National Agricultural Research Project

STATUS REPORT

OF THE

CENTRAL ZONE

Vol. I

KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA, TRICHUR, 680 654

English

NARP
STATUS REPORT
Central Zone
Vol. I

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Compiled and edited by

Associate Director,
Central Region
R.A.R.S. Pattambi

Published by

Dr. A. G. G. Menon
Director of Extension
Kerala Agricultural University
Mannuthy 680 651, Trichur, Kerala

Cover design

V. Chandranandan

Printed at

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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 stating 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 area and production of crops and new field problems have cropped in 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 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 team 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.

This 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
Kerala Agricultural University

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.

Kerala Agricultural University,
Vellanikkara,
13-07-1989

(Sd/-)
M. ARAVINDAKSHAN
Director of Research.

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GENERAL AGRICULTURAL CHARACTERISTICS OF THE STATE

CHAPTER I

General Agricultural Characteristics of the State

1.1 General description of the State —Delineation, population

1.1.1 General description

Kerala State lies in the South-West corner of the Indian peninsula between 8° 18' and 12° 48' north latitudes and 74° 52' and 77° 22' east longitudes, as a long narrow strip of land, 32 to 133 km wide, between the Western Ghats in the east and the Arabian Sea in the west with a 580 km long coastal line. In the south, the state is bounded by Tamil Nadu and in the north by Karnataka. Though the smallest state in India with a geographical area of 38863 km², Kerala supports a population of 254 lakhs, which is 3.7 per cent of the total population of the country. 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 the Arabian Sea on the west. The large number of lakes and backwaters provide a unique scenic beauty to the land(Fig. 1).

Kerala is administratively divided into 14 districts spread over 61 taluks covering 1557 villages. There are 1000 panchayats, 3 corporations, 43 municipalities, 3 townships/cantonments, 107 census towns and 151 development blocks in the state. The district-wise distribution of the above is given in Annexure–1.

1.2 Physiography

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

The land is panoramic with ever green forests and picturesque landscapes and backwaters. The details of the rivers flowing within the state, their catchmen area etc. are given in Annexure-2. Out of the 44 rivers originating from the Western Ghat. 41 flow towards west into the Arabian Sea and the remaining 3 towards east into the Bay of Bengal. The rivers of Kerala are typical monsoon-fed and fast flowing ones. 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 topography, the land resources in the state fall generally into four well defined natural divisions each running almost parallel in north–south orientation (Fig. 2). These are:

1.2.1 High Ranges (above 750 m 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 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

Fig.1.

MAP OF KERALA

ADMINISTRATIVE DIVISIONS

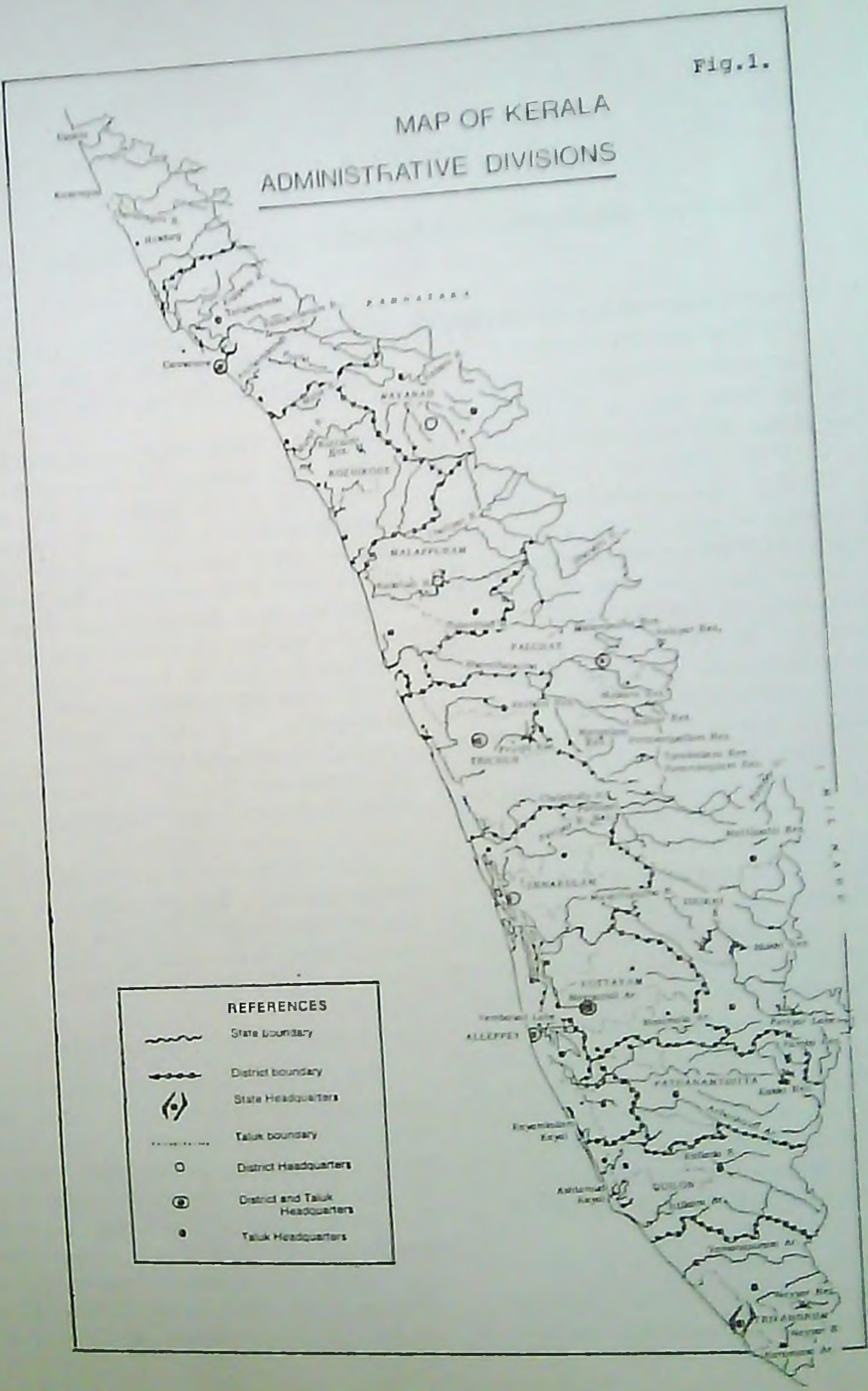


Fig.2.

MAP OF KERALA
PHYSIOGRAPHY

(2690 m), Mukunti (2550 m) and Nilgiris (2470 m). The Palghat gap with a width of 32 km is the largest pass in the Western Ghats. In addition, there are a few other passes in the Ghats such as Aramboli, Kumali, Kambam, Thevaram, Bodinaikannur Karkkon, Periya and Perambadi The High Range region is dominated by plantations of tea, coffee, rubber and cardamom.

1.2.2 Highland (75—750 m above MSL)

This hilly tract on the western side of 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 percentage of organic matter. A large percentage of the population of hill tribes live in this region.

1.2.3 Midland (7.5—75 m above MSL)

The midland plains comprising about 42 per cent of the land mass have an undulating terrain intersected by numerous rivers, small hills and valley and 59 per cent of the state's population live in this tract. The soil is mainly laterite and supports an intense diversity of seasonal, annual and perennial crops like rice, sugarcane, tapioca banana, ginger, coconut, arecanut, pepper, cashew, rubber etc.

1.2.4 Lowland (upto 7.5 m above MSL)

The lowland bordering the Arabian Sea is a strip of land running along the coast. This region comprises 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 monsoons, several places are liable to be flooded, particularly 'Kuttanad'' area which is situated below the sea level. This region is noted for its picturesque back waters 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 rivers.

1.3 Soil

1.3.1 Geological formations

Three main geological formations are recognised viz. Archaeans (oldest rocks), Warkala beds of Tertiary Age (upper miocene to pliocine) and Recent deposits (quarternary). All of these have north-alignment (Fig. 3). They are identified as follows:

A. Crystalline rocks

i. Dharwar formation

These occur in the Malabar area only. They are represented by granetiferous—ferruginous quartzites, mica, talc, schists etc. and are found exposed in south-east Wynad and north-west of Gudalur.

ii. Champion gneiss

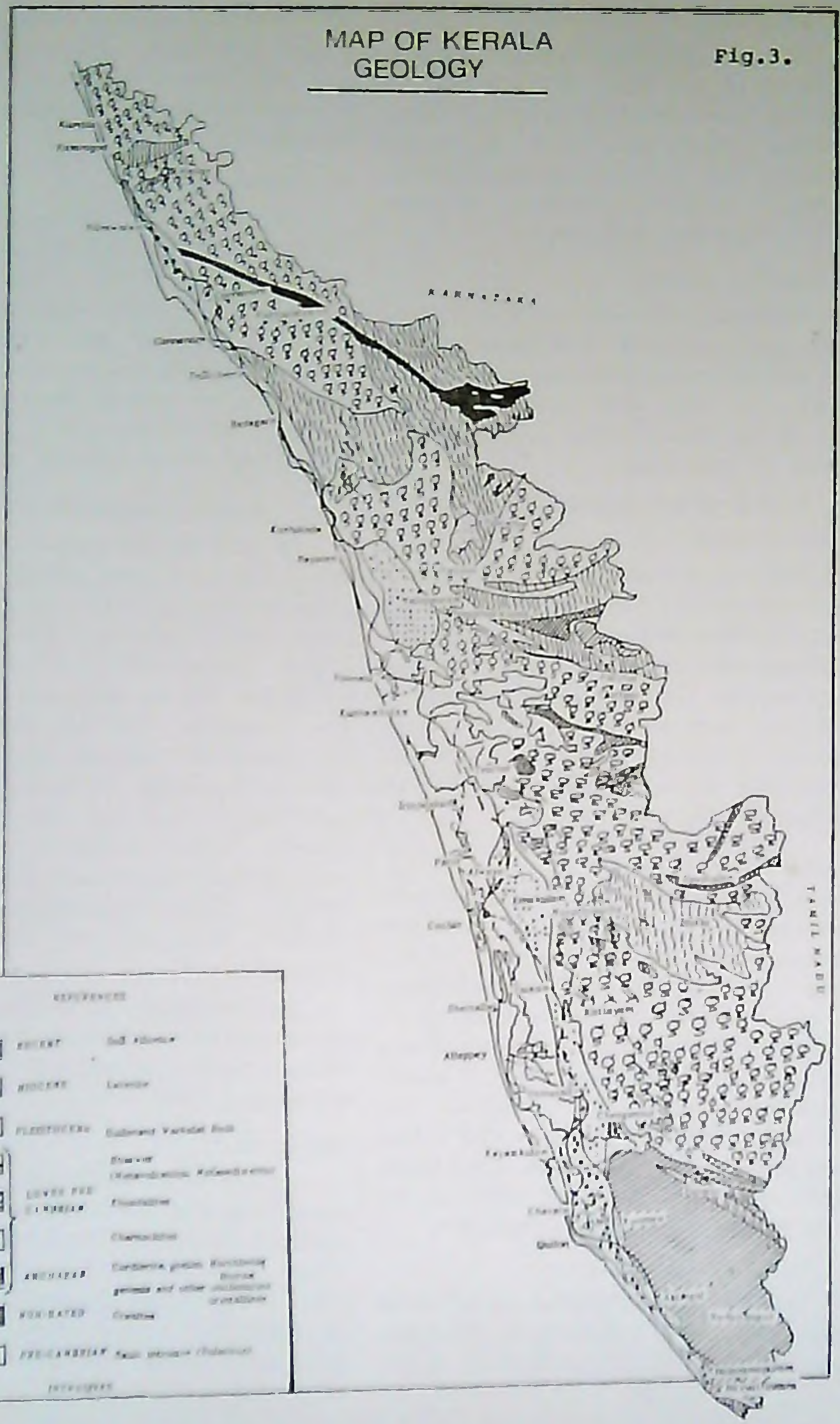
They are seen in south-east of Wynad and have gold bearing veins. Rocks appear to be of post peninsular age and resemble the champion gneiss of Karnataka state.

iii. 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 the Trivandrum area the gneiss belongs to the Peninsular suite and are made of quarts, orthoclase, mica and hornblende. Charnockite and leptynites are the most common gneisses in this area.

MAP OF KERALA
GEOLOGY

Fig.3.



iv. Charnockite

A good portion of 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 charnockites of north Kerala where garnet is absent.

v Closepet granite

Archaean intrusions of post charnockite age are found in Malabar region. The two intrusions of biotite granite found in Kalpetta hills and Sultan's Battery, have strong resemblance to the Dorne-gneiss of Hazaribagh.

B. Precambrian system

i 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.

ii 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 Warkalai 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.

iii The Warkalai formation

This represents the most conspicuous sedimentary bed occurring in Warkala. They are best exposed at Warkala 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.

iv 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 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 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 into Red loam, Laterite, Coastal alluvium, Riverine alluvium, Onattukara alluvium, Brown hydromorphic, Saline hydromorphic, Kuttanad alluvium, Black soil and Forest loam. (Fig. 4).

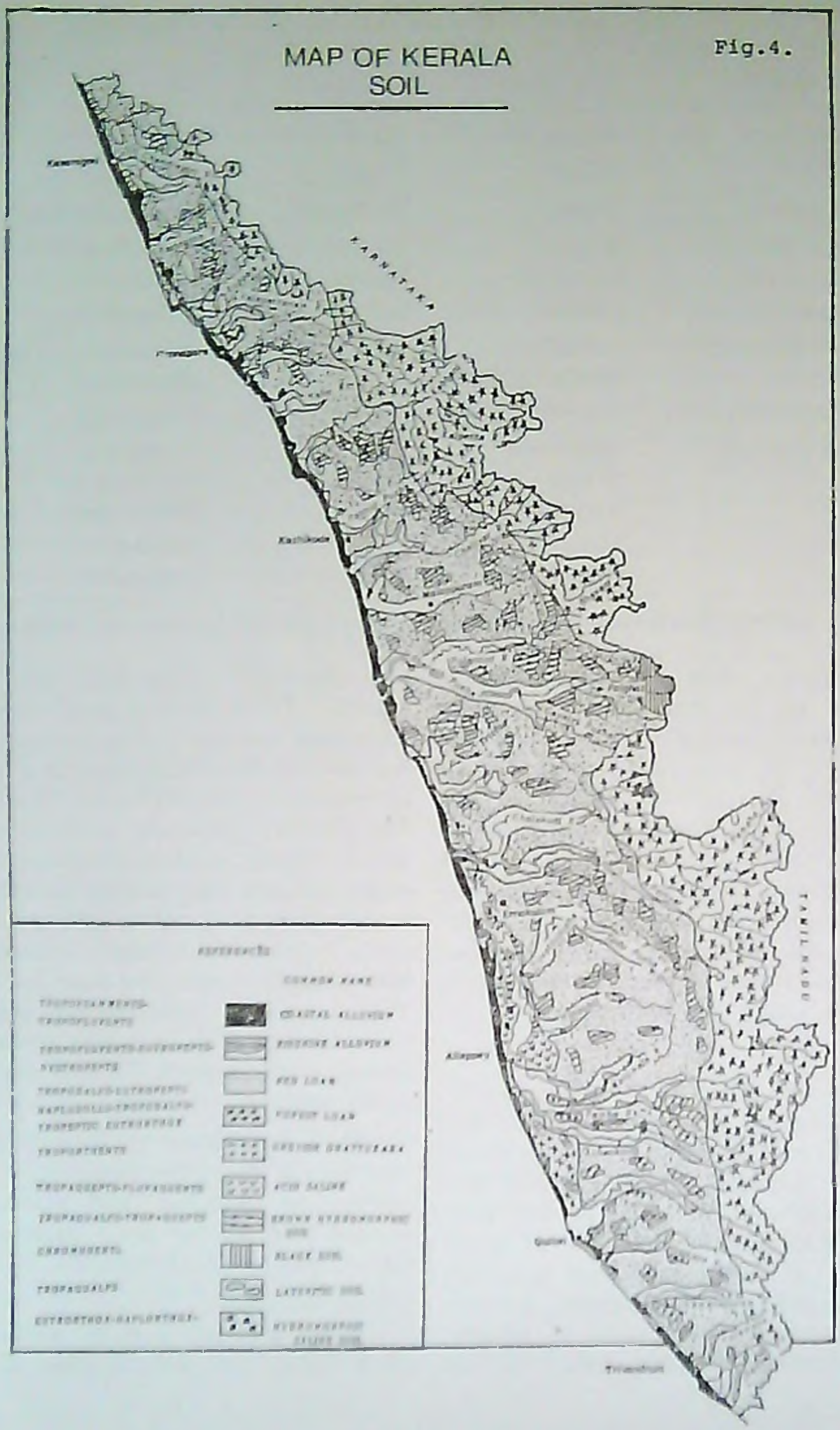
The soil types of Kerala and their corresponding tentative taxonomic classification upto the great soil group level are given in Table I.

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 and small hillocks. The rapid permeability

Fig.4.

MAP OF KERALA
SOIL



Table—1 Soil types of Kerala and their taxonomic classification.

Soil types	Order	Suborder	Great soil groap
Red loam	Alfisol	Udalf	Troupudalf
Laterite	Oxisol	Orthox	Eutrorthox
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	Aquent	Fluvaquent
Black soil	Vertisol	Udert	Chromudert
Forest loam	Mollisol	Udoll	Hapludoll
	Alfisol	Udalf	Troupudalf

Source: Soils of Kerala, Soil Survey Branch, Department of Agriculture, Kerala (1978).

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 conducive 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 can be cut 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 bases. They have poor waterholding 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 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 Onattukara region comprising of 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 in low lying areas of coastal strip. They have been formed as a result of transportation and sedimentation 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 grey horizons, mottling streaks, hardpans, organic matter depositions, iron and manganese concretions, 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 met 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 other parts of the country. The net work of backwaters and estuaries bordering the coast serve as inlet of tidal waters to flow into these areas, causing salinity. Wide fluctuations in the intensity of salinity have been observed. During rainy season, the fields are flooded and most of the salt is leached out, leaving the area almost free of salts. Electrical conductivity of the soil during this season ranges from 0.1 to 2.0 m mhos/cm^1. 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 m mhos/cm^1. These soils are in general brownish, deep and imperfectly drained.

The profiles show 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 lower layers, causing problems of acidity. The *Pokkali* (Ernakulam district) and *Kaipad* (Cannanore district) soil come under this category of soil.

Kuttanad alluvium

The Kuttanad region covering about 875 km² 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 part 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 to the construction of the Thanneermukkam 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 viz. Kayal soils, Karappadam soils and Kari soils, which are dealt within the zone of problem areas.

Black soils

Black soils of the state 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) high in clay content and CEC and hence exhibit characteristic cracking during the dry periods. They are usually located in gently slopping to nearly level lands. The levels of potassium and calcium are moderate, while the soil is low in nitrogen and phosphorus.

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 0.5 to 1.5 m and 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

As the name indicates, these soils are 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. These soils in general show wide variation in depth. They are dark reddish brown to black with loam to silty loam texture. In denuded areas, leaching and deposition of humus in lower layers is 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 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 a number of soil testing laboratories in the state run by the State Department of Agriculture and other agencies (Tables 2 and 3).

1.3.4 Fertility status of Kerala soils

For the purpose of giving fertilizer recommendations based on soil test values, the soils of the state are grouped into ten fertility classes numbering from 0 to 9. 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 to general recommendation currently followed by the soil testing laboratories of the state are given in Annexure 4.

1.3.5. Fertilizer 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 soil in general possesses the least CEC, water holding capacity and nutrient retentivity. In other words, the soils are not inherently fertile. The phosphate fixation is very high.

Table 2 Soil testing laboratories of the State Department of Agriculture

Location	Capacity (No. of samples per year)
Stationary Soil Testing Laboratories	
Trivandrum	20,000
Quilon	18 000
Ettumanoor (Kottayam)	16,000
Alleppey	20,000
Vyttila (Ernakulam)	16,000
Thodupuzha (Idukki)	16,000
Trichur	10,000
Pattambi (Palghat)	20,000
Malappuram	18,000
Tikkoti (Kozhikode)	16,000
Cannanore	18,000
Mobile Soil Testing Laboratories	
Alleppey (four southern districts)	10,000
Pattambi (four 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.

