Kuttanad area comprises the low lying lands and the backwater systems in the districts of Alleppey and Kottayam, covering 10 taluks and 16 development blocks. The backwater systems lie at a level of 1.0 to 2.5 m below MSL and are interspersed with lakes, lagoons, estuaries and marshes. The main feature of Kuttanad is that it gets flooded during the monsoons. As these areas are connected to the sea through backwater lakes, they are subjected to sea water inundation periodically. The paddy lands comprises the area reclaimed during different periods of the past from the backwater and are known as "padasekharams". These padasekharams are classified into five groups, the single crop puncha lands, the kayal lands, the karappadams, the double crop lands and the kari lands based on soil characteristics and topography. The area of each padasekharam ranges from a few hectares to above 1000 ha, owned by several cultivators

Pokkali

This area comprises the marshy areas of Ernakulam district where salt water intrusion is the problem. The total area of the region is about 8,903 ha covering four taluks and seven development blocks. The soils are acid-saline. The land is submerged during the monsoon period and is frequently disturbed by sea water inundation due to the tidal currents. Only one rice crop is raised in these fields. After November, the lands are used for prawn culture.

Kole lands

The kole area lies continuously among the coastal strip of Trichur and Malappuram districts, covering five taluks and eight development blocks with an area of 11,000 ha. The lands are reclaimed lake beds. Acidity, salinity, poor drainage and presence of toxic salts are the characteristics of this region. Only one paddy crop is generally taken. The fields are under submergence during the rest of the period.

In the case of all the above four areas, coconut and rice are the prinicipal crops. The entire area is affected by the complex disease (root wilt). Tapioca and other tubers, fruit trees, banana and vegetables are the other important crops of these areas.

Sugarcane lands

Geographically, this area lies towards the East as an ascending narraw strip of land with mountains and sea in the East and west, respectively. The soils are mainly laterite and alluvium. This region gets rainfall during both the monsoons. Heavy rainfall is received during the months of May to September. The winter during December-January is mild and dry spell occurs during February-April. Rice and sugarcane are the important crops in the low lying and submersible areas and coconut, in the plains. Tubers, condiments and spices, vegetables and banana are the other important crops. Nearly 3000-3500 ha of land are now under sugarcane cultivation.

1.13 Research Stations in the State

There are 27 Research Stations/ Centres in the State which come under the Kerala Agricultural University. These have been grouped faculty-wise into three, namely, Faculty of Agriculture, Faculty of Veterinary and Animal Sciences and Faculty of Fisheries. A brief note on these research stations is given below.

1.13.1 Research stations under the Faculty of Agriculture

1. NARP—Centre for the southern zone Regional Agrl. Research Station Vellayani

The southern zonal centre of the NARP came into being on 30-11-1981. The Special Station at Kottarakkara was started on 26-4-1986. An area of 8.96 ha of land was acquired at Sadanandapuram for this purpose. The lead function of the southern zone is to conduct research on homestead farming system and also on cassava based farming systems.

2. Coconut Research Station, Balaramapuram

This was started in 1965 by the Government of Kerala and taken over by the KAU in 1972. The location of the Station is at Kattachalkuzhy, about 3.2 km South of Balaramapuram on the Balaramapuram-Vizhinjam road. The total area is 14.13 ha. The soil is deep red loam. The entire area is under coconut. Research on all aspects of coconut, particularly the agronomic aspects, are being conducted in this centre.

3. Cropping Systems Research Centre, Karamana

This station was started in 1955 as a Model Agronomic Centre and was taken over by the KAU in 1972. The Station was renamed as the Cropping Systems Research Centre in 1983. The lead function of the Station is to carry out studies on all aspects of rice-based cropping systems under the AICARP. The Station is located 3.0 km from Trivandrum Central Railway Station, at an altitude of 29 m above MSL. The soil is sandy loam. Total area of the farm is 7.29 ha.

4. NARP-Centre for the zone of Problem Areas—Regional Agrl. Research Station, Kumarakom

This was started in 1947 with the financial aid of the Indian Central Coconut Committee in an area of 23.26 ha leased out from Mr. Baker. This land was acquired by the Government of Kerala in 1958 and was taken over by the KAU in 1972. An area of 21.5 ha (State Seed Farm) was transferred to the Station in 1980. The Station was upgraded as the Regional Agricultural Research Station in 1982.

The farm is situated 17 km West of Kottayam on the Kottayam—Vechoor road, at an altitude of 0.6 m above MSL. The soil is alluvial clay. The total area of the farm is 45.11 ha, out of which 23.61 ha are reclaimed garden lands and 21.50 ha, wet lands. The wet lands are put under rice-fish culture. The garden lands are under coconut.

The lead function of the Station is to conduct research on coconut diseases and integrated crop livestock-fish farming. The verification functions include rice in Kayal areas.

5. Rice Research Station, Kayamkulam

The Station was started in 1939 under the Travancore University. This was taken

over by the Department of Agriculture, Government of Kerala in 1957. Till 1962, the Station functioned on leased lands. In February 1963, 11.65 ha of land were acquired on the northern side of the Kayamkulam—Punaloor road. The KAU took over the centre in 1972. The Station is situated 1.0 km east of Kayamkulam town, at 3.05 m above MSL.

The total area of the farm is 13.85 ha, out of which 11.65 ha are under wet lands. On the wet lands, two crops of rice are taken. In the dry land, research on coconut-based farming systems is carried out. The lead functions are to conduct research on rice and rice-based farming systems for the Onattukara region.

6. Sugarcane Research Station, Thiruvalla

This was taken over from the Pampa River Factory on 20-12-75. Experiments were started under the AICRP in January 1977. The station is located at Kallungal (Nedumpuram Panchayat) on the bank of the Manimala river, 6.0 km South of Thiruvalla town. The gross area of the farm is 25.66 ha and the net are aavailable for cultivation is 21.57ha. The geographic location of the farm is 9.6°N latitude and 76.5°E longtiude, and at 25.14 m above MSL. The soil is alluvial with a mean pH of 5.5. The Kerala Agricultural University scheme for intensification of research on sugarcane was taken up in 1978-79 and this was wound up in 1995-86. The ICAR *ad hoc* project on survey and appraisal of sugarcane diseases is under implementation, since June 1983.

7. Rice Research Station, Moncompu

This centre was started in 1940 to cater to the needs of the Kuttanad region The KAU took over the Station in 1972 The location is on the northern side of the Alleppey—Changanacherry road, 12 km from Changanacherry and Alleppey. The soil is alluvial clay. The total area is 8.66ha, of which 1.73 ha is under garden lands. The lead function is to conduct research on all aspects of rice cultivation in the Kayal and Karappadam lands of Kuttanad.

8. AICRP Centre on Agrl. Drainage, Karumady

This is under operation from 1-12-'81 in farmers' fields in the Kavil Thekkumpuram Padasekharam at Karumady, with a water shed area of 88.91 ha and with a paddy area of 75.238 ha. The Centre is located 10 km away from Ambalapuzha on the Ambalapuzha - Thakazhi road. The padasekharam has alluvial kari soil with high content of organic matter. The objective of the Centre is to conduct studies on agricultural drainage under actual farming situations.

9. Rice Research Station, Vyttila

This was started in 1958 on leased lands. Land was acquired at Ponnurunny (Vyttila) in 1963. The total area of the farm is 8.91 ha of which 3.05 ha are put under fish culture. Pokkali rice experiments are conducted in an area of 2.01 ha. An area of 2.24 ha is set apart for seed multiplication. The dry land occupies 0.61 ha. The lead function is to conduct research on all aspects of pokkali rice and rice-fish farming systems.

10. NARP Centre for the Northern zone Regional Agrl. Research Station, Pilicode

Research work on coconut commenced n Kerala with the establishment of four research stations (Nileswar 1, 2, 3 and

Kasaragod) in the Kasaragod taluk of South Kanara district in 1916. Regular experimental work commenced in these stations from 1930. In 1972, when the Kerala Agricultural University came into existence, the Research Stations at Nileswar 1 and 2 were brought under the University. These stations were reorganised with the headquarters at Pilicode in the year 1981 under the National Agricultural Research Project with the objective of solving the location-specific farming problems in the northern zone of Kerala. Altogether, the Station has a land area of 56.90 ha of which 4.0 ha are wet lands and 52.90 ha. garden lands. The important crops grown are coconut (44.9 ha), rice (63.30 ha in two seasons), cashew (1.0 ha), fodder (1.10 ha) and pulses (1.5 ha).

11. Pepper Research Station, Panniyur

The Station was started in 1952-53 in Panniyur village, Taliparamba taluk in Cannanore district. With the acquisition of additional area in 1981, the total extent of the farm increased to 26.13 ha. The main crop is pepper, which at present occupies an area of about 13 ha. The other subsidiary crops are rubber, coconut, arecanut, mango and other fruit plants. Annual crops such as banana, tapioca, vegetables etc. are also raised on small scale.

12. NARP centre for the Central Zone Regional Agrl. Research Station, Pattambi

The Rice Research Station, Pattambi was established of Paddy Breeding Station in 1927, to evolve high yielding rice varieties suited to the different agro-climatic conditions of the State In 1930, the Station was converted as the Agricultural Research Station. In 1962, it became the Central Rice Research Station with Regional Centres at Mannuthy, Kayamkulam and Vyttila under the Government of Kerala. With the implementation of the NARP, the Station was re-organised as the Regional Agricultural Research Station of the central zone. The lead function of the Station is to conduct research on rice, pulses, oilseeds and rice-basnd farming systems. The Station also functions as an advanced centre for studies on laterite soil management.

The Station is located 10°N latitude and 76°E longitude and at an elevation of 25 m above MSL. The total area is 63.64 ha. The soil is laterite sandy loam. Ridges and slopes of low hills form bulk of the *modan* lands in the Station. *Palliyals* are high level terraced lands with extremely porous soil. The soil in double cropped wet land is moderately fertile and deep.

13. Aromatic and Medicinal Plants Research Station, Odakkali

The station was started in 1951 as the Lemongrass Breeding Station under the Department of Industries in the erstwhile Travancore-Cochin state and it was taken over by the Department of Agriculture as the Lemongrass Research Station in 1954. This is the only station in India where intensive studies on *Cymbopogon flexuosus* are being carried out. The Centre was taken over by the KAU in 1972. The Station is located 27 km East of Alwaye on the side of the Alwaye-Idukki road, at an elevation of 66 m above MSL. Soil is laterite. The total area of the farm is 12.4 ha.

14. Agronomic Research Station, Chalakudy

The Station was originally established by the Kerala State Department

of Agriculture in 1962 at Pariyaram, near Chalakudy to carry out studies on water requirement and cropping patterns for the irrigated areas, in two ha of leased land. The scheme was wound up in 1970. Later on, the Research Station was re-established at the present site in 1972 in an area of 8.95 ha acquired by the Department of Agriculture under the schema for conducting agronomic research in irrigated areas. The Station was taken over by the KAU in 1973 for implementing the co-ordinated project for research on water management sponsored by the ICAR. The scheme has started functioning at the present Centre from July 1975 onwards. The NARP sub-project for water management studies in the central region of Kerala was started under the technical and administrative control of this Centre from 1983-84 onwards. The station is situated on the northern side of the Chalakudy-Sholayar road, about 400 m away from the Chalakudy town. The Station is located at 10° 20' N latitude and 76° 20' E longitude at an altitude of 3.24 m above MSL. The soil is sandy loam. The total area of the farm is 8.95 ha comprising 7.05 ha of wetlands and 1.90 ha of uplands.

15. Banana Research Station, Kannara

Research on banana and pineapple was started in Kerala in 1958 at Mannuthy under a scheme financed partly by the ICAR. Since the area available was not adequate, the present site at Kannara having an area of 19.7 ha was acquired in 1963 and the scheme was shifted from Mannuthy to Kannara. The Station is located 3.0 km West of Kannara at Marakkal. The geographical location is at 10° 05' N latitude and 76° 17' E longitude, at an elevation of 55.60 m above MSL. The soil is laterite loam and alluvial in some pockets. In 1970, the All India Co-ordinated Fruit Improvement Project was sanctioned and the research programmes on banana and pineapple under the project were brought under the Banana Research Station, Kannara. In 1974, the venue of pineapple research was shifted to Vellanikkara, in an area of 7.0 ha.

The major objectives are to improve the varieties of banana and pineapple by introduction, selection and hybridisation, to standardise the management practices and to find out suitable control measures for the pests and diseases of these crops.

16. Cashew Research Station, Madakkathara

This Centre was started on 18.2.1972 to carry out investigations under the All India Co-ordinated Research Project on Cashew and Spices. The Multi-State Cashew Research Project started functioning in the Centre on 15.2.1982. The total area of the Station is 18 ha of which about 7.0 ha is under experiments.

17. Agricultural Research Station, Mannuthy and Instructional Farm, Vellanikkara

This Station was originally established during 1957 as the Rice Research Station, Mannuthy in the then Central Farm, as a separate research unit to study the various problems confronting rice cultivation in the middle lateritic region of Trichur and Ernakulam districts. The Station was taken over by the KAU from the Department of Agriculture in 1972. In the year 1976, this Station was converted as the Research Station and Instructional Farm of the College of Horticulture. The Station is

located at Mannuthy by the side of the National Highway (NH 47), at a distance of 6.0 km East of Trichur at 10° 22' N Latitude and 76° 16' E longitude and at an altitude 1.5 m above MSL. The soil in the wet lands is sandy loam and that of the garden land is laterite loam. The total area is 38.19 ha. The Agricultural Research Station, Mannuthy forms a Sub-Station of the Central zone of the NARP and also for the Special Zone for Problem Areas covering the kole lands of Trichur. Apart from the projects undertaken under NARP, experiments under the All India Co-ordinated Rice Improvement Project, the ICAR *ad hoc* scheme on annual oil seeds and University projects are also being implemented at this Station.

18. Cashew Research Station, Anakkayam

This Station was started in 1963 under a scheme included in the Third Five Year Plan. The Research Station is situated in Anakkayam village in Ernad taluk of Malappuram district, on the western side of the Malappuram-Manjeri road, about 8.0 km from Malappuram at an elevation of 106.8 m above MSL. The Station occupies an area of 9.92 ha of which 8.0 ha area is under cashew and 0.5 ha is put under coconut. Rest of the area is occupied by buildings, roads etc. The soil is red laterite. The land is slopy and of uneven terrain. The soil is deep at some places and rocky in many places.

The objective of the Station is to do intensive research with the object of increasing the yield of cashew. This is achieved through breeding and selection to evolve promising varieties, recommending proper manurial schedules and cultural practices, and measures to control the pests and diseases. The evolution of suitable vegetative propagation methods and distribution of quality planting material also form part of the activities of the Station.

19. AICRP on Agroforestry, Livestock Research Station, Thiruvazhamkunnu

This scheme was started during December 1983 with the following objectives:

Collection, screening and selection of promising germplasm of indigenous and exotic species from similar ecological regions.

Breeding and genetic improvement of tree crops and fodder species to develop compatible associations in consonance with the cultural practices of local population.

Developing techniques of cultural practices (in land preparation, propagation, spacing, thinning, pruning, pollarding etc.), cropping and harvesting systems suitable for different systems of agroforestry (ie. Agrihorti-silvi-pastural combinations) acceptable to the local population.

Developing sequential system of intercropping, so that the inter and under space of the land are utilized as long as possible by crops and later, till rotation, by shade bearing (sciophytic) fodder, shrubs and grasses with appropriate management practices.

Replacing shifting cultivation with stable cultivation by adopting appropriate manegement related to agro-forestry based on its capabiliiy.

Evaluating the economics of different agroforestry systems and ostablishing its correlation with the aims and objectives of resource management, namely, conservation, development and utilisation.

20. NARP Centre for the High Ranges Rcgional Agrl. Research Station, Ambalavayal

The Research Station was established in 1946 as part of the Wynad Colonisation Scheme to carry out research on various aspects of improvement of Agriculture in Wynad, to make available quality seeds and planting materials for distribution to the cultivators and to rondor scientific advice on improved agricultural technology. In 1966, the Station was upgraded as the Central Horticultural Research Station to undertake intensive research on major horticultural crops, especially fruits, spices, essential oils etc.

In 1972, the Station was taken over by the KAU and was brought under the National Agricultural Research Project in November, 1983. It was upgraded to the status of a Regional Agricultural Research Station for High Range Zone with lead function on citrus, mango and other fruits and paddy-based farming systems and verification functions for pepper, essential oils and medicinal plants.

The Station is situated in Sultan's Battery taluk of Wynad district, at an elevation of 974 m above MSL and has an area of 87.3 ha. The geographic location is at 11° 37' N latitude and 76° 12' E longitude. The soil is loam, rich in humus.

21. Cardamom Research Station, Pampadumpara

The Cardamom Research Station, Pampadumpara was started in the year 1956 to undertake research programmes on various agronomical, botanical, entomological and phytopathological probiems of cardamom cultivation. The Station is situated in the high ranges of Kerala in the Pampadumpara village, Udumbanchola taluk of the Idukki district, 35 km from Kumily in the Kumily-Munnar road. The All India Co-ordinated Spices and Cashew-nut Improvement Project of the ICAR was initiated in the Station during 1972. The total area of the farm is 46.44 ha.

1.13 2 Research Stations under the Faculty of Veterinary and Animal Sciences

1. Livestock Research Station, Thiruvazhamkunnu

The farm was originally established in 1950 by the then Government of Madras. This was transferred to the KAU in 1972. This was converted to the Livestock Research Station with effect from 14-8-1978. The farm is located in the Mannarghat taluk of Palghat district, 17 km North-West of Mannarghat town. This station is spread over an area of 163.3 ha of which 84.37 ha is under fodder crops. The major objective of this station is to conduct research on

scientific breeding of livestock, livestock management and fodder production.

2. Cattle Breeding Farm, Thumburmuzhi

This farm, originally started by the State Animal Husbandry Department, was transferred to the KAU in 1972. The farm has an area of 25.2 ha out of which 18 ha is under fodder cultivation. The main varieties of grasses grown are guinea, improved guinea, napier, hybrid napier and para.

The main objectives of the farm are to rear weaned calves, artificially breed them and supply as pregnant heifers to the University Livestock Farm, Mannuthy. The farm is also engaged in conducting basic and applied research on cross-bred calves. The facilities such as artificial insemination, veterinary aid and supply of slips of improved varieties of fodder grass were made available to the farmers in the surrounding area.

3. University Livestock Farm, Mannuthy

This farm, started in 1921, was transferred to the KAU in 1972. The farm serves the needs of teaching, research and extension education activities of the different departments of the College of Veterinary and Animal Sciences. The facilities available in the farm are utilised for imparting practical training to the students of the College as well as for the short term training programmes conducted by the departments of Animal Management, Animal Nutrition Animal Genetics and Breeding, Animal Reproduction, Dairy Science etc. The farm maintains a herd of cross-bred cattle of Jersey, Brown Swiss and Holstein. The total area available for fodder production is 69 ha.

4. University Poultry and Duck Farm, Mannuthy

The Poultry Farm, Mannuthy of the State Animal Husbandry Department was transferred to the KAU in 1972. The major objectives of the farm are to provide hatching eggs, chicks and breeders for farmers and development departments, to provide the necessary facilities for teaching the students and to undertake research on various aspects of poultry production.

5. Pig Breeding Farm, Mannuthy

The Pig Breeding Farm, Mannuthy was started in 1965 with an area of 4.2ha. The main objective of the farm, transferred to the KAU in 1972, are to conduct research on various aspects of swine production to serve as a demonstration unit for the farmers and an instructional unit for the students, and to distribute good quality piglets to the farmers.

1.13.3. Research Station under the Faculty of Fisheries, Instructional Farm, Puduveypu-Panangad complex

In additional to the fish pnnds (0.43ha available at Panangad, an Instructional Farm of 101 ha has also been established at Puduveypu. At Panangad, 3.5 ha of private land has been taken on lease for prawn cultivation.

The Research Stations with their areas are listed in abstract of Table 23.

Table 23. Research Centres/Stations/Farms in the Kerala Agricultural University showing area under each Centre/Station/Farm as on 1-9-1986.

Sl. No.	Research Station	Area (ha)
A.	FACULTY OF AGRICULTURE	
	Southern zone	
1.	Coconut Research Station, Balaramapuram	14.13
2.	Cropping Systems Research Centre, Karamana	7.65
3.	Special Station, Kottarakkara	8.96
4.	Instructional Farm, Vellayani	95.35
	Special zone of problem areas	
5.	Regional Agrl. Research Station, Kumarakom	44.76
6.	Rice Research Station, Moncompu	8.57
7.	Rice Research Station, Kayamkulam	11.65
8.	Sugarcane Research Station, Thiruvalla	19.48
9,	AICRP on Agrl. Drainage (on leased land) Karumady	—
10.	Rice Research Station, Vyttila	8.91
	Central zone	
11.	Regional Agricultural Research Station, Pattambi	63.64
12.	Aromatic and Medicinal Plants Research Station, Odakkali	12.70
13.	Agrl. Research Station, Chalakudy	8.95
14.	Banana Research Station, Kannara	17.30
15.	Cashew Research Station, Madakkathara	15.25
16.	Agrl. Research Station, Mannuthy	38.34
17.	Cashew Research Station, Anakkayam	9.92
	Zone for High Ranges	
18.	Regional Agricultural Research Station, Ambalavayal	87.30
19.	Cardamom Research Station, Pampadumpara	46.44
	Northern zone	
20.	Regional Agricultural Research Station, Pilicode & Nileswar	75.12
21.	Pepper Research Station, Panniyur	26.52

B.	FACULTY OF VETERINARY AND ANIMAL SCIENCES	
22.	Livestock Research Station, Thiruvazhamkunnu	163.30
23.	Cattle Breeding Farm, Thumburmuzhy	25.20
24.	University Livestock Farm, Mannuthy	69.00
25.	University Poultry and Duck Farm, Mannuthy	0.50
26.	Pig Breeding Farm, Mannuthy	4.20
C.	FACULTY OF FISHERIES	
27.	Instructional Farm, Puduveypu	101.00
	Total area of the above farms	984.14
	Area under KAU Estate	391.43
	Total area under KAU	1375.57

CHAPTER II

General Agricultural Characteristics of the High Range Zone

2.1 Delineation

The high range zone of Kerala is a sub region of western ghats with an elevation above 750 m from MSL comprising of the hill districts of Wayanad and Idukki, Nelliampathy and Attappady hill ranges of Palghat district, Thannithode and Seethathode panchayaths of Pathanamthitta district. Aryankavu, Kulathupuzha and Thenmala panchayaths of Quilon district and Peringamala, Aryanadu, Vithura, Kallikadu and Amboori panchayaths of Trivandrum district. The delineation map of the zone is given in Fig. 12 and the list of panchayaths in the zone is given in Annexures 54, 55 and 56.

The total geographical area and population (as per 1981 census) of the zone are 11140.67 Km² and 1764236 respectively. Relatively the high range zone shared 28.67 per cent and 6.78 per cent respectively of the total geographical area and population in the state. The average literacy rate of the zone is 63.05 per cent.

2.2. Physiography

The geographical regions comprising the zone are not contiguous. The following six regions constitute the high range zone.

a) Wayanad

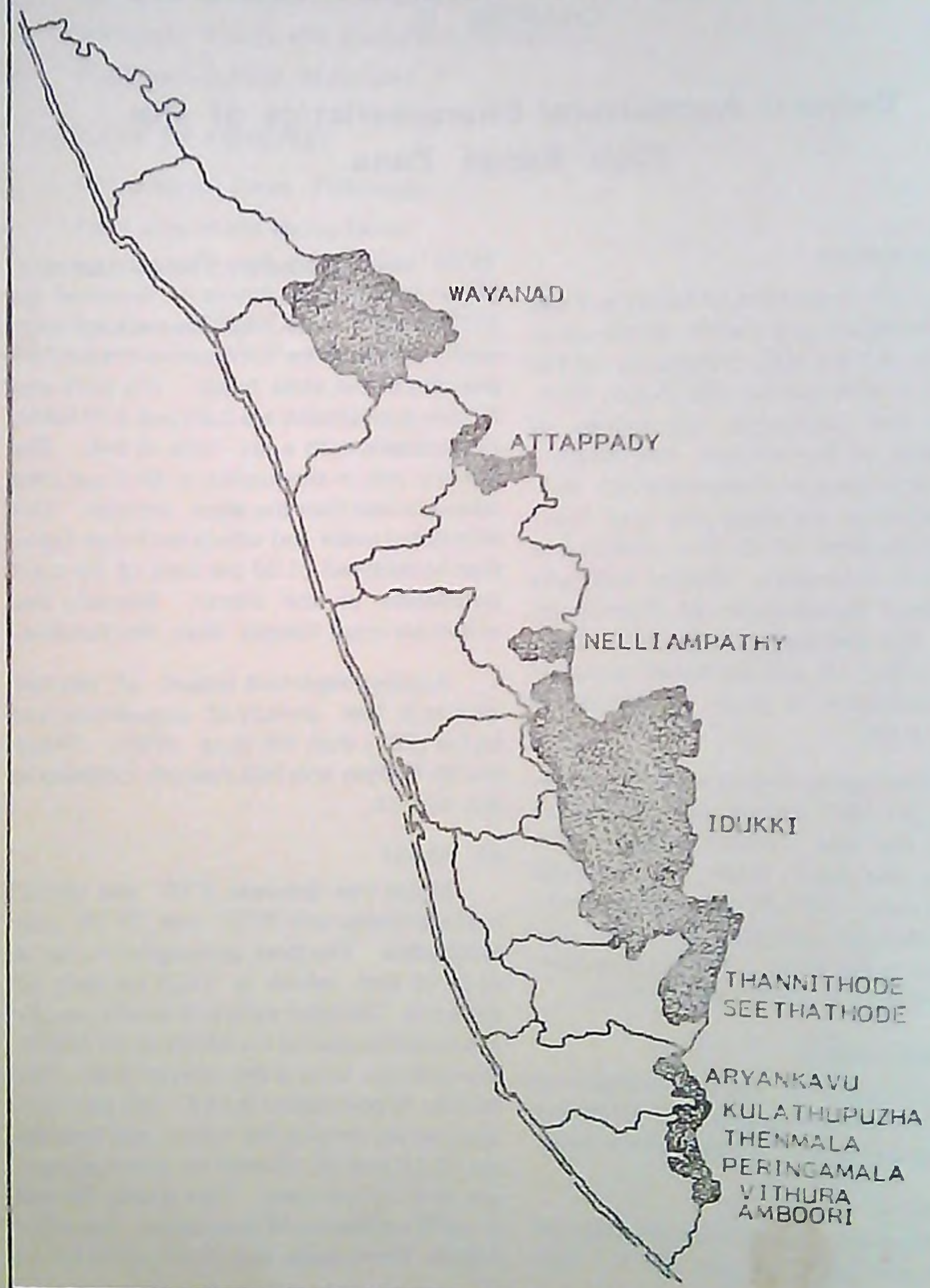
Wayanad district lies between 11°26' and 11.59' north latitudes and 76°26' and 75°46' east longitudes. The total geographical area and population of Wayanad are 2125.6 Km² and 554026, respectively, which accounts for 5.47 per cent and 2.17 per cent of the state totals. The male and female populations are 2.84 and 2.70 lakhs, respectively, with a sex ratio of 946. The literacy rate in this region is 58.3 per cent which is less than the state average. The scheduled caste and scheduled tribes together constituted 21.06 per cent of the total population in the district. Notably, the males are more literate than the females.

Another important feature of this hill district is low density of population per sq.km (260) than the state (655). There are 30 Harijan and 802 Adivasi colonies in this district.

b) Idukki

Idukki lies between 9°16' and 10°22' north latitudes and 76°37' and 77°25' east longitudes. The total geographical area is 5149.62 Km² which is 13.25 per cent of the state. The total male and female populations in this district are 49499 and 476637, respectively, with a sex ratio of 946. The density of population is 192. The percentage literacy among the males and females are 72.15 and 62.55 with an average literacy of 67.44 per cent. This district formed in 1972 comprises of Devicolam, Udumbanchola, Peerumedu and Thodupuzha taluks

FIG-12. HIGH RANGE ZONE - DELINEATION



is the largest among the districts in the state. There are 14 peaks which exceed 2000 m above MSL in this district.

c) Nelliampathi and Attappadi hill tracts

The Nelliampathy hill ranges have an average elevation of 900m above MSL. It lies about 10 Km south of Nenmara and 33 Km from Palghat. Nelliampathy has a total area of 564.04 Km^2 and population of 8371. The male and female population are 4534 and 4337, respectively. The literacy rate is 39.1 per cent.

The Attappady hill ranges are bounded by the Nilgris and Coimbatore districts of Tamil Nadu in the north and east, Palghat taluk in the south and Karumba, Puttassery and Mannarghat revenue villages of Mannarghat taluk of Palghat district and Eranad taluk of Malappuram district in the west. It lies between 10°15' and 11°15' north latitudes at elevations ranging from 750 to 1000 m above MSL. The highest peak Malleswaram is at 1664 m above MSL.

Attappady has a total geographical area of 820.64 km^2 which comprises of three revenue villages viz. Attappadi-1 (Agali Panchayath), Attappadi II (Pudur panchayath) and Attappadi III (Sholayar panchayath; the famous silent valley ecosystem lies within this area). Attappady is mostly a tribal area with a tribal development area of 765 Km^2.

The total population of the Attappadi block is 62,246 with 31,953 males and 30,292 females. Out of this, there are 20,659 scheduled tribes and 3348 scheduled castes. The literate population is 23,383 with 37.6 percent literacy. The tribal halmlets are known as 'Oorus' and there are 116 such 'Oorus'. The number of households in Attappady is 13179.

d) Thannithode and Seethathode Panchayaths of Pathanamthitta District.

The Thannithode and Seethathode panchayaths are near to the famous sabarimala Pilgrim Centre. The total geographical area of these two panchayaths is 1080.39 Km^2 with a population of 30,544. Out of the total population, 155,38 are males and 14952 females. Number of households was 6094 as per the 1981 census.

e) Aryankavu, Kulathupuzha and Thonmala Panchayaths of Quilon district

The above panchayaths lies in the Pathanapuram taluk of Quilon district. They together constitute a total geographical area of 783.22 Km^2 and population of 66741 as per the 1981 census. The male and female populations are 33371 and 32870, respectively. The percentage literacy in this area is 65.2. Out of the total population, 1694 persons are scheduled castes and 1821 scheduled tribes.

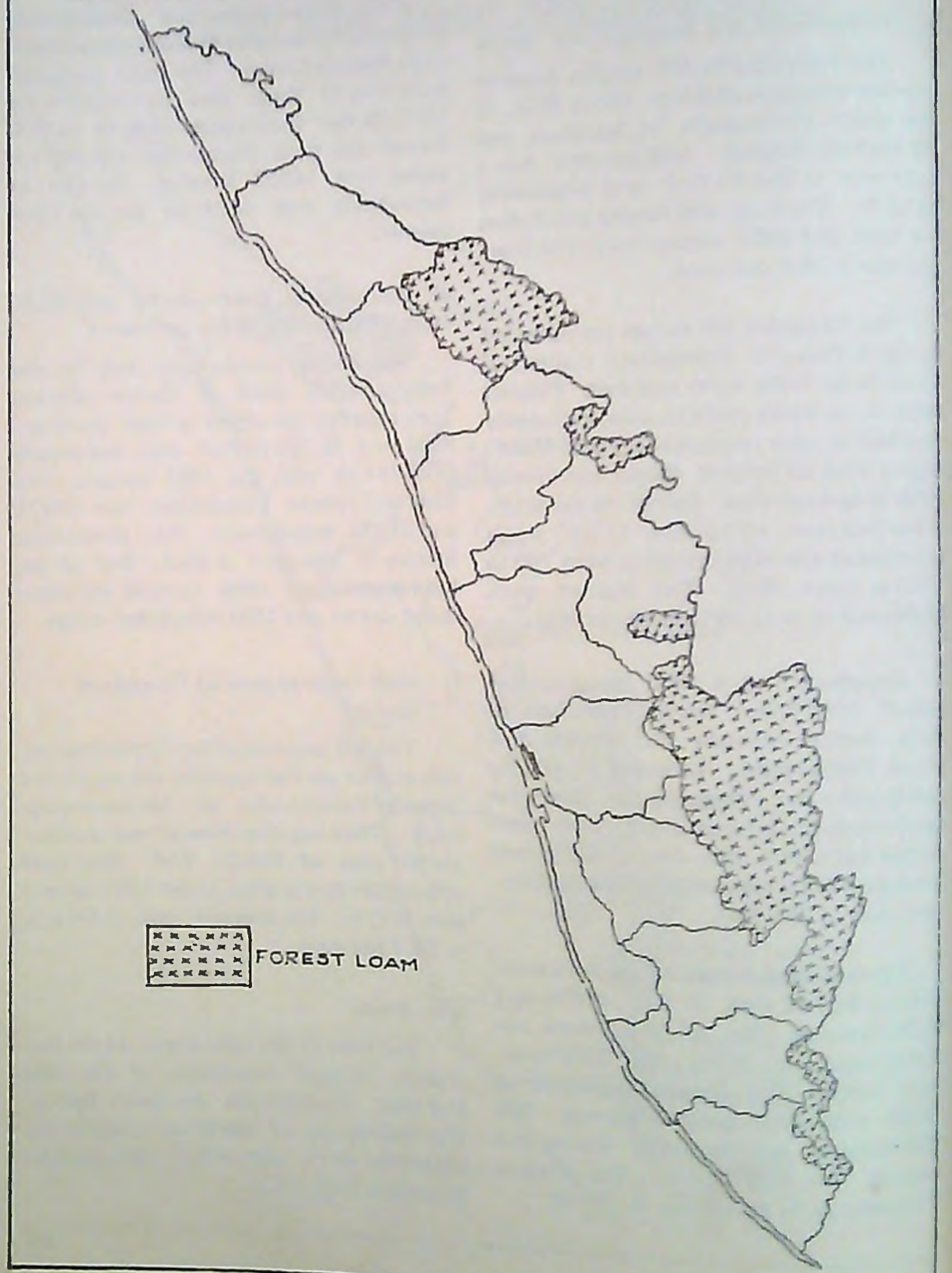
f) High range regions of Trivandrum district

The hill areas identified in the Trivandrum district are Poringamala, Aryanadu and Vithura Panchayaths of Nedumangadu taluk. They together have a total geographical area of 610.22 Km^2. The total population in this area as per 1981 census was 10716. The average rate of literacy is 63.7 per cent.

2.3 Soils

The soils of the zone come under five groups. A brief description of the soils and their classification are given below. The description of typifying pedons are presented under concerned agroecologic situations (Fig. 13.)

FIG-13. HIGH RANGE ZONE - SOILS



FOREST LOAM

	Common name	Order	Sub order	Great group
1	Lateritic	Alfisols	Udalfs	Hapludalfs
2	Soils of rain shadow region	Inceptisols	Ochrepts	Ustochrepts
3	Forest loam	Inceptisols	Tropepts	Humi tropepts
4	Brown hydromorphic	Entisols	Aquents	Haplaquert
5	Riverine alluvium	Entisols	Flavents	Udifluvents

Soils of the arable lands (clear felled forests converted to plantations and homesteads) lateritic shallow with predominance of gravel and boulders and good physical properties. The surface soils are rich in organic matter with textures ranging from loam to clay loam.

The rain shadow region is characterised by shallow sandy to sandy clay loam soils which are well drained and formed from gneissic parent material under low rainfall (300 mm) and high temperature conditions.

The forest loams cover the typical forest lands and cardamom plantations. Such soils occupy areas coming under the situations III and V. They are shaliow soils with immature profiles. Surface soils are rich in organic mattor and sub surface layers have gneissic boulders and weathered rock fragments.

The brown hydromorphic soils ara in a group typical of the wet lands which occur in the valley bottoms of undulating topography. The soils are deep and consist of colluvium brought down from the side slopes and also alluvium by stream water. Drainage is the main problem in these soils.

The riverine alluvium occur throughout the zone as narrow stretches mostly along the banks of rivers and riverlets. They include very deep soils rich in nutrients. These soils have the problem of periodic flooding during monsoons.

2.4 Climate

The climate prevailing in this zone is by and large mild subtropical which is condusive for growing both subtropical and tropical crops. Idukki district in general has tropical humid climate. High altitude region of this zone have a cool climate.

Major portion of the rains are received during south west monsoon from June to August and the rest during nort east monsoon (October to December). Rainfall during the period from January to March is low which greatly influence the production of major crops like coffee, tea, rice, pepper etc. In Wayanad, annual rainfall varies from about 1624 mm in Pulpally area to 4511.8 mm in Lakkidi. In Idukki, rainfall varies from 750 mm in Marayur to 5000 mm in Elappara and surrounding areas. Thus, while Munnar, Devicolam, Pallivasal and Vellathooval are high rainfall areas in Idukki district. All other regions in Wayanad, Idukki and other regions receive annual, rainfal ranging from 3000 to 4000 mm. The rainfall pattern in selected centres in Wayanad and Idukki districts are given in Annexures 57 & 58. High velocity winds are common during south west monsoon months and dry winds blow in March/April.

The high altitude regions experience severe cold. In general, low temperature prevails from October to January while February to April are warmer months.

In Wayanad (Ambalavayal) the mean maximum and minimum temperatures for the last five years were 29.1°C and 17.8°C respectively. In certain days, night temperature goes down to 15°C. In the eastern parts of Idukki district, temperature goes to 1°C in certain periods. In general, the minimum temperature range is 5 to 15°C. In areas other than Idukki and Wayanad, the minimum and maximum temperature ranges are 14 to 17°C and 26 to 27°C, respectively. The mean monthly temperature and humidity recorded at RARS, Ambalavayal for the past five years are given in Annexure-59.

The high range zone generally experiences high relative humidity which goes even upto 95 per cent during south west monsoon months. In Wayanad, the mean relative humidity varies from 76.8 per cent during January/March to 86.9 per cent in June/August. In Idukki, it ranges from 90 to 95 per cent during the south west monsoon period.

The Attappady ranges enjoy a cool humid climate during rainy season. The slopes facing west and immediately lying to east get about 3000 mm rainfall. However, towards Tamil Nadu boundary the rainfall even dwindles to 1000 mm.

Nelliampathy has a cool and pleasant climate. The annnual rainfall is around 3900 mm and the temperature varies from 15°C in December to 29°C in April.

2.5 Land use pattern

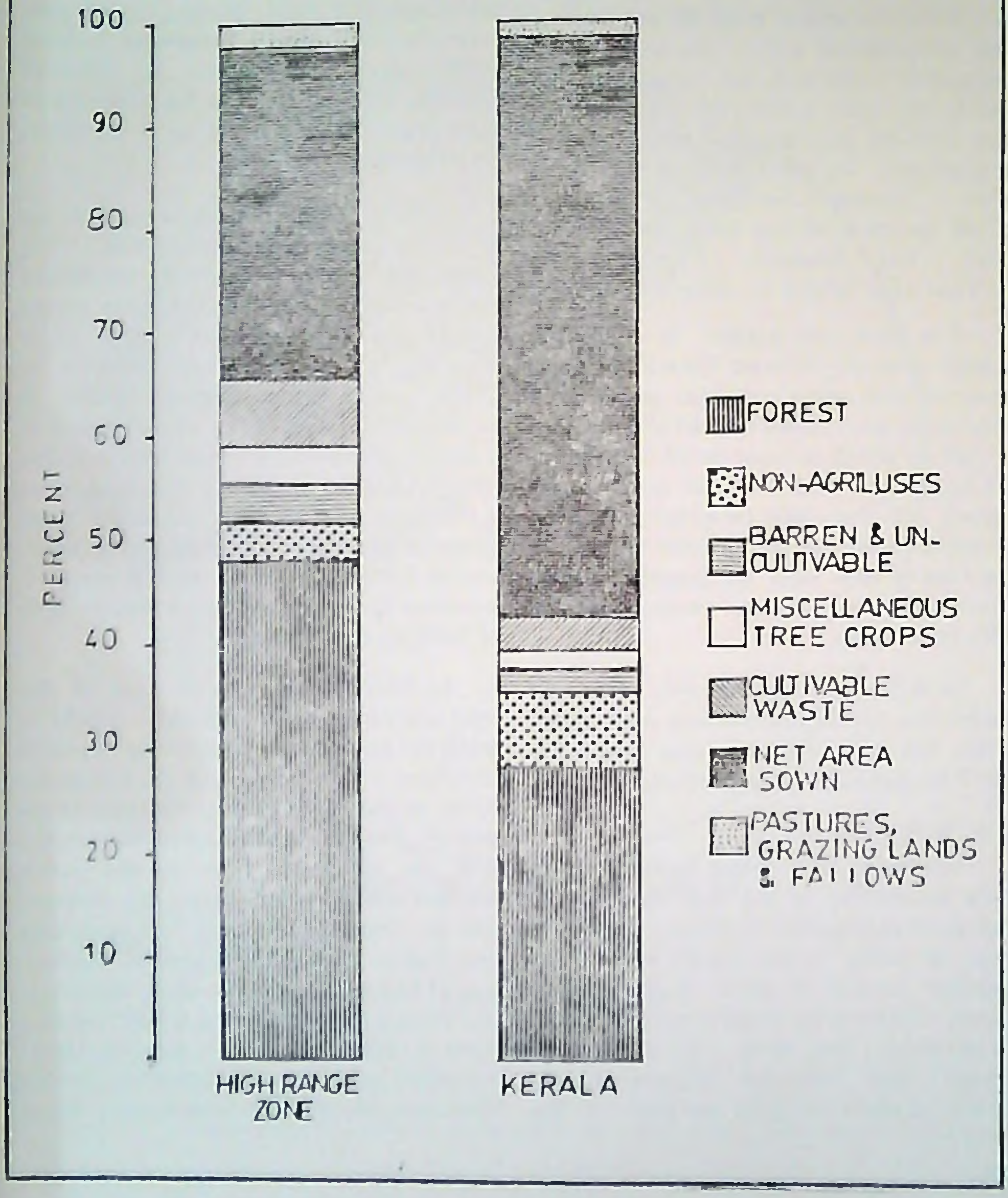
The land use pattern of the high range zone comprising of Wayanad, Idukki and parts of Palghat, Quilon, Pathanamthitta and Trivandrum districts is shown in (Fig. 14) and given in Annexure-60 & 61.

The total geographical area of the zone is 114067 ha which accounts for 28.67 per cent of the state total. The area sown and total cropped area are 362803 ha and 411654 ha which comes to 16.64 per cent and 14.38 per cent respectively of those in the state. Forest occupies 541710 ha in the zone which works out to 50.58 per cent of the total area under forest in the state.

The land use pattern of the high range zone differs markedly from that in the state as a whole. Relating to the total geographical area, the net area sown, total cropped area and forests in the zone shared 32.56 per cent 36.95 per cent and 48.62 per cent, respectively. But considering the state as a whole, their corresponding shares in the total geographical area are 56.11 per cent, 73.65 per cent and 27.84 per cent respectively. While the relative shares of total cropped area, area sown more than once, net area sown and land put to non-agricultural use in the high range zone are perceptibly less than corresponding shares in the state as a whole. The shares of forests, barren and uncultivable land, land under miscellaneous tree crops and cultivable wastes are higher This difference in the land use pattern is a peculiar characteristic of the rural agrarian economy with less urbanisation. The lower share of the area sown more than once and the higher share of the cultivable waste in the total geographical area point to the possibilities of increasing agricultural production through intensive cultivation and extending the cultivation to more cultivable areas which are now lying barren.

The cropping intensity defined as the total cropped area as per cent of the net area sown is 113.46 which is less than the cropping intensity (131.24) in the state as a whole. The low cropping intensity in the zone vis-a-vis that in the state is

FIG-14. LAND USE PATTERN - HIGH RANGE ZONE AND KERALA



due to the predominance of perennial plantation crops.

For a better exposition, the land use pattern of Wayanad, (Fig. 15) Idukki. (Fig. 16) and Attappadi regions of the zone are briefly discussed below.

The total cropped area in Wayanad, is 133803 ha which is 62.45 per cent of the geographical area. The area sown more than once and net area sown are 20751 ha and 113052 ha which works out to 9.76 per cent and 53.19 per cent respectively of the total geographical area. Forests occupied (78787 ha) 37.06 per cent of the total geographical area, The intensity of cropping is 118 per cent which is relatively loss.

The land use pattern in Idukki is similar to that in Wyanad. The total cropped area, net area sown and area sown more than once are 172849 ha, 161356 ha and 11423 ha which account for 33.57 percent, 31.38 per cent and 2.23 per cent, respectively, of the total geographical area. Notably, forests occupy 260207 ha (50.67 per cent of the total geographical area). The cropping intensity works out to 107.12 per cent.

In Attappadi region, the net area under non agricultural use and area cultivable but not cultivated area 24901 ha, 2377 ha and 3304 ha respectively.

2.6 Irrigation

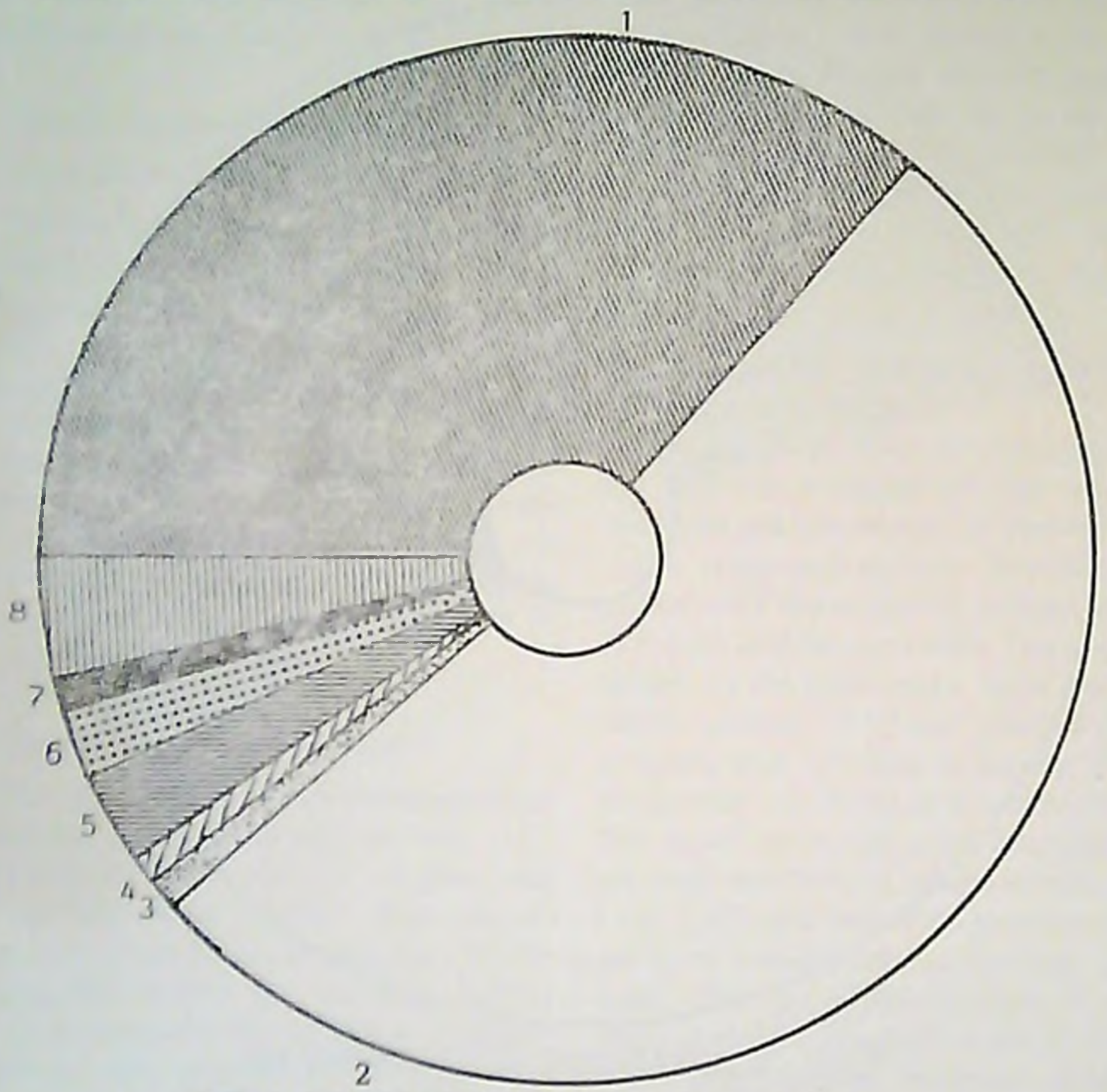
Irrigation is a major factor limiting crop production in the high range zone. For want of irrigation facilities, a second crop of paddy is not raised during the summer season in most of the paddy fields. There is no major irrigation project in the zone. The total area irrigated in Idukki and Wayanad districts is only 11386 ha which is 3.05 per cent of the net area sown. (Annexure-63). This shows the meagre investment in the development of Agriculture.