Table—3. Other soil testing laboratories

Location	Organisation	Capacity samples per annum
Kanjirappally	Kerala State Rubber Marketing Federation	1,200
Meppadi	UPASI Tea Advisory Service	2,000
Munnar	-do-	3,500
Myladumpara	Indian Cardamom Research Institute	2,000
Puthupally	Rubber Research Institute of India, Kottayam	3,000
-do- (Mobile)	-do-	30,000
Udyogamandal	FACT	10,000
-do- (Mobile)	-do-	2,000
Vandiperiyar	UPASI Tea Research Sub Station	

Source: Fertilizer Association of India.

Due to high rainfall during South West monsoon, a major part of the applied N and K is lost in 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 wetlands. Toxicity due to higher concentrations of soluble iron and aluminium occurs in low lying areas subject to rice culture. Lack of irrigation during 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-5 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 to 49.38 kg/ha. The total consumption of fertilizers at present is 1.41 lakh tonnes and assuming the same rate of growth experienced during the last 26 years, the consumption by 2000AD is predicted to be 2.56 lakh tonnes (Table 4). The cropwise fertiliser requirement is also given in Table 5. Two important factors which have drastically influenced the consumption of fertilizers are the cost of fertilizer and the price of agricultural produce.

The NPK consumption ratios for the last few years are given in Table 6.

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 major consumption of fertilizer in the state is for rice where the recommendation is in a 2:1 ratio. For other crops (the next important crop is coconut) the requirement of K_2O is more and hence the ratio suggests the lack of application of fertilizers at the recommended rate.

Table—4 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-'86.

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

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 shows that the crop growth is not inhibited by temperature, but governed by rainfall alone.

1.4.1 Rainfall

The rainfall distribution in Kerala is bimodal. We get heavy rains during both the monsoons viz., South West monsoon and North East monsoon. The mean date of onset of the South West monsoon varies from 25th May to 1st June while North East monsoon starts during 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 while the southern parts extending from Ponnani to

Table—5. 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	00.6	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 Fertilizer Technology, ICAR, New Delhi, 1986.

Table 6

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 Agrl. Chemistry. College of Horticulture, Kerala Agricultural University, Vellanikkara.

The classification of Moisture Availability Regimes (MAR) of Kerala is as follows:

Sl. No.	Criteria	MAR	Symbol
1.	6 or more months with MAI in the range 0—0.33	Dry	A
2.	5 or more consecutive months with MAI in the range 0.33—0.67	Semi-dry	B
3.	5 or more consecutive months with MAI in the range 0.67—0.99	Sub-humid	C
4.	5 or more consecutive months with MAI in the range 0.99—1.33	Humid	D
5.	5 or more consecutive months with MAI in the range 1.33—1.67	Per-humid	E
6.	5 or more consecutive months with MAI above 1.67	Wet	F

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 increases from the coast to the foot hills and then decreases on the hill tops. This trend is partially disrupted in the Palghat region. Though the annual rainfall in the northern region is more, the effective rainfall is only about 40 per cent while it is 80 per cent 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 sixty per cent of annual rainfall is received during the South West monsoon (June–September). Around 25 rainy 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–December) is quite different from 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.

1.4.2 Water balance of Kerala

The water balance which gives the soil moisture status in general is depicted in Fig. 9 for the selected stations of Kerala. Unlike southern region, deficit of water is seen for longer duration in the northern region of Kerala (Kasaragod and Cannanore districts), especially in the low land and mid-land regions. This is mainly because of the North East monsoon which is erratic over Cannanore and Kasaragod districts.

1.4.3. Surface air temperature

The mean annual temperature varies from 25.4°C to 31.0°C in the Central part of Kerala (Fig. 9). However, major portion of the midlands falls under 27.5°C (Annexure 6). The diurnal variations are not high (5-7° C) except in the high land regions where the difference goes up to

Fig.5.

MAP OF KERALA
CLIMATE : RAINFALL

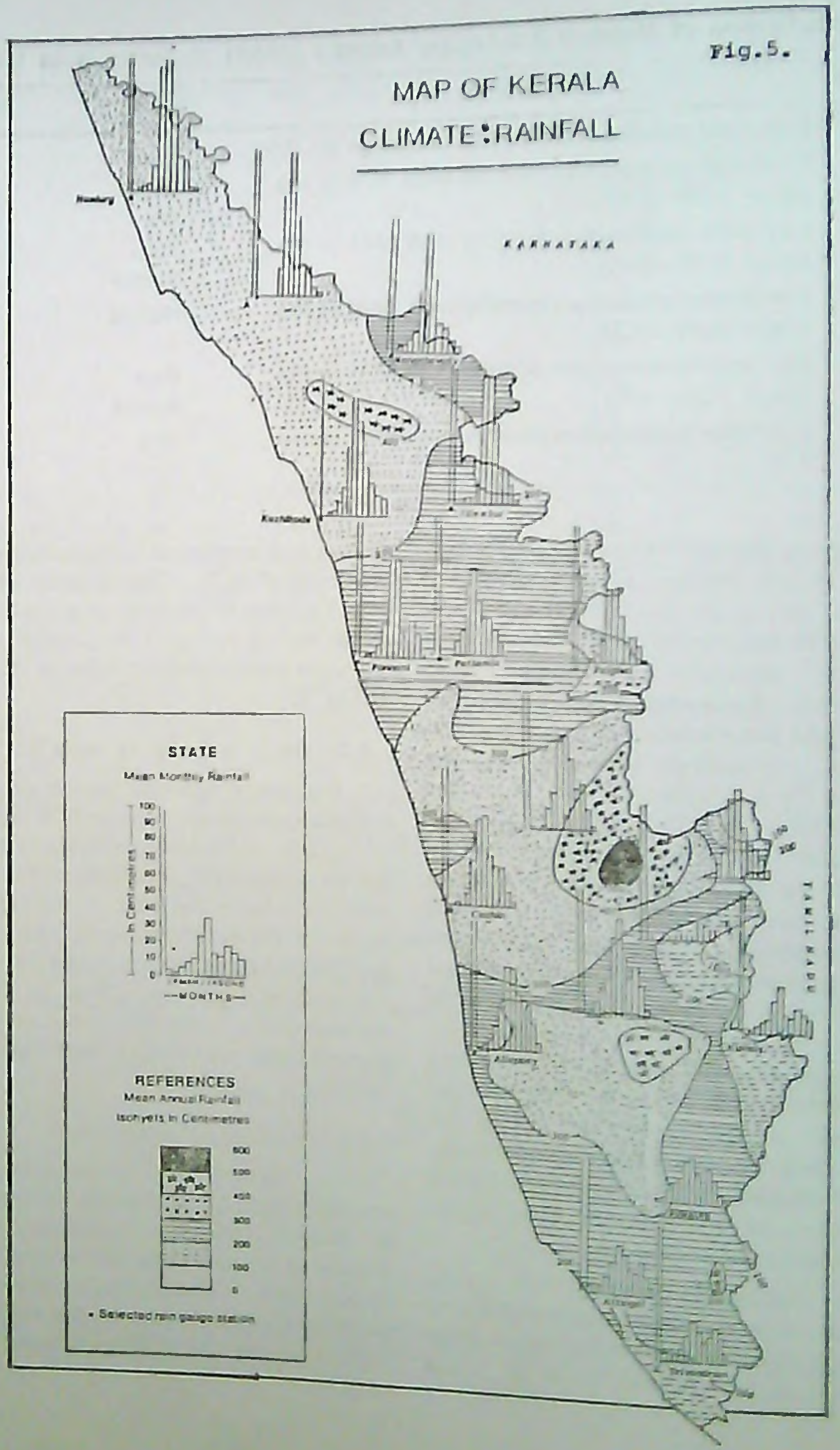
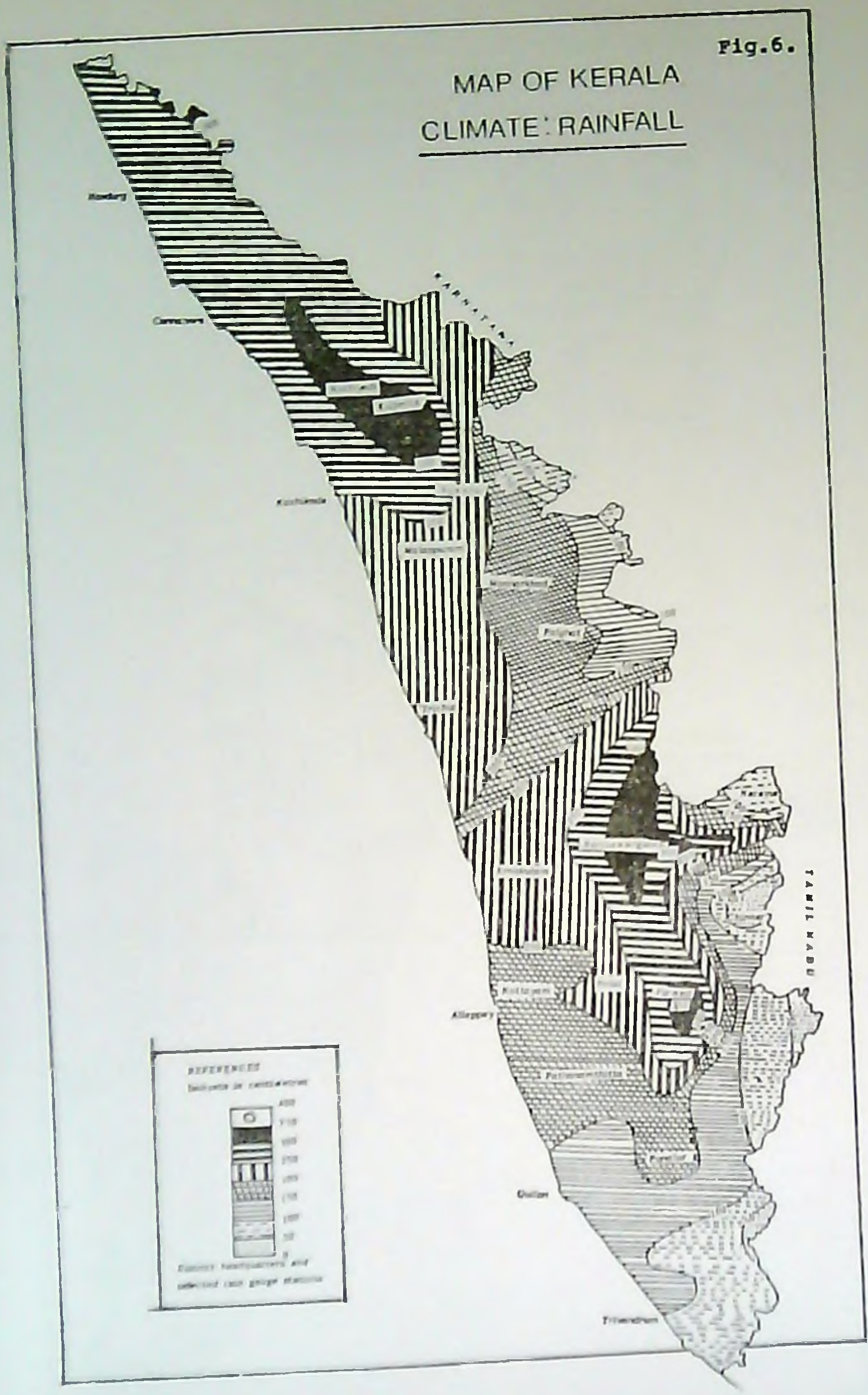


Fig.6.

MAP OF KERALA

CLIMATE : RAINFALL



MAP OF KERALA
CLIMATE : RAINFALL

Fig.7.

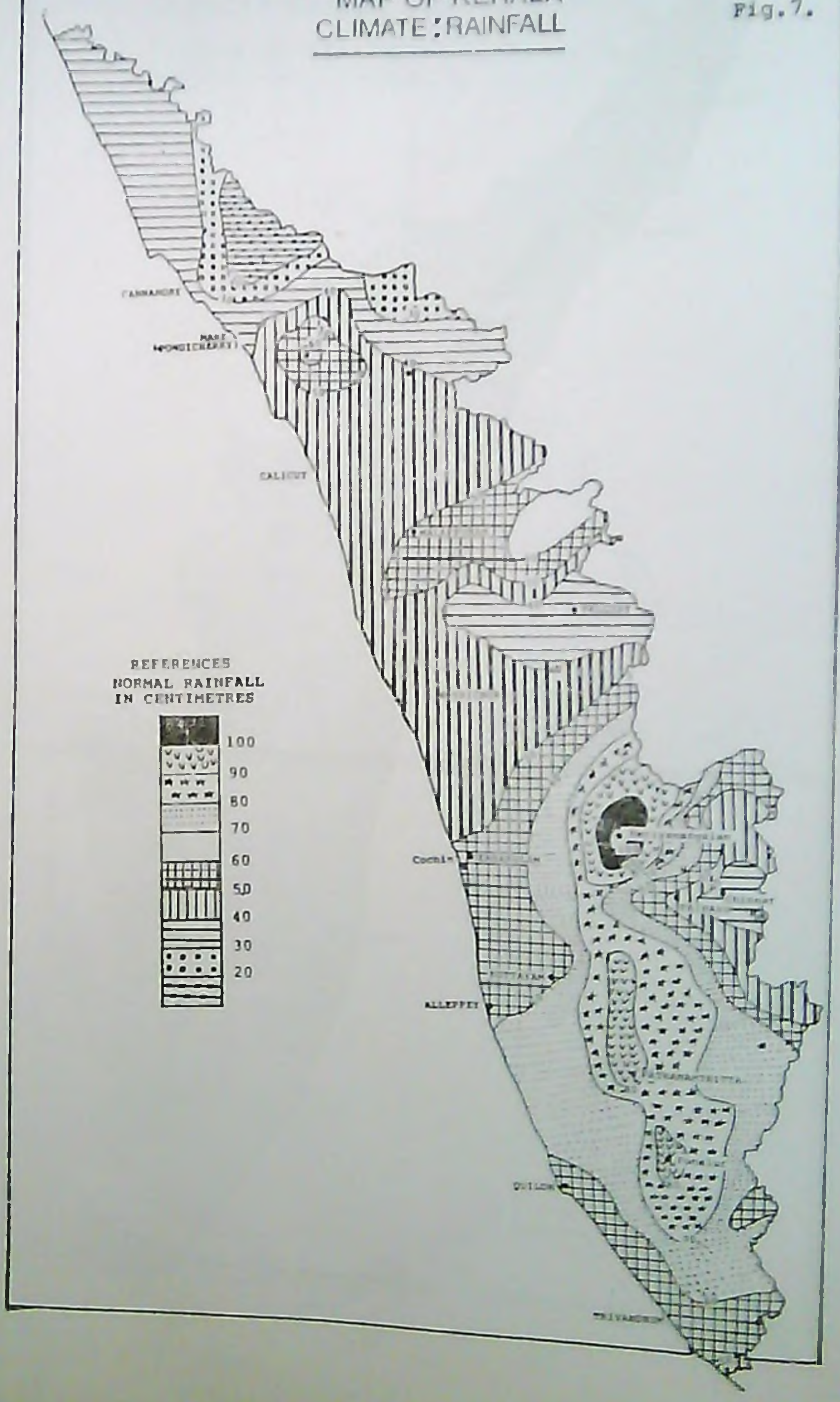


Fig.8.

MAP OF KERALA
CLIMATE: RAINFALL

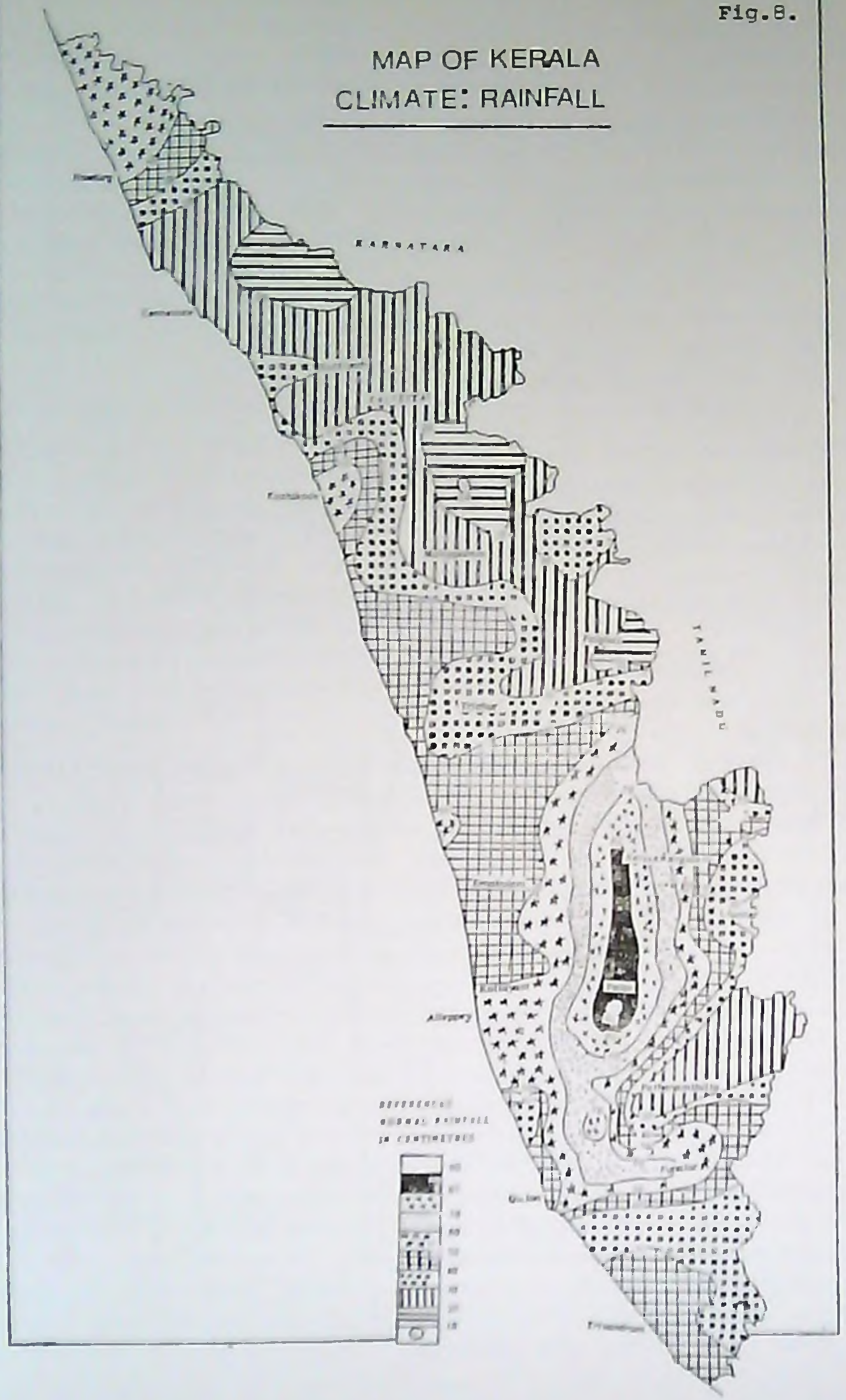
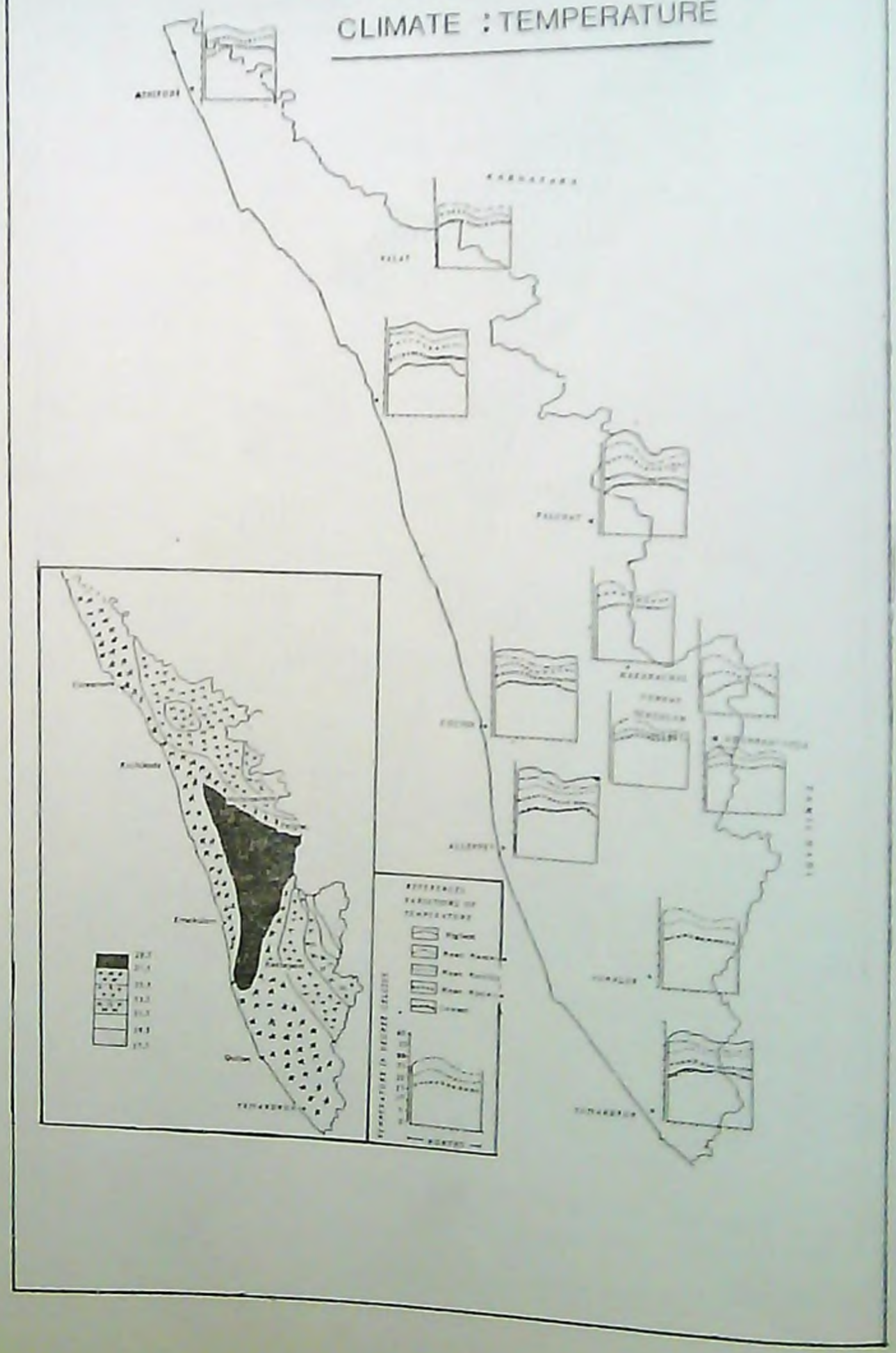


Fig.9.

MAP OF KERALA

CLIMATE : TEMPERATURE



15°C. This is a typical 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 29-31° 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 during 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 experience easterly and westerly winds due to coverging effect of the Gap. Westerly and north westerly winds are noticed in Cochin and Alleppey (Fig 10). In general, easterly and north easterly winds occur in the morning hours. This is because of the land and sea breezes. The number of calm days are more in inland region than coastal region due to sheltering effects of the Western Ghats. The maximum wind speed is observed during the South West monsoon and decreases from November onwards. Alleppey, Cochin and Trivandrum have wind speeds of more than 20 km/h. while Palghat and Punalur experience less than 5 km/h.

1.4.6. Potential evapotranspiration

The mean pan evaporation per day is 4.8 mm at Kasaragod, 4.5mm 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 and often exeeds 6 mm/day during summer months.

1.4.7. Sunshine

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

1.5 Land Use Pattern

The net area sown rose from 19.24 lakh ha in 1960–'61 to 21.80 lakh ha in 1980–81, an increase of about 13.3 per cent. In 1984-'85 the net area sown was 21.84 lakh ha. The area remained almost the same during the past five years (Table 7). In the case of total cropped area of gross cropped area (GCA), there was an increase of about 23 per cent during the two decades from 1960-'61 to 1980-'81. The GCA in 1960-'61 was 23.49 lakh ha while in 1980–'81 it was 28.85 lakh ha. This was mostly due to an increase in the cropping intensity from 122 to 132 per cent over the period. The GCA in 1984–'85 was only 28.75 lakh ha. The percentage of net area sown to the gross area remained almost the same during the last five years, while there was an increase in the area of land put to non-agricultural uses. The area under permanent pastures and other grazing land, land

Fig.10.

MAP OF KERALA
CLIMATE : WIND

REFERENCES

under miscellaneous tree crops, cultivable waste, fallow other than current fallow, and current fallow fell substantially during this period. However, during the past five years, the area remained stable for all the above categories. Tables 7 and 8 give a detailed picture of the situation during the last five years and the last two decades. The total forest area of the State is remaining at 10.81 lakh ha for the last five years and constitute about 28 per cent of the total geographical area (Table 9). The district wise distribution of the forest area for the years 1978–'79 to 1980-'81 are given in Annexure 10. The division-wise area of reserve forests and vested forests in Kerala is also given in Annexure 11.

Table–7. Classification of Area and Intensity of Cropping
(1960-'61 to 1984–'85) (Area in '000 hectares)

	60-61	70-71	80-81	81-82	82-83	83-84	84-85
Total Geographical area according to village papers	3858	3858	3858	3858	3858	3858	3858
Forests	1056	1055	1082	1082	1082	1082	1082
Land put to non-agricultural uses	205	275	270	266	276	278	280
Barren and uncultivable land	151	72	86	85	86	87	86
Permanent pastures and other grazing land	45	28	5	5	5	5	4
Land under miscellaneous tree crops not included in the net area sown	204	132	64	5	55	55	51
Cultivable waste	144	80	129	130	130	129	130
Fallow land other than current fallow	62	23	27	27	27	27	27
Current fallow	67	24	44	44	44	43	41
Net area sown	1924	2172	2180	2190	2179	2180	2184
Total cropped area	2349	2933	2885	2905	2862	2862	2875
Area sown more than once	425	761	705	715	682	681	690
Intensity of Cropping	122	135	132	133	131	131	132

Source: 1 Agricultural Statistics in Kerala—The 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
Total area according to village papers	100	100	100	100
Forest	27.37	27.35	28.04	28.04
Land put to non-agricultural uses	5.31	7.17	7.00	7.26
Barren and uncultivable land	4.02	1.87	2.23	2.23
Permanent pastures and grazing land	1.17	0.73	0.13	0.10
Land under miscellaneous tree crops	5.29	3.42	1.66	1.32
Cultivable waste	3.73	2.08	3.34	3.37
Current fallow	1.74	0.62	1.14	1.06
Fallow other than current fallow	1.60	0.60	0.70	0.70
Net area sown	49.87	56.30	56.51	56.61

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

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 and Land use in Kerala, December 1980. Directorate of Economics and Statistics, Trivandrum.

The suitability of land and climate for a number of crops 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 1.32 in Kerala (1984-85) as against the national level 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 geographic 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 and 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) and 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 lakh ha (net) or 14 lakh ha (gross). The ten completed projects together irrigate an area of 0.77 lakh ha (net) or 1.47 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 irrigated in the State. Thus the gross irrigated area covered by major and medium irrigation projects till June 1985 was 3.57 lakh ha. A list of ongoing major and medium irrigation projects and their achievements during 1984-85 are given in Annexures 12 and 13.

Thus, in 1984-'85, there were 12 ongoing major irrigation projects and 6 ongoing medium irrigation projects under different stages of construction. Of these the major works on 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 and physical targets and achievements during 1983-'84 and 1984-'85 are furnished in Annexure 14. The number of schemes proposed and completed during 1984-'85 under each category are also given in Annexure 15.

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	0.13	0.12	0.09
Per capita forest area	0.06	0.05	0.04

Source: Land Research and land use in Kerala 1980
Directorate of Economics and Statistics, Trivandrum

1.6.2. Irrigation potential

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

1.6.3. Ground water availability

Compared to 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 30 lakhs of domestic wells in the different panchayats of the State. The fact that the existing 12 major irrigation projects along with the 6 medium projects under different stages of investigation and execution could cover irrigation hardly 50 percent of the total area under crops and the vagaries of the recent drought in 1983 have been an eye-opener to the farmers and they have realised that tapping of ground water is essential for the survival of crops as well as for better 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 to raise two rainfed crops of paddy into tripple cropped lands using ground water.

Systematic hydrological studies by the State Groundwater Department and 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. A number of areas have been identified as suitable for construction of filter point wells and these are being extensively developed for that purpose. From 1982 to the end of March 1986 the department had constructed 548 filter point wells in Trivandrum, Quilon, Alleppey, Trichur, Ernakulam, Malappuram, Calicut and Cannanore districts. Besides these, suitable sites were cleared and appropriate designs were given for 656 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 the farmers to irrigate their agricultural land. The Ground water Department also dug 286 borewells and 18 tube wells for providing drinking water to Harijan/Girijan colonies. The present utilisation of ground water through dug wells, dug-cum-bore wells is rather limited to certain areas. The wells are tapping the near surface aquifer in Malappuram, Kozhikode, Palghat, Cannanore and Ernakulam districts. In the other districts it is yet to catch up. The department had so far cleared sites for 7113 open wells throughout the state. The district-wise break up of irrigation wells in the state is given below. (Table 11)

1.6.4. Inland Navigation System

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

Table-11. District-wise break-up of irrigation wells

District	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 Wynad	—	3079
Cannanore and Kasaragod	—	10831
Total	13578	145779
Overall total of Irrigation wells	—	159357

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 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 following three main heads viz. i) the interior coastal canal system; ii) the river navigation system and iii) 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 produce from the areas lying around the canal but also the needs of the industries such as tile, timber, coir, fertilizers, 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 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 it 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 State. Quilon town is on the banks of the Ashtamudi lake (52 km^2 in area). The Kayamkulam lake, south of Vembanad lake and Ashtamudi lake are connected by backwaters and the 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 earths and 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 bank 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 million tonnes of freight traffic in the year 1970 and 26.6 million passengers in the year 1976. As the inland waterways connect enroute many villages and serve rural region, they provide stimuli to develop small scale cottage industries in rural areas. Moreover, the State of Kerala being mostly rural the inland waterways 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 and suggested proposals for implementation during the Sixth Five Year Plan amounting to Rs. 154.4 million. The details of the proposed schemes are given in Table 12. The plan schemes under the IWT are being implemented by four agencies viz., Public Works Department, State Water Transport Department, Kerala State Road Transport Corporation and Kerala Inland Navigation Corporation.

1.7 Socio-Economic characteristics. Land holding pattern

1.7.1 Area, population and literacy

Kerala ranks seventeenth in respect of area (18863 km^2) and twelfth with respect to population (254 lakh according to 1981 census), which accounts for 3.71 per cent of the national population. The population density of Kerala is 655

per km² as against the national average of 221. The total rural population is 207 lakh while urban population is only 47 lakh. 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 lakh and the total female population of 129 lakh in 1981 represent an increase of 19 lakh and 22 lakh respectively over the 1971 census (Annexure 16).

Sex ratio is 1032 females per 1000 males. The female population is found to be increasing at a faster rate than 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.

There are 25 lakh scheduled castes and 2.6 lakh 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 castes/scheduled tribes is given in Annexure 17.

Table—12 Scheme-wise outlays for the development of Inland Water Transport in Kerala.

Scheme	Fifth Plan Outlay 1974-1979 (in million rupees)	Outlay proposed 1978-1983 (in million rupees)
Direction and Administration		
i) Establishment of a Dredger Organisation (PWD).	—	25.00
Assistance to Transport Services		
i) Completion of existing and a few new canal schemes in State Sector (PWD).	5.50	80.00
ii) State Water Transport Department Schemes.		
a) Terminal facilities		
b) Crafts (Augmentation of Ferry Services)	1.80	9.90
c) Equipment and Workshops		
d) Training of Staff		
iii) Ferry services of the KSRTC		
a) Acquisition of fleet	—	7.50
b) Workship machinery and slipway construction	—	3.50
Training and Research		
i) Traffic Studies, Hydrographic Survey Unit etc.	—	3.50
Other facilities		
i) Preparation of Master Plan	0.20	—
ii) Deepening and improving existing boat routes operated by the SWT Department.	—	5.00
iii) 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.

The total working population in the State is 78 lakh which is 30.7 per cent of the total population of the State. Out of this, 27.9 lakh 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 are 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 lakh constituting 3.2 per cent of the States' 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 lakh and the number of households is 44 lakh.

Kerala leads all 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 81.6 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

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

Table—14. Infant mortality rates in Kerala

Year	IMR
1951—60	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, 1985. Directorate of Economics and Statistics.

It is striking to note that during fifties about one eighth of infants born would die before attaining one year showing the IMR of 120 per thousand 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 has the lowest rate, both in rural and urban areas (Annexure 11).

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 in Kerala and India.

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	52.1

Source : Economic Review, 1985.

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

1.7.3. Unemployment and Educational Status

Kerala has a very high level of unemployment. According to a survey on unemyloyment 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 lakh. There were 2.98 lakh of students studying in the Art 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 amounts to Rs 5965 crores in 1984–'85 at current prices. It is estimated that the primary sector contributed 36.66 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 Land Reforms Amendment Act of 1969, landlordism has been abolished in the State and the 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 private forests, 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 in Kerala as per 1976–'77 agricultural census was 35,01,100 and the total area operated in the same year was 17,19,100 ha. According to 1980-'81 consus, the total number of operational holdings was 41,80,900 and the total area operated became 18,05,300 ha. Between these two consus the number of operational holdings have increased by 19,42 per cent (6,79,800 nos.) and the area operated have increased by only 5 per

cent (86,200 ha). 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 the large (ie. 10 ha and above) occupies only 0.1 per cent. (Table 16). The total number of operational holdings in Kerala is 4.68 per cent of the total number of operational holdings in India during the year 1980-81, whereas the total operated area accounts only 1.11 per cent of the area operated in India.

The medium (between 4 and 10 ha) and 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 and was reduced to 18.02 per cent in 1980-'81. For India the percentage of operational holdings under these classes was 11.46 which accounts to 52.50 per cent of the operated area in 1980-'81.

The average size of holding for the State was 0.49 ha in 1976–'77 and this was reduced to 0.43 ha in 1980-'81. The average size of 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 a 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 arecanut palms, banans or plantains, drumstick, pappaya, jack, mango and other fruit trees. In addition to these, the presence of one or two livestock (cows, goats, or buffaloes) with a small unit of poultry consisting of 4 to 5 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 of the produce provided subsidiary income to the house owner.

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

Class and size of holdings	Percentage 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 and 2 ha)	6.93	17.99	1.37	1.42
Semi-madium (between 2 and 4 ha)	2.96	14.00	2.68	2.75
Medium (between 4 and 10 ha)	0.85	9.05	5.45	5.98
Large (10 ha and above)	0.10	2.41	35.14	17.27
Total/Average	100.00	100.00	0.43	1.82

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

1.7.7. Farm prices

Annexure 27 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. Average daily wage rates of carpenter and mason in the agricultural sector in 1981 were Rs. 22.49 and Rs. 22.50 respectively. However, the wages paid in different localities usually excelled 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 requirement 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 and fruit crops like mango, banana, pineapple, jack and seasonal crops like cowpea, blackgram, red gram etc. In addition to this, in homesteads vegetables and tubers are largely grown. 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. A list of important crops of Kerala along with area, production and productivity over a period of eleven years are given in Annexure 28.

1.8.2. Crop sequences

With its diverse soil and ecological conditions there exists a high degree of variability in cropping in the State. Polyculture is the rule in most of the areas. The important crop combinations and crop sequences in the lowland, midland, highland and high ranges are given below.

i. Lowland

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

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

ii. Midland

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

In 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.

iii. Highland

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

iv High ranges

Perennial	—	Coffee, tea, rubber, cardamom.

In drylands mixed cropping pattern is generally followed. In the lowlands and parts of midlands coconut based mixed cropping system is followed. In the midlands tapioca based cropping system are widely practiced.

In wet land areas where generally rice based cropping system is followed, the major crop sequences in three seasons are:

1. Rice-rice-rice
2. Rice-rice-pulses/vegetables/oil seeds/sweet potato
3. Rice-banana/tapioca
4. Rice-rice-fallow

Eventhough a polycropping pattern with mixed stand of various crops is observed thoughout the state, four major farming systems can be identified.

1. Rice based farming system
2. Coconut based farming system
3. 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 homestead farming.

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.

1.9. 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, which is the staple food of Kerala presents an alarming picture in respect of area and production, during the last decade 1975-'76 to 1984-'85. From the area of 8.76 lakh ha in 1975-'76 it has come down to 7.30 lakh ha in 1984-'85, ie a decrease of about 17 per cent during the decade. The productivity has increased from 1520 kg/ha in 1975-'76 to 1719 kg/ha in 1984-'85, an increase of about 13 per cent. Hence, it may be noted that the drastic reduction in area is the main reason for the low total production of rice in the state.

The production of rice has been almost stagnant during the last few years. The population of the state has been growing at an annual rate of 1.79 per cent resulting in a widen gap between internal production and requirement. The current level of production in the state meets only 42 per cent 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 3.90 million tonnes of rice, that is to say, three

times the current internal production. If production does not increase adequately, there would be a yawning gap between availability and requirements, necessitating extreme dependence on outside suppliers. This shows the gravity of Kerala's food problem and the need to find urgent solutions 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 conditions including problem areas such as modan lands, waterlogged and flooded areas, high altitude areas, coastal saline areas etc. These, differing in agro-

Table – 17: Area (000' ha), production (000' tonnes) and productivity (kg/ha) of major crops of Kerala (1975–'76 to 1985-'86)

Crop		1975–76	1980-81	1984-85	1985-86*
Rice	Area	876	802	730	678
	Production	1339	1272	1256	1173
	Productivity	1520	1587	1719	1729
Coconut	Area	693	651	687	687
	Production**	3439	3296	3453	3149
	Productivity***	4963	4617	5023	4584
Tapioca	Area	327	245	217	215
	Production	5390	4061	3694	3463
	Productivity	16491	16575	17047	16106
Pepper	Area	108	108	106	106
	Production	25	29	17	29
	Productivity	227	263	161	274
Rubber	Area	207	238	312	320
	Production	129	140	189	185
	Productivity	623	590	605	578
Arecanut	Area	77	61	57	57
	Production**	13387	10805	9269	5033
	Productivity***	174719	176437	162614	88298
Cashew	Area	109	141	137	137
	Production	122	82	72	73
	Productivity	1122	579	527	533
Tea	Area	N.A.	36	35	N.A.
	Production	46	51	56	53
	Productivity	N.A.	1402	1608	N.A.
Coffee	Area	N.A.	58	64	N.A.
	Production	18	24	43	24
	Productivity	N.A.	406	672	N.A.

Note: * Figures for 1995-'86 are provisional
** Million nuts
*** Nuts/ha

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

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 courses. Moreover, toxic proportions of iron and aluminium salts are washed into the low lying rice fields.

iv. High cost of cultivation, low labour productivity and constant 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 development for effective utilisation of the irrigation potential created.

vi The consumption of fertilisers in the State is also 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 kg/ha. In terms of NPK, it amounts to 6.7 kg nitrogen, 1.5 kg phosphorus, 4.3 kg potash per ha. for HYV and 0.6kg nitrogen, 1.7 kg phosphorus and 2.3 kg potash per hectare for traditional varieties of rice. The doses of fertilizers for HYV and local varieties according to the recommended package of practices are 90 kg nitrogen, 45 kg phosphorus, 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 of rice, we should consider the following measures.

i. Increase the coverage of HYV in all seasons.

ii. Bring more area under punja crop (summer). Irrigation is a major constraint here and to tackle this, ground water resource has to be exploited.

iii. Increase productivity in areas where it is relatively low now.

iv. Ensure optimum fertilizer 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 area under coconut in the world. Kerala has nearly 6.87 lakh hectares under cultivation (1984-'85).

The production in 1975-'76 was 3439 million nuts while in 1984-'85 it was 3453 million nuts. Productivity has increased from 4953 nuts/ha to 5023 nuts/ha during the period. However, the increase is not found to be impressive as it is below the all India average. The incidence of root wilt disease, extending cultivation in marginal and unproductive land, inadequate input usage, unscientific underplanting in existing stand causing overcrowding of palms, inadequate management practices, unfavourable seasonal conditions, inferior genetic base of the cultivars, incidence of pests and diseases contribute to the poor yield.

Coconut is mostly grown in 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 299 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 earning 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 adversely affects the growth and productivity of 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.

They 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 variety is not cultivated commercially. The hybrids involving tall and dwarf as parents are popular with the farmers but they occupy only a small area at present. 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.

The following new hybrids have been released in the State in addition to the earlier hybrid T x D.

Kera Ganga, Laksha Ganga, Ananda Ganga.