The high range zone is well endowed with a number of rivers and riverlets, streams, etc. and so has an enormous potential for irrigation development through meticulous planning. Minor or small projects like check dams, lift irrigation systems wells, ponds etc. suited to different localities can help to solve the problems of scarcity of irrigation water to a considerable extent.

In Wayanad district, three projects are at various stages of implementation. The Karapuzha irrigation project envisages construction of a dam at Vazhavatta across Kabani river a tributory of Kaveri. It is expected to irrigate about 4650 ha in Vythiri and Sultan's Battery taluks. A second project aims at the construction of a dam at Manantoddy across Manantoddy river, a tributory of Kabani. Banasurasagar a dual purpose project is proposed to he constructed across Choornipuzha, a tributory of Panamaram river. This project is expected to provide irrigation in an area of 2800 ha in Wayanad.

In Idukki, only two per cent of the total cropped area is irrigated. Idukki is traversed by numerous perennial streams and rivers. The Periyar and its tributeries drain nearly 75 per cent of the area of the district. The Kaliyar and Kudayathur Puzha with its tributeries flow in the north western direction and drain the western part of Thodupuzha taluk. The Manimala and Pampa river drain the south western part of Thodupuzha taluk. The Manimala and Pampa river drain the south western parts of Idukki. The north western Marayur valley is drained by Pambar which flows in north eastarn direction to Tamil

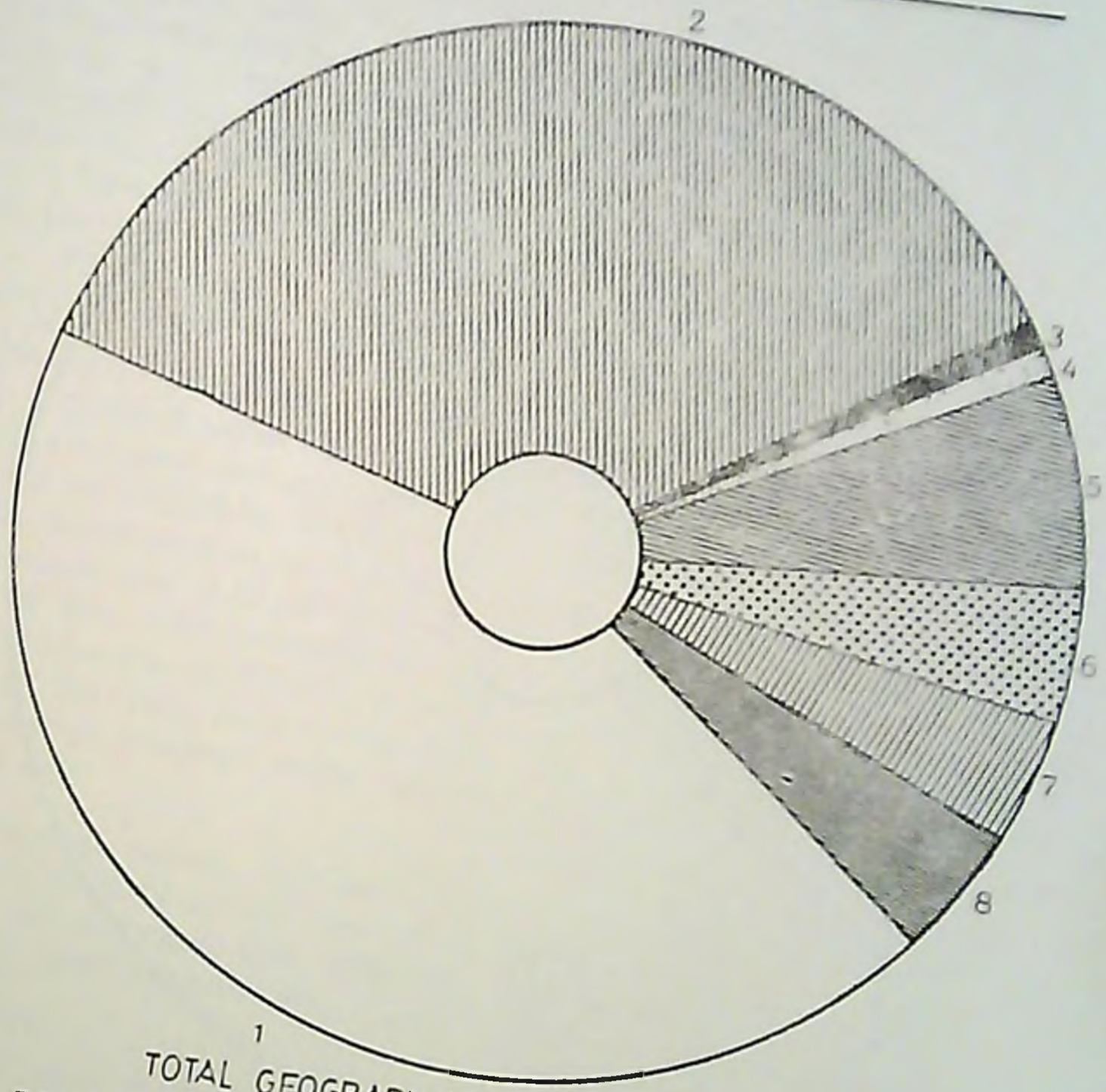
FIG-15. LAND USE PATTERN IN WAYANAD DISTRICT (1983-'84)



TOTAL GEOGRAPHICAL AREA 212560 ha.

1. FOREST
2. NET AREA SOWN
3. CURRENT FALLOW
4. FALLOW OTHER THAN CURRENT FALLOW
5. CULTIVABLE WASTE
6. MISC. TREE CROPS
7. BARREN AND UNCULTIVABLE LAND
8. NON-AGRICULTURAL LAND

FIG-16. LAND USE PATTERN OF IDUKKI DISTRICT



TOTAL GEOGRAPHICAL AREA 514962 ha

1 FOREST
2 NET AREA SOWN
3 CURRENT FALLOW
4 FALLOW OTHER THAN CURRENT FALLOW
5 CULTIVABLE WASTE
6. MISC. TREE CROPS
7 BARREN PASTURES AND GRAZING LANDS
8. NON-AGRL LAND

Nadu. Vattavada and Kottakambu in the north eastern boundary are drained by Tennar, a tributory of Pambar which flows towards north from Chittuvarai through Vattavada Kottakambu and enters Tamil Nadu. Pampar, a tributory of Amaravathy drains a part of Kaveri basin. Another riverlet drains the eastern part of Chakkumpalam village. The area under irrigation from difierent sources in Wayanad and Idukki districts are given in Fig. 17 & 18.

2.7 Socio economic characteristics

a) Land holding pattern

The number of households in the zone is 256961 with an average holding size of 1.47 ha which is higher than the state average. The distribution of operational holdings in Wayanad, Fig, 19 & 20. Idukki and the zone are given in Annexure-63. The first size class with area 0.02 to 0.99 ha shared more than 60 per cent of the total number of households in both the hill districts. The average holding sizes in Wayanad and Idukki districts are 1.64 ha and 1.31 ha respectively.

b) Demographic characteristics

The total male and female populations are 899482 and 864754 and the sex ratio is 961. Notably, in all the regions, sex ratio is less than 1000. The density of population per Sq.km ranged from 15.7 in Nelliampathy to 200 in Sultan's Battery with an average density of 158.4. Similarly the literacy rate ranged from 37.6 per cent in Attappadi to 68.7 per cent in Thodupuzha. The average literacy rate in the zone as per 1981 census was 58.08 per cent. The scheduled caste and scheduled tribes constituted 10.25 and 9.28 per cent respectively of the total population. Summary of the demographic features are given in Annexure-64.

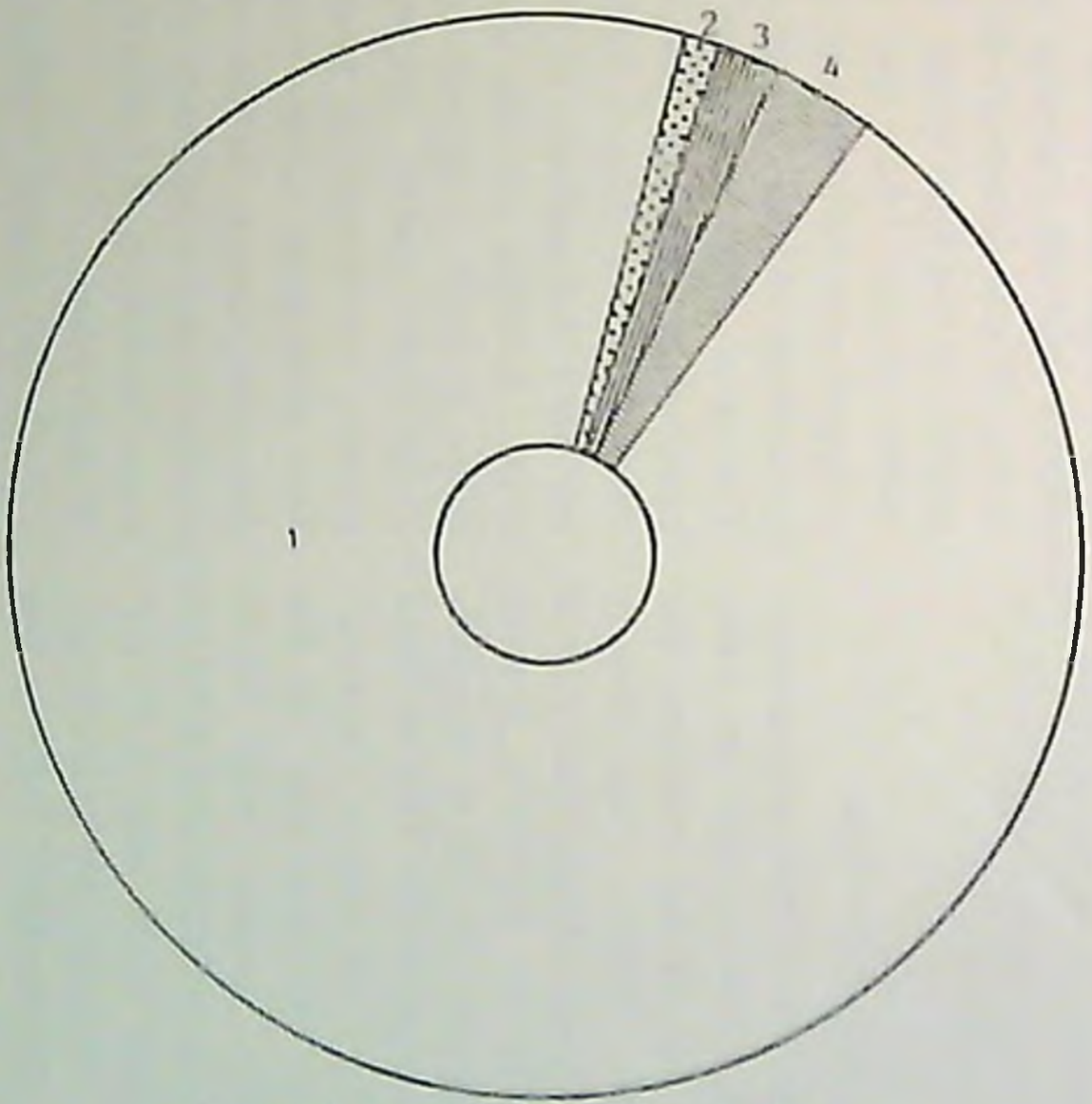
The occupational distribution of the work force (Annexure-65) shows that while there are 592371 main workers, 66405 are marginal workers and 1115435 non workers. The average work participation rate is 33.3 per cent. The percentage distribution of main workers shows that on the whole there are 22.81 per cent cultivators, 33.08 per cent agricultural labourers and 5.10 per cent household workers. The principal occupation of the people in this zone is Agriculture which accounts for the major share of the household income. Another notable feature of Agriculture in this zone is that most of the farmers are full time agriculturists growing mostly commercial crops.

2.8 Cropping pattern, major crops and crop sequence

High range zone is characterised by the high value nature of crop production with the predominance of perennial plantation crops and spices. The major crops grown and the cropping pattern are given in Fig. 21 and Annexure-66. The major crops grown in the high range zone are coffee, which shared 14.67 per cent of the total cropped area followed by paddy (14.03%), cardamom (13.95%) and rubber (12.44%). The other important crops are pepper, tea, coconut and tapioca wihch shared 7.76 per cent 7.86 per cent 5.04 percent and 4.48 per cent respectively, of the total cropped area. But the relative shares of different crops in total cropped area in the state show that paddy, coconut rubber and tapioca are the major crops in the state. This difference in the relative shares of different crops is due to the peculiar agroclimatic conditions prevailing in the zone favouring the economic cultivation of such crops.

Coffee based farming system is the notable feature of Wayanad. Coffee is

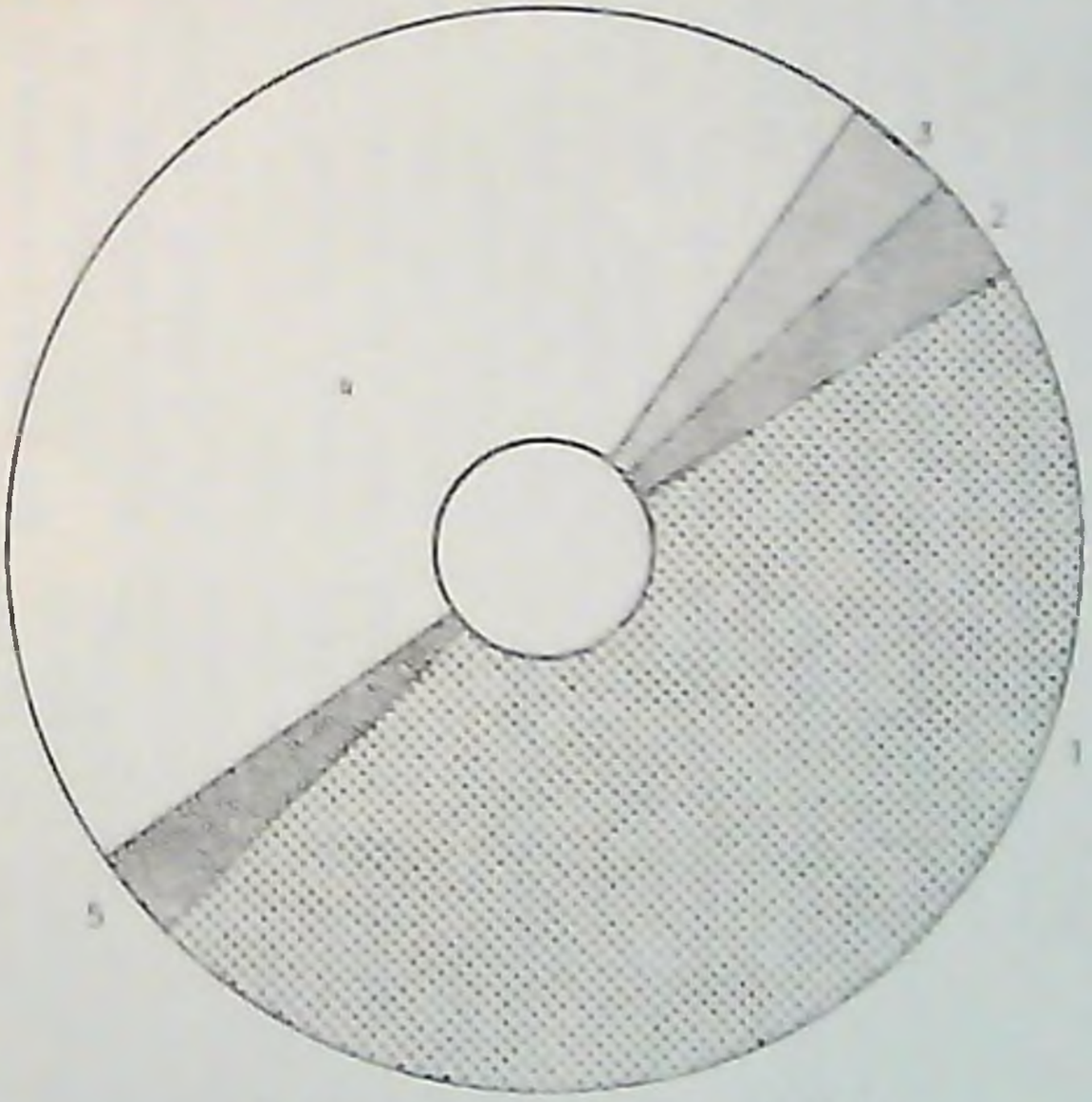
FIG-17. AREA UNDER IRRIGATION FROM DIFFERENT SOURCES IN WAYANAD DISTRICT



TOTAL AREA IRRIGATED 57[illegible] ha

1. OTHER SOURCES
2. MINOR AND LIFT IRRIGATION
3. TANKS AND WELLS
4. PRIVATE CANALS

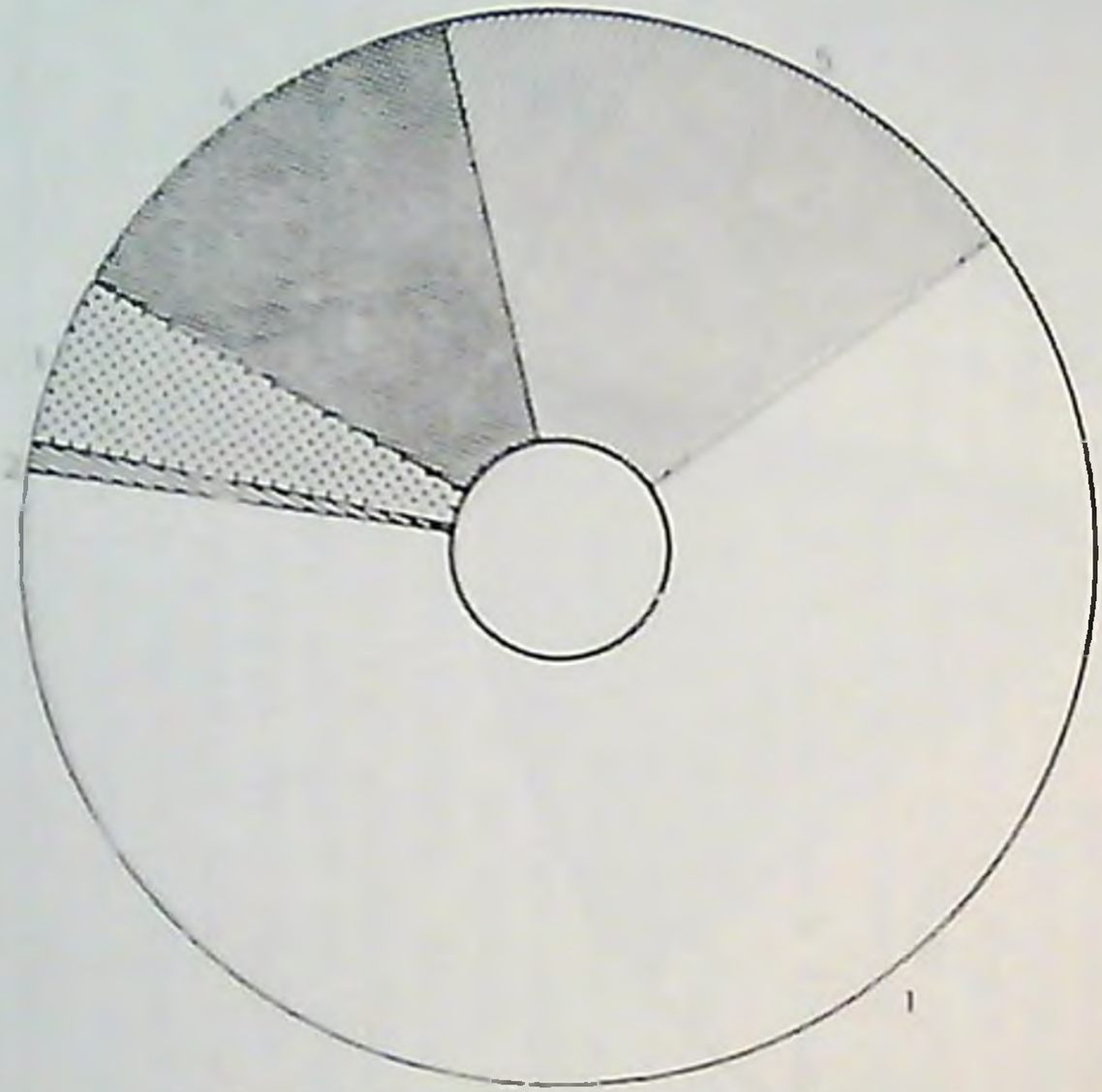
FIG-18. AREA UNDER IRRIGATION FROM DIFFERENT SOURCES IN IDUKKI DISTRICT



TOTAL AREA IRRIGATED 2298 ha

1. OTHER SOURCES
2. MINOR AND LIFT IRRIGATION
3. TANKS AND WELLS
4. GOVERNMENT CANALS
5. PRIVATE CANALS

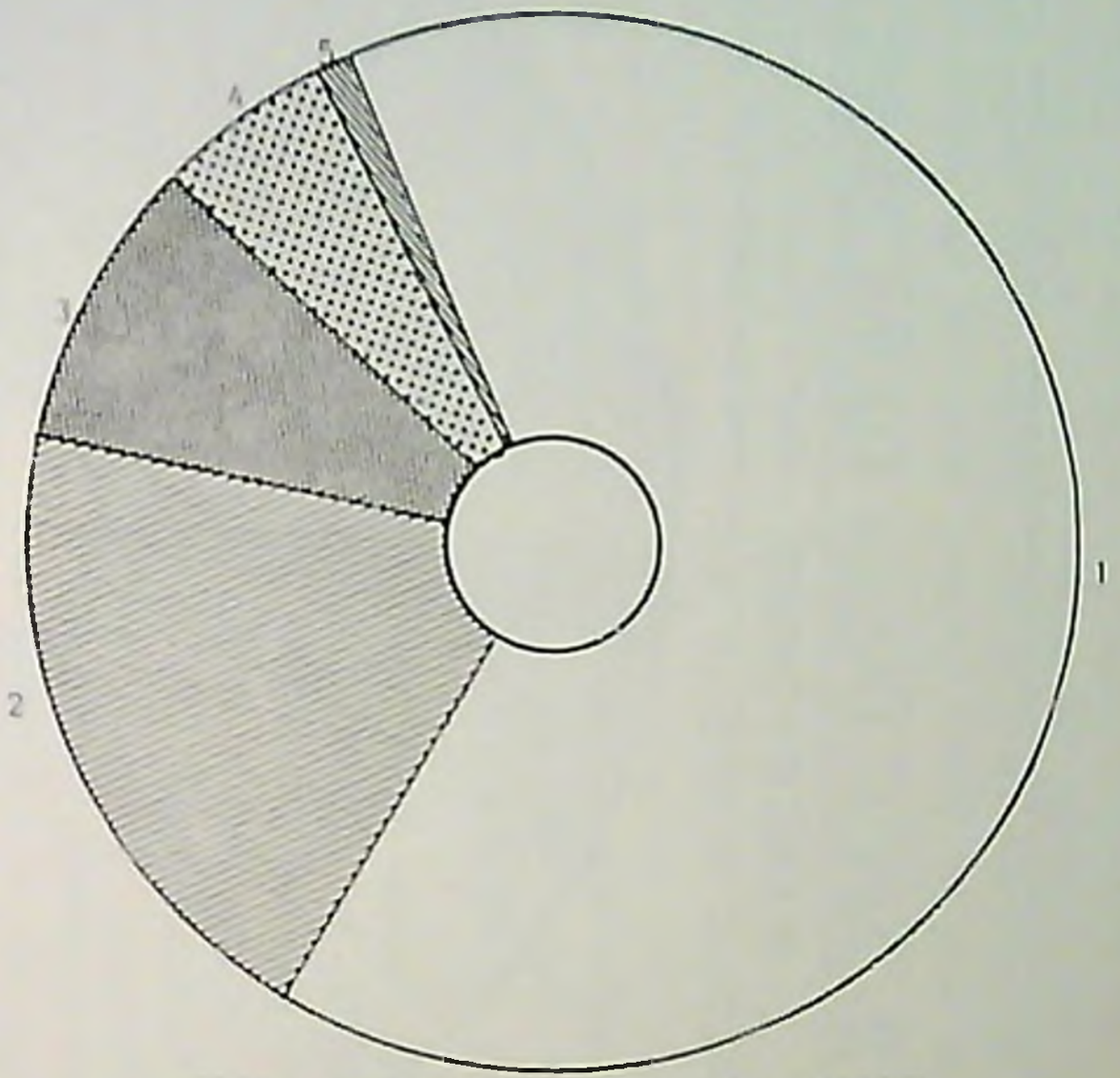
FIG-19. DISTRIBUTION OF OPERATIONAL HOLDINGS - WAYANAD



TOTAL NUMBER OF HOLDINGS 68829

1. 0.02-0.90 ha.
2. ABOVE 10 ha.
3. 4-9.99 ha.
4. 2-3.99 ha.
5. 1-1.99 ha.

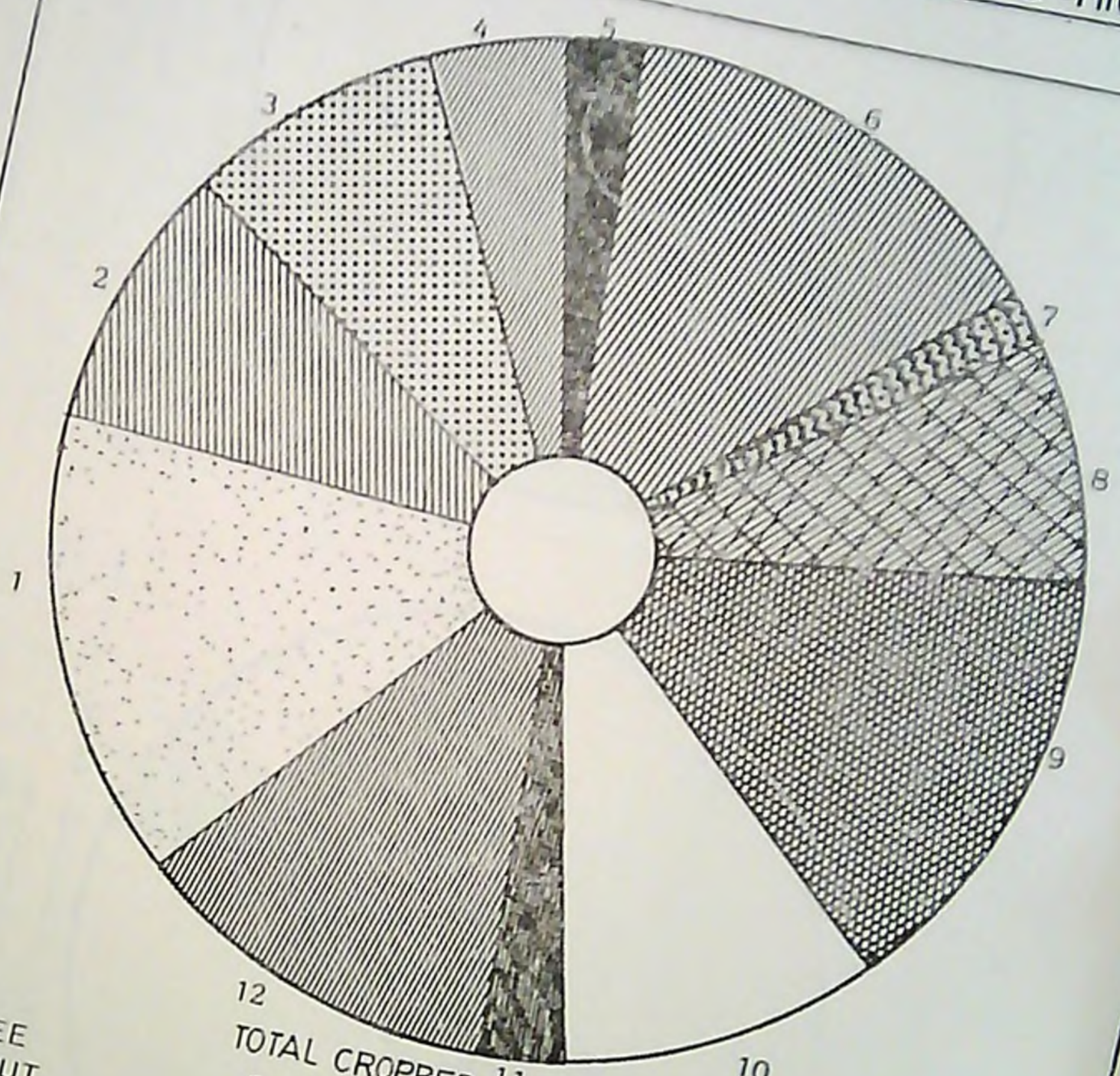
FIG-20. DISTRIBUTION OF OPERATIONAL HOLDINGS. IDUKKI



TOTAL NUMBER OF HOLDINGS 123327

1. 0.02-0.90 ha.
2. 1-1.99 ha.
3. 2-3.99 ha.
4. 4-9.99 ha.
5. ABOVE 10 ha.

FIG-21- AREA UNDER MAJOR CROPS -HIGH RANGE ZONE



TOTAL CROPPED AREA 411654 ha.

1. COFFEE
2. COCONUT
3. TEA
4. TAPIOCA
5. BANANAS
6. CARDAMOM
7. GINGER
8. PEPPER
9. PADDY
10. OTHER CROPS
11. JACK
12. RUBBER

grown both as a pure crop and as a mixed crop along with pepper. Coffee and mandarin orange mixed system which was once prevalent throughout Wayanad has now became almost extinct because of the citrus decline and consequent low yields. Albeit, pepper is grown largely along with coffee, in the north-eastern parts of the district especially in Pulpally and Mullankolly areas it is grown mostly as a mono crop. Rice fields of Wayanad area is in the valleys formed by hillocks. In majority of the paddy lands only a single crop of paddy is taken. A second crop with high yielding medium duration varieties is raised wherever irrigation facilities are available. In recent years, a two year rotation with paddy-banana, paddy-ginger and paddy-tapioca/vegetables is followed when a second crop of paddy cannot be raised. Cucurbits, yams etc, are also grown in the rice fields. The area under major crops in Wayanad district is given in Annexure-67 (Fig 22)

Coffee is the most important crop of Wayanad sharing 41.17 per cent of the total cropped area followed by Paddy (22%) and then pepper (6.1%). The other major crops are tea (4%), cardamom (3%), Jack (3.8%), coconut (2.4%), rubber (2.4%), tapioca and ginger. Notable, rubber and coconut which were not traditionally grown in this district is gradually gaining importance.

In Idukki (Annexure-68 & Fig 23) cardamom is the major crop sharing 28.6 per cent of the total cropped area followed by rubber (16.6 per cent). The other important crops are coconut (8.7%), pepper (7.42%) and tapioca (5.3%). Paddy which shares 25.5 per cent of the total cropped area in the state accounts only 4.9 per cent of the total area in Idukki.

In the Attappadi hill ranges (Annexure-69) rubber is the most important crop with an area of 2395 ha followed by tapioca (1625 ha) and groundnut (1286 ha). The other crops in this region are cotton (302 ha), coconut, paddy (115 ha) and cashew (46 ha).

2.9 Production and productivity of crops

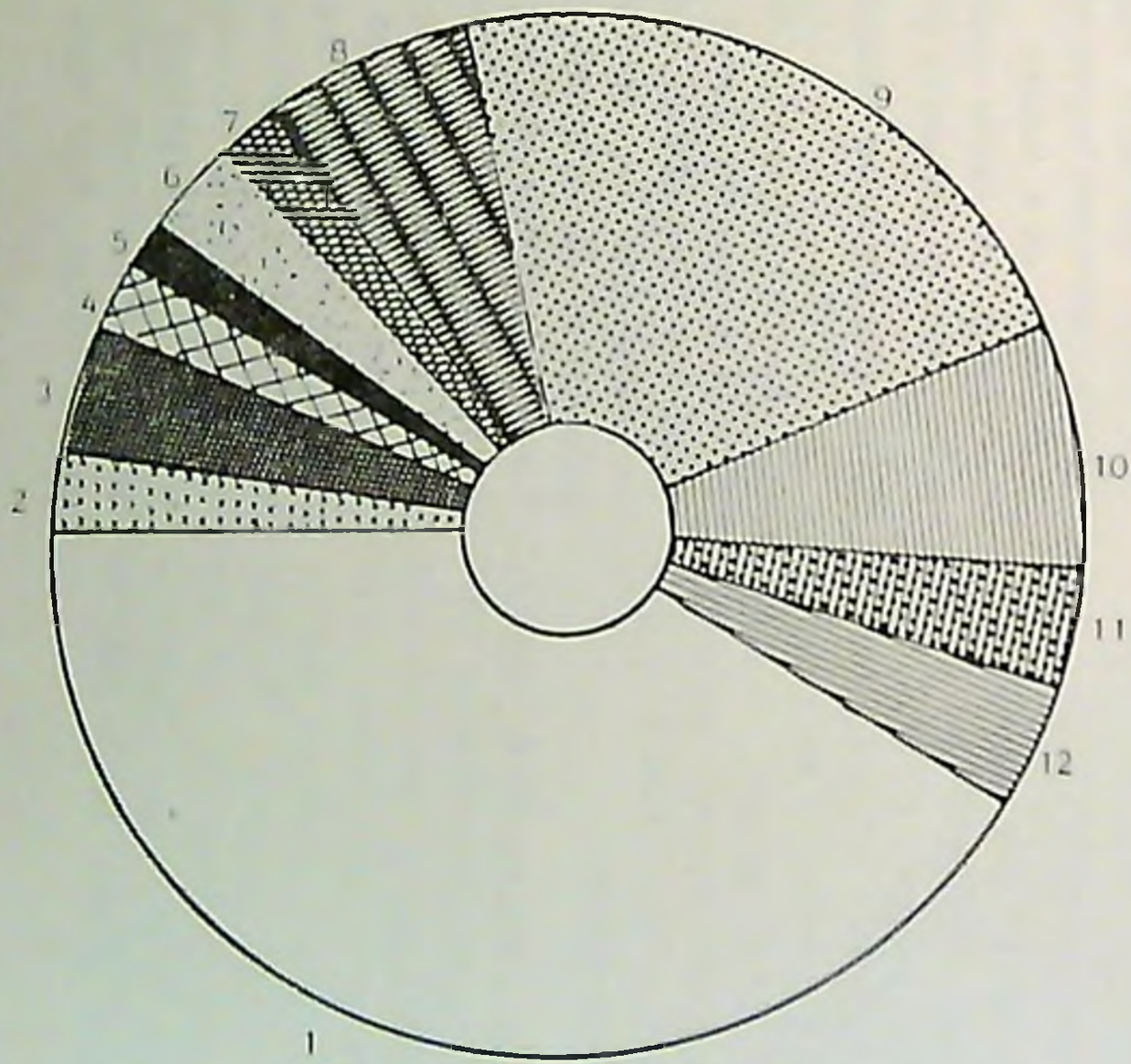
Production and productivity of major crops in the high range zone, Wayanad and Idukki are given in Annexure-70, 71 & 72.

The high range zone accounted almost entirely the production of crops like cardamom, tea and coffee in Kerala. Similarly, it shared about 51 per cent of the total ginger production and 31 per cent of the total production of pepper in the state. A comparison of the productivity of crops in the high range zone vis-a-vis those in the state (Fig. 24) shows that rice, pepper, ginger, turmeric, banana and other plantains, tapioca and tea recorded relatively higher yields than those in the state as a whole. Production and productivity of major crops in Wayanad and Idukki are shown in (Fig. 25)

2.10 Horticulture status and constraints

The high range zone, located in a sub tropical evergreen forest belt is ideally suited for horticultural crops like fruits and spices and may rightly be called the paradise of horticultural crops in Kerala. Since the higher regions enjoy mild sub tropical to tropical climatic conditions, both sub tropical and tropical crops can be grown there. Besides tropical fruits, sub tropical fruits like, mangostein, avocado, litchi, pomogranate etc. come up well in this region. In addition to summer vegetables, cool season vegetables like cabbage, cauliflower, knol-khol, radish, carrot, turnip, beet root, potato, onion,

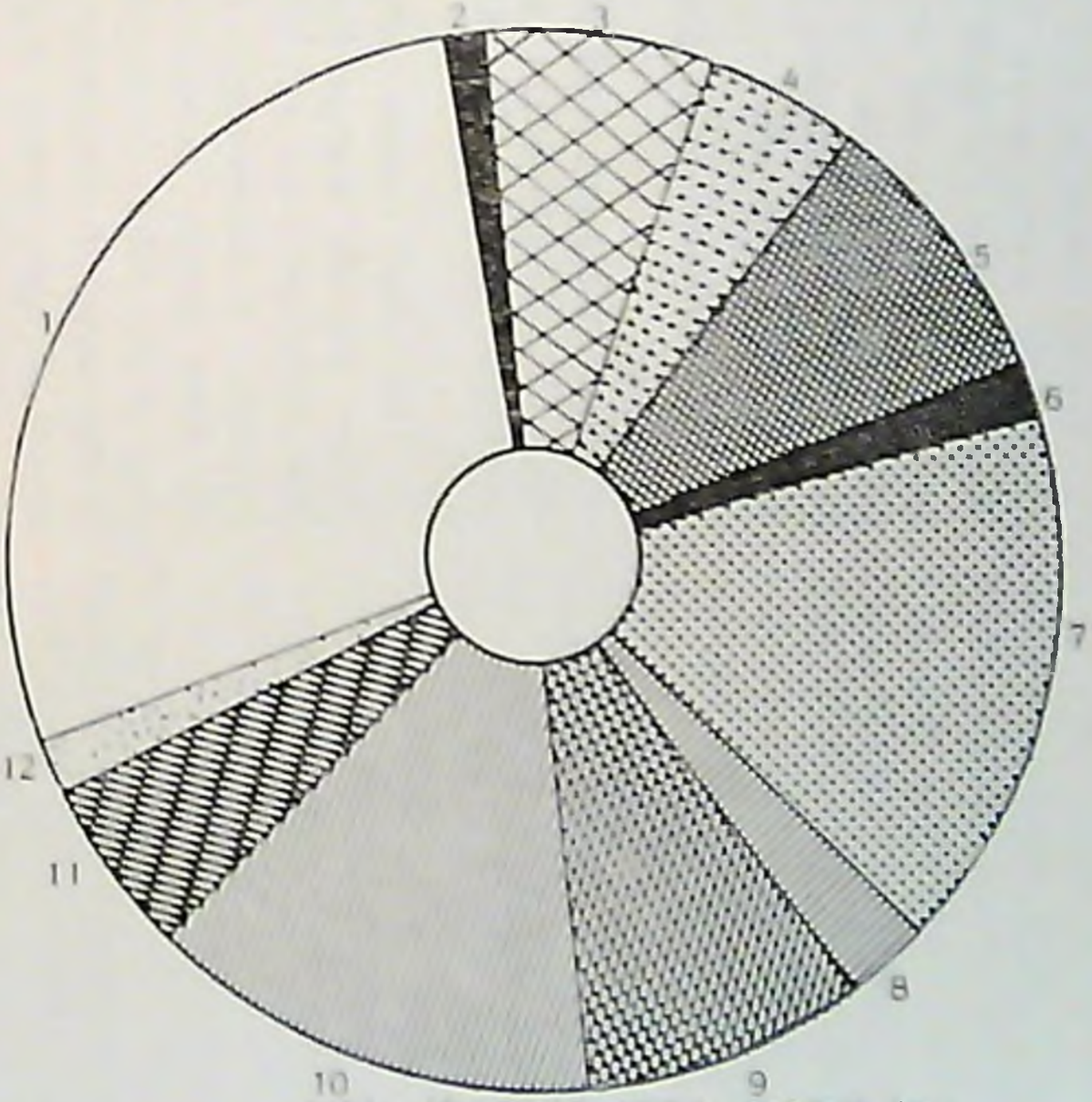
FIG-22. AREA UNDER MAJOR CROPS - WAYANAD DIST.



TOTAL CROPPED AREA 133803 ha

1. COFFEE
2. COCONUT
3. TEA
4. TAPIOCA
5. BANANAS
6. CARDAMOM
7. GINGER
8. PEPPER
9. PADDY
10. OTHER CROPS
11. JACK
12. RUBBER

FIG-23. AREA UNDER MAJOR CROPS - IDUKKI DIST.



TOTAL CROPPED AREA 172849 ha.

1. CARDAMOM
2. GINGER
3. PEPPER
4. PADDY
5. OTHER CROPS
6. JACK
7. RUBBER
8. COFFEE
9. COCONUT
10. TEA
11. TAPIOCA
12. BANANAS

FIG. 24. PRODUCTIVITY OF MAJOR CROPS IN HIGH RANGE ZONE AND KERALA

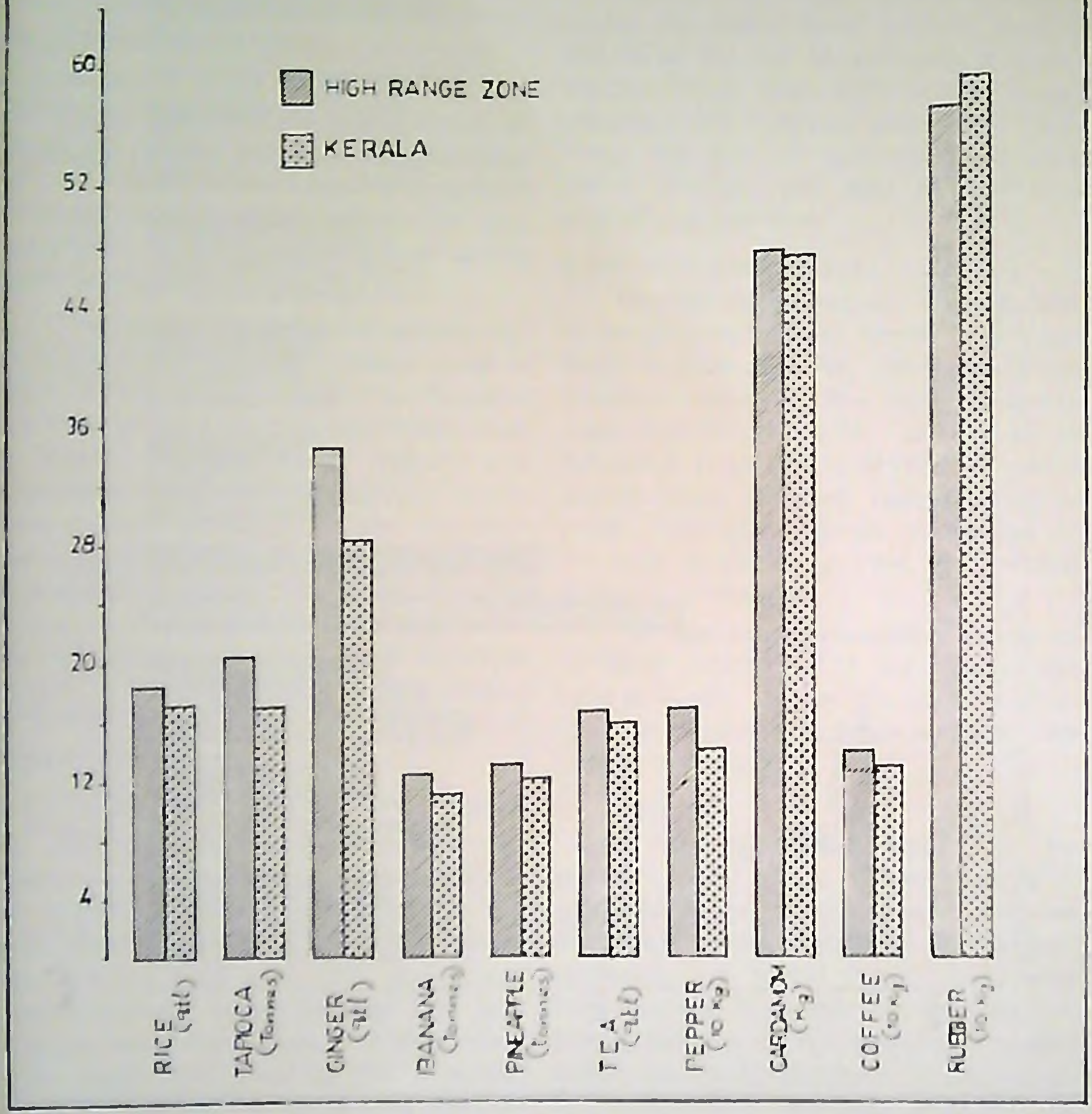
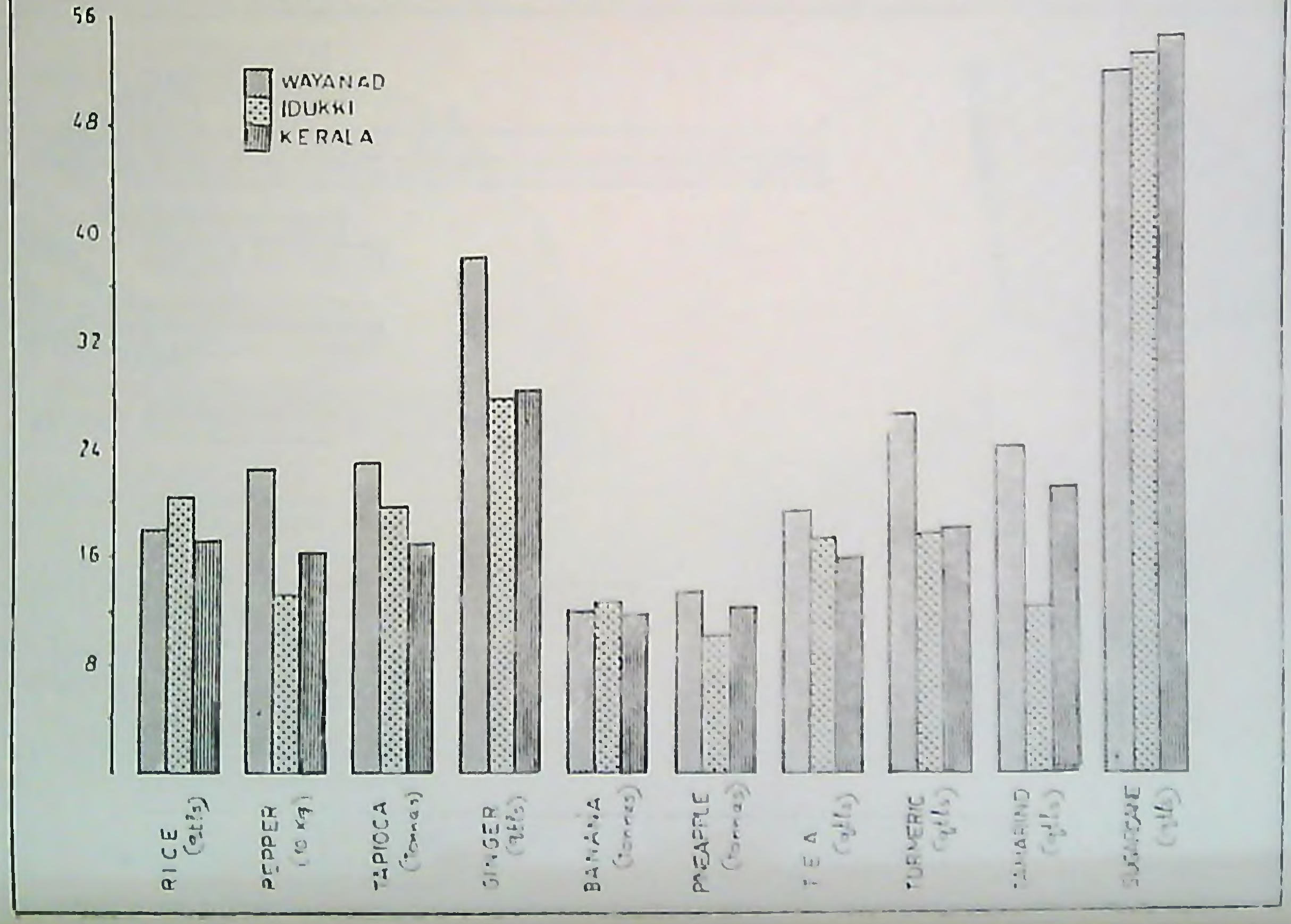


FIG-25 PRODUCTIVITY OF MAJOR CROPS IN WAYANAD, IDUKKI & KERALA

(1984 85)



garlic, french beans, peas etc. are also grown. But the potential for growing both summer and winter vegetables is not fully tapped.