1.9.3. Tapioca

Tapioca (cassava) is a crop of great economic significance in 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 1984-'85 it was 2.17 lakh ha. The production of tapioca also came down by about 31 per cent during the decade 1975–1985. From a total production of 53.9 lakh tonnes in 1975-'76, it came down to 37 lakh tonnes in 1984-'85. However, productivity slightly increased during the decade. From 16491 kg/ha in 1975-'76, the productivity increased to 17047 kg/ha in 1984-'85. 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 of Kerala.

Tapioca is also 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 involved 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 prices.

iv. Poor avenues of alternate use of the produce.

1.9.4. Pepper

Pepper is an important export oriented commodity. It is also a crop of small and marginal farmers. The area under its cultivation in the State has decreased by

2.3 per cent during the decade. The total cultivated area in 1975-'76 was 108 thousand hectares which came down to 106 thousand hectares in 1984-'85. The production decreased from 25000 tonnes in 1975-'76 to 17000 tonnes in 1984-'85. The productivity also decreased by 29 per cent. In 1984-'85 the productivity was 161 kg/ha while in 1975-'76 it was 227 kg/ha. Hence the low productivity is the main reason for low production of pepper in the State.

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 plantation requires planting and under planting at regular intervals to replace the old, diseased and damaged pepper vines around each standard. Systematic manuring or plant protection is not practised by the farmers which is one of the major reasons for the low productivity.

The hybrid Panniyur-1 which is an early bearing high yielding variety is becoming popular in the State. The other promising varieties are Karimunda, Kalluvally and Kottanadan.

1.9.5 Rubber

Rubber is the one crop which has registered substantial increase in area by about 1.05 lakh hectares during the decade, an increase of about 50.7 per cent. In 1984-'85 the total area under rubber was 3.12 lakh ha. The total production of rubber also increased during the decade. From the production of 1.29 lakh tonnes in 1975-'76, it increased to 1.89 lakh tonnes in 1984-'85. The productivity is found to be slightly decreased during the decade. In 1975-'76 the productivity was 623 kg/ha but in 1984-'85 it was only 605 kg/ha. Hence it is because of the increase in area, the production of rubber is 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 attractive returns from rubber is bound to alter the land use pattern in favour of rubber in other remaining areas as well.

1.9.6 Cashew

During the decade 1975-1985, there was an increase of about 0.28 lakh ha under cashew (an increase of about 26 per cent). From an area of 109 lakh ha in 1975-'76, it rose to 1.37 lakh ha in 1984-'85. But, in spite of the increase in area, it is disappointing to note that the production decreased by about 41 per cent during the decade. From the production of 1.22 lakh tonnes in 1975-'76, it came down to 0.72 lakh tonnes in 1984-'85. The productivity registered a fall of 53 per cent during this period. Adverse weather conditions might be the reason for such low productivity during the last five years. Since the import of raw cashewnuts from other countries has already declined and the State require, a large quantity of cashew for industries, the total production in the State has to be considerably increased. Since there is no scope for further increase in the area under cashew, the emphasis should be on increasing the productivity through better management practices. It

is estimated that about 30 per cent of the loss in production could be saved if timely plant protection measures are resorted to

1.9.7 Arecanut

The area under arecanut has decreased during the decade 1975-'85. In 1975-76 the total area under arecanut was 0.77 lakh ha whereas in 1984-'85 it was only 0.57 lakh ha. The production and productivity have also come down. In 1975-76 the production was 13387 million nuts whereas in 1984-'85 it was 9269 million nuts, a reduction of 30 per cent. The productivity declined from 174719 nuts/ha in 1975-'76 to 162614 nuts/ha in 1984-'85. The drought conditions 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 is 35,000 ha in 1984-'85 and the production is 56,000 tonnes. The productivity reached highest in 1984-'85 with 1608 kg/ha. Since this is mainly a plantation crop, there cannot be a drastic change in the area under its cultivation 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 1984-85 was 64,000 ha. The production of coffee has increased from 18000 tonnes in 1975-'76 to 24000 tonnes in 1980-'81. The productivity also increased from 406 kg/ha in 1980-'81 to 672 kg/ha in 1984-'85.

1.10 Livestock

1.10.1 General Status

According to the thirteenth quinquennial livestock census of 1982, Kerala has 56.44 lakh livestock (Fig.11) and 151 lakh poultry population. There was an increase of 3.25 lakh (6.12 per cent) livestock and 19.94 lakh (12.65 per cent) poultry over the 1977 census. The district-wise details are given in Annexure 31.

The livestock population is highest in Quilon district (12.07 per cent) whereas the poultry population is highest in Malappuram district (11.09 per cent). The district with the lowest percentage of both livestock and poultry is Wynad. 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.

Table-18: Districts with the largest and the smallest numbers of livestock and poultry in Kerala

Species of Livestock/ poultry	Districts with	
	Largest numbers	Smallest numbers
Cattle	Quilon	Wynad
Buffaloes	Palghat	Malappuram
Goat	Quilon	Wynad
Pigs	Kottayam	Malappuram
Fowls	Malappuram	Wynad
Ducks	Alleppey	Wynad
Total livestock	Quilon	Wynad
Total poultry	Malappuram	Wynad

Fig.11.

MAP OF KERALA
LIVESTOCK

REFERENCES

NUMBER OF LIVESTOCK

700 000

600 000

500 000

400 000

300 000

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
Buffaloes	Palghat	Idukki
Goats	Trivandrum	Idukki
Pigs	Kottayam	—
Total livestock	Alleppey	Idukki
Total poultry	Alleppey	Idukki

The changes in the major species of livestock over the census between 1966 and 1982 are as shown in Annexure 33. Buffaloes and other livestock (of which pigs formed the bulk) declined during 1982, whereas cattle and goats showed notable increase over the years. The density (numbers per km^2) of livestock and poultry population in each district have been indicated in Annexures 34. 35 and 36. The districts with the highest and the lowest density are given in Table 19.

Idukki district is having the lowest density of all major species of livestock and poultry. The dominance of Alleppey with regard to overall livestock and poultry is due to very high density of cattle and ducks in the district. The density of goats increased in all the districts over the period 1977 to 1982. 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 1966 to 1982 is shown in Annexure 37. The population of adult males declined by about half over the last 15 years which indicates their non-availability for agricultural purposes. It should be noted that the number of young males (3 years and under) remained almost stationery during this period whereas the number of the young and adult female cattle increased.

The effect of cattle improvement programme can be observed in the distribution of desi and improved (mostly exotic cross breeds) cattle. This distribution over the age groups and over the two census (1977 and 1982) is shown in Annexure 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 lowest percentage of improved cattle are given in Table 20.

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

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 female (1-3 years)	Alleppey	Kozhikode
Total cattle	Trivandrum	Wynad

1.10.3. Buffaloes

Unlike cattle, adult males outnumber adult females indicating the preference of male buffaloes for draught purposes. Total buffaloes declined by about 47000 (10 per cent) during 1977 to 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 3 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 ie from 16.83 lakh to 20 04 lakh during 1977 and 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 used more for the supply of meat than milk and it is high time that concrete steps are taken towards improving meat yield from goats. Goats are more or less evenly distributed, but their density varied widely between districts from 85 to 20 with a State average of 52 per km^2.

1.10.5 Poultry

The principal species of poultry are fowls and ducks which together account for over 99 per cent of total poultry at 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 density of fowls varied from 732 to 110 between districts while that of ducks varied from 109 to 1, with the State averages of 374 and 14 per km^2, respectively for the two species. Districtwise 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 Wynad the lowest (2.42 per cent). In the case of improved poultry also the districts south of Ernakulam together have larger numbers. Thus, as in the case of cattle, more accelerated development of poultry appears to be in the southern districts compared to central and northern districts. Few development programmes for ducks have been initiated in the State.

1.10.6. Livestock products

i. 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 is 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) over the two decades 1964-'84. 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 contributions 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 0.66 per cent respectively.

Turning to productivity, the per day yield of all 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 in cross-bred cows, non-descript cows, buffaloes and goats respectively. The cross-breeding programme has had its contribution in the yield of cross-bred cows. But it is interesting to note that, in spite of the lack of developmental effort, the yield of buffaloes showed appreciable increase in the five year period. When compared to all India, milk production in 1983-'84 was 3.17 per cent of the country as indicated in Annexure 47.

ii. Eggs

The production of eggs in the State during 1983-'84 was estimated to be 1260 million numbers. There was an increase of 978 million eggs or 347 per cent over the past two decades (1964-1984). 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 neighbouring States by rail as well as by road. The transport by rail was 95.82 lakh in 1984 and by road was 1737 lakh, making the total of 1832.81 lakh ie 14.55 per cent of the production. This indicates the large demand for eggs in the State and the scope for improving poultry production.

Another expanding area where there is considerable scope for development and research activities is broiler production. The 1982 census shows 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.

iii. 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 mention that these estimates are under-estimates 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 bovines

alone (goat and sheep) was 15.58 per cent and the balance of 3.75 per cent was of pigs. Thus, the bulk of the meat consumed in the State is beef.

The production of this large quantity of beef was made possible primarily through large scale transport of cattle and buffaloes from 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 and calls for efforts to put in this direction (Annexures 51 and 52).

iv. 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 accounts 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 sector. 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 that 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 be divided into the marine and inland. Kerala has a coast line of 580 km, with 38,000 km² 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 production. When Kerala produced 3.9 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 27,001 tonnes of inland fish, forming only 2.7 per cent of the total inland production. In the availability of area of inland water Kerala ranked 5th, while in inland fish production its position was 10th only. In total 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,

Table 21: Religion-wise distribution (in percentage) 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

Kerala has a traditional fishermen population of 7,78,882 distributed in 1,18,801 households. This works out to 3 per cent of the State's population and 14 per cent of the fishermen population of India, although the State has only 8 per cent of 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 35,076 fishing boats are operated in the State, including both mechanised and non-mechanised. Of the total Kerala fishermen population, 6,02,457 are marine fishermen and 1,76,416 are inland. 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, viz 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 1979 census are shown in Table 22.

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 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 fishermen of Kerala still do not own, any land. Out of 1,18,801 households, 80.4 per cent have their own house, 4.5 per cent live in rented houses, while 15.1 per cent do not have a houses. Ninety per cent of the fishermen houses are not electrified. Out of about 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.

Table 22: Percentage distribution of income groups of fishermen

Income groups (Rs. per annum)	Percentage of household
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

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, ie. providing the infrastructure basis for concentrating on the developmental process in favour of the traditional sector. The Kerala Marine Fisheries Regulation Act 1980, 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 is to develop policies in favour of the traditional sector. The attempt is to provide means of production to the actual producer 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 this, education and research are now mainly under Kerala Agricultural University, while the other activities are carried out by the Department of Fisheries and its sister organisation the 'Matsyafed'.

i. 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 are newly sanctioned, one each at Alleppey, Cannanore and Quilon.

For the development of fish culture in freshwater tanks, the Fish Farmer's 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 new Central Farm has been started in Poyya in Trichur district with central assistance. There is a Pilot Shrimp Hatchery at Azhikode. The freshwater farms are coming up, one each at Polachira, Parapparangadi, Alwaye and Pallom.

ii. Matsyafed

In Kerala there are three corporations for the development of fisheries—Kerala Inland Fisheries Development Corporation, Kerala Fisheries Corporation and 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, charting out a programme to provide intermediate technology, providing basic infrastructure facilities at grass root level for better processing and marketing

which ensures 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 charting of programmes to tap deep sea resources.

Under the Federation, there are four Ice Freezing Plants at Cannancre, Calicut. Cochin and Neendakara, one Nylon Net Factory at Cochin, 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 Malippuram, 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 development of fishermen.

iii. Kerala Agricultural University

As per the Kerala Agricultural University Act, 1972, Fisheries Education comes under the purview of the University and the 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 and in-service personnel engaged in development programme 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 seed. Studies are also envisaged in the field of Fishery, Biology, Ecology, Processing, Craft and Gear technologies, 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 in 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 2 year duration in Marine Biology and Industrial Fisheries under Cochin University, in Aquatic Biology and Fisheries under Kerala University and in Mariculture under Central Marine Fisheries Research Institute are also being offered in the State.

iv. Other Organisations

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

1) Central Marine Fisheries Research Institute (ICAR)

With its headquarters at Cochin, it 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 also got a prawn hatchery, a brackish water farm and a Krishi Vigyan Kendra at Narakkal.

2) Central Institute of Fisheries Technology (ICAR)

It is carrying out research studies in the field of fishing, fish storage and processing. The headquarters of the Institute is at Cochin, with a research centre at Calicut.

3) Marine Products Export Development Authority (Government of India)

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

4) 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.

5) Fishery Survey of India (Government of India)

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

6) 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.

7) Export Inspection Agency (Government of India)

The agency functions in Cochin with the objective of controlling the quality of marine products for export.

1.10.10. Fisheries constraints

Although Kerala is the foremost State in India in marine fish production, it lags far behind in inland 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 it can give a big boost to our fish production and the related socio-economic aspects. As such, development of inland fisheries should be given top priority in the future planning for fishery development of the State. The major constraints in the development of this sector are:

1) Insufficiency of the stocking material
2) Feed
3) The acidic conditions of the fields
4) High capital investment required for 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 offshore 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 and at a moderate estimate of 1 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 Indian States in the matter of freshwater 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 waterspread 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 one. The proposed outlay for the VII Plan is 6500 crores 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 brackish-water fish farms (ii) riverine fish culture and cage and pen culture, fish culture in ponds, tanks and paddy fields, culture of air-breathing fishes (iii) trout culture, insurance cover to fish farmers (iv) establishment of a fish feed production unit (v) establishment of laboratories and strengthening of the survey unit (vi) patrolling of backwaters (vii) establishment of fishing harbours and landing facilities (viii) organising deep-sea fishing (ix) provision of processing, preservation and marketing facilities (x) mechanisation and improvement of fishing crafts, establishment of service centres for outboard engines (xi) setting up of a resource management cell (xii) establishment of a Central Fisheries Management Technical Institute and strengthening the Regional Fisheries Technical High Schools and (xiii) providing social amenities to fishermen and strengthening of 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 system 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 mechanical efficiency and reduce the drudgery associated in the use of them. 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 machinery are lagging behind the requirements. The tractor population 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 the 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 regions 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 is given below:

1.12.1. Northern zone

This zone consists of the four northern districts of Kerala viz. Kasaragode, 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) ie. 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 ie. South-West and North-East. The annual average rainfall for the zone is 3379mm. Although the zone is endowed with plentiful rainfall, a prolonged dry spell of 4 to 5 months duration does occur every year from December to May. Moisture stress during this period adversely affects the growth and production of perennial crops like coconut, arecanut and pepper. Similarly, torrential rains during the months of June and July create crop hazards due to waterlogging. The mean maximum and minimum temperatures of the region are 33°C and 23°C, respectively. Westerly and Northwesterly winds prevail during the South-West monsoon and easterly winds during December to March. The maximum wind speed lies between 10 km/h and 15 km/h. 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 viz. Palghat, Trichur and Ernakulam excluding the high ranges, 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 973689 hectares ie. 25 per cent of the area of the State. The total population of the zone is 70 12 lakh (1981 census) ie. 27.54 per cent of the population of the State. The number of farming families is about 3.8 lakhs. The zone is characterised by a comparatively heavier rainfall during the South-West monsoon and less rainfall during the North-East monsoon period leaving in between a dry spell of 6 months from December to May. The mean maximum and minimum temperature of the zone are 31.4°C and 21 1°C, 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. 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, Quilon, Pathanamthitta, Alleppey and Kottayam with 18 taluks and 45 development blocks and 265 panchayats, with a total geographical area of 7,26,200 ha ie. 18 68 per cent of the area of the State. Total population of the zone is 69 87 lakh ie. 27.45 per cent of the population of the State. Nearly 12 lakh operational holdings exist

in the four districts of the zone. Out of these, 63.82 per cent is within the range of 0.04 ha to 0.25 ha in size. The region has a tropical humid climate, with an aggressive summer and plentiful seasonal rainfall. The hot season from 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 regions of the State, the rainfall is comparatively well distributed with the result that the effective annual rainfall is more (ie 80 per cent) than that in the other zones. The annual average rainfall for the zone is 2664 mm. The mean maximum and minimum temperatures of the zone are 36.76°C and 21.15°C, respectively. The soils are lateritic, the texture ranging from sand to sandy loam and clay loam. The major crops of the region are rice, coconut, tapioca, pepper, cashew, rubber, arecanut, sugarcane, pulses and banana.

1.12.4 High Range zone

This zone comprises the districts of Wynad and Idukki, Nelliampathy and Attappady hill ranges of Palghat district, Tanithode and Seethathode panchayats of Pathanamthitta district, Ariyankavu, Kulathupuzha and Thenmala panchayats of Pathanapuram taluk in Quilon district and Peringamala, Aryanad and Vithura panchayats of Nedumangad taluk and Kallikad and Amboori panchayats of Nevyattinkara taluk in Trivandrum district. Thus altogether, the zone comprises 9 taluks, 11 development blocks and 84 panchayats with a total geographical area of 21, 77, 280 ha ie. 56 55 per cent of the area of the State. Since the districts of the region are not contiguous, the agricultural characteristics differ widely. The features of the two districts viz. Wynad and Idukki are given separately.

Wynad 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 213200 ha and having a population of 5,54,026. The entire population is rural. The scheduled caste and scheduled tribe population 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 19.6°C, 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 2000 m. Idukki district has 4 taluks, 8 development blocks and 51 panchayats. The geographical area of the district is 5,06,100 ha ie. 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 part of the Deviculam taluk gets 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 viz. 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, pepper, coffee, banana and vegetables.

1.12 5. Special zone of Problem Areas

This region comprises of 5 areas viz. Onattukara, Kuttanad, Pokkali, Kole and Sugarcane lands spread over the six districts of Kerala viz. 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.

i. Onattukara

This area falls into Quilon and Alleppey districts, covering three taluks and 8 development blocks with a total geographical area of 72550 ha. In olden days Onattukara area was considered to be the rice grannery of erstwhile Travancore. But recently due to various reasons it has become a problem area with low level of production and productivity. The total population of the area is 10,94,432. Of this, about 77 per cent purely depend upon agriculture for their livelihood. A very intensive cropping pattern of two rice crops and a sesamum/pulses/vegetable crop is followed in this area.

ii. Kuttanad

Kuttanad area comprises of the low lying lands and the backwater system found in the districts of Alleppey and Kottayam, covering 10 taluks and 16 development blocks. The backwater system lies 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 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 known as padasekharams. These padasekharams are classified into five groups viz. single crop puncha lands, kayal lands, karappadams, double crop lands and 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.

iii. Pokkali

This area comprises of the marshy lands of Ernakulam district where salt water intrusion is the problem. The total area of the region is about 8,903 ha covering 4 taluks and 7 development blocks. The soils are acid saline. The land is submerged during monsoon period and is frequently disturbed by the sea water inundation due to the tidal currents. Only one rice crop is raised. After November, the lands are used for prawn culture.

iv. Kole lands

The Kole area lies continuously along the coastal strip of Trichur and Malappuram districts, covering 5 taluks and 8 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 characteristics of the region. Only one paddy crop is generally taken and during the rest of the period the fields are under submergence

In the case of all the above four areas coconut and rice are the principal 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.

v. Sugarcane lands

Geographically this area lies towards the east as an ascending narrow 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 low lying and submercible areas and coconut in the plains. Tuber, condiments and spices, vegetables and banana are the the other important crops. Nearly 3500 ha of land is 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 viz. Faculty of Agriculture, Faculty of Veterinary and Animal Sciences and Faculty of Fisheries. A brief note on these research stations are given below.

1.13.1. Research stations under the Faculty of Agriculture

1) NARP Southern zonal Centre, College of Agriculture, Vellayani

The Southern zonal Centre of the NARP came into being on 30-11-'81. The special station at Kottarakkara was started on 26-4-'86. 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 system.

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. Soil is deep red loam. The entire area is under coconut. Research on all aspects of coconut crop, particularly 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 KAU in 1972. The station was renamed as Cropping Systems Research Centre in 1983. The lead function of the station is to carry out studies on all aspects of a rice-based cropping system under the AICARP. The station is located 3 km south of Trivandrum Central Railway Station at an altitude of 29 m above MSL. Soil is sandy loam. Total area of the farm is 7.29 ha.