There is great scope for development of commercial floriculture in the high ranges. Suitable varieties and agro techniques for commercial floriculture need be developed. A good collection of wild orchids are available in the natural forests. These have to be collected and developed for commercial cultivation.

Medicinal plants are the richest source of herebal medicines. A large number of medicinal plants are seen in the forests under natural conditions. Survey and collection, identification, maintenance and necessary research on medicinal plants need be intensified.

The supply of quality planting materials of horticultural crops has always been in short of demand in the zone. The Regional Agricultural Research Station, Ambalavayal is mainly engaged in the research and development of the horticultural crops. The nursery attached to the Regional Agricultural Research Station, Ambalavayal is the major source of quality planting materials of spices, fruit crops and ornamental plants. The Cardamom Research Station, Pampadumpara, a sub-station of RARS Ambalavayal, also runs a small nursery of ornamental plants.

2.11 Agricultural engineering status

Data on agricultural implements and machinery in Wayanad and Idukki districts alone are available (Annexure-73). The total number of tractors and power tillers available are 162 and 130 respectively which account for 12.13 per cent and 3.31 per cent, respectively, of their totals in the state. The total number of power operated sprayers and dusters is 500 which shared 24.29 per cent of the total in the state. But the number of diesel engine pumpsets and electric pumpsets are 307 and 689 whicd are only 1.25 per cent and 0.93 per cent of the totals in the state. Notably, this region share a relatively higher percentage of tractors and power operated sprayers and dusters in the state than the other agricultural implements and mechinerios.

Among the power operated implements, the mould board plough, leveller and trailer are the major items of implements. There are 172 mould board ploughs, 263 levellers and 78 trailers. There are also 14 combined harvesters which is 23.33 per cent of the total available in the state.

2.12 Live stock status

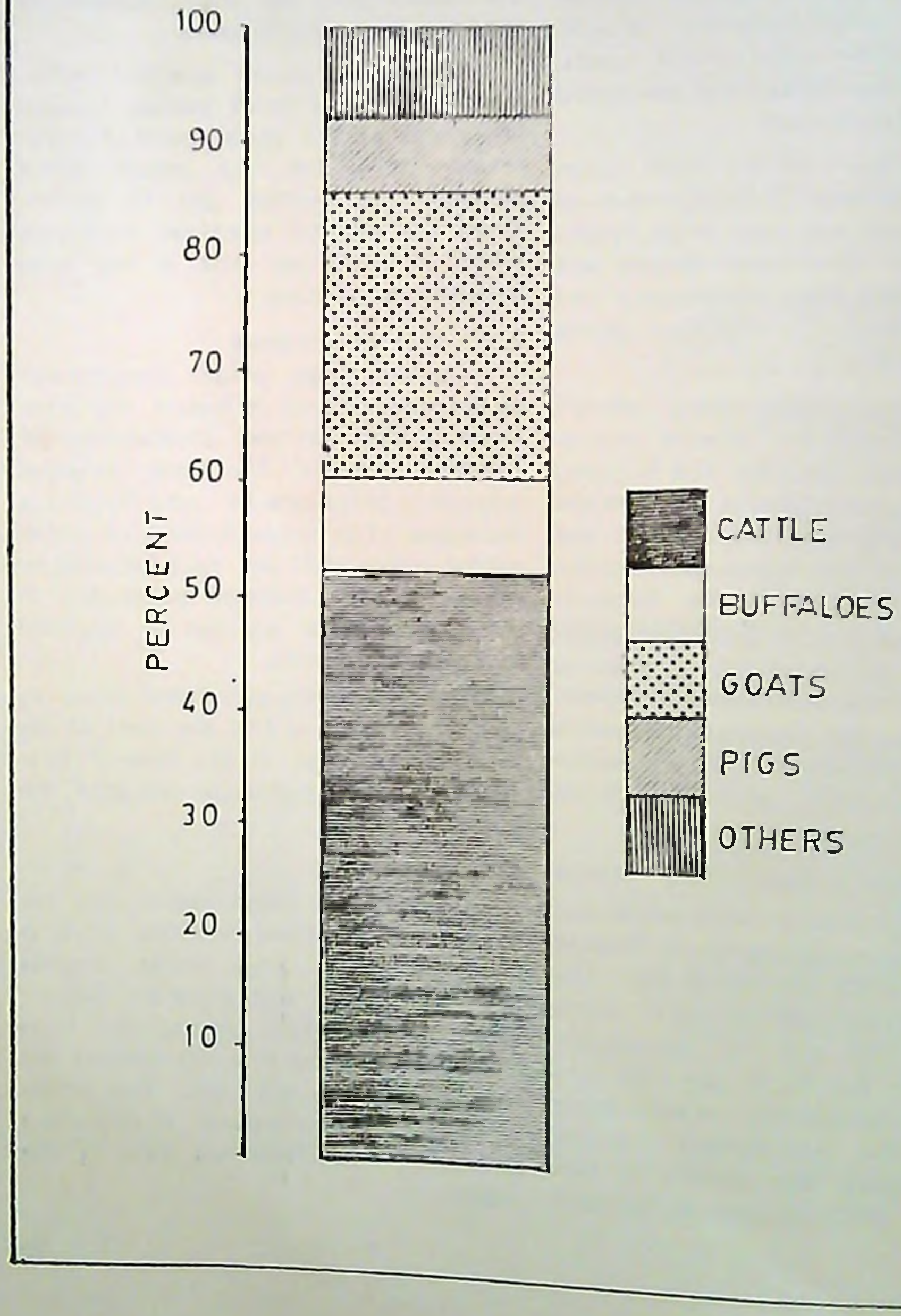
The high range region, characterised by the predominance of forests and grass lands, is ideal for the development of livestock industry. The total livestock population (Annexure-74 and Fig. 26) is estimated to be around 615494 of which cattles share 60.31 per cent followed by goats. The total livestock population in the zone is 10.90 per cent of the total livestock in the state.

The total poultry population comes to 1072273 which is 7.11 per cent of the total in Kerala. As in the case of livestock, the poultry population was also the highest in Idukki.

a. Fisheries

As the high range region has no coastal areas, inland fisheries alone is practiced there. Large ponds, streams and rivers are the main areas for fishing. Although, the Idukki district has large reservoirs and dams it is not utilised for fish culture on a big way. The possibilities for the development of pisiculture in the dams and reservoirs exist in the region.

FIG-26. LIVESTOCK POPULATION_HIGH RANGE ZONE (TOTAL-615494)



2.13 Agricultural marketing

A brief description of the market systems for different agricultural commodities are given below:

a) Coffee

The marketing of coffee is fully regulated by the Coffee Board. The dried beans are collected from producers through recognized collection depots. The produce is then pooled together and marketed by the Board.

b) Pepper

Pepper is marketed mostly as dried berries. The intermediaries involved in pepper market are hill produce merchants, brokers, commission agents and exporters. The major exporting centres of pepper are Cochin and Bombay. Being an export oriented commodity, the price of pepper showed frequent variations.

c) Ginger

Ginger is marketed as green and dried ginger. In Wayanad, a major share of ginger is marked as green ginger. In Idukki and other regions it is mostly marketed in the form of dry ginger. Ginger prices exhibit marked fluctuations and the consequent uncertainties. There is no organised/ regulated marketing system for ginger.

d) Rubber

Rubber is a controlled commodity and its marketing requires licence from the Rubber Board. It is mostly marketed as ribbed smoked sheets. The primary dealers operating at the village level purchase rubber from the producers. These primary dealers in turn sell it to the secondary dealers operating at the major markets and finally to the manufacturing industries. Brokers and commission agents also operate in the rubber market. There are six grades of rubber viz. RMA-IX, RMA-1, RMA-2, RMA-3, RMA-4 and RMA–5.

e) Cardamom

Cardamom is sold at auction centres. It is usually collected by agents who place it for auction. Merchants from different centres participate in these auctions.

f) Vegetables and fruits

There is no organised marketing system for fruits and vegetables.

2.14 Research Organisations in the zone

The research organisations in the zone and their assigned lead and verification functions are given below:-

Sl. No.	Name of station	Lead function	Verification function
1.	Regional Agricultural Research Station, (Kerala Agricultural University), Ambalavayal	Citrus, mango and other fruits, hill paddy and rice based farming system.	Pepper, ginger and other spices, medicinal & oil yielding plants
2.	Cardamom Research Station, (Kerala Agricultural University), Pampadumpara	Cardamom	Pepper and hill paddy
3.	Regional Coffee Research Station, (Coffee Board), Kalpetta	Coffee	—
4.	Indian Cardamom Research Station (Spices Board), Myladumpara	Cardamom	Other spices
5.	Cadbury Cocoa Research Station, Kalpetta	Cacao	—
6.	UPASI sub station, Vandiperiyar, Idukki	Tea, coffee and cardamom	—
7.	Indo-Swiss project, Mattuppetti, Idukki	Livestock and fodder crops	

CHAPTER III

Agro Ecological Situations

The zone is classified into five agro ecological situations based on topography elevation, rainfall and nature of forest cover. The criteria for classification of agro ecological situations are given below:

3.1 Basis/criteria in identifying the agro ecological situations

i) Elevation—

Medium Elevation (ME) 750 to 1500 m above MSL. High Elevation (HE) above 1500 m above MSL.

ii) Topography—

Up Lands (UL), Wet Lands (WL)

iii) Rainfall—

Low Rainfall (LRF) less than 200 cm,
Medium Rainfall (MRF) 200 to 300 cm,
High Rainfall (HRF) above 300 cm

iv) Forest cover—

Areas with Forest Cover (FC)

Areas with No Forest Cover (NFC)

Based on the above, the following five situations were identified:

Situation I :

Uplands, medium elevation, medium rainfall no forest cover (UL, ME, MRF, NFC)

Situation II:

Uplands, high elevation, low rainfall no forest cover (UL, HE, LRF, NFC)

Situation III:

Uplands, medium elevation, high rain fall, forest cover (UL, MF, HRF, FC)

Situation IV :

Wet lands, medium rainfall, no forest cover, medium elevation (WL, MRF, NFC. ME)

Situation V :

Forest (F)

3.2 Sumary of agro ecological situations

The agro ecological situations identified above are scattered throughout the zone and are not contiguous. Situations I, III and IV lie at medium elevation. Situation II lies at high elevation but the rainfall is low. Situation V is dosignated as forests, both natural and forest plantations. These forests share about 50 per cent of the total forest area in the state. Situation IV, namely, the wet lands are seen throughout the zone in between the hillocks. Single crop and double crop paddy lands are seen in this zone. As all the situations lie at medium to high elevations, these regions experience mild sub-tropical climate with low temperatures. The climate is condusive for growing both tropical and sub tropical crops. The climate in regions like Kanthalloor and Vattavada of Idukki district is comparatively dry. The estimated area under different crops in the five situations are given in page 75.

AGRO ECOLOGICAL SITUATIONS IN THE HIGH RANGE ZONE

Sl. No.	Agro ecological situation	Soil	Rainfall (cm)	Altitude (m above MSL)	Principal crops	Special features	District/ taluks covered
1	2	3	4	5	6	7	8
1.	Situation I (UL, ME, MRF, NFC)	Clay loam	200—300	750—1500	Coffee, tea, rubber, pepper, tapioca, ginger, coconut, banana, arecanut and perennial fruits	1. Coffee in mixed cropping system and as mono crop 2. Tea as a mono crop 3. Rubber as a mono crop 4. Pepper as a mono crop and as a mixed crop along with coffee 5. Tapioca, ginger, banana and yams as a pure crop and as inter-crop in young coffee and pepper plantations 6. Coconut as a mixed crop with coffee and pepper 7. Arecanut as a mixed crop with coffee and cardamom	Throughout Wayanad district, Peerumade, Udumbanchola and Devikulam taluks of Idukki district, Nelliampathy and Attappady hills of Palghat district, Thannithode and Seethathode of Pathanamthitta district, Aryankavu Kulathupuzha and Thenmala of Quilon and the five panchayaths in Trivandrum district

1	2	3	4	5
2.	Situation II (UL, ME, LRF, NFC)	Sandy clay loam	Below 200	Above 1500
3.	Situation III (UL, ME, HRF, FC)	Forest loam	Above 300	750—1500

6	7	8
Sugarcane, winter-vegetables like cabbage, cauliflower, onion, garlic etc., ragi sorghum and wheat	This situation experiences a typical climate different from that in the other regions of the high range zone. Sugarcane is grown as a monocrop and its productivity in this situation is significantly higher than that in the lower elevations. This region is ideally suited for growing winter vegetables. There is large scale cultivation of winter vegetables. Ragi sorghum and wheat are also grown as pure crops	Chakkupallam, Marayur, Kanthallur, Munnar and Chinnar areas of Idukki district and parts of Attappadi hill tract
Cardamom	Cardamom is grown in natural forests	Devicolam, Udumbanchola and Peerumade taluks of Idukki district, Nelliampathy and Attappady of Palghat, parts of Thannithode and Seethathode Panchayaths of Pathanamthitta and part of high ranges in Quilon and Trivandrum districts

1	2	3	4	5
4.	Situation IV (WL, ME, MRF, NFC)	Alluvial	200—300	750 – 1500
5.	Situation V (FO)	Forest soil	Above 300	Above 750

6	7	8
Rice based cropping system, with ginger, banana, pulses, yams, vegetables, sesamom etc., as subsibiary crops	Single crop and double crop paddy lands are seen. In single crop paddy lands a second crop of vegetables and ginger, are raised wherever irrigation facilities are available. Second crop of pulses is raised when no irrigation facility is available. In paddy lands with irrigation facilities a second crop of paddy is raised. A two year rotation with paddy followed by banana is also seen.	Throughout the wet lands of high ranges of Wayanad, Idukki, Palghat, Pathanamthitta, Quilon and Trivandrum
Forests	Both natural and artificial forests come under this situation. These forests are parts of Western Ghats characterised by a rich diversity of plant species and genera. The artificial forests include plantations of teak, eucalyptus, pine and other soft wood trees	Throughout the high ranges of Wayanad, Idukki, Palghat, Pathanamthitta, Quilon and Trivandrum districts

Area under different crops in the five Situations

Crop	Situation				
	I	II	III	IV	V
Rice				57762	
Pepper	31932				
Ginger	5002			1006	
Turmeric	554				
Cardamom	5378		52012		
Banana and other plantains	5214	891		4430	
Sugarcane	312	4161		508	
Cashew	3497				
Tapioca & Other tuber crops	13121	5624		4314	
Tea	32344				
Coconut	33834				
Coffee	60405				
Rubber	51234	3295			
Arecanut	7152				
Vegetables	540	4812		1272	
Groundnut, pulses and oil seeds		4186			
Ragi and sorghum		3064			
Wheat		1940			

3.3 Agricultural characteristics of agro ecological situations

3.3.1 Situation I (UL, ME, MRE, NFC)

i) Delineation of the area

This situation is spread throughout the high range zone and is not contiguous. This is the major agricultural situation in the zone characterised by rich diversity of crops and cropping patterns.

ii) Physiography

This situation is seen throughout Wayanad. Peerumade, Udumbanchola and Devikulam taluks of Idukki district, Nelliampathy and Attappadi hills of Palghat, Thadnithode and Seethathode of Pathanamthitta, Aryankavu, Kulathupuzha and Thenmala Panchayaths of Quilon district and the high ranges of Trivandrum (Amboori, Peringamala, Vithura, Aryanadu and Kallikkadu) district. The land is mostly undulating with gradual to very steep slopes.

iii) Climate

This situation enjoys a mild sub-tropical climate with rainfall ranging from 200-300 cm. The rainfall distribution pattern typifies heavy falls during June to August, moderate rains during September to November and light or no falls during December to May.

iv) Soils

Soils of this situation are mostly ferralitic with sandy clay loam to clayey texture. Surface soils are rich in organic matter. The sub surface layers have lateritic gravel and gneissic boulders. Soils are rich in sesquioxides and are acidic (pH-5.0 to 6.2) and generally poor in P and K, low in bases with low CEC. They are well drained with good physical properties and respond well to management.

Description of a typical soil profile under the situation is given below.

Location	Mangayam, Palode, Trivandrum district
Depth (cm)	Description
0-25	Very dark brown (10 YR 2/2) silt loam, massive, non-calcareous, well drained, abundant roots, few iron gravel upto 3 mm size; few earth worms, clear and wavy boundary
25-56	Dark brown (7.5 YR 4/4) clay loam; granular, non-calcareous, well drained, few roots, weathered boulders of 25 cm diameter, red motling common, clear wavy boundary.
56-150	Strong brown (7.5 YR 5/6) clay loam, sub angular blocky, well drained, few roots, non calcareous, mixed with the the weathered parent material in the process of laterisation, merges with the laterite bed below.

Analytical results of soil profiles

Depth (cm)	Mechanical composition					Textural class	Water holding capacity	N	C	CEC	pH
	Gravel	CS	FS	Silt	Clay						
Palode (Trivandrum) 0-25	28.0	37.1	24.9	12.0	26.0	Clay loam	49.84	0.24	2.44	8.3	4.2
25-56	36.0	31.3	22.7	12.0	34.0	Gravelly clay loam	41.94	0.09	1.92	6.5	4.3
56-150	48.0	30.2	23.5	14.1	32.2	Gravelly clay loam	40.0	0.12	1.15	5.7	4.2

v) Land use pattern

Land under this situation is intensively used for cultivation of crops, predominantly plantation crops.

vi) Irrigation

Agriculture in this situation is mostly rainfed. However, irrigation with private tanks and wells can be seen. The major crops of this situation, coffee and pepper respond to rainfall during preblossom and and blossom periods. Thus rains during January to March largely determine yields during the ensuing season.

vii) Land holding pattern

Published data on size distribution are not available. However, it may be noted that the average holding size is greater than the state average, a peculiar feature of agriculture in the high ranges. Agriculture is the main occupation of a major chunk of the population. The farmers with relatively larger size class of holdings are popularly called 'Planters' Thus a commercialised type of farming is seen in this situation.

viii) Major crops and cropping patterns/ systems

The major crops grown in this situation are perennials like coffee, tea, rubber and arecant and annuals like ginger, banana, yam etc. While tea and rubber are grown as monocrops, coffee, pepper. coconut and arecanut are raised as monocrops or in combinations. The estimated area under different crops in this situation is given below (Fig. 27).

Sl. No.	Crops	Area (ha)
1	Coffee	60405
2	Pepper	31932
3	Tea	32344
4	Rubber	51235
5	Cardamom	5378
6	Arecanut	7152
7	Ginger	5002
8	Banana	5214

Coffee is the major crop occupying about 60,405 ha followed by rubber grown in lower elevations.

The major cropping/farming systems are coffee based farming system, perennial monocrops, annual crops in uplands, perennial fruit plants and minor spices.

a) Coffee based farming system

Three typical situations of this system could be observed viz.

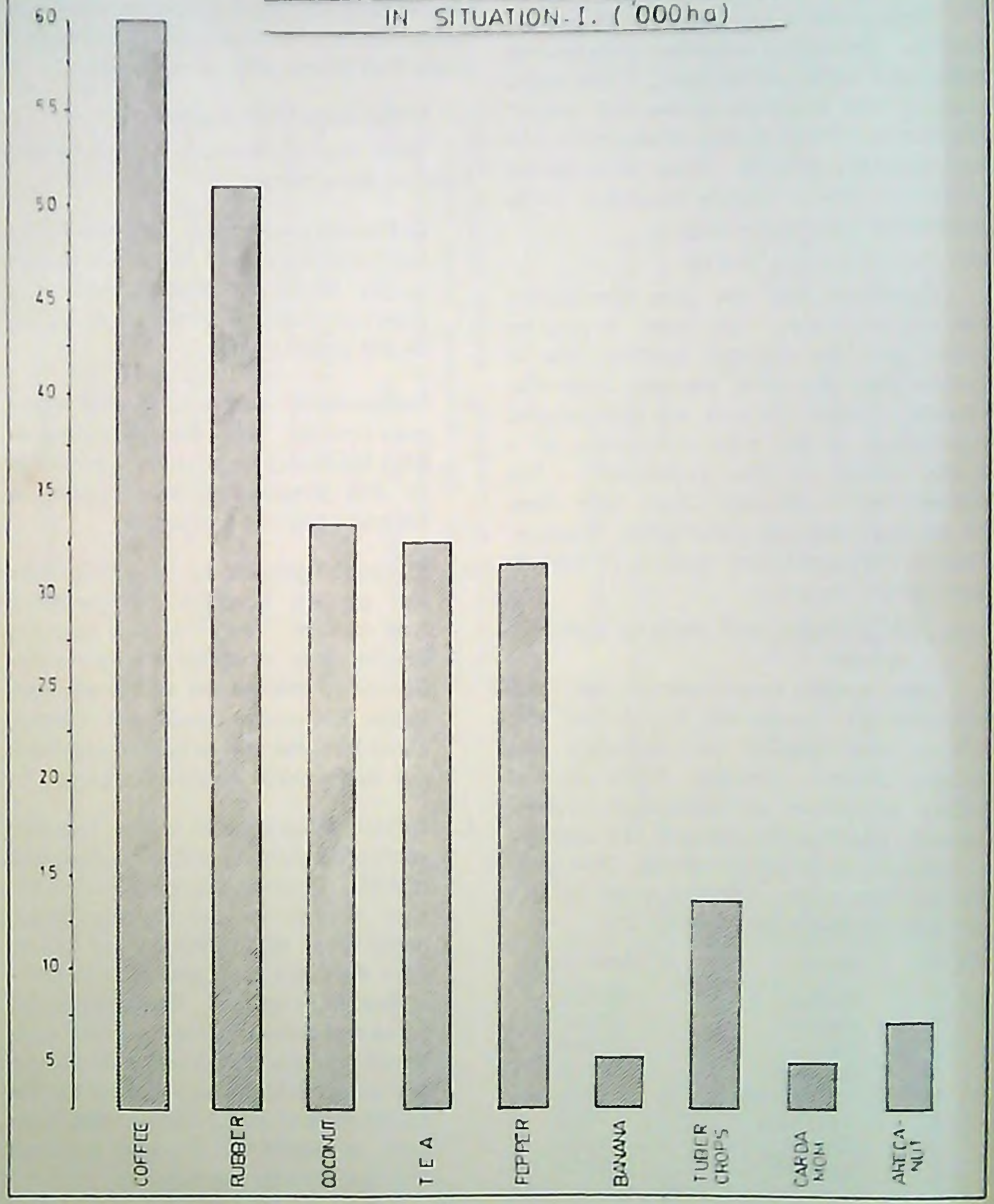
1. Coffee as a pure crop: Robusta is the most popular variety of coffee grown in this situation. Though coffee is grown as a pure crop pepper is trailed on the shade trees.

2. Coffee along with pepper as a mixed crop system: This system is now-a-days becoming popular in this region. In this system, pepper is raised in between two rows of coffee.

3. Coffee in homesteads: Perennial crops like pepper, coconut, orange and a host of other tree crops are raised in homesteads. Coconut is a new introduction to this system and to the high range. But orange has almost disappy eared from the coffee gardens possibl- due to the citrus decline syndrome.

4. Intercropping annuals in the first two years after planting coffee pepper and rubber: This practice provides reasonable returns to the grower during initial years when there is no returns from the main crop and is seen throughout high ranges. Banana, ginger, yams and turmeric are the most preferred annuals. Cultivation of banana and ginger is found to be better for the establishment and growth of the main crop, as these crops are well manured and fertilized by the farmers.

FIG. 27. AREA UNDER MAJOR CROPS IN SITUATION-I. ('000ha)



b) Perennial monocrops

1. Pepper

Although pepper is mostly grown as mixed crop it is grown as a pure crop in Pulpally, Mullankolly, Seethamound, Kurumbalakotta and in parts of Idukki districts. Rainfall in these regions is comparatively low and they experience a warm dry climate condusive for spiking in pepper.

Pepper is planted at a spacing of 3 x 3m or 4 x 4 m. Silver oak *(Graveilia robusta)*, Dadap (*Erythrina lithosperma*) and Moringa (*Moringa elegera*) are the main standards used for trailing pepper. Karimunda, a local variety and Panniyur 1, a high yielder released by the Kerala Agricultural University are the popular varieties. During the first two years after planting annuals like banana and ginger are grown as intercrops which generate additional income to the grower.