4) NARP zone for Problem areas, Regional Agricultural 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 Government of Kerala in 1958 and was taken over by KAU in 1972. An area of 21.5 ha (State Seed Farm) was transferred to the Station in 1980. The station was upgraded as 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 is reclaimed garden land and 21.50 ha is wet land. The wet land is put under rice-fish culture. The entire garden land is under coconut.

The lead function of the station is to conduct research on coconut diseases and integrated crop livestock-fish farming. The verification function includes 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. The KAU took over the centre in 1972. Till 1962, the station functioned on leased land. In February 1963, 11.65 ha of land was acquired on the northern side of the Kayamkulam—Punaloor road. The station is situated 1 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. In wet lands, two crops of rice are taken. In the dry land, research on coconut based farming is carried out. The lead function is to conduct research on rice and rice-based farming system 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 AICRP in January 1977. The station is located at Kallungal (Nedumpuram Panchayat) on the bank of the Manimala river, 6 km south of Thiruvalla town. The gross are of the farm is 25.66 ha and the net area available for cultivation is 21.57 ha. The geographic location of the farm is 25.14 m above MSL at 9.6°N latitude and 76.5°E longitude. The soil is alluvium 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 1985-'86. The ICAR *ad hoc* project on survey and appraisal of sugarcane disease 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-Alleppey. Soil is alluvial clay. The total area is 8.67 ha 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 Karappadom lands of Kuttanad.

8) AICRP Centre on Agrl. Drainage, Karumady

This is under operation from 1.12.1981 in farmers' fields in the Kavil Thekkumpuram Padasekharam at Karumady with a

water shed area of 89.91 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 soil of the padasekharam is alluvial kari soil with high content of organic matter. The objective function 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 land. Land was acquired at Ponnurunny (Vyttila) in 1963. The total area of the farm is 8.91 ha of which 3.05 ha is 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 Northern zonal Centre, Regional Agricultural Research Station, Pilicode

Research work on coconut commenced in Kerala with the establishment of four research stations (Nileswar, 1, 2, 3 and Kasaragod). In the Kasaragod taluk of the 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 re-organised with the headquarters at Pilicode in the year 1981 under the National Agricultural Research Project with the objective of solving location-specific farming problems in the Northern zone of Kerala. Altogether, the station has a land area of 56.90 ha of which 4 ha are wet lands and 52.90 ha are garden lands. The important crops grown are coconut (44.9 ha), rice (63.30 ha in 2 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 is 26.13 hectares. 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 Central zone, Regional Agricultural Research Station, Pattambi

Rice Research Station, Pattambi was established as 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 NARP, the station was re-organised as Regional Agricultural Research Station of the Central zone. The lead function of the station is to conduct research on rice, pulses and oilseeds and rice-based farming systems. The station also functions as an advanced centre for studies on laterite soil management.

The station is located at 10° N latitude and 70° E longitude at an elevation of 25 m MSL. The total area is 63.64 ha. The soil is laterite sandy loam. Ridges and slopes of low hills form the 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 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 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 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 2 ha of leased land. This 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 scheme for conducting agronomic research in irrigated areas. The station along with the staff was taken over by the KAU in 1973 for implementing the Co-ordinated Project for Research on Water Management sponsored by ICAR. The scheme has started functioning at the present centre from July 1985 onwards. The NARP sub-project for water management studies in the central zone of Kerala was started under the technical and administrative control of this centre from 1983-'84 onwards. The Research station is situated on the northern side of the Chalakudy-Sholayar road about 400 metres 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 total area of the farm is 8 95 ha comprising 7.05 ha wet land and 1.90 ha of upland.

15) Banana Research Station, Kannara

Research on banana and pineapple in the State was started in Kerala in 1958 at Mannuthy under a scheme financed partly by 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 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 alluvium in some pockets. In 1970, the All India Co-ordinated Fruit Improvement Project was sanctioned and the research programme on banana and pineapple under the project was brought under the Banana Research Station, Kannara. In 1974, the venue of pineapple research was shifted to Vellanikkara in an area on 7 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 pests and diseases of these crops.

16) Cashew Research Station, Madakkathara

This centre was started on 18–2-1972 to carry out investigation under 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 experimental crop.

17) Agrl. 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 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 National Highway at a distance of 6 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 land is sandy loam and that of the garden land is laterite loam. The total area is 38.12 ha. The Agricultural Research Station, Mannuthy forms a sub-centre 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 All India Co-ordinated Rice improvement Project, *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 stated in 1963 under a scheme included in the Third Five Year Plan. The Research station is situated in Anakkayam village in Ernad taluk in Malappuram district, the location of the station being on the western side of the Malappuram–Manjeri Road, at a distance of about 8 km from Malappuram. The station occupies an area of 9.92 ha of which 8 ha area is under cashew and 0.5 ha is put under coconut. Rest of the area is occupied by buildings, roads etc. The elevation of the location is 160.8 m above MSL. Soil is red laterite. The land is slopy and of uneven terrain. Soil is deep at some places and rocky in many places.

The objective of the station is to evolve materials, methods and means to increase 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 pests and diseases The evolution of suitable vegetative propagation methods and distribution of quality planting materials 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 sp. from similar ecological regions.

Breeding and genetic improvement of trees, crops and fodder sp 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, etc.), and cropping and harvesting systems suitable for different systems of agro-forestry (ie. Agri-Horti-Silvi-pastural combinations) acceptable to local population.

Developing sequential system of inter-cropping, so that the inter and under space of the land is 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 management related to agro-forestry based on its capability.

Evaluating the economics of different agroforestry systems with the aims and objectives of resource management viz. conservation, development and utilisation.

20) NARP zone for the High ranges Regional Agricultural Research Station, Ambalavayal

The research station was established in 1946 as part of 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 render scientific advice on improved agricultural technology. In 1966, the station was upgraded as Central Horticultural Research Station to undertake intensive research on major horticultural crops especially fruits, spices, essential oils etc.

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

The station is situated in Sultan's Battery Taluk of Wynad district at an elevation of 914 m above MSL and has an area of 87 3ha. 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 with a view to undertake research programme on various agronomical, botanical, entomological and phytopathological problems of cardamom cultivation. The station is situated in the high ranges of Kerala in the Pampadumpara village, Udumbanchola taluk of the Idukki district 35km from Kumily in the Kumily-Munnar road. The All India Co-ordinated Spices and Cashewnut Improvement Project of ICAR was initiated in the station during 1972. The total area of the farm is 46 44ha.

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 Government of Madras. This was transferred to KAU in 1972. This was converted to Livestock Research Station with effect from 14-8-1978. The farm is located in 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 84.37ha is under fodder crops. The major objective of this station is to conduct research work on scientific breeding of live-stock and its 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, 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 crossbred calves. The facilities such as artificial insamination, veterinary aid and supply of improved varieties of fodder grass slips are 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 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 crossbred 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 KAU in 1972. The major objectives of the farm are to provide hatching eggs, chicks and breeders for farmers and Development Departments, to provide necessary facilities for teaching the students and to undertake research in various aspects of poultry production.

5) Pig Breeding Farm, Mannuthy

The Pig Breeding Farm, Mannuthy was started in 1965 with an area of 4.2 ha. The main objective of the farm are to conduct research in various aspects of swine production, to serve as a demonstration unit for 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 Farms, Puduveypu, Panangad complex

In addition to the fish ponds (0.43ha) available at Panangad, an Instructional Farm of 10.1 ha has also been established at Puduveypu. At Panangad 3.5 ha of private land has been taken on lease for prawn cultivation.

A list of the Research Stations showing total area is given in Table 23.

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

Sl. No	Research Station	Total area (ha)
A.	FACULTY OF AGRICULTURE	
a)	*NARP Southern Zone*	
1	Coconut Research Station, Balaramapuram	14.13
2	Cropping Systems Research Centre, Karamana	7.29
3	Special Station, Kottarakkara	8.69
4	Instructional Farm, Vellayani	95.35
b)	*NARP Special Zone of Problem Areas*	
5	Regional Agrl. Research Station, Kumarakom	45.11
6	Rice Research Station, Moncompu	8.66
7	Rice Research Station, Kayamkulam	13.85
8	Sugarcane Research Station, Thiruvalla	25.66
9	AICRP on Agrl. Drainage (on leased land) Karumady	—
10	Rice Research Station, Vyttila	8.91
c)	*NARP Central Zone*	
11	Regional Agrl. Research Station, Pattambi	63.04
12	Aromatic and Medicinal Plants Research Station, Odakkali	12.40
13	Agronomic Research Station, Chalakudy	8.95
14	Banana Research Station, Kannara	19.70
15	Cashew Research Station, Madakkathara	18.00
16	Agrl. Research Station, Mannuthy	38.19
17	Cashew Research Station, Anakkayam	9.92
d)	*NARP Zone for High Ranges*	
18	Regional Agricultural Research Station, Ambalavayal.	87.30
19	Cardamom Research Station, Pampadumpara	46.44
e)	*NARP Northern Region*	
20	Regional Agricultural Research Station, Pilicode	56.90
21	Pepper Research Station, Panniyur	26.13
B.	FACULTY OF VETERINARY AND ANIMAL SCIENCES	
22	Livestock Research Station, Thiruvazhamkunnu	103.30
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	
	Total area under all the above farms	101.00
	Area under KAU Estate	978.42
	Total area under KAU	391.43
		1369.85

CHAPTER II

GENERAL AGRICULTURAL CHARACTERISTICS OF THE CENTRAL ZONE

CHAPTER II

General Agricultural Characteristics of the Central Zone

2.1 Delineation of the area of the zone

The Central Zone of Kerala (Fig. 12) comprises the districts of Ernakulam, Trichur and Palghat. The *Pokkali* soils in the district of Ernakulam, *Kole* soils of Trichur district and the Attappadi area in the Palghat district are, however not included in this zone.

The Central Zone is bounded on the east by Coimbatore district of Tamil Nadu and Idukki district of Kerala State, on the north by Malappuram district of Kerala State, on the west by Arabian sea and on the south by Kottayam and Alleppey districts of Kerala State. The zone lies between north latitudes 9° 47' and 11° 16' and between east longitudes 75° 52' and 76° 50'. The total geographical area of the zone is 9,831. sq. km; equal to 25 3 per cent of the area of Kerala State. The zone supports a population of 70,12,152 (1981 census) accounting for 27 55 per cent of the State population. The density of population varies between a minimum of 456 per sq. km (Palghat district) and a maximum of 1,053 per sq. km (Ernakulam district) with a mean value of 773 per sq. km against the State average of 654 per sq. km. Out of the State total of 61 taluks and 151 Community Development Blocks, the zone has 17 taluks and 44 blocks. A detailed taluk wise demarkation is given in Fig. 13. Out of the total 1000 panchayats in the State, 274 are in the zone. The delineation of central zone and the list of panchayats in each district is given in Annexures 54, 55, 56 and 57.

2.2 Physiography

The land mass of the Central Zone can be basically classified into three natural physiographic divisions viz., the highland, mid land and the low land (Fig. 14). The topography of the high land region is mountainous with altitudes ranging from 400 to 2000 metres above M. S. L. The mid land region has a rolling topography with hills and valleys. The low land of the coastal area is made of river deltas, back waters and the shore lands of the Arabian Sea. The landscape of the zone is traversed by six rivers. The Bharathapuzha with tributaries Malampuzha, Valayar, Mangalam, Meenkara, Gayathri, Pothundi and Kanhirapuzha provide good irrigational facilities to the Palghat district. Bhavani and Siruvani, the tributaries of Cauvery, flow through the Attappadi tract of the Palghat district. Trichur district is situated between the two big rivers of Kerala—the Bharathapuzha and the Periyar. Other important rivers of the zone are Chalakudi, Karuvannur and Kecheri.

2.3 Soils

The Central Zone consisting of the three districts of Ernakulam, Trichur and Palghat is complex in its topographical

Fig. 12 LOCATION OF CENTRAL ZONE

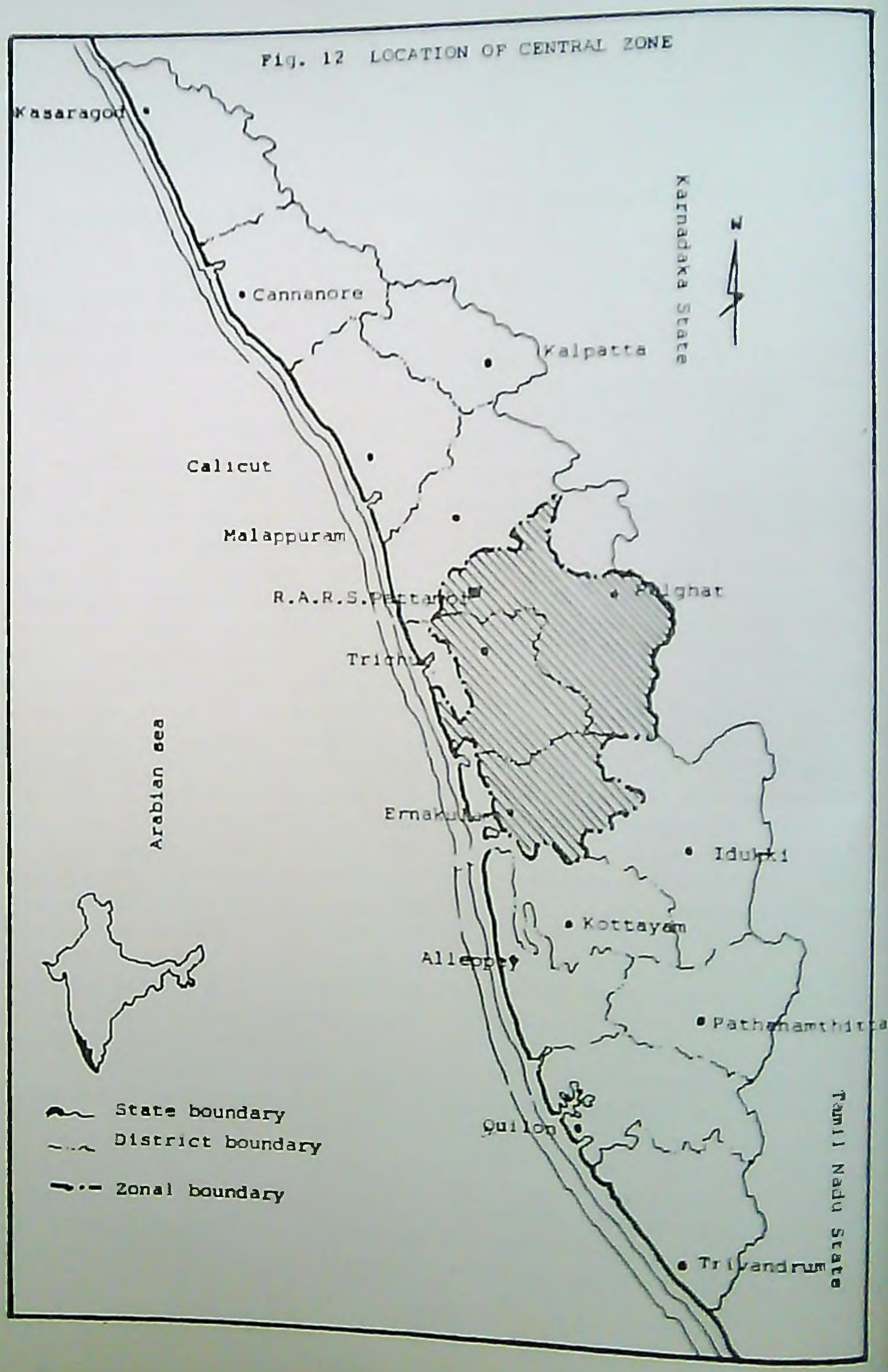


Fig.11. CENTRAL ZONE SHOWING TALUKS

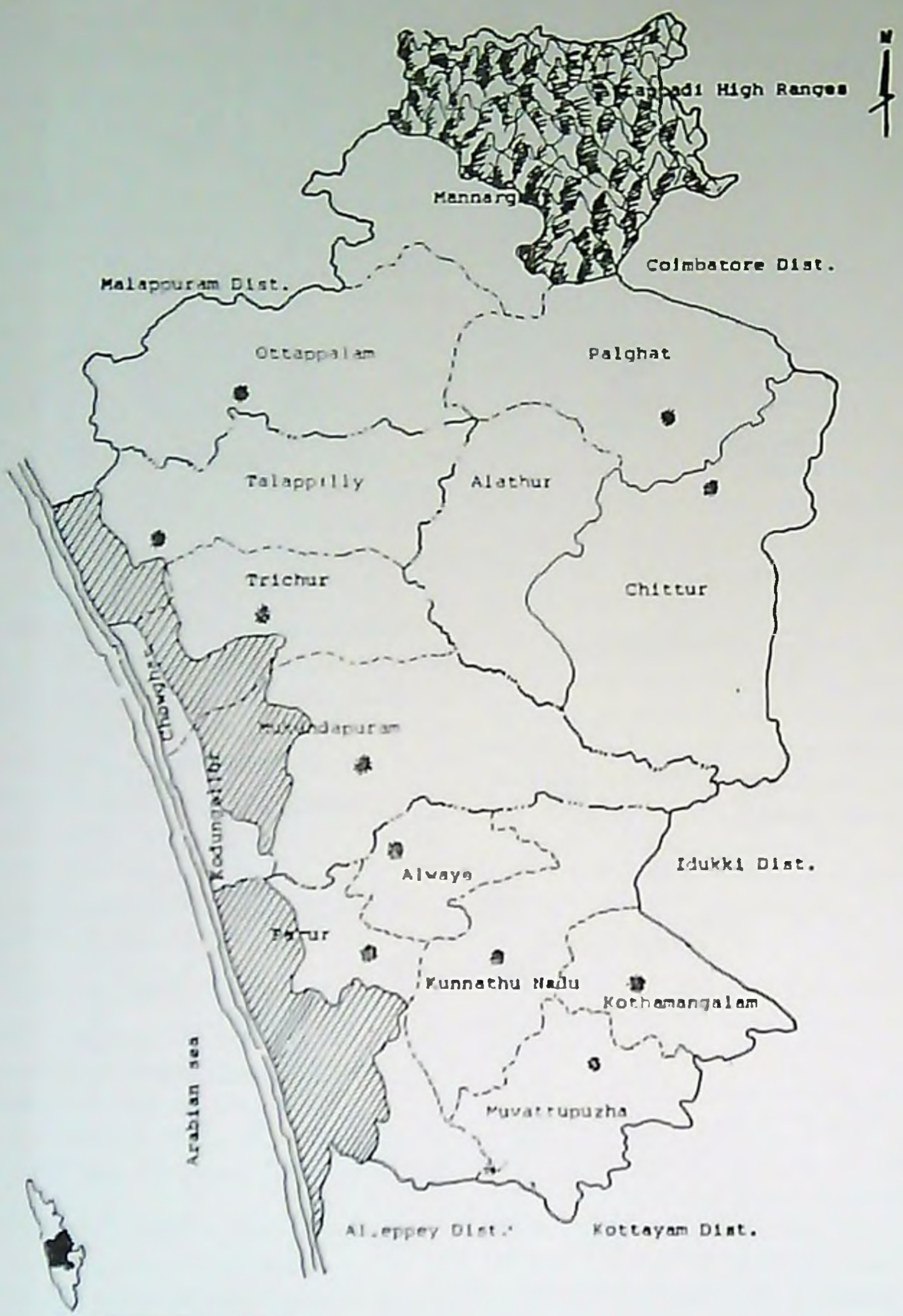


Fig.14. PHYSIOGRAPHY OF CENTRAL ZONE

Low land below 7.5 meter MSL

Mid land 7.5 to 75 meter MSL

High land 75 to 750 meter MSL

Hills (included in High Ranges) above 750 meter MSL

features and as such the soils identified in the zone are included in different groups on the basis of the physiographic positions, morphological characteristics and other physiochemical properties.

Based on the physiographic heterogeneity the Central Zone is divided into four broad geomorphic units and twelve soil associations have been mapped based on the similarity in the nature of development and other morphological characteristics like colour, texture, structure, consistency, permeability, drainage, etc.

The four physiographic divisions are:

a. The rocky elongated ridges and hillocks on the north eastern and south eastern parts of the zone, characterised by the presence of loamy soils developed under forest cover

b. The mid undulating region characterised by the narrow and broad valleys, elevated plains and isolated hillocks located in between the eastern high lands and back water areas of the west.

c. Bottom lands with concave relief (the Kole lands) located towards the western parts of Trichur district.

d. Sea board on the west consisting of the coastal alluvial plain.

2.3.1. Soil associations mapped

Soils occurring in each physiographic division are grouped into different soil associations and accordingly twelve soil associations have been identified in the Central Zone as described below (Fig 15).