2. Tea

Tea is grown mostly in estates. Nenmeni, Muppainad, Kottappady, Meppadi and Thariode are the main tea growing areas of Wayanad district. In Idukki, tea estates are seen in Peerumade, Udumbanchola and Devikolam taluks. Tea is also grown in Nelliampathy hills of Palghat and Ponmudi hills of Trivandrum district. The research and development activities in tea are undertaken by the United Planters Association of South India (UPASI) which has regional research stations at Coonoor and Vandiperiyar.

3. Rubber

Rubber is a main crop in the high ranges of Pathanamthitta and Quilon districts. In Wayanad, it is cultivated in Pulpally, Ambalavayal, Thariode, Kuppadithara, Kuppathode, Nadavayal, Payyampallil, Kammana and Poothadi areas. It is also grown in the lower reaches of Peerumadu and Udumbanchola taluks of Idukki district.

4. Coconut

Coconut, a crop of recent introduction is gaining popularity especially in Wayanad. It is cultivated in a mixed system with coffee and pepper in homesteads,

5 Arecanut

Arecanut is grown in a mixed system, throughout the high ranges along with cardamom, cacao, pepper etc. It is seen in Vythiri taluk of Wayanad, Devikolam and Udumbanchola taluks of Idukki, Nelliampathy of Palghat, high ranges of Pathanamthitta, Quilon and Trivandrum districts.

c) Annual crops in uplands

1. Tapioca and other tubers like yams are grown as monocrop or as intercrops in young coffee and popper plantations.

2. Ginger

Ginger is a high value spice crop grown throughout the high ranges. The crop is planted during May-June as a rainfed crop and harvested during December-January.

3. Banana

Nendran banana is grown as a pure crop on a commercial scale throughout the high ranges. Other varieties like Palayankodan, Poovan, Grosmichel etc., are also seen. It is also grown as an intercrop in the first 2 to 3 years after planting perennial plantation crops. This practice is found to enhance the establishment of the main crop as it will provide shade and ideal conditions for its early growth.

d) Perennial fruit plants

Perennial fruit plants like mango, jack, sapota, guava, litchi, avocado etc. are grown in homesteads. Mandarin orange,

an important fruit crop in Wyanad and Nelliampathy till the recent past, is gradually disappearing.

e) Minor spices

Minor spices like, clove, nutmeg, cinnamon, all spice, etc. are also grown throughout the high ranges mostly in homesteads.

ix) Adoption pattern and production constraints

1. Coffee

Major area is planted with old Wyanadan or local Robusta coffee which have low production potential. Under shading or overshading' over crowding, under nourishment etc. result in low yield. No proper spacing is adopted for planting intercrops like pepper. Adequate manuring is not done for all crops in the farming system. The crops are raised purely as rainfed. However in some large estates sprinkler irrigation is adopted for coffee.

Constraints in production: (i) Lack of high yielding coffee strains suitable for Wyanad conditions. (ii) The most optimum crop combinations and scientific planting methods which would give maximum net returns per unit area have not been evolved. (iii) Cropping system approach in the manurial and fertilizer application is not available. (iv) Timely blossom and backing showers are very essential for good coffee yield. Very often one or both of these showers fail which result in poor crop yield. (iv) Suitable and timely control measures against various pests and diseases of different crops in the crop mix are not being adopted.

Research responsibilities:

(i) Evolving/identifying high yielding coffee strains and replanting unproductive gardens which have lost their production potential due to old age in a phased manner. (ii) Developing ideal crop mix in the coffee based farming system (iii) Developing scientific, agronomic orchard management practices and fertilizer schedules for cropping systems. (iv) Developing low cost sprinkler irrigation units for small holdings. (iv) Effective control measures against mealy bug and shoot borer of coffee are to be evolved.

2. Annual crops in young coffee plantations

Beds, pits or mounds are taken depending upon the crop selected (ginger, turmeric, tuber crops etc) for planting with the receipt of first monsoon showers in April. Farmers by and large grow these crops along the contours in slopy areas without adopting any soil conservation measures. This results in considerable soil erosion. But if beds for ginger are taken against slopes, it will result in waterloging which in turn aggravate the bacterial wilt diseases.

Constraints in production: (i) Soil erosion due to non adoption of soil conservation. measures. (ii) Lack of knowledge about the most profitable intercrops in different situations. (ili) Poor adoption of recommenned practices for various crops with particular reference to fertilizer application. Research responsibilities: (i) Identification of suitable planting methods in slopy areas. (ii) Identification of most profitable crop varieties for specific localities. (iii) Fixingup fertilizer schedules for effective plant protection measures for individual crops and the cropping system.

3. Pepper

In monocropping system, the pepper is planted at 3m x 3m spacing and Dadap or silver oak is used as the standard. Manuring or plant protection operations are not generally practiced for pepper, except few cultivators.

Constraints in production: (i) Since the initial fertility status of the soil is very high, the cultivators do not generally apply fertilizers. This would adversely affect productivity in the long run. (ii) Non adoption of preventive/control measures against pollu, quick wilt and slow wilt diseases which result in the death of large number of vines. (iii) Dependence on only one crop/variety will restrict alternative source of income in years of crop failure.

Research responsibilities: (i) Identification of high yielding regular bearing varieties for monocropping systems. (ii) Fixing up optimum fertilizer requirements for high yield. (iii) Identification of best live or dead standards which do not compete with pepper for plant nutrients (iv) Development of technologies for pepper processing (v) Evolving effective preventive/control measures against diseases and pests (vi) Measures to improve the overall productivity of pepper garden.

4. Tea

Cultivation of tea is usually undertaken by plantation companies. The small cultivators do not have tea plantations. The UPASI is providing all research and developmental supports for tea.

5. Rubber

The research and developmental activities for this crop are undertaken by the Rubber Board. Farmers generally adopt all the scientific recommendations due to the attractive subsidy schemes and the steady prices.

6. Coconut

As stated elsewhere, coconut is cultivated as a mixed crop, mainly in coffee plantations and in homesteads. Organic manure application is a common practice. Intercultivation is also done.

Constraints in production: (i) The best cultivar for high altitude areas have not been identified. (ii) Proper cultural and manurial methods in a mixed system has not been standardised. (iii) The most economical crop caffeteria with coconut has to be evolved. (iv) Shading by the shade trees in coffee plantations and competition of coffee etc. may result in relatively lower yields.

7. Arecanut

Arecanut is mostly cultivated as a mixod crop with cardamom and pepper. Mangala, cultivar is getting popular.

Constraints: (i) Nut size is smaller than that in lower elevations (ii) Improper drainage in valley areas reduce the growth and yield. (iii) Mahali, a fungal disease is causing reduction in yield.

8. Perennial fruits

Fruit crops like citrus, jack, mango, etc. are grown as intercrops in coffee plantations, or in homesteads. Other fruit crops liko sapota, litchi, avocado, mangostein, guava etc, are also cultivated in homesteads.

Constraints: (i) Die-back of citrus (ii) Late flowering of mango and cashew which results in the fruit maturity stage coinciding with rainy saason and thus impairing the quality. (iii) Pest and disease problems.

9. Tapioca

Planting is done with the receipt of summer showers in March/ April. Generally, no manures are applied. Digging, weeding, earthing up etc. are done.

Constraints in production: (i) The best variety for high altitude regions have not been identified. (ii) The best fertilizer dose and time of application have not been standardised.

Research responsibilities: (i) Identification of high yielding varieties for different locations. (ii) Standardisation of fertilizer doses and time of application.

10. Ginger

Planting is done in beds of about 1m width, 25 cm height and of convenient length prepared in flat lands or on steep or gentle slopes. Heavy dose of cattle manure, fertilizers and green leaf are applied. Weeding, earthing up and mulching are done twice or thrice.

Constraints in production: (i) Optimum manurial and fertilizer doses and time of application for maximum yield have not been fixed. (ii) Effective control measures against bacterial wilt and soft rot are not available.

Research responsibilities: (i) Developing economic control measures against bacterial wilt disease and soft rot. (ii) Evolving optimum fertilizer schedule. (iii) Evolving/screening bacterial wilt resistant or tolerant cultivars.

3. 3. 2 Situation II (UL, HL, LRF, NFC)

i) Delineation

This situation is mostly seen in Udumbanchola and Devicolam taluks of Idukki district. Areas like Chakkupallam, Marayur, Chinnar, Vattavada, Kanthallur and parts of Attappady constitute this situation.

ii) Physiography

The areas coming under this situation are undulating with small hillocks.

iii) Climate

This situation enjoys a peculiar climate different from that in the rest of the high ranges. These regions receive very low rainfall, less than 200 cm with a fairly long dry spell during summer months. However, during winter, the night temperature drops below 15°C.

iv) Soils

The soils of this situation are developed mainly from crystalline and gneissic rocks comprising of granite, silmanite gneiss, hornblende, biotite and pink gneiss. They have been formed under comparatively lower rainfall and high temperature conditions. Soils are shallow and have sandy loam to sandy clay loam surface texture. The sub surface layers of the profile reveal rock fragments and weathered gneiss. Soils have neutral reaction (pH 6.65) and are rich in plant nutrients and respond well to management.

Analytical results of a surface sample from Marayur, Idukki district are given below:

Analytical results of a surface sample from Marayur, Idukki district

pH	6.65
Electrical conductivity	0.15
Sand (%)	56.5
Silt (%)	23.0
Clay (%)	20.5
Textural class	Sandy clay loam
CEC (Me/100g)	5.1
Organic carbon (%)	0.67
Total nitrogen (%)	0.091
Available nitrogen	0.015

v) Land use pattern

The land under this situation is cultivated with a variety of crops. Sugarcane, cool season vegetables, ragi, sorghum, wheat, rice etc. are grown in this situation. The agroclimatical feature of the Kanthallur, Vattavada, Kottakkombu, Keezhanthur and Marayur locations are suited for growing cool season vegetables like cabbage, cauliflower, beet root, onion, garlic, potato, beans etc.

vi) Irrigation

Due to scarcity of water, no irrigation is practised. The crops are rainfed.

vii) Major crops and cropping pattern

Sugarcane, winter vegetables, ragi, sorghum, wheat etc. are grown in this situation (Fig.28)

a, Sugarcane

Sugarcane is a major crop in Marayur, Kanthallur, Chakkupallam areas. It is taken as a monocrop. Generally, the crop takes long duration and has higher productivity than in the plains. The quality of 'Gur' is also better than that at the lower elevations.

b Winter vegetables

Cool season vegetables like cabbage, cauliflower, beet root, carrot, potato, french beans, garlic and onion are grown as monocrop under rainfed conditions.

c. Ragi and sorghum

In Marayur and Chinnar areas, ragi and sorghum are grown as rainfed crops in patches.

d Wheat

In patches, wheat is cultivated in Marayur and Vattavada areas as monocrop.

viii) Adoption pattern and production constraints

1 Sugarcane

The crop is grown in uplands under no forest cover. No specific cultivars are recommended for this region. But farmers cultivate varieties evolved by the Tamil Nadu Agricultural University. Similarly, specific fertilizer recommendations are also not available.

Constraints in production: (i) The high yielding varieties for the situation have not been identified. (ii) Quality seed materials are not obtained according to demand. (iii) Optimum time of planting, cultural, manurial and plant protection practices etc. are lacking.

Research responsibilites: (i) Screening of varieties of winter vegetables suited for growing in this locality and distribution of their seeds. (ii) Standardisation of agrotechniques for cool season vegetables grown in the region.

2 Ragi, Sorghum and Wheat

These crops are also grown in rainfed conditions. Specific recommendatiens on cultivation of these crops are lacking. Screening cultivars suited to the situation, standardisation of cultural and manurial operations etc. are the research responsibilites.

3.3.3 Situation III (UL, ME, HRF, FC)

i) Delineation

This situation is prevalent in Vythiri, Lakkidi and Meppadi areas of Wayanad, Attappadi and Nelliampathy areas of Palghat district and Devicolam, Udumpanchola and Peerumade taluks of Idukki district. A major portion of Idukki district comes under this situation.

ii) Physiography

The land under this situation is mostly undulating with gentle to steep slopes and are situated at 750-1560 m from MSL.

iii) Climate

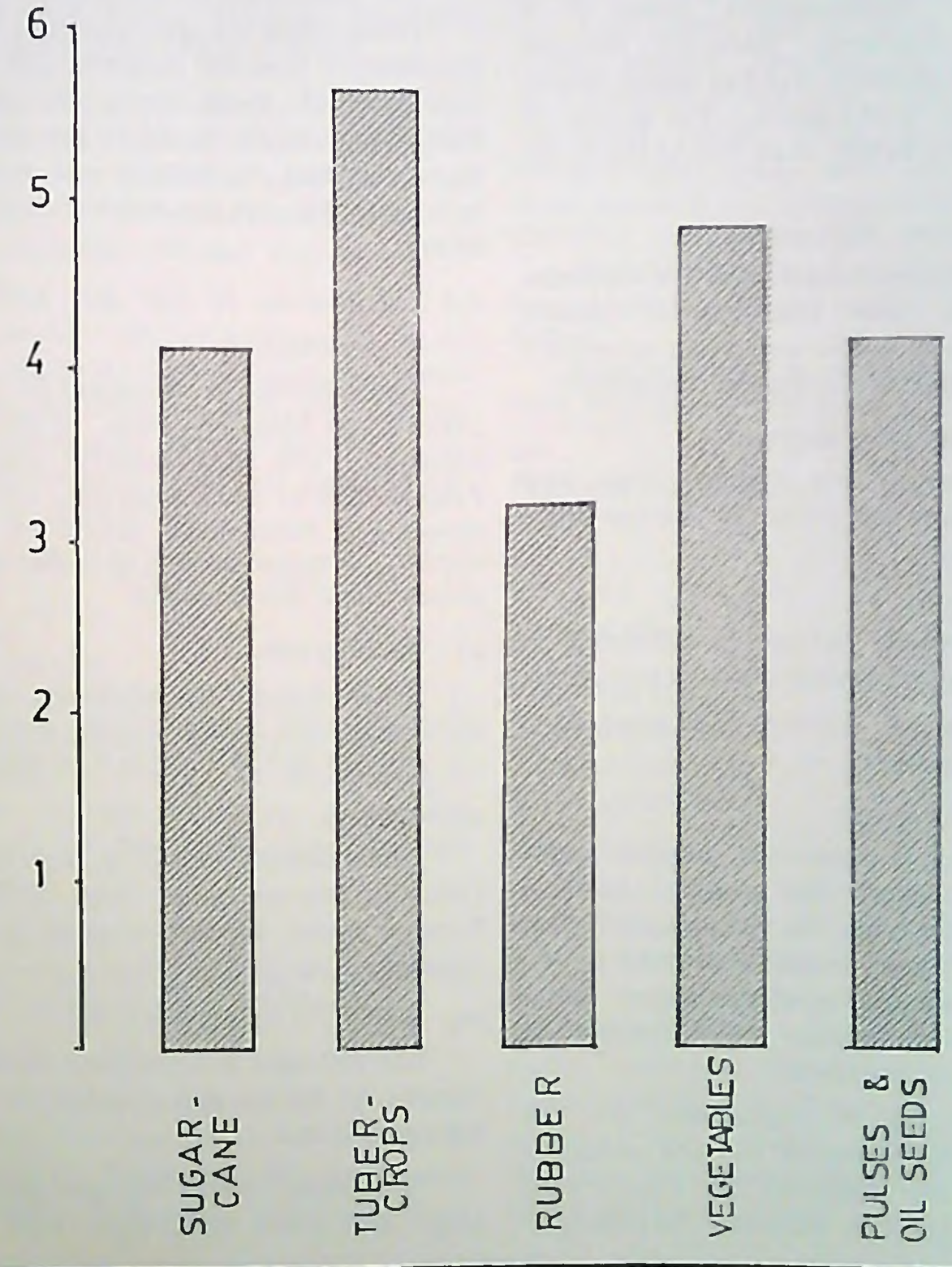
This situation onjoys a high rainfall (annual rainfall more than 300 cm). Tropical forest conditions exist in these regions.

iv) Soil

The soil type is forest loam with high content of humus and organic matter in the upper layers.

The forest loams occupy the area under cardamom plantations with forest

FIG - 28. AREA UNDER MAJOR CROPS IN SITUATION - II ('000 ha)



cover. They have immature shallow profiles with rock fragments. Soils are rich in organic matter in the surface, acidic in reaction but show wide variations in texture. The surface soils have high cation Exchange Capacity due to high organic matter content and also show accumulation of exchangeable bases like calcium, magnesium and potassium. Sub surface layers are rich in sesquioxides and poor in nutrients. They are well drained with good physical properties.

Typical soil profiles found in this region are presented hereunder.

a) Thekkadi series

The Thekkadi series is a member of the fine, kaolinitic, isohyperthermatic family of tropeptic eutrorthox. Soils have a thin organic horizon of decomposed forest litter, dark reddish brown medium acid clayey. A horizons and dark red to reddish brown medium to very strongly acid clayey B Horizons. Thekkadi soils have been developed on gneissic material on moderately sloping hills at an elevation of about 750 m above MSL in Idukki district. The climate is humid tropical with mean annual temperature of 27.1°C and mean rainfall of 400 mm.

Typifying pedon : Thekkadi/clay forest

Classification : Tropeptic Eutrothox

Horizon	Depth (cm)	Description
1	2	3
O1	0-5	Partially decomposed forest leaves and twigs with some soil
A1	5-27	Dark reddish brown (5YR 2/m) clay; weak fine subangular block structure breaking to weak medium granular friable, stricky and plastic; many medium to coarse roots, 2 to 5 mm size quartz gravel about 3 per cent by volume; common fine tubular pores, pH 6.0 clear smooth boundary.
B1	27-58	Dusky red (2.5 YR 3/2m) clay; weak fine to moderate medium subangular blocky, structure, friable, sticky and plastic; common medium and coarse root; 3 to 5 mm size quartz gravel 3 to 5 per cent by volume; common fine tubular pores, pH 5.6; abrupt wavy boundary
B21	58-85	Dark reddish brown (2.5 YR3/4m) clay; weak fine to medium subaugular blocky structure; very friable; sticky and plastic; few medium; coarse roots; 2 to 15 mm size quartz gravel, 5 to 10 per cent by volume; common fine tubular pores; pH 5.3; clear smooth boundary.
B22	85-113	Dark red (2.5 YR 3/6m) clay; weak fine medium subangular blocky structure; very friable; sticky and plastic; few medium and coarse roots; 2-15 mm size quartz gravel 6 to 10 per cent by volume; common fine tubular pores pH 5.0, clear smooth boundary.

1	2	3
B23	113-143	Dark red (2.5 YR 3/6m) gravelly clay; weak fine to medium sub-angular blocky structure; very friable, sticky and plastic; 2 to 15 mm size quartz gravel 10 to 15 per cent by volume; common fine tubular areas; pH 5.0, clear smooth boundary.
B3	143-190	Dark red (2.5 YR 3/6m) gravelly sandy clay; coherent mass breaking to granular structure; very friable, sticky and plastic; 2 to 20 mm size quartz gravel 30 to 60 per cent by volume; pH 4.9.

b. Periyar series

Location : Periyar—Manantoddy. Wayanad

Horizon	Depth (cm)	Description
O1	0-2	Partly decayed leaves and litter
A2	2-6	Dark brown (7.5 YR 3/2) clay loam; crumb; friable; slightly plastic; fine roots pleanty; few gneissic gravels, clear smooth boundary, rapid permeability.
B1	6-21	Dark reddish brown (5 YR 3/4) clay loam medium, weak subangular blocky; friable, sticky and slighly plastic; fine roots pleanty, gravel 21 per cent; clear wavy boundary; moderate permeability
B2	21-42	Yellowish red (5 YR 4/6) clay; weak, medium subangular blocky; friable sticky and plastic; fine to medium roots pleanty; gravel 27 per cent; clear wavy boundary; moderate permeability.
B3	42-90	Yellowish red (5 YR 3/6) clay; weak, medium subangular blocky; friable, sticky and plastic; few medium to fine roots; moderately slow permeability

Analytical results of soil profile

Location	Depth (cm)	Gravel	Mechanical composition				Textural class	C	CEC	pH
			Course sand	Fine sand	Silt	Clay				
Thekkadi	0-27	2	27.9	14.7	16.2	41.2	Clay	3.29	14.0	6.0
(Idukki)	27-58	3	29.6	12.8	15.7	42.5	Clay	1.43	9.1	5.6
	58-85	7	29.7	11.2	12.5	46.6	Clay	1.00	5.7	5.3
	85-113	8	26.8	11.8	16.2	45.2	Clay	0.87	4.5	5.0
	113-143	17	26.2	12.1	18.0	43.7	Gravelly clay	0.31	3.4	5.0
	143-190	39	39.2	9.6	11.0	40.2	Gravelly sandy	0.69	2.7	4.9
Periyar	0-30	21.30	10.53	21.63	18.65	27.89	Clay loam	3.02	—	—
(Manantoddy	30-60	27.30	7.74	18.34	15.54	31.08	Clay	1.27	—	—
Wayanad)	60-90	28.60	10.18	19.35	10.38	31.49	Clay	0.79	—	—
	90-120	36.95	5.83	14.73	10.77	31.72	Clay	0.84	—	—

v) Land use pattern

Natural forests are cleared and cardamom is planted.

vi) Irrigation

Usually cardamom is not irrigated. But in some hillocks or valleys fresh water streams are available.

vii) Major crops and cropping pattern/ system

Cardamom is the main crop grown in the situation. In majority of areas it is grown as pure crop in forest land after removal of underneath growth. In some areas it is intercropped with pepper. The area under cardamom in different situations is presented inFig.29.In Idukki district. some farmers are successfully maintaining bee-hive colonies in the cardamom estates. The bees were found to increase pollination and fruit set and thus high yields from cardamom.

viii) Adoption pattern and production constraints

Constraints in production: (i) Defore-station has brought about changes in ecosystem which is seriously affecting cardamom cultivation (ii) Information about the influence of macro-and micro-climatic factors on flowering and fruit set is lacking. (iii) Pests like cardamom borer, rhizome weevil, thrips, nematodes, etc. and diseases like Azhukal. Katte are serious problems.

Research responsibilities: (i) Evolving high yielding disease resistant clones and thus increasing the overall productivity (ii) Economic, quick and cheaper methods of vegetative propagation (iii) Detailed studies on the influence of macro and micro climatic factors on the growth and fruiting of cardamom. (iv) Effective control measures against nematodes, Azhukal, fruit borer etc.

3.3.4 Situation IV

(WL, ME, MRF, NFC)

i) Delineation

This situation is seen throughout the high ranges. The lower portions and valleys in between two hills forms the wet lands. The total geographical area of the situation is about 60,000 ha.

ii) Physiography

Wet lands are seen mainly in hill valleys and river banks. The land is gently slopping from one end to the other. Terracing is done in some areas.

iii) Climate

The annual rainfall ranges from 200 to 300 cm. Heavy showers are received from June-August. Rainfall is moderate in September-November to May. Slight or no rains are received during December to May.