A. Rocky elongated ridges and hillocks

1. Vaniampara — Painkulam — Neriyamangalam III Association:

Soils grouped under this association are relatively old and are formed as a result of weathering of gneissic rocks and charnekites under forest cover. The soils are deep to very deep, moderately to excessively drained with moderate permeability. The textural range noticed is from loam to gravelly silty clay loam and colour varies from black to dark reddish brown. Partly weathered gneissic boulders and quartz gravels are seen to occur down the profile.

Soils of Vaniampara series consists of moderately deep to deep, very dark brown to black loamy surface soils underlained by dark greyish brown gravelly loam soils. Soils grouped under Painkulam series are very deep and dark brown in colour with clay loam surface and gravelly clay loam–sub surface soils Neriyamangalam III series represents deep to very deep, well drained dark reddish brown clay loam surface soils followed by yellowish red silty loam sub-surface soils.

Area occupied by this association is under forest and the slope gradient varies from 20 to 60%. Soils mapped under the association are seen distributed on the hilly and forest region towards the south-eastern part of the Central Zone.

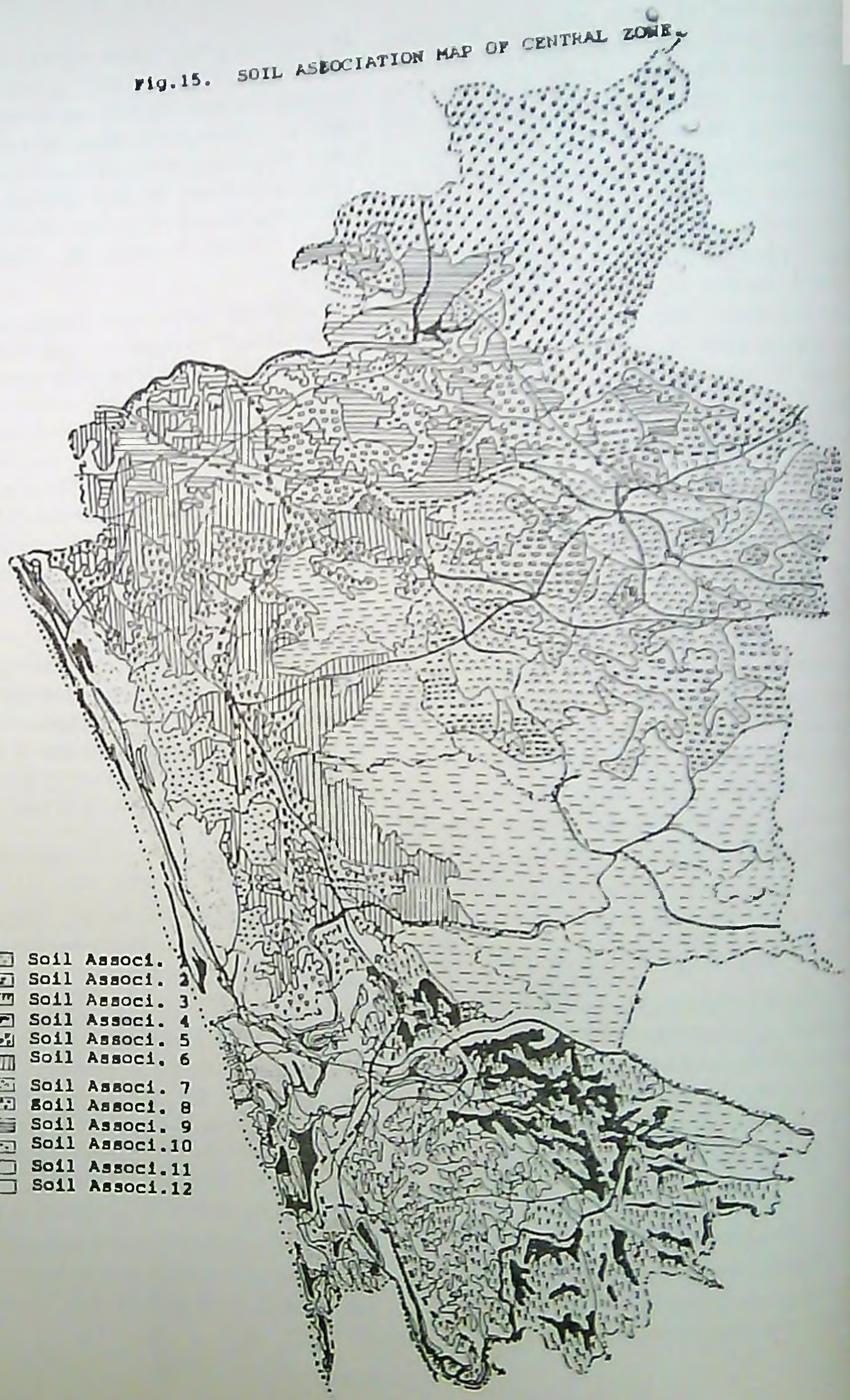
2. Karuvarachindaki—Paruthimala II—Anakkatty Association:

Soils grouped under this association are found to occur in the strongly slopping to very steep hilly regions of Attappadi forest.

Karuvarachindaki series represents the very deep dark reddish brown to dusky red clay loam surface soils underlained by red coloured soils of the same texture with increase in clay percentage down below. The soils seem to have gneissic gravels in the sub-soils in deeper layers.

Paruthimala II series represents very deep dark yellowish brown to dark greyish brown, silty loam to silty clay loam soils

Fig.15. SOIL ASSOCIATION MAP OF CENTRAL ZONE



developed from gneissic parent material. Anakkatty series located in steep to very steep hilly regions of Mannarghat taluk consists of deep to very deep yellowish red to reddish brown loamy soils developed under forest cover. The soils have a compact gravelly texture in the subsurface while very few gravels are seen in deeper layers

B. The Mid-undulating Region

This land form represents the major cropped area of the Central Zone. Eight soil associations mentioned below are mapped in this region.

3 Thodupuzha—Punnamattom—Odakkali—I Association:

This association consists of the gravelly soils of Thodupuzha and Odakkali—I series and riverine alluvium of Punnamattom series occurring on moderately to strongly sloping garden lands in the central and eastern parts of Ernakulam district. Thodupuzha and Odakkali—I series represents deep to very deep gravelly clay loam soils followed by gravelly clay sub-soils. Riverine alluvium occuring along the garden lands are grouped under Punnamattom series. All the three soil series are well drained with moderate permeability and are medium in nutrient status. They are suitable for a wide variety of crops.

4. Kothamangalam— Kuttamangalam—Charalade Association —

Soils mapped under these three series occurring in geographic association in gently to moderately sloping lands are confined to valley portions in Kothamangalam, Muvattupuzha and Kunnathunad taluks.

The yellowish brown, Kuttamangalam soils are deep with sandy clay loam texture whereas the gravelly Kothamangalam soils are very deep with clay loam texture. The Charalade soils are deep to very deep, yellowish brown clay loam to clay soils with red mottlings in the sub-soil. The Kuttamangalam and Charalade soils being located in valley portions are put under paddy cultivation whereas the Kothamangalam soils occurring along the valley fringe can be put under a wide variety of crops under irrigation.

5. Thrikkakara—Mulanthuruthy—Ayroor Association:

Soils mapped under this association are seen in nearly level to gently sloping paddy fields towards the central and western parts of Ernakulam district.

Thrikkakara soils are imperfectly drained deep dark yellowish brown fine textured clay soils deposited over organic debris. Soils grouped under Ayroor series are very deep greyish brown silty clay loam surface textured soils underlained by greyish brown clay loam to clay sub-soil formed by mixed alluvium. Mulanthuruthy soils are deep to very deep, dark greyish brown sandy loam to sandy clay loam surface texture followed by highly mottled clay sub-soils. These three soils have moderate water holding capacity and medium natural fertility. They are medium to acidic in reaction. These soils are put under paddy cultivation.

The Thrikkakara soils limit the choice of crops due to continuous wetting because of the lay of the land.

6 Ayyanthole—Kizhupallikkara – Kolazhy Association:—

Soils occupied by this association are located in narrow and broad valleys in the central part of Trichur district.

Soils of Ayyanthole series are dark greyish brown and very deep with surface texture varying from sandy loam to clay

loam. They possess highly mottled (red) clay sub-soils. Soils are developed from colluvium and alluvial sediments brought down from the neighbouring slopes Kizhupallikkara series represents very deep dark grey colluvial deposits showing wide variation in surface texture and stratification of sediments. Here also the sub-soil is mottled with red colour The grey colour of soil denotes impeded drainage.

Kolazhi series comprises of deep to very deep dark brown well drained gravelly clay loam to sandy clay loam surface soils followed by brownish yellow clay loam to silty clay loam sub-soils.

The soils grouped under this association are located in the valley portions of the central undulating plains in Trichur, Mukundapuram and Thalappilly taluks. These soils are put under paddy cultivation.

7. Koratti – Anjur – Velappaya Association:-

Soils grouped under this association are redeveloped over laterites and are located in the gently to moderately sloping lands and elevated plains in Mukundapuram, Talappilly, Trichur and Ottappalam taluks. They are put under coconut, arecanut, cashew, banana etc.

Koratti series represents dark brown to reddish brown, deep to very deep soils with clay loam to gravelly clay subsoils. Soils are developed over quariable laterite.

Anjur series consists of moderately deep to deep dark reddish brown soils, derived from hard laterite. The surface soil is gravelly clay.

Soils grouped under Velappaya series are moderately deep to deep dark brown gravelly clay loam soils developed over quariable laterite.

8. Peruvemba – Koduvayoor — Valiyavallampathy Association:

Soils grouped under this association are located on very gently to moderately sloping lands in the broad valley portion in Chittoor, Palghat and Ottappalam taluks, representing the major paddy growing area of the tract.

Peruvemba series represents light medium textured surface soils with dark brown colour. The sub-soils are medium to heavy textured with reddish yellow to dark yellowish brown colour. Quartz and ferromanganese gravels are noticed in the profile. Koduvayoor series represents very deep sandy clay loam alluvial soils with dark greyish brown to yellowish brown colour. The soils are well drained. Valiyavallampathy series represents imperfectly drained, very deep black to dark brown fine textured silty clay loam soils. Calcium carbonate nodules are seen distributed in the profile. Cracks are developed during summer. These soils are put under paddy cultivation.

9. Kottekkad — Kanjikkulam — Mannoor Association:-

The soils grouped under this association occurring on the sloping lands and elevated plains are formed by the weathering of gneissic rocks under subtropical climate They are seen distributed in Chittoor, Ottappalam and Palghat taluks.

Kottekkad series represents deep to very deep sandy clay loam to silty clay loam yellowish brown soils. Kanjikkulam series consists of deep to very deep dark brown gravelly clay loam soils developed over laterite. The Mannoor series consists of moderately deep to deep gravelly clay loam, yellowish red soils occurring in the gently sloping

plains Gneissic gravels are seen scattered throughout the profile.

Soils under this association are put under a wide variety of dry land crops.

10 Karakkurissy—Kunnathara—Vadanamkurissy Association:

Soils grouped under this soil association are found to occur in nearly level to gently sloping valleys of Mannarghat, Ottappalam and parts of Palghat taluks.

Karakurissy series represents very deep, loamy soils with very dark brown surface soils and greyish coloured subsoils. Kunnathara soils consist of very deep dark brown loamy alluvial soils occurring on nearly level to very gently sloping lands. Vadanamkurussi series represents very deep dark yellowish brown silty loam soils underlined by dark greyish brown loamy sub soils, developed from colluvial deposits.

The soils grouped in this association are put under paddy.

C. Bottom lands with concave relief:-

11 Konchira — Anthikad — Perumpuzha Association:-

Soils grouped under this association are peculiar in its nature of development, occurrence and behaviour They are located in the Kole lands most of which area are below sea level. Main characteristics of the soil included in this association is the predominent clayey texture throughout the profile. Colour of the soil ranges from dark brown to black. The soils are alluvial in origin and are imperfectly drained.

Soils of Konchira series are deep to very deep and fine textured and found to occur as deposits over organic debris. Depth of the organic layer varies considerably. Uniform clay texture is a typical character. Anthikad series also consists of very deep dark greyish brown fine textured clayey soils developed over alluvium. These soils are also having lime shells distributed in the sub soils. Perumpuzha soils are similar in its characteristics with Anthikad soils, but do not have lime shells in the profile.

The soils are medium acidic in reaction and are subjected to inundation resulting in periodic high water table.

Soils mapped under this association are distributed towards the western parts of Trichur and Mukundapuram taluks.

D. Sea board on the west consisting of the coastal alluvial plain:-

12. Manathala—Udayamperoor—Vypeen Association:-

The soils included in this association are located towards the western coastal belt extending from Sherthallai on the south to Punnayurkulam on the north. This sandy belt formed out of coastal alluvial sediments is mainly put under coconut cultivation. Rice is cultivated in the low land portions.

Soils of this association are young with immature profile development. Manathala series comprises of very deep dark brown to dark yellowish brown excessively drained sandy soils.

Udayamperoor series is uniform in texture with sandy loam soils of yellow colour. Vypeen soils are fine textured black silty clay loam soils occurring along the low land portions in the coastal belt.

2.3.2 *Soil types identified in the zone*

The important soil types of the zone are given in below.

1 Laterites

Laterites are found in the mid land physiographic division of the zone. Laterites are typical weathering products of gneissic and granitic rocks developed under humid tropical conditions. Heavy rainfall and high temperature prevalent in the zone are conducive to the process of laterisation. *In situ* laterites have been formed by the leaching of bases and silica from parent rock with concurrent accumulation of oxides of iron and aluminium. The surface soils are mostly reddish brown to yellowish red in colour. The texture of surface soils ranges mostly from gravelly loam to gravelly clay loam. These soils have in general A B (C) profiles which are deep to very deep. The profiles have well developed horizon with abundant ferruginous and quartz gravels. The plinthit is characterised by a compact vesicular mass below the B horizon, composed essentially of a mixture of hydrated oxides of iron and aluminium. Extensive stretches of undurted laterites with hard surface crust are of common occurrence in the zone. Laterites are in general poor in available nitrogen, phosphorus and potash and are low in bases. The organic matter content is also low. They are generally acidic with a pH range from 5.0 to 6.2. These soils are generally well drained and respond well to management practices.

2 Coastal alluvium

These soils are found in the coastal tracts of Trichur and Ernakulam districts. They have been developed from recent marine deposits and show incipient development expressed in immature AC profiles. The texture is dominated by sand fraction. They are excessively drained with very rapid permeability. The horizon is usually thin and the surface textures observed are loamy sand and sandy loam. The water table is high in low-lying areas like Ponnani and Nattika taluks. Profiles in these areas show mottlings in lower layers. These soils are poor in plant nutrients and have low cation exchange capacity. They are also very low in soil organic matter content.

3 Riverine alluvium

These soils occur mostly along the banks of the rivers and their tributaries mentioned earlier. They show wide variations in their physico-chemical properties and in the arrangement of layers depending obviously on the nature of 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. The fine sand fraction usually predominates. Presence of mica flakes has been observed in the alluvial soils of Trichur and Ernakulam districts. In old basins, clay illuviation is noticed in the profile. Hydromorphic conditions are also variously expressed as grey colours and mottlings and accumulation of organic matter in lower horizons as in Kole lands of the Trichur district. These soils are comparatively more fertile than laterite soils. They respond well to management practices.

4 Brown hydromorphic

Hydromorphic soils as a group occur extensively in all the three districts of the zone. These soils are mostly confined to valley bottoms between undulating topography in the mid land and in low lying

areas of the coastal strip. They have been formed as a result of transportation and sedimentation of material from adjoining hill slopes and also through deposition by rivers. They exhibit wide variations in physico-chemical properties and morphological features. In a majority of these soils, the water table is high. The development of the soil profile has occurred under impeded drainage conditions. These soils therefore exhibit characteristic hydromorphic features like clay horizons, presence of mottling, streaks, hard pans, organic matter deposition, iron-manganese concretions etc. In certain areas, occurrence of gravel and laterite within the profiles has been observed, indicative of the colluvial factor in soil formation. In general these soils are very deep and brownish in colour. The surface texture varies from sandy loam to clay. The coarse and fine fractions show varying pattern in their occurrence within the profiles. These soils are generally poor in phosphorus, calcium and other bases. The soil reaction is in the acidic range.

5 Black soils

Black soils are found in the Kerala state, only in the Chittur taluk, of the 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. These soils are dark in colour, low in organic matter, calcareous, moderately alkaline, high in clay content and cation exchange capacity and are very sticky and plastic. They are generally located in gently sloping to nearly level lands. These soils are deficient in nitrogen and phosphorus but have moderate levels of potassium and calcium.

6. Forest loams

These soils are the products of weathering of crystalline rocks under forest cover. They are restricted in occurrence in the forest areas of high ranges of the eastern part of the zone. 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 are dark brown in colour, with loam to silty loam texture. The dark colour of surface horizons is due to the presence of organic matter derived from the vegetation. In denuded areas leaching and deposition of humus in lower layer is observed. The B horizon usually contains gneissic gravels and boulders. The C horizon consists mostly of gneissic parent material under different stages of weathering. These soils are generally acidic with pH ranging from 5.5 to 6.3. They are rich in nitrogen but poor in bases because of heavy leaching.

2.4 Climate

2.4.1 Rainfall

The Central zone, being situated on the windward side of the Western Ghats and falling within the direct-sweep of South-West monsoon receives heavy rainfall. Ernakulam district is benefitted by the highest average rainfall (3550 mm), followed by Trichur (3215 mm). Neriamangalam in Ernakulam district receives the highest rainfall period of 172 rainy days. Palghat district being located in the Palghat gap of the Western-Ghats receives only an average of 2115 mm of annual precipitation. Even though the zone receives good amount of rainfall, the distribution pattern of the precipitation is quite erratic. It can be seen from the rainfall distribution maps that higher amounts of rainfall are generally observed in the southern half of the zone, particularly the eastern region adjacent to the western ghats. The annual rainfall

varies from less than 2000 mm in the South-East part of the zone (Fig 16). rainfalldistribution in the South-West monsoon season is more or less similar to that of the annual rainfall pattern. Low rainfall of less than 1000 mm is observed in the North-East region of the Palghat district, whereas, rainfall of more than 3000 mm is observed in the South-East portion of the Central zone. It can be seen that during the North-East monsoon season, rainfall of less than 400 mm is observed in the Central Palghat district, whereas the areas near Neriyamangalam in Ernakulam district receive more than 1000 mm. During the other period of the year, the rainfall varies from less than 200 mm to more than 800 mm. A major part of the Palghat district receives less than 300 mm, whereas, the areas near Neriyamangalam receives more than 800 mm. More than 75 per cent of the annual precipitation is received during the three months of June, July and August, torrential rains leading to flooding of low lands and enhancing the surface run off of top soil. The monthly distribution pattern of the rainfall of the zone is given in Annexure 58.

According to the climatological parameters, Palghat has a tropical type of climate except in the Attappady hills. The district receives heavy showers during the South-West monsoon period from May to August and scanty North-East monsoon showers during October-November. The Attappadi hills and the eastern part of the areas adjoining Coimbatore district of Tamil Nadu receive very low rainfall and are subject to very long drought spells from December to May.

The warm humid weather conditions of Trichur district is influenced by the coastal wind and marine climate. Based on the pattern of precipitation there are four seasons in the district.

Dry spell	:	December to February
Hot weather period	:	March to May
South-West monsoon period	:	June to September
North-East monsoon period	:	October, November

Ernakulam district has typical humid climate with heavy annual rainfall (3550 mm). The South West monsoon is the major contributor, about 60 per cent of the annual precipitation being recorded during this period. The share of the North-East monsoon is 25 per cent and the remaining 15 per cent is summer showers. Among the three districts of the zone the rainfall distribution pattern is more uniform in this district.