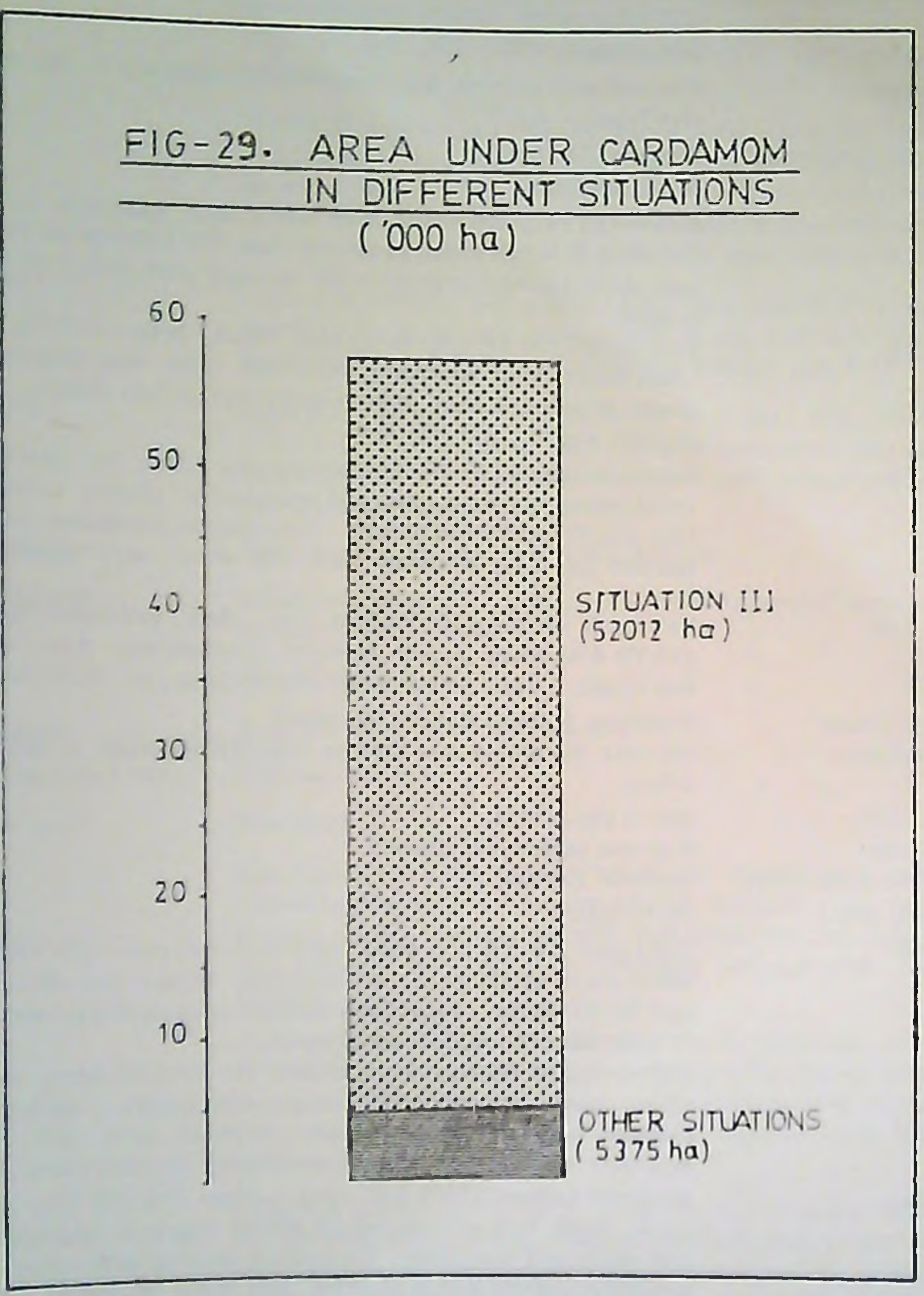
iv) Soils

Wet lands are seen in the valleys of undulating uplands. Soils are mostly a mixture of colluvium and alluvium and are rich in organic matter, acidic and show wide variations in texture. They are very deep and fairly rich in most of the plant nutrients. The main problem is poor drai-nage and associated toxicities of iron.

Details of typical soil profiles in this situation are given below:

FIG-29. AREA UNDER CARDAMOM IN DIFFERENT SITUATIONS

('000 ha)



a. Location: Thoduvetty, Sultan's Battery, Wayanad hilly area. The profile was situated on a gently slopping valley.

Elevation: 900 m above MSL

Drainage: Free and well drained. Slow permeability observed in the lower clay layer.

Ground water table: Shallow, 140 cm

Depth (cm)	*Description*
0—10	Brown (10 YR 5/3) sandy clay loam, dark yellowish brown (10 YR 4/4) when moist; moderate, fine and subangular blocky and slightly plastic, well drained; strongly acid (pH 5.3) roots present
10—35	Pale brown (10 YR 6/6) sandy clay loam, brown (10 YR 5/3) when moist; faint mottling; moderate, fine and subangular blocky structure; friable, slightly sticky and slightly plastic, well drained; slightly acid (pH 6.4)
35—80	Yellowish brown (10 YR 5/4) sandy clay loam, no change in moist state; moderate, fine and subangular blocky structure; firm, slightly sticky and plastic. Permeability moderate; neutral reaction (pH 6.7); boundary clear and sharp with underlying horizon.
80—140	Yellowish brown (10 YR 5/4) clay, dark yellowish brown (10 YR 4/4) when moist; massive, structureless; firm, sticky and plastic. Slow permeability; slightly acid (pH. 6.2)

b. Location: Chulliode, Sultan's Battery, Wayanad

Topography: Hill area, the profile was sited on high laying plots of terraced valley.

Elevation: 950 m above MSL

Drainage: Free and excessively drained

Ground water table: Shallow, 120 cm

Depth (cm)	*Description*
0—10	Light grey (10 YR 6/1) sand, light brownish grey (10 YR 6/2) when moist; single grain, structureless; loose, non-sticky and non 10-20 plastic. Excessively drained with rapid permeability; strongly acid (pH 5.3), roots present.
	Light grey (10 YR 7/2) sand, brown (10 YR 5/3) when moist; single grain, structureless; loose, non plastic, excessively drained with rapid permeability; medium acid (pA 5.7); boundary clear and sharp with underlying horizon, roots few.
20-30	Brownish yellow (13 YR 6/6) sand, yellow (10 YR 7/5) when moist, weak, fine and subangular blocky structure: slightly hard non sticky and non plastic. Excessively drained with rapid permeability; slightly acid in reaction (pH 6.4); boundary diffuse with underlying horizon,

30-45	Brownish yellow (12 YR 6/6) loamy sand, Yellowish brown (10 YR 5/8) when moist: moderate, fine and subangular blocky structure slightly hard, non plastic, moderately well drained; slightly acid (pH 6.3); boundary diffused with underlying horizon
45-60	Brownish yellow (10 YR 6/6) loamy sand, yellowish brown (13 QR 5/6) when moist; weak; fine and subangular blocky structure; slightly hard, non sticky and non plastic, moderately well drained with moderately rapid permeability; neutral reaction (pH 6.6); boundary clear and sharp with underlying horizon.
60-90	White (10 YR 8/1) loamy sand, light grey (10 YR 7/1) when moist; single grain, structureless; non sticky and non plastic, moderately rapid permeability; neutral reaction (pH-6.8)
90-120	Light grey (10 YR 6/1) loamy sand, dark grey (10 YR 4/1) (13 YR 4/1) when maist; single grain, structureless, non sticky and don plastic, moderately well drained with moderately rapid permeability; strongly acid (pH-5.4)
c. Lacation:	Nellurnad, Manantoddy (Wyanad District).
Topography:	Hilly area, the profile was sited on the central portion of narrow terraced valley.
Elevation:	800 m above MSL
Drainage	Free and moderately well drained
Ground water table:	Shallow, 90 cm
Depth (cm)	Description
0-10	Pale brown (10 YR 6/3) loam, brown (10 YR 5/3) when moist; moderate, fine and subangular blocky structure; very friable slightly plastic; Well drained with moderately rapid permeability very strongly acid (pH 4.7); boundary diffused with lower horizon
10-15	Light yellowish brown (10 YR 6/4) loam, yellowish brown (10 YR 5/6) when moist, moderate, fine and subangular blocky structure; friable, sticky and plastic. Moderately rapid permeability; strongly acid (pH 5.1); boundary diffused with lower horizon
15-30	Brownish yellow (10 YR 6/9) clay loam; yellowish brown (10 YR 5/8) when moist; massive, structureless; friable; very sticky and plastic; slow permeability; very strongly acid (pH-4.9) boundary diffused with lower horizon

30-50	Brownish yellow (10 YR 6/6) loam, yellowish brown (10 YR 5/8) when moist; massive; structureless; slightly hard; firm, very sticky and plastic; slow permeability; very strongly acid (pH-4.5)

d. Location — Pinengode, Kottathara Panchayath, Calpetta (Wayanad district)

Topography: — Hill area, the profile was sited on the central portion of a terraced valley

Elevation: — 700 m above MSL

Drainage: — Free and well drained

Ground water table: — Shallow, 87 cm.

Depth (cm)	Description
0-10	Yellowish brown (10 YR 5/4) loam, dark yellowish brown (10 YR 4/4) when moist; weak, subangular blocky structure; very friable, slightly sticky and slightly plastic. Well drained with rapid permeability; very strongly acid (pH 4.8) boundary diffused with lower horizon
10-15	Pale brown (10 YR 6/3); sandy loam, dark yellowish brown (10 YR 3/4) when moist; weak, subangular blocky structure; friable; slightly sticky and slightly plastic; well drained with rapid permeability, very strongly acid (pH 4.8) boundary gradual with lower horizon
15-25	Light grey (10 YR 6/2) loamy sand, pale brown (10 YR 6/3) when moist; weak; subangular; blocky structure; friable; slightly sticky and slightly plastic; moderately well drained; acid reaction (pH 5.1); boundary clear and sharp with lower horizon
25-40	Yellowish brown (1 YR 5/8) loamy sand, brown (7.5 YR 4/4) with moist; mottling distinct and many; principal colour of myttles is dark brown (10 YR 4/5); moderate subangular; blocky structure; friable, slightly sticky and plastic. Moderately well drained; strongly acid (pH 5.3); boundary diffused with lower horizon
40-87	Light grey (7,5 YR 6/0); sandy loam; grey (7.5 YR 5/0) when moist; massive strectureless firm sticky and very plastic; moderately well drained; strongly acid (pH 5.1)

Analytical results of soil profiles

Location	Depth cm	Mechanical composition				Textural class	W.H.C.	C	C.E.C.	pH (after water logging)
		C.S.	F.S.	Silt	Clay					
1	2	3	4	5	6	7	8	9	10	11
Thoduvetty	0-10	34.7	33.9	7.4	21.4	Sandy clay loam	27.8	1.52	6.72	6.8
	10-35	37.3	33.1	7.3	20.4	,,	25.17	1.14	5.83	6.9
	35-80	36.7	32.3	7.4	23.3	,,	30.73	6.23	3.25	6.8
	80-140	22.5	28.8	12.6	35.5	Clay	33.91	0.36	5.01	6.4
Chulliyode	0-10	76.2	16.4	2.0	3.0	sand	26.05	1.37	4.01	5.8
	10-20	74.7	20.3	1.0	2.0	,,	25.00	1.16	3.8	6.0
	20-30	67.2	22.8	8.4	1.4	,,	27.00	0.11	1.8	6.4
	30-45	64.4	22.6	8.4	4.4	loamy sand	28.40	0.10	2.5	6.3
	45-60	61.7	22.9	7.0	6.0	,,	30.40	0.08	2.5	6.6
	60-90	62.6	22.9	7.0	7.4	,,	31.20	0.03	1.32	6.8
	90-120	60.8	23.4	7.5	8.2	,,	33.20	0.02	1.30	5.4
Nellurnad	0-10	42.0	24.2	17.0	14.9	laom	32.04	1.14	6.13	6.6
	10-15	41.6	24.6	12.0	21.0	,,	31.44	0.84	6.00	6.6
	15-30	38.4	20.8	15.0	25.0	clay loam	35.74	0.51	5.32	6.5
	30-50	44.6	17.5	15.5	21.8	loam	32.01	0.38	4.08	5.4
	50-90	34.9	29.5	15.0	19.8	,,	33.62	0.50	4.91	5.5
Pinangode	0-10	49.0	19.8	12.4	16.3	loam	31.43	1.46	4.93	6.5
	10-15	58.0	20.5	18.3	6.5	,,		0.98	3.24	6.3
	15-25	54.4	22.2	18.0	5.0	,,	23.41	0.26	2.53	5.4
	25-40	45.0			6.5	,,	27.96	0.10	2.82	5.4
	40-87	39.8	28.8	22.0	0.3	,,	29.4	0.08	2.91	5.1

v) Land use pattern

The wet lands are mostly cultivated with paddy. In most areas, only a single crop of paddy is taken for shortage of water in the second crop season. However, in the rice fallows, crops like ginger, banana, vegetables, pulses and sesamom are grown in a limited scale. In recent years, because of the high cost of production and the relatively lower returns, farmers are lossing interest in paddy cultivation. Large area of wet lands are being converted for cultivation of more profitable crops. The business of brick making and urbanisation are also grabing large areas of wet lands.

vi) Irrigation

The first crop is purely rainfed. In most of the areas since irrigation facilities are not available, a second crop is not taken. However, in some places, especially the river banks of Panamaram river in Wayanad, lift irrigation is done using pumpsets. Besides public irrigation facilities, large farmers take a second crop with their own wells and pumpsets. There is scope for improving lift irrigation on river banks and well irrigation where perennial river water is not available.

vii) Major crops and cropping pattern/ systems

The duration of paddy in the high ranges is longer than that in the lower elevations. When the local cultivars take about 170-200 days, the medium duration high yielding varieties like Jyothi etc. take 120-130 days to mature.

The major cropping systems followed are given below:

Paddy—fallow—Since irrigation facilities are not available a second crop cannot be taken.

Paddy—paddy—This is practiced wherever irrigation facilities are available.

Paddy—ginger—This system has now became widely popular due to the relatively higher profits from ginger.

Paddy—pulses/vegetables—Vegetables are grown only if there are irrigation facilities. The popular vegetables are bitter gourd, snake gourd etc.

Paddy—tapioca/banana— This system is practiced as two year rotation.

The area under major crops in this situation is shown in Fig. 30

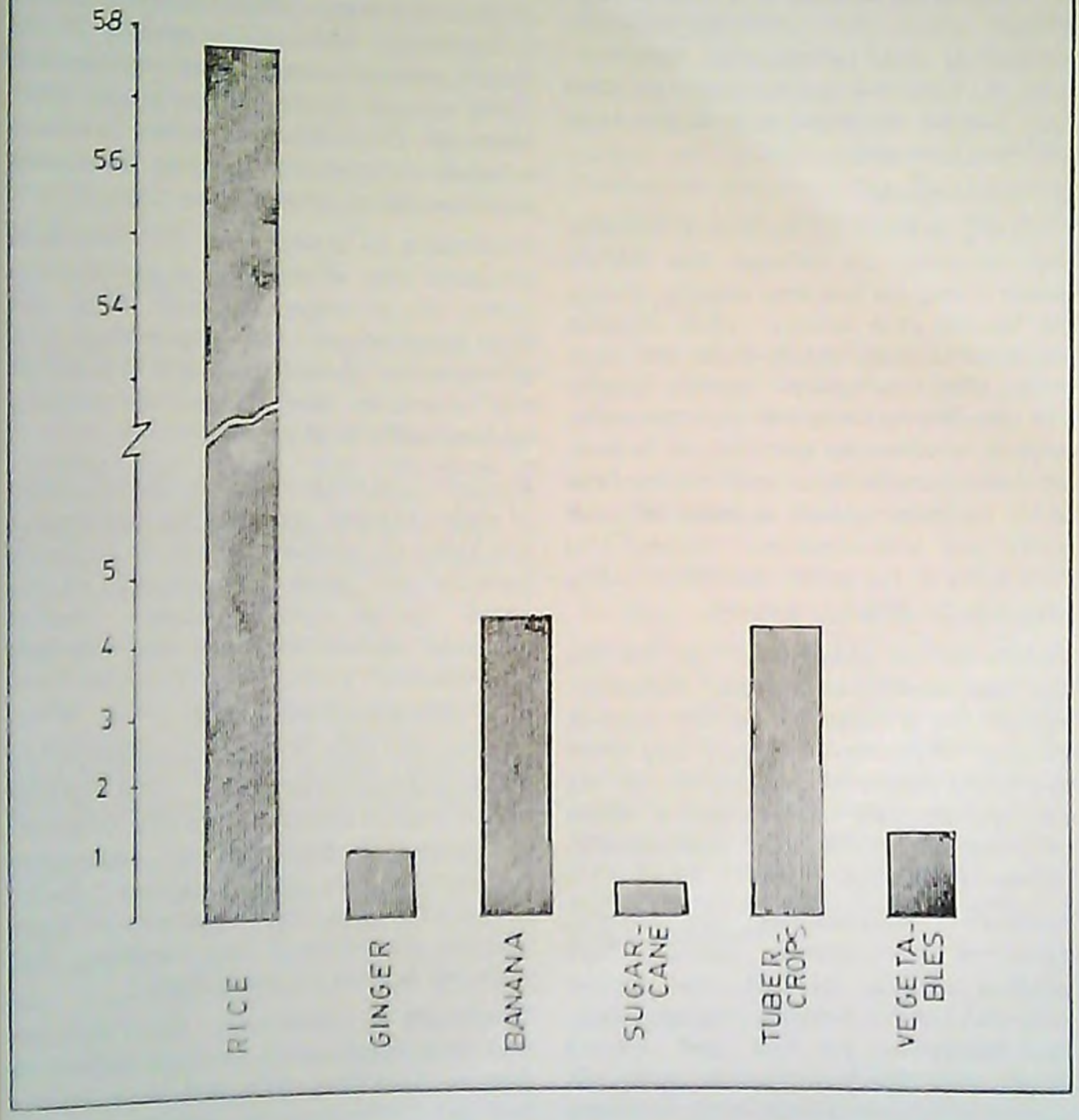
viii) Adoption pattern and production constraints

a. Paddy—fallow

Traditional, very long duration varieties (170 to 200 days) like Marathondi, Maranellu, Chettuveliyan, Chomala etc. and H4 are used. Crop is usually transplanted. Nursery is raised in May-June and transplanting goes on till the end of August and harvesting is done in December. Green leaf and cattle manure are applied as organic manure. Few cultivators apply fertilizers.

Constraints in production: (i) Due to very long duration of varieties, double cropping is not possible in a major area (ii) Low temperature during the crop growth period changes duration (iii) Fertilizer recommendation for high altitude areas not available (iv) Water management is not possible due to high rainfall (v) Recommended improved varieties are not adopted by cultivators due to low straw yield and susceptibility to diseases like blast (vi) High cost of weeding

FIG-30. AREA UNDER MAJOR CROPS IN SITUATION-IV ('000 ha)



(vii) Lack of proper drainage facilities. Research responsibilities: (i) Identification of high yielding long/medium/short duration varietal combinations for growing during first and second crop seasons so that two crops of paddy can be taken from the same land (ii) Identification of varieties with built in tolerance to cold spell for growing during winter season (iii) Fixing up fertilizer schedules for high altitude areas iv) Evolving economic methods of weed control (v) Identification of blast tolerant/resistant varieties (vi) Control measures against blast and *Udbatta* diseases.

b. Paddy-paddy

Long duration tall traditional varieties and improved tall varieties like H4 are grown during the first crop season. During the second crop season, short duration improved varieties like IR-8, IR.-20. Jaya, Jyothi, Taichung Native-1 etc. are grown. The second crop season is from December to April. When the first crop is rainfed, the second crop is taken with the facilities of lift irrigation system installed on river banks and well irrigation. Natural flow from tanks on the upper reaches of valley also used for irrigation purpose.

Constraints in production: (i) As the first crop season extends upto December, second crop is taken during the summer months. Water scarcity is felt very often during the period of the growth (ii) As the second crop is taken only in some pockets there is change of concentration of pest and disease attack.

Research responsibilites: (i) Identification of short/medium duration high yielding varieties for first and second crop seasons (ii) Evolving optimum fertilizer requirement for first and second crops (iii) Effective control measures against pests and diseases (iv) Evolving a manngement schedule which will reduce cost of production and thus increase returns from unit area.

c. Paddy-ginger

After the first crop of paddy, ginger cultivation in rice fallows is becoming very popular because of high returns. This is mainly sold as green ginger. A two year rotation is also followed with paddy and ginger. After harvest of paddy in December, beds of 1m width, 25 cm height and convenient length are formed. Cattle manure is applied as basal dose. Most of the cultivators follow a heavy schedule of fertilizers. The crop is irrigated from January to May.

Constraints in production: (i) Manurial schedule, time of planting, water requirements etc, of irrigated ginger have not been standardized (ii) Water stagnation during heavy rainfall period is a problem (iii) Bacterial wilt disease is causing serious losses to the farmer

Research responsibilities: (i) Identification of most suitable varieties for growing in rice fields (ii) Standardisation of cultural, manurial and water requirements of irrigated ginger (iii) Effective control measures against bacterial wilt and soft rot diseases.

d. Paddy-pulses/vegetables

The first crop of paddy is followed by pulses/oilseeds/vegetables. After harvest of first crop of paddy, pulses like cowpea, blackgram etc. Sesamum and vegetables are cultivated in some localities. Cultivation of pulses and sesamum is done utilising the residual soil moisture. Pot watering is done for vegetables

Constraints in production: (i) The most profitable crops suited for rice fallows in different localities have not been identified (ii) Technology for utilising the rice

fallows utilising the limited soil moisture have not been developed (iii) Package of practice recommendations based on research findings are not available (iv) Optimum time of planting and varieties of cool season vegetables like cabbage, cauliflower, etc. have not been idantified. Research responsibilities: (i) Detailed investigations to identify the varieties of cowpea, blackgram, greengram, sesamum, vegetables etc. will have to be undertaken (ii) Agrotechniques for cultivation of selected crops will have to be standardised (iii) In view of the possibilities of growing cool season vegetables in Wayanad, the most suited crop varieties, time of planting and agronomic practices will have to be evolved.

e) Paddy-banana

A two year rotation followed with paddy and banana. After harvest of paddy in December, raised beds are formed and suckers are planted on beds. The trenches on either side of the beds will serve as drainage channels. In some places, ginger, yams or vegetables are planted as intercrop in banana. Irrigation is given to banana from January to May.

Constraints in production: (i) Heavy and continuous rains sometimes flood lowlying areas which cause water stagnation and consequent wilting of banana (ii) No specific manurial and fertiliser recommendations are available for banana in Wayanad.

Research responsibilities: (i) Identification of best Nendran cultivar for high altitude areas (ii) Fixing up optimum time of planting (iii) Identification of most economic intercrops in banana (iv) Evolving fertilizer dose and time of application (v) Optimisation of a cropping system which will maximise profits from wet lands.

3.3.5 Situation V (FO)

i) Delineation of the area

Forests, natural and man made, are spread throughout the zone. The total forest area comes to about 541710 ha and is not contiguous. Of late there has been widespread depletion of forests due to intrusion.

ii) Physiography

This situation is seen throughout Wayanad and Idukki districts, Attappadi and Nelliampathy hills of Palghat, high ranges of Pathanamthitta, Quilon and Trivandrum districts. The land is mostly undulating with gradual to very steep slopes.

iii) Climate

The climate prevailing in these forests may be classed as tropical humid. They also receive rainfall of about 300 cm. The bulk of the rains are received during June to August. Weather conditions are comparatively cool in these regions.

iv) Soils

Soils of this situation are typical forest type with immature shallow profiles and rock fragments. They are rich in organic matter in the surface, acidic and show wide variation in texture. The surface soils have high cation exchange capacity due to high organic matter content and show accumulation of exchangeable bases namely Ca, Mg and K. Sub surface layers are rich in sequioxides and poor in nutrients.

Typical soil profiles under this situation are given below:

a) Viripura silt loam, Mankulam area of Devicolam taluk, Idukki district.