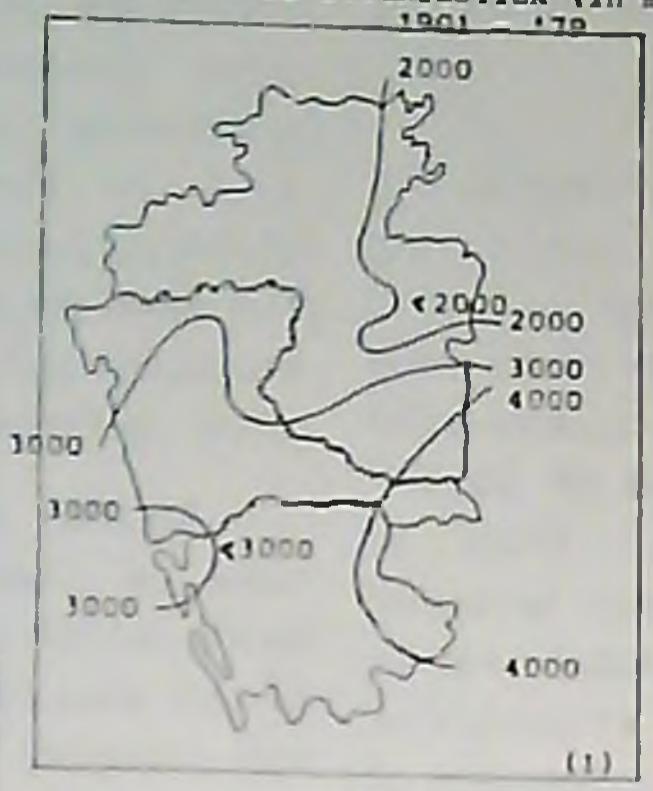
2.4.2. Temperature

The variations in the level of temperature are only marginal in the districts of Trichur and Ernakulam as they are influenced by the coastal marine climate. On the other hand in Palghat district the temperature variations are more pronounced. The average maximum temperature of the zone varies from 24.8°C to 31.4°C and that of minimum from 21.1°C to 23.1°C striking a mean range from 22.7°C to 27.5°C. However the mean value for humidity is as high as 82%, the months from June to August recording values above 90% (Annexure 59).

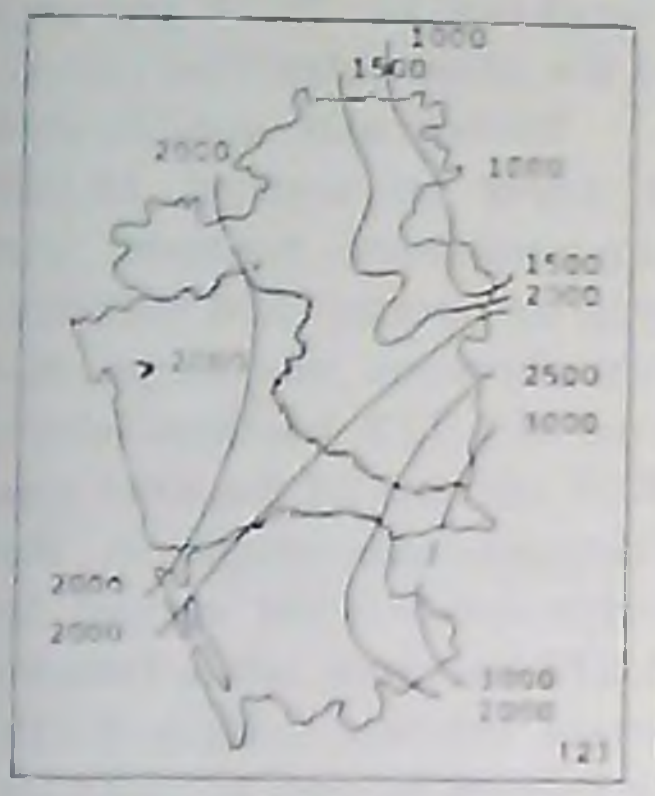
2.4.3. Humidity

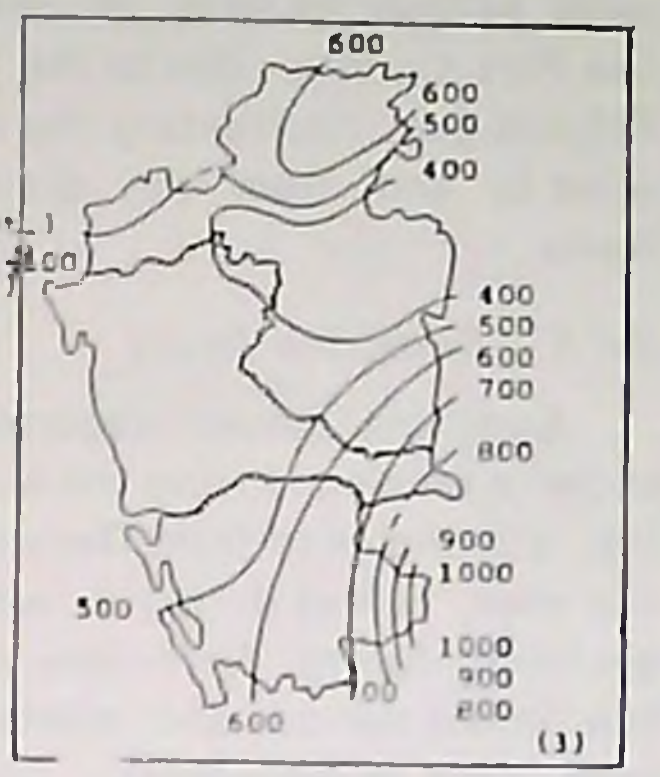
High rainfall conditions coupled with tropical location generate high humidity conditions, more or less throughout the year in the case of Ernakulam and parts of Trichur district. The average for the year is about 70% in these zones but in Palghat the humidity is around 40% during December–March due to the entry of hot

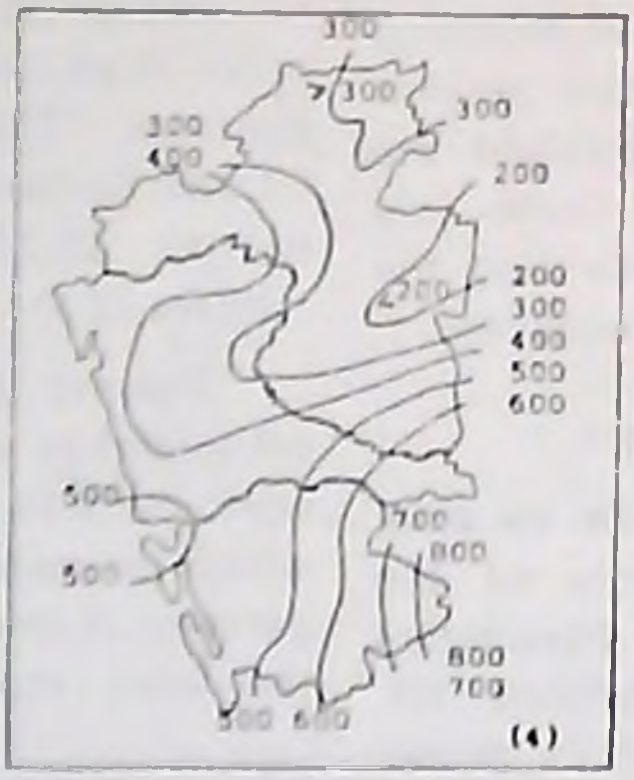
Fig.16. RAIN FALL DISTRIBUTION (in mm) CENTRAL ZONE



(1) Annual rain fall
(2) South West Monsoon (June-Sept.)
(3) North East Monsoon (Oct.-Dec.)
(4) Other than Monsoon (Jan.-May)







dry winds from Tamil Nadu through the Palghat gap in the Western Ghat. High humidity conditions keep evaporation relatively low and to that extent put less demand on water. At the same time, high humidity conditions favour the incidence of pests and diseases (Annexure 59)

2.4.4. Wind velocity

Wind speeds tend to be higher during the monsoonal months and low during summer months. Variability in wind velocity between the districts of the zone is low, even though there are coastal belts as well as inland tracts devoid of coastal line such as Palghat tract. Even at Palghat also the wind speeds recorded were as high as that at coastal station like Fort Cochin, due to the existence of Palghat gap, facilitating the movement of wind to and from the plains of Tamil Nadu.

2.4.5. Sunshine hours

Sunshine hours recorded naturally show a maxima during the summer months, starting even from December, recording peak values during January to March declining during April-May and touching low levels during the monsoon periods from June to November. The values are at the lowest ebb during June-July paradoxically these months providing the maximum possible hours of sunshine.

2.4.6. Water balance elements

An attempt has been made to work out the water balance elements of the Central zone from the weather parameters recorded from the three stations viz. Vellanikkara, Palghat and Cochin representing the three districts of the zone-Trichur, Palghat and Ernakulam (Fig. 17). The water balance elements are given in Annexure 59.

2.5 Land Use Pattern

The total geographical area of the zone is 9,73,689 hectares which cover about one-fourth of the total land mass of Kerala. The forests occupy about 2,47,999 hectares in this zone which accounts for 22.93 per cent of the Kerala state (Annexure 60). The forest areas are mainly concentrated in the Attappady tract of Palghat district, Thalappilly, Mukundapuram and Trichur taluks of Trichur district and Malayattur ranges of Kunnathunadu taluk and Kothamangalam taluk of Ernakulam district.

An area of 88,699 hectares of the zone is classified as non-agricultural lands which work out to 31.71 per cent of the area of the state classified under this category. Barren and uncultivable waste lands cover an area of 18,659 hectares, while permanent pastures and other grazing lands occupy 558 hectares. Land under miscellaneous tree crops account for an area of 9,723 hectares which forms only 19.05 per cent of the total area under miscellaneous tree crops in the state. Cultivable waste lands extend to an area of 35,878 hectares, while fallows other than current fallows occupy 9,216 hectares. The current fallows account for 14,352 hectares of the zone, which works out to 33.73 per cent of the current fallows of the state.

The net area sown in the zone is estimated as 5,48,905 hectares and area sown more than once as 2,51,489 hectares, which represents 25.13 per cent and 36.44 per cent of the corresponding categories of the land mass of Kerala (Fig. 18).

2.6 Irrigation

The total area under irrigation in the Central zone is 1,45,210 hectares which works out to 61 per cent of the total area

Fig.17. CLIMATIC WATER BALANCE OF CENTRAL ZONE

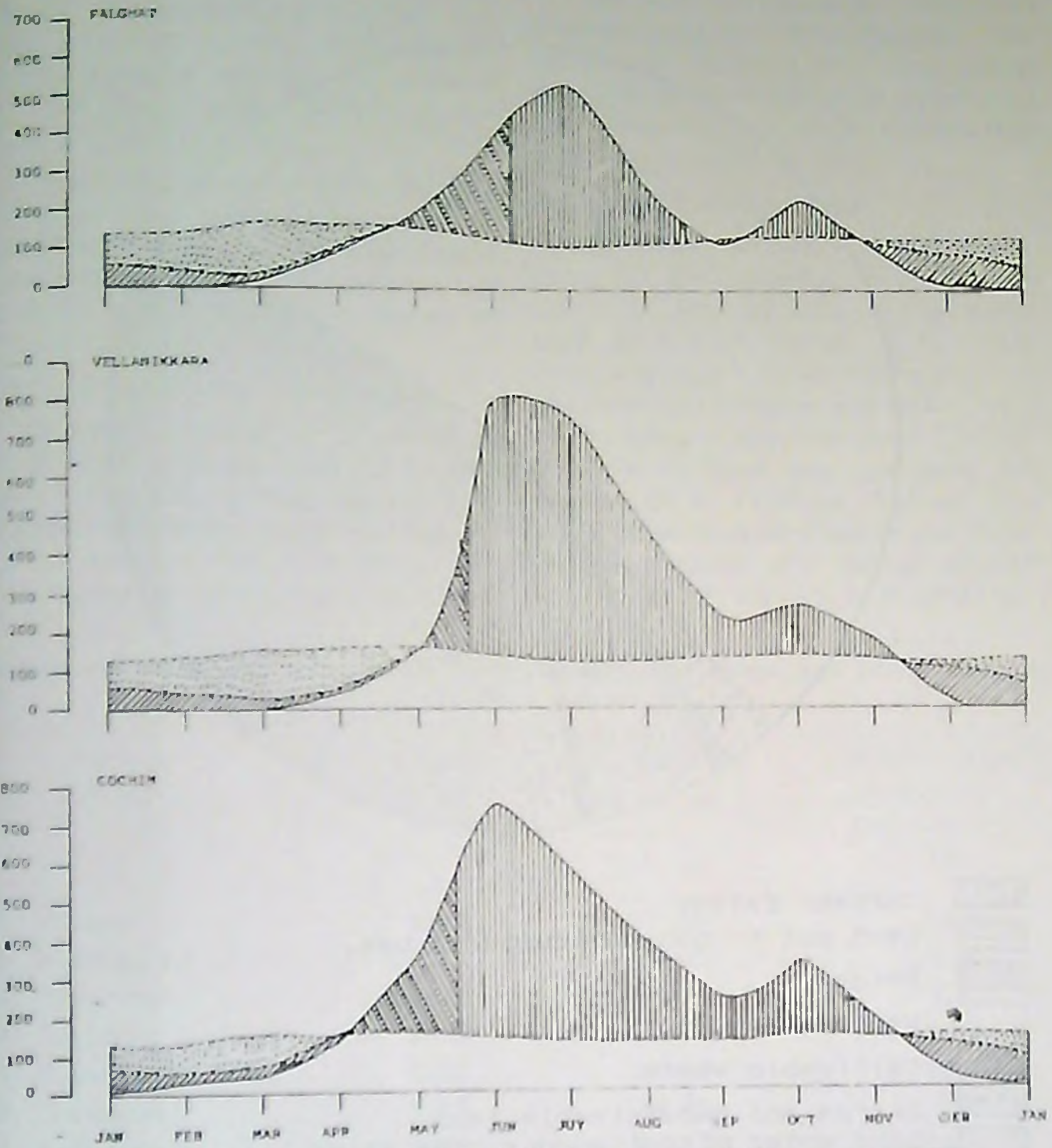
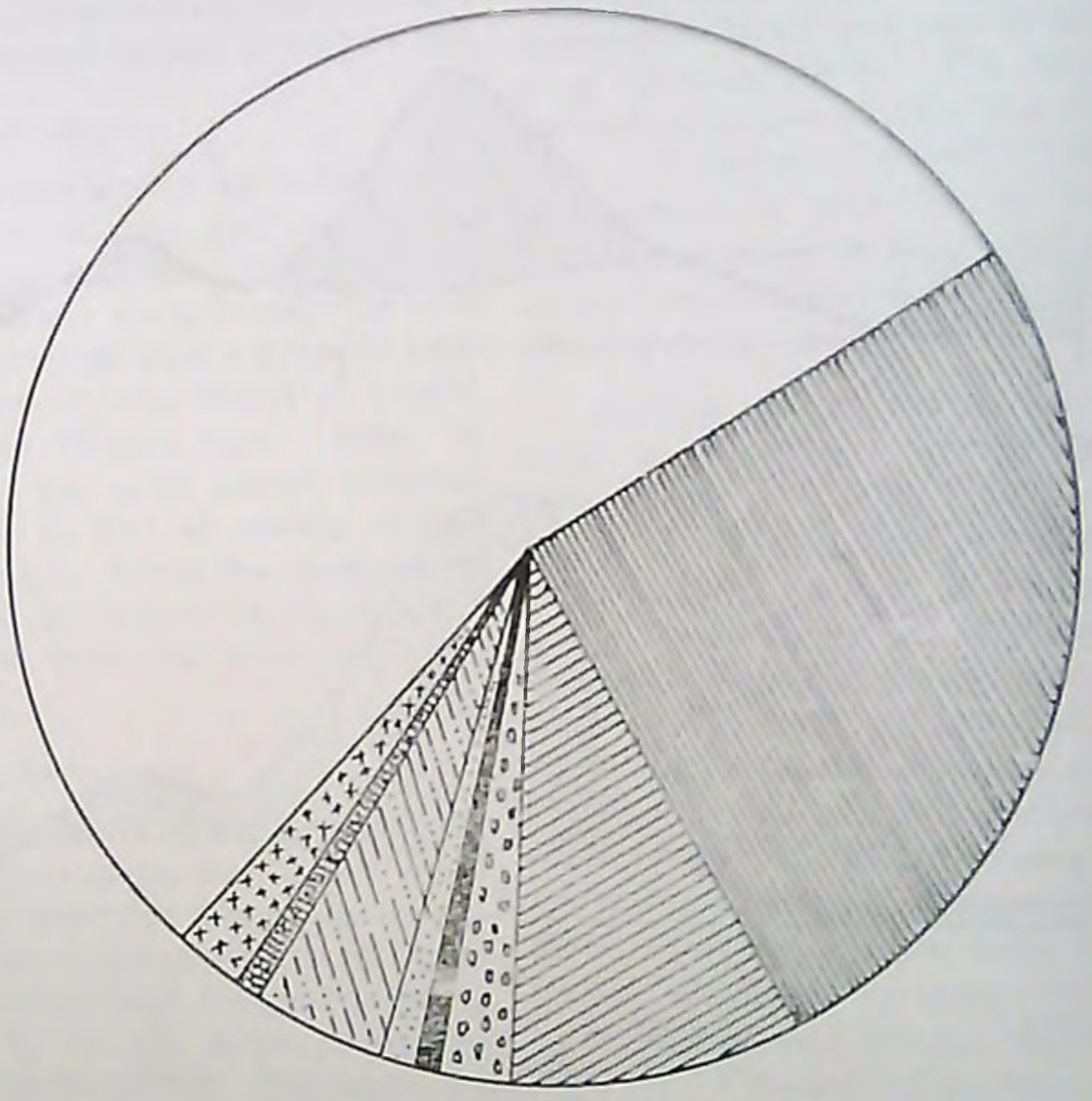


Fig.18. LAND USE PATT2RN OF CENTRAL ZONE (1984-85)



Current fallow
Land put to non-agricultural use.
Forest
Net area sown
Cultivable waste
Barren and uncultivable land
Land under miscellaneous tree crops
Fallow other than current fallow
Permanent pastures of grazing land

irrigated in the State. Source wise, the Government canal provides irrigation to 58 per cent while private tanks and wells account for about 15 per cent of the total irrigated area. (Annexure 60 and Fig. 19). Irrigation water is mainly utilized for raising rice crop (2 09,970 ha). In Trichur district coconut and arecanut are also grown widely under irrigated conditions (Annexure 61).

There are 24 major and medium irrigation projects implemented in the state. Out of which 17 are located in the Central zone (Annexure-62). These projects are operated in the various river basins as detailed below.

2 6 1. Bharathapuzha River Basin

The Bharathapuzha is the longest of all the rivers in Kerala State. The main river with a length of 250 km originates in Anamalai hills and flows through all the five taluks of Palghat district and joins the sea near Ponnani town of Malappuram district. Unlike the other river valleys in the state, the land here is less undulating and better suited for easy and effective irrigation.

The important tributaries, streams and irrigation projects of Bharathapuzha river are listed in Annexure 63. The ayacut area and the additional food production due to the irrigation projects of this river basin are given below.