Horizon	Depth (cm)	Description
A1	0-5	Dark reddish brown (5 YR 2/2) moist; silt loam; medium; moderate crumb; friable; slightly sticky; abundant roots; few quartz gravels; clear wavy boundary.
A3	5-10	Brown (7.5 YR 5/4) moist; silt loam; medium, moderate subangular blocky structure; friable slightly sticky and slightly plastic; plenty of roots few quartz gravels; gradual wavy boundary.
B21	10-48	Strong brown (7 YR 5/6) moist; gravelly silty clay loam; moderate course; sub angular blocky structure; firm sticky and slightly plastic; patchy thin cutans; plenty of roots, few quartz, gravels, gneissic boulders of varying size and shapes present.
B22	48-110	Red (2.5 YR 4/6) moist, clay; moderate, course subangular structure; firm sticky and plastic; few roots; quartz gravels of varying size and shape present.

b) Devikolam-Munnar, Idukki District

Depth (cm)	Description
0-34	Dark reddish brown (5 YR 2/2) loamy sand; crumb, friable non-calcareous; quartz grains of 2 cm diameter; abundant roots, well drained; yellow and black mottling common; clear well defined wavy boundary.
34-75	Strong brown (7.5 YR 5/8) loamy sand; crumb; friable non-calcareous; very few roots, partially weathered pieces of rocks; black and yellow mottling; wavy and diffuse boundary.
75-150	Red (2.5 YR 4/8) gravelly silt loam; sub angular blocky; noncalcareous; well drained; highly weathered rock fragments and quartz grains present; roots absent.

c) Baveli series

Location—Baveli Manantoddy, Wayanad

Depth (cm)	Description
0-60	Dark reddish brown (5 YR 3/2) clay loam; massive; friable; noncalcareous; quartz grains; roots abundant; well drained; no mottling; no earth worms; clear and well defined boundary.
60-97	Dark Red (2.5 YR 3/6) dry coarse sandy loam; granular; friable; noncalcareous; no earth worms; well drained; yellow mottling prominent with slight red and black admixture; hard layer; very few roots; diffuse boundary
97-120	Red (2.E YR 4/6 dry) coarse sand; loose; noncalcareous; earth worms absent; well drained; black yellow and red mottling common; very hard layer; root penetration difficult.
Above 120	Parent rock

Analytical results

Lacation	Depth (cm)	Mechanical components					Textural clay	WHC	N	C	CFC	pH
		Gravel	C. S	F. S.	Silt	Clay						
Viripura	0—5	5.8	33.6	7.1	36.0	21.5	Silt loam	35.00	0.154	2.10	10.00	5.8
	5—10	20.4	38.2	7.4	30.0	22.5	,,	38.33	0.137	2.07	11.30	5.4
	10—48	25.2	30.0	9.2	28.5	30.5	Gravelly silt clay loam	41.66	0.126	1.75	11.80	5.3
	48—110	20.0	36.1	10.8	14.0	37.5	Clay	45.00	0.114	1.63	12.0	5.8
Devicolam	0—34	20.8	38.0	29.4	24.0	11.5	Loamy sand	48.9	0.46	5.56	16.4	5.5
	34—75	4.7	37.5	45.5	20.0	49.0	,,	40.3	0.05	0.49	3.1	4.5
	75—150	2.4	33.9	37.8	26.3	49.0	Silty loam	47.2	0,04	0.14	1.1	4.2
Baveli	0—60	21.5	29.4	46.6	14.0	14.0	Loam	28.8	0.16	1.16	8.9	5.2
Wayanad	60—97	46.0	26.5	33.5	9.0	40.0	Gravelly clay	35.7	0.10	0.56	12.7	5.8
	97—120	39.2	25.6	34.2	12.0	28.2	Gravelly clay loam	34.2	0.15	0.42	9.9	5.3

v) Land use pattern

The forests of the high ranges constitute, about 50 per cent of the total forest area in the state. The whole forests can be divided into two groups, the natural and man made forest (forest plantations). The important products obtained from these plantations are timber, fuel wood, teak poles, bamboo, cane, ivory rod, sandalwood, honey, dammer, etc. Plantation of teak, eucalyptus, soft wood, bamboo wattle, fire wood, pine and accasia are the major forest plantations. Besides these, coffee, pepper, cocoa etc. are also maintained as forest plantations.

Remote sensing studies conducted by the Land Use Board, elucidate the following facts: (i) The percentage area under forests in Idukki is only 53. (ii) About 24,000 ha in Idukki district classed as forests is barren land which may be brought under forests. (iii) The present practice of clear felling of valuable forests for raising plantations has to be restricted as it has many drawbacks and destroy the rare flora. (iv) The number of soft wood species in mixed plantations should be increased to meet the increasing demands of soft wood industries and (v) The area under sandal wood plantations in Marayur may be increased.

3.4 Agricultural engineering status

The production and productivity of many crops like paddy, coffee, vegetables etc. can be increased considerably if the irrigation facilities are improved. For instance, due to lack of irrigation facilities the second crop of paddy is taken only in about 28.3 per cent of the paddy land. Suitable water harvest-technologies in the valleys and gullies and design of water harvest ponds are to be standardised to improve the irrigation facilities.

In coffee, often, the failure of pre-blossom showers result in poor yields in the ensuing seasons. Providing sprinkler irrigation during the pre-blossom period if rains fail will substantially increase the yields.

Similarly, soil erosion and landslides also cause problems in the steep slopes. Most effective and economic methods of soil conservation measures are to be standardised.

Farm implements suited to hill ranges are to be fabricated. Development of bed former, ginger harvester, fruit pluckers, coffee pluckers, pepper harvesting devices, cardamom driers etc. can reduce wage employment and bring down the cost of production.

More than 80 per cent of cardamom produced in the state is from Idukki district. Even now curing of cardamom is done by conventional method which results in substantial wastage of energy. Evolving fuel efficient curing houses will besides reducing costs of cardamom curing, reduce the wastage of firewood.

3.5 Livestock constraints

During the last one decade, a large number of development schemes for livestock have been implemented by the central and state agencies. This increased momentum has also created multifarious obstacles or constraints in livestock development. About 12 per cent of the total livestock population is affected by various types of diseases. Veterinary facilities for diagnosis of many parasitological infestations etc. are also meagre. Farmers are ignorant in purchasing good quality breeds and since the cost of livestock has gone up high, people are often cheated; they purchase low quality animals with high cost. Prohibitive cost of the concentrates and

poor marketing facilities of milk are also major constraints in livestock development. Facilities for processing of surplus milk especially in rainy season, have to be improved. Farmers are not giving much importance for maintaining a replacement stock; they are not interested in calf rearing.

3.6 Typical innovative agricultural farming practices with rationales

Innovative practice	Rationale
Rice	
i) Nursery technique-the seeds are soaked in cowdung slurry and heaped for 3-4 days. The sprouted seeds are sown in nursery/main field	This practice helps to get higher germination percentage
ii) During second crop season (December) cowdung-slurry treated seeds are kept in gunny bags, on which heavy weights are placed. Sometimes the gunny bags are kept immersed in cowdung pits	This practice helps to overcome the inhibition of germination due to low temperature
iii) Farmers usually adopt higher seed rate, often twice the recommended rate in the nursery	This practice is followed taking into consideration the damage by birds and to use higher number of plants/hill in the case of delayed transplanting
iv) The twigs of wild-camphor, are placed in the main field of transplanted crop during early stage of growth	This is to minimise the damage caused by case worms
Ginger	
i) Storage of seed rhizomes after separating into seed bits	Induce more sprouts and increase germination percentage
ii) Sowing cowpea seeds on beds at the time of planting ginger which will be later uprooted and used for second mulching	Mulching material for second mulching can be saved. Also helps in N fixation in the soil and moisture conservation more effectively
iii) Use of spent leaves of eucalyptus as mulch	Eucalyptus leaves will take longer period for decay and thereby offer prolonged mulching effect as compared to green leaf mulch
Pepper	
i) Lowering, the vines and burrying in soil after coiling around the standard up to the length of first lateral production in the case of vines which produce laterals at higher level above the ground	Induce more laterals at lower level which help in maximum utilization of vertical space thereby increase the productive area and the yield
ii) Planting standard (karimurukku) and rooted cuttings of pepper together in the same year in adjacent pits with extra manuring and pruning of the standard	Time lag between planting of standard pepper can be saved which help to get early crop by one year

CHAPTER IV

Research and Extension Linkages

4.1 Linkages between research activities

The Regional Agricultural Research Station, Ambalavayal and its sub station Cardamom Research Station, Pampadumpara maintain close linkages with other four NARP zones. The Director of Research and Associate Directors of Research at the head quarters closely monitor the planning, implementation and progress of research activities. Linkages are also maintained with the central institutions like ICAR, Spices Board, Coffee Board and other Agricultural Universities to the extend necessary in utilizing their research findings and for strengthening germplasm collections. However, there is much scope for strengthening this linkage especially with centres located in areas with similar agro ecological situations.

4.1.1 Linkages within the zone

In addition to the Regional Research Station, Ambalavayal, the Cardamom Research Station, a sub station in the high range region is located at Pampadumpara of Idukki district. Close linkages are maintained between these stations of the zone since the implementation of NARP. The other agricultural research stations of the zone are Regional Coffee Research Station, Kalpatta, Cadbury's Cocoa Research Station, Kalpetta, Indian Cardamom Research Station, Myladumpara and UPASI Tea Research Station, Vandiperiyar. The crops and areas of research of the above stations are given below.

Sl No.	Research Station/Institute	Crops/aspects of research/ development
1	Regional Agricultural Research Station, Ambalavayal.	Citrus, mango, other fruits, hill paddy, pepper, ginger, other spices, medicinal and oil yielding plants, rice based farming system and coffee based farming system.
2	Cardamom Research Station Pampadumpara	Cardamom, hill paddy and pepper.
3	Regional Coffee Research Station, Kalpetta.	Coffee.
4	Indian cardamom Research Station, Myladumpara.	Cardamom and other spices.
5	Cadbury's Cocoa Research Station, Kalpetta.	Cacao
6	UPASI sub station, Vandiperiyar, Idukki.	Tea, coffee and cardamom.
7	Indo-Swiss project, Mattuppetti, Idukki.	Livestock and fodder crops.

4.1.2 Linkages between different zones and head quarters

The Regional Research Station, Ambalavayal has close linkages with the Regional Agricultural Research Stations at Pilicode, (Northern zone), Pattambi (Cenral zone) Kumarakom (Zone of problem areas) and Vellayani (Southern zone) and their sub-stations. We also have close co-ordination with the Pepper Research Station, Panniyur, a sub station of the Northern zone. The Director of Research and the Associate Directors of Research at the Directorate of Research closely monitor the planning and implementation of the various research programmes.

4.1.3 Linkage with central and other institutions and universities

The Regional Agricultural Research Station, Ambalavayal, maintains close linkage with various central and state institutions in collaborative research programmes, enriching its germplasm collections etc. The above institutes and the areas of mutual interest are given below:

Sl. No.	Research Station/Institute	Areas/Crops
1	2	3
1	Regional Coffee Research Station, Kalpetta, Wayanad.	Coffee
2	Central Plantation Crops Research Institute, Kasargod	Plantation crops
3	National Research Centre for Spices, Marikunnu, Kozhikode	Spices
4	Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram	Tuber crops
5	Directorate of Cocoa, Arecanut and Spices, Kozhikode	Cacao, arecanut and spices
6	Centre for Water Resources Development and Management, Kunnamangalam,	Water management aspects
7	Kozhikode Punjab Agricultural University, Ludhiana	Citrus and cool season vegetables
8	Central Horticultural Experimental Station (IIHR) Chethalli	Citrus and spices
9	University of Agricultural Sciences, Bangalore	Fruits
10	Indian Institute of Horticultural Research, Bangalore	Fruits and vegetables
11	G. B. Pant, University of Agriculture and Technology, Pant Nagar	Cool season vegetables
12	Tamil Nadu Agricultural University, Coimbatore	Fruits and vegetables
13	Assam Agricultural University, Jorhat	Ginger
14	Dr. Y. S. Parmar University of Horticulture and Forestry, Solan	Ginger
15	Indian Cardamom Research Station, Myladumpara	Cardamom
16	UPASI Sub Station, Vandiperiyar	Cardamom

The Cardamom Research Station, Pampadumpara maintains close linkages with Cardamom Research Station of Myladumpara and Appangala and the Spices Board.

4.2 Linkages with extension agencies

The Research results evolved are to be dessiminated to the farmers without time lag. This is facilitated by the close linkage with the State Agriculture Department through the Kerala Agricultural Extension Project (KAEP). Besides the Department of Agriculture, linkages are also established with various agencies involved in extension and development like Animal Husbandry Department, Nationalized Banks, Dairy Development Department, Non Political Voluntary Organizations, Tribal Development Department, Fertilizer and Pesticide Supply Agencies, Spices Board, Coffee Board, Rubber Board etc.

4.2.1 Pre-season Workshops

Two pre-season workshops are conducted every year before the commencement of the Rabi and Khariff seasons separately in Wyanad, Idukki and other districts of the zone. The extension personnel and scientists discuss the important issues relating to various crops for the next season and develop technologies in respect of all crops to be transmitted to the farmers. The interaction with the extension personnel facilitates proper feed back information from the real farm situations.

4.2.2 Monthly workshops

Under the Kerala Agricultural Extension Project (KAEP) workshops are conducted regularly at monthly intervals. Scientists at the Regional Agricultural Research Station, Ambalavayal serve as resource personnel in the workshops for Wayanad. In Idukki district scientists of the Cardamom Research Station, Pampadumpara serve as the resource personnel. In addition to the scientists of Kerala Agricultural University and Officers of the State Agricultural Department, scientists of Coffee Board, Spices Board etc. and representatives of the input agencies also participate in these workshops.

4.2.3 Zonal Research Advisory Committees

The Zonal Research Advisory Committee (ZRAC) meetings of the region are conducted twice in a year to review the progress of research and extension activities, discuss and identify farming constraints and make recommendations pertaining to the zone. Scientists from Kerala Agricultural University, regional stations of the ICAR, commodity boards like Spices Board, Coffee Board, and Rubber Board attend these workshops. Besides scientists extension and development officers of the departments of Agriculture, Dairy Development, Commodity Boads, Commercial Banks, NABARD and other input agencies also do attend the workshops.

4.2.4 Short training programmes

The Regional Agricultural Research Station in collaboration with the Krishi Vigyan Kendra organises training programmes on Animal Husbandry and Agriculture for the village level workers and progressive farmers. The station also organises training in Agriculture and nursery management in collaboratian with the District Rural Development Agency under the TRYSEM programme. Periodical training programmes for the village level workers of the departments of Agriculture in nursery management, plant propagation, plant protection etc. are also conducted here. The Krishi Vigyan Kendra, a sister organisation of the Regional Agricultural Research Station, gives emphasis on development of tribals. The tribals are trained in Agriculture, Animal Husbandry

and Home Science and thus their overall development.

4.2.5 Joint field visits

The joint visits facilitate a common platform for scientists and extension personnel to visit the farmers fields and to have a better appraisal of the farm situation. These visits help besides help solve specific farming problems, facilitates understanding the adoption pattern, production constraints and thus help the scientists attune their research activities to suit the farmers requirements and extension personnel to sharpen their skills. Joint field visits are conducted regularly in the farmers fields.

4.3 University's extension oriented activities

Lab-to-land programme and village adoption programme are the major extension scheme of the University carried out by RARS, Ambalavayal. The Cardamom Research Station, Pampadumpara also implements the lab-to-land and the village adoption programmes.

4.3.1 Krishi Vigyan Kendra

The Krishi Vigyan Kendra at the Regional Station was started in October 1982 as a University scheme and from June, 1984 onwards it is fully financed by the ICAR. Eversince its inception, the staff of the Kendra are giving rigorous training in Agriculture, Animal Husbandry and Home Science to the tribal population for their overall development. Although the Krishi Vigyan Kendra is aimed at the development of Agriculture of the tribals, it is also giving training to progressive farmers, workers and members of the voluntary agencies engaged in rural development.

4.3.2 Lab-to-land programme

The lab-to-land programme was implemented by the Regional Station upto September, 1984. Twenty five tribal farmers of the Thaloor Tribal Colony were selected for the programme. Distribution of inputs like coffee seedlings, rooted cutting of pepper, banana suckers, fertilizers, chicks, goats, feed etc. and transfer of low cost know-how on raising these crops/livestock were the main activities under this programme. Demonstration plots on pulses and oil seeds were also laid out in rice fallows in the last second crop season.

4.3.3 National demonstration

The national demonstration programmes are in operation in the region.

4.3.4 Operational research project

Operational research projects are not undertaken at present in this zone.

4.3.5 Publication programme

Scientists of the Regional Research Station, Ambalavayal and Cardamom Research Station, Pampadumpara publish research papers in leading journals of national importance. Popular articles are also published in dailies and popular agricultural magazines. A book on introductory Agriculture was prepared and published by the Directorate of Extension of the Kerala Agricultural University. Another booklet on roses is being published by the above Directorate.

4.3.6 Radio/TV programmes

Scientis's of the zone frequently participate in broadcasts of current agricultural, animal husbandry and home science topics through the All india Radio for the benefits of the farmers at large.

4.3.7 Other extension programmes

Other extension programmes include agricultural exhibitions, taking classes in agricultural seminars, consultancy services etc. The station organize exhibitions at science fairs, flower show etc. Periodically agricultural films are also arranged in collaboration with the Krishi Vigyan Kendra.

4.4 Feed back

The monthly workshops, Zonal Research Advisory Committee meetings and joint field visits provide opportunities for the scientists to interact with extension personnel and thus obtain feed back from them.

4.5 Strategy for strengthening research extension linkages

A good research and extension linkage is maintained through various programmes like the monthly workshops, zonal workshops, pre-season training, Krishi Vigyan Kendra's activities etc. The above linkages will be strengthened for effective transfer of technology to the ultimate client, the farmer.

CHAPTER V

Research Priorities

Based on the research and extension linkages and feed back, tho research gaps, constraints and research priorities were identified.

5.1 Research gaps/needs

The research gaps/needs under various agroecological situations are presented in in Chapter III of this report.

5.2 Research priorities

Based on the constraints and research gaps. the research priorities identified are listed below.

5.2.1 Fruits and vegetables

Mango and cashew

i) Screening cultivars with early flowering and fruit/nut maturing (by April-May) characteristics, ie., before the onset of monsoon

ii) Standardisation of quick, easy, economic and cheaper methods of vegetative propagation

Banana

i) Screening banana cultivars under rainfed and irrigated conditions for table and culinary purposes

ii) Survey, collection and evaluation of various clones/ecotypes of Nendran suited to the region

iii) Standardisation of optimum cultural practices

Vegetables

i) Varietal evaluation to select suitable high yielding cultivars of cool, season vegetables such as cabbage cauliflower, carrot, beet root, peas, knol-khol and french beans

ii) Standardisation of agrotechniques for these vegetables

iii) Studies on water requirement and economic methods of irrigation

iv) Plant protection measures against pests and diseases

5.2.2 Spices and plantation crops

Ginger

i) Studies on the control of bacterial wilt of ginger caused by *Pseudomonas solanacearum*

ii) Screening varieties against bacterial wilt

iii) To develop agrotechniques for irrigated ginger

Coffee based farming system

i) Studies to develop tha most profitable crop combinations in coffee based farming system i. e., coffee + popper + mandarin orange, coffee + popper + clove/nutmeg, coffee + pepper + coconut, coffee + pepper + sapota/mangostein

ii) Studies on the effect of micro and macro climates in various cropping systems on the crop productivity

iii) Formulation of suitable plant protection measures for the above system

Pepper

i) Screening pepper cultivars suited to mixed and mono cropping systems of the high range region

ii) Standardisation of agrotechniques, for high range region

iii) Detailed studies on the control of quick and slow wilt diseases of pepper and to evolve effective methods to control them

Cardamom

i) Evolving high yielding cultivars with resistance/tolerance to katte and azhukal diseases and thrips

ii) Studies on shade regulation through artificial shading materials like coconut fronds, plastic sheets, thatching grasses etc. on the growth and productivity of cardamom

iii) Studies on the efficiency of sprinkler and basin irrigation on the productivity of cardamom

iv) Studies on foliar feeding of nutrients in combination with bio-fertilizers to maximise the production of cardamom

v) To develop suitable cardamom based cropping systems

vi) Investigation on the causes of ill filling of cardamom capsules and to develop techniques to alleviate this problem

vii) Studies to maintain an optimum balance between vegetative growth and productivity

viii) Effective control measures against azhukal diseases, thrips and root grubs

ix) Detailed studies on various shade trees and their influence on the growth and yield of cardamom

x) Standardisation of quick and easy method of vegetative propagation

5.2.3 Agro-forestry

i) Studies to select suitable tree species for feed, fodder, green manures and small timbers under agri-silviculture, silvi-pastural and horti-silvicultural systems

ii) Evolving suitable agro-forestry system for the tribal areas

iii) Ecological studies regarding regeneration, management techniques, growth rate and ability of different species for the reclamation of waste lands

5.2.4 Agricultural economics/ extension

The peculiar nature of Agriculture in the high ranges with a variety of crops and their mixes offer great scope for research in Agricultural economics and extension. A few topics of importance are listed below:

i) Development of optimum perennial crop models

ii) Optimisation of cropping systems for the wet lands

iii) Studies on the agricultural situation in tribal colonies

iv) Comparative economics of perennial crops and their mixes peculiar to this region

5.3 Research strategies

It is not possible to take up all the research programmes identified/listed in the research priorities in the Regional Station. Research programmes pertaining to citrus and other fruits, cool season vegetables, ginger, coffee and coffee based farming systems, hill paddy, agro-forestry etc. will be undertaken at the RARS, Ambalavayal. Research results on fundamental and crop improvement aspects in coffee, spices, fruits, summer vegetables

etc. and plant protection aspects from other research stations or institutes will be utilized. This station will have only verification function on these aspects. All the detailed research programmes on cardamom will be undertaken by the Cardamom Research Station, Pampadumpara.

The research stations of the Kerala Agricultural University, Commodity Boards and the ICAR regional stations will work in close co-ordination for the overall development of Agriculture in the high ranges As the RARS Ambalavayal and the CRS Pampadumpara have little facilities to undertake basic research, they will concentrate primarily on applied/verification research. Such basic research as may be required will be done by the ICAR regional stations and at the University headquarters.

The RARS will have lead functions for mandarin orange and fruits like mango, hill paddy and paddy based cropping systems. The station will also undertake verification testing functions for pepper, ginger and other spices. The CRS Pampadumpara will have lead function for cardamom and verification function for pepper and hill paddy. The Indian Cardamom Research Station Myladumpara will undertake lead function in cardamom and verificational function in other spices. The Regional Coffee Research Station, Kalpetta will undertake lead functions in coffee and coffee based farming systems. The Cadbury, Cocoa Research Station, Kalpetta is undertaking research in cacao. In addition to the above stations located in the high range zone, the regional stations of the ICAR and the departments at the University headquarters also undertake research on improvement, management and protection of these crops. The findings of these stations will however be verified at RARS and CRS before making recommendation to the farmers.

5.4 Stations to undertake identified research needs/programme

i)	Fruits, cool season vegetables, coffee based farming system, hill-paddy, bacterial wilt of ginger, agro-forestry, water management and animal management	: RARS, Ambalavayal
ii)	Cardamom, verification function of hill paddy and winter vegetables	: CRS, Pampadumpara
iii)	Coffee, crop improvement, nutritional and plant protection aspects	: Regional Coffee Research Station, Kalpetta
iv)	Summer vegetables	: College of Horticulture, Vellanikkara
v)	Farm implements	: Kelappaji College of Agrl. Engineering and Technology, Tavanur
vi)	Rubber	: Rubber Research Institute of India, Kottayam
vii)	Tea	: UPASI Tea Research Station

5.2 Development strategy

The success of any programme depends on the overall adoption and increased income of farmers from unit area This is closely linked with the development and extension activities. The following are some areas which require special emphasis for the development of the region.

i) Watershed management and soil conservation.

Though the soil conservation programmes are mostly intended and should be concentrated in hill ranges' practically no soil conservation programmes were undertaken in this region. It is high time to programme and implement the soil conservation measures here to reduce the soil erosion. Farmers seldom adopt such practices.

Similarly, as noted elsewhere, only about 28 per cent of the paddy lands are put under a second crop of paddy due to lack of irrigation facilites. If sufficient water conservation measures are adopted especially in the hillocks or valleys of paddy lands and small water sources are developed for irrigation a large area can be put under second crop of paddy or vegetables.

ii) Increase in cool season vegetable production

The high range zone is suited for cultivation of cool season vegetables. There is heavy demand for cool season vegetables like cabbage, cauliflower, carrot, radish, beet root, french beans, onion etc. in the whole state which is now met from the neighbouring states. Vattavada Kanthallur, Marayur and Munnar areas of Idukki district are highly suited to the winter vegetebles and crops like potato, cole crops, garlic, onion etc. But no organised attempt is being made to expand the cultivation of these crops in these regions. The farmers are facing shortages of quality planting materials seeds, fertilizers etc. These should be made available by the Government agencies to increase area and production of these crops. Improvement of irrigation and marketing facilities along with supply of such inputs will definitely help to expand the area and production.

iii) Sericulture

Sericulture as a vocation, could be practised with reasonable profits throughout the high ranges. Now it is practised on a large scale in places like Marayur, Kanthalloor, Attappady hill ranges etc. Lured by the profits from it, large number of farmers are turning towards this vocation.

iv) Apiculture in cardamom planatations

Experiments at the cardamom Research Station, Pampadumpara has clearly showed that keeping active beehive colonies in the cardamom estates could increase the yields of cardamom by increased pollination of cardamom, This practice will provide additional returns to the grower by way of honey produced. Apiculture in cardamom plantations is practised in and around Pampadumpara. This could be extended to other parts of the region as well.

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