2.6 2. Kecheri River Basin:

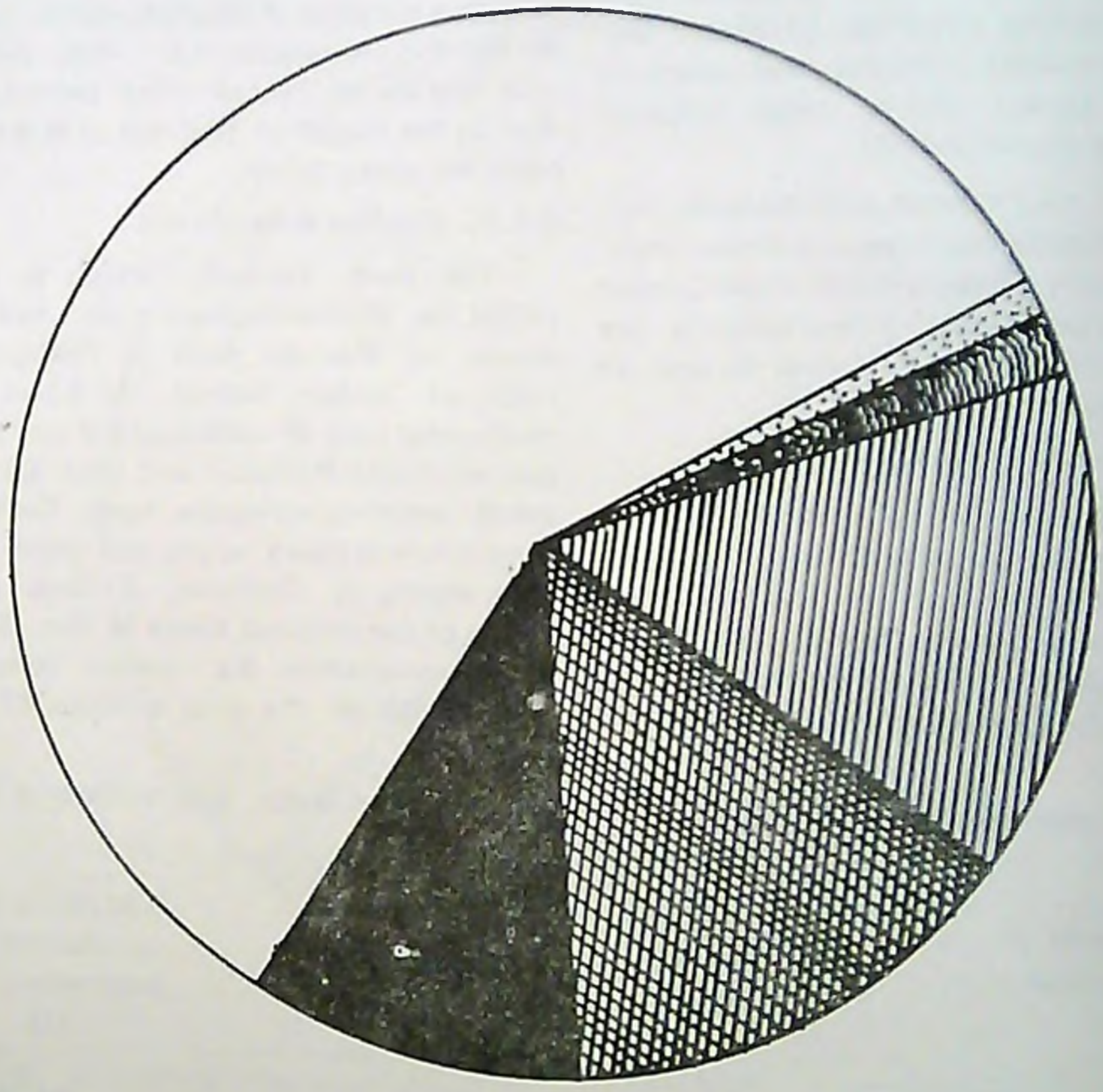
The river Kecheri, which is also called the Wadakkanchery river, has its source in Machad hills in Thalappilly taluk of Trichur district. It flows due north-west upto Wadakkanchery and then due west upto Nelluvayi and then takes a south westerly direction upto Kecheri, from where it flows south and joins the back waters at Chettuva. Kecheri river is one of the smallest rivers in the State and is practically dry during summer. The length of the river is about 43 km.

Irrigation projects/Ayacut area in the Bharathapuzha river basin and additional food production estimated

Sl. No.	Name of Project	Ayacut (ha)	Cost (in lakhs)	Additional food production (estimates) (t)
1	Walayar	3238	131.66	6470
2	Malampuzha	21045	580.00	38560
3	Cheerakuzhi	1620	90.76	3240
4	Gayathri-I & II	5455	220.00	6070
5	Pothundi	5465	234.00	10930
6	Mangalam	3440	106.00	6780
7	Kanhirapuzha	9720	926.15	25300
8	Chitturpuzha	17300	536.61	32160

Source: Centre for Water Resources Development & Management, Kozhikode—673 571, January 1983

Fig. 19. AREA UNDER IRRIGATION IN CENTRAL ZONE
SOURCE WISE 1980 - 81



Government Canal

Private canal

Government tanks and wells

Private tanks and wells

Minor & lift irrigation

Other sources

The river valley comprises of lands mainly in Thalappilly taluk. Vazhani Dam constructed at the upper reaches of the river is the only irrigation scheme of this river basin, at a total cost of Rs. 107 57 lakhs, covers an ayacut area of 3565 hectares. With an estimated additional food production of 7130 tonnes.

2 6.3 Karuvannur River Basin

The Manali river in the north and Kurumali river in the south join at a place called Palakkadavu near Arattupuzha in Trichur taluk and they together form the Karuvannur river. The Kurumali is made up of two rivers, the Ghimoni and Muppli. The Karuvannur river takes a south west direction upto Panakulam and then takes a westward direction of flow. Before joining the back waters, the river branches into two, and the southern branch flows south to join Periyar up stream of Crangannur bar and the northern branch known as Knolipuzha, drains into the back waters at Chettuva. The Karuvannur, being a river of flash flow, and its connection to the sea after reaching the plains is long and circuitous; flood conditions prevail during monsoon seasons especially in its lower reaches. The river flows through the taluks of Mukundapuram, Trichur and Chittur. The Peechi irrigation project implemented at a total outlay of Rs. 235 lakhs, has an ayacut area of 17555 hectares with an estimated additional food production to 35110 tonnes.

2 6.4 Chalakudy River Basin

Chalakudy river originates from Anamalai and Nelliampathi hills. It has four main tributaries known as Sholayar, Parambikulam, Thekadi and Karappara. The river has a length of 144 km. The river basin comprises of lands within the taluks of Mukundapuram, Parur and Chittur. After a meandering course of 144 km., the river joins the northern arm of the Periyar and empties into the back-waters to the south of Cranganore bar. Chalakudy is one of the few rivers in the State whose irrigation potential has been investigated in detail. The Chalakudy irrigation project has been implemented at a total cost of Rs.188.6 lakhs. This has an estimated ayacut area of 19690 hectares favouring an additional food production of 16390 tonnes.

2 6.5 The Periyar River Basin

The Periyar river is the second longest river in the State. It starts from Sivagiri peak near Devikulam. The river is joined at about 16 km down stream by Mullayar river. After passing through Vandiperiyar it is joined by Perumthura river, further down tributaries like Chertoni, Chittar, Perinjankutty and Muthirapuzha successively.

After the confluence of Muthirapuzha with Periyar, further down it is joined by Deviar and passes through Neriamangalam. About 12 km down, the Edamala river joins Periyar and from here as far as Malayattur, the Periyar is 300 metres in width and is fed by numerous streams. The river divides into two branches after reaching Alwaye. The principal branch flows north west, joins with Chalakudi river at Puthanvelikara. The other takes a southern turn and is broken up into a number of small channels falling into the Vembanad lake at Varapuzha. The length of the river is about 218 km and during its course of flow it passes through the taluks of Peermedu, Devikulam and Thodupuzha and Idukki district, Muvattupuzha, Kunnathunad and Parur of Ernakulam district. The Periyar valley irrigation scheme taken up under the second five

year plan of Kerala State is a major irrigation project of the Central zone. The scheme comprises of (1) a barrage across river Periyar at Bhoothathankettu to divert water for irrigation purposes (2) a head works regulator on the left bank of the river and (3) a main canal on the left bank of the river and ending at the tail end of the river with a net work of distributories. The project with a total out lay of Rs. 1150 lakhs will cover an ayacut area of 32380 hectares with an estimated additional food production of 42.298 tonnes

2.6.6 Muvattupuzha Basin

The Muvattupuzha river is formed by a union of three rivers Thodupuzha, Kaliyar and Kothamangalam, joining together near Muvattupuzha town. From Muvattupuzha, the combined discharges from the three rivers, flow in a westerly direction, under the name of Muvattupuzha river for about 13 km and then turns to south passing through Ramamangalam and Piravom. From Piravom, the river flows through low swampy lands and at Vettikkattu Mukku it bifurcates and flowing west empties its waters into Vembanad lake through Ithupuzha and Murinjapuzha. The maximum length of the river is 120 km and during its course It passes through Thodupuzha, Muvattupuzha, Vaikkom and Kanayannur taluks. The river has not been harnessed for irrigation on a large scale yet, even though there exists some small lift irrigation works where the river water is lifted for providing life irrigation to rice during periods of drought.

Idukki-cum–Muvattupuzha scheme, with a dam Melamkaram for utilizing the tail waters from Idukki hydroelectric scheme are under investigation. This scheme with a proposed out lay of Rs. 1,000 lakhs is expected to have an ayacut of 17,400 hectares with an estimated additional food production target of 1,70,000 tonnes

Trend of the area of Paddy under irrigated and non irrigated conditions

On perusal of the data presented in Annexure-VI, for the years 1981 to 1985 an increased trend in irrigation is seen in winter rice crop in all the three districts, as that of the State trend But Trichur district showed a lesser area under irrigated paddy than the other districts.

2.7. Socio-economic characteristics-land holding pattern

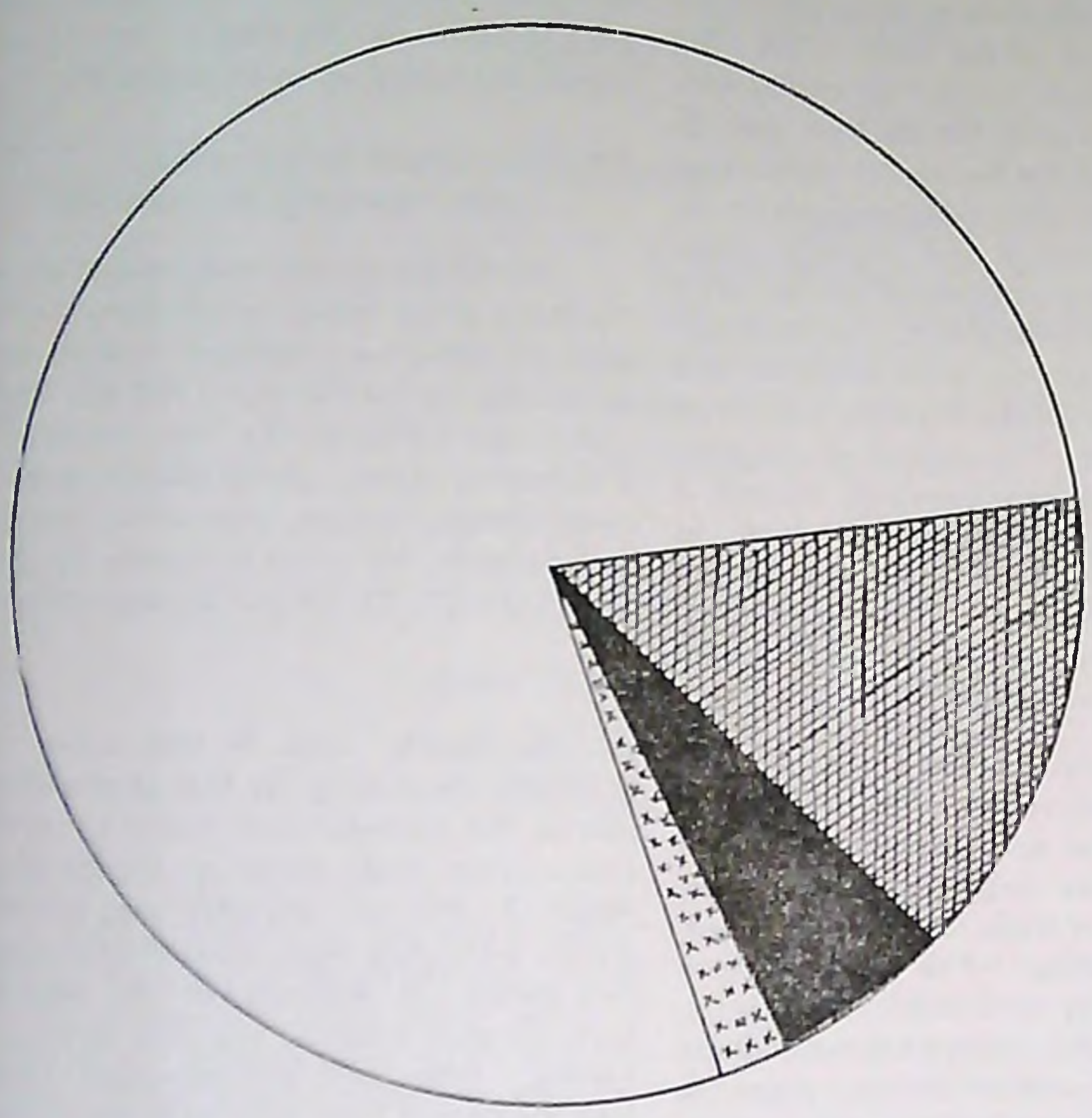
As in the case of the state in general about 80 per cent of the population of the zone is directly dependent on agricultural sector The land reforms and other land legislative measures initiated in Kerala are reflected in the fragmentation of agricultural holdings in the Central Zone also. More than 75 per cent of the holdings have extents less than a hectare. Holding of size more than 4 hectares account for only 1.59 per cent (Fig. 20).

The Central Zone harbours about 3.79 lakhs of farming families. The percentage of literacy works out to 67.97 per cent for the zone, the Ernakulam district topping with 75.71 per cent and Palghat district recording the lowest level of 55.88 per cent among the districts of the zone. The high population density and limited cropped area available in the state as a whole, has reduced the per capita operational area to 0.113 ha. while the same for the Central Zone also works out to almost the same figure of 0.114 hectare (Annexure 65).

2.8. Major crops and crop sequences

The diversity in the agroecological conditions experienced in the zone is

Fig. 20. LAND HOLDING PATTERN OF CENTRAL ZONE (1985)



Below 1 ha

Between 1 to 2 ha

Between 2 to 4 ha

Above 4 ha

reflected in the wide range of crops cultivated here. Water loving rice and drought tolerant cashew nut are seen side by side due to the peculiar agroecological situations prevailing in this zone. Rubber, Coconut and Arecanut grown under hot humid tropical conditions as well as tea and coffee prefering cool and temperate climate find significant position in the cropping pattern of the zone This kind of farming system, being a general pattern for the state as well has its own peculiarities. One of the features of agriculture in Kerala is its poly culture in which an assortment of annual and perennial crops are raised in the homestead gardens with coconut as the pivotal crop In the lowlands rice is grown predominantly and other crops like pulses, oilseeds, tubers and vegetables are fitted in the cropping sequence Uplands generally support a poly crop of perennials and annuals. In higher elevations (hills & hillocks) except in the case of plantation crops like rubber, coffee, cardamom, tea etc. are raised generally as pure crops

Rice is the major crop covering nearly half of the total cropped area of the zone, at the same time accounts for 50 per cent of the total area under rice in the State. Other important crops raised are coconut, tapioca and pulses. The crop cotton in the state is only confined to the Central Zone, so also more than 95 per cent of the area under groundnut in the State is located in the Palghat district of the zone. Vegetables are widely raised in river banks and lake beds.

The changing socio-economic characteristics of the zone and the wage hike in the agricultural sector have direct impact on the cropping pattern of the zone. Labour intensive crops like paddy grown under upland conditions are giving way to commercial crops like coconut, arecanut and cashew. Single crop rice fields are being widely converted to mounds or bunds for planting coconuts, even though there is legislation against it. Many fields are even used for brick making as rice farming is becoming less and less remunerative and often culminate in losses to the farmer. The major cropping seasons are depicted in Fig. 21 and the details furnished in Annexure 66.

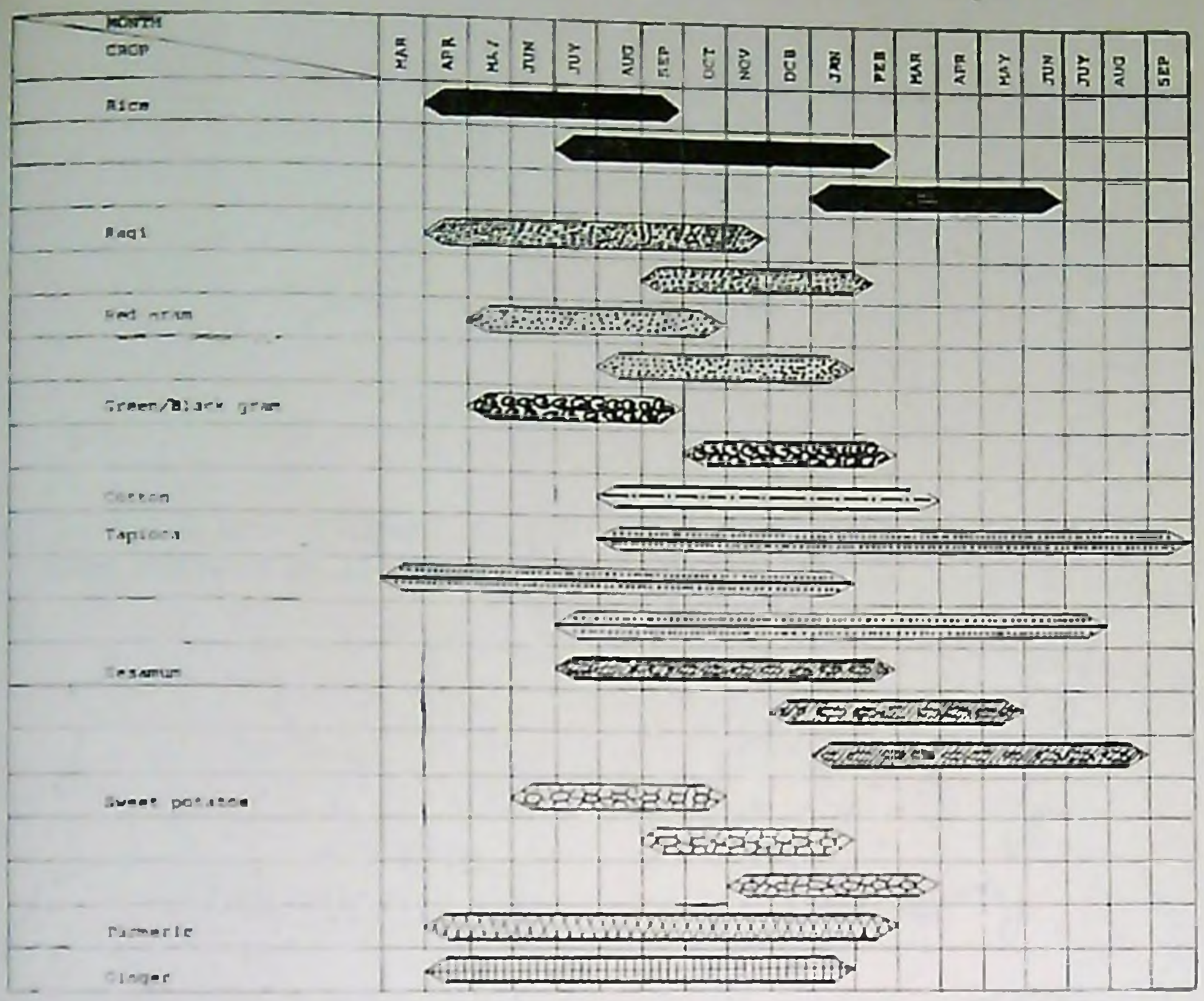
2.9. Important crops—area, production and productivity

The details of area and production of the major crops in the Central Zone for the past ten years are presented in Annexure 67 and 68 and for the year 1984 and 1985 in Annexures 67a and 68a. The density and distribution of rice, pulses, banana, sugarcane, tapioca, cotton, groundnut, pepper and coconut are given in Figures 22, 23, 24, 25, 26, 27, 28, 29 and 30 respectively.

2.9.1. Paddy

The paddy area in this zone is gradually decreasing as that of the state due to the conversion of paddy lands as house sites and coconut plantations. About 24.468 ha. of paddy area contributing 6.4% has been converted during this period. A majority of the area is from Palghat district, the rice bowl of Kerala. Even with this reduction in the area the central zone still have 49.2% of the paddy area contributing 51.5% production of the state. (Fig. 31 and 32). Among the districts in the Central Zone, Palghat occupies an important position accounting for 46.5 per cent area of the zone and 23 per cent of the area of the state. In account for 54.2 per cent of the zone and 28 per cent of the state's production of paddy.

Fig.21. SEASONS OF PRINCIPAL ANNUAL CROPS IN CENTRAL ZONE



Further analysis of the area of paddy under different seasons shows that Palghat is having lesser area under 'Punja' (summer) crop as compared to other districts of the zone. This is mainly due to the dry spell prevailing in this district during summer, whereas in the first and second crop seasons Palghat is having more area than the other districts since monsoons are normally active and supplementary irrigation is available during this season.

The production of rice is more in the first and second crop seasons in Palghat district whereas it is lowest in the third crop ie., summer season This is due to the less area cultivated in the summer for want of irrigation facilities. A similar trend is seen in the productivity too, but in the first and second crop seasons, the Palghat district is well above the state's average (Fig. 33). If more irrigation facilities are available it is possible to increase the area and production during summer in Palghat district.

2.9.2 Taluk-wise Analysis

In the Ernakulam district Kanayannur, Kothamangalam and Parur taluks are showing a downward trend in the area of paddy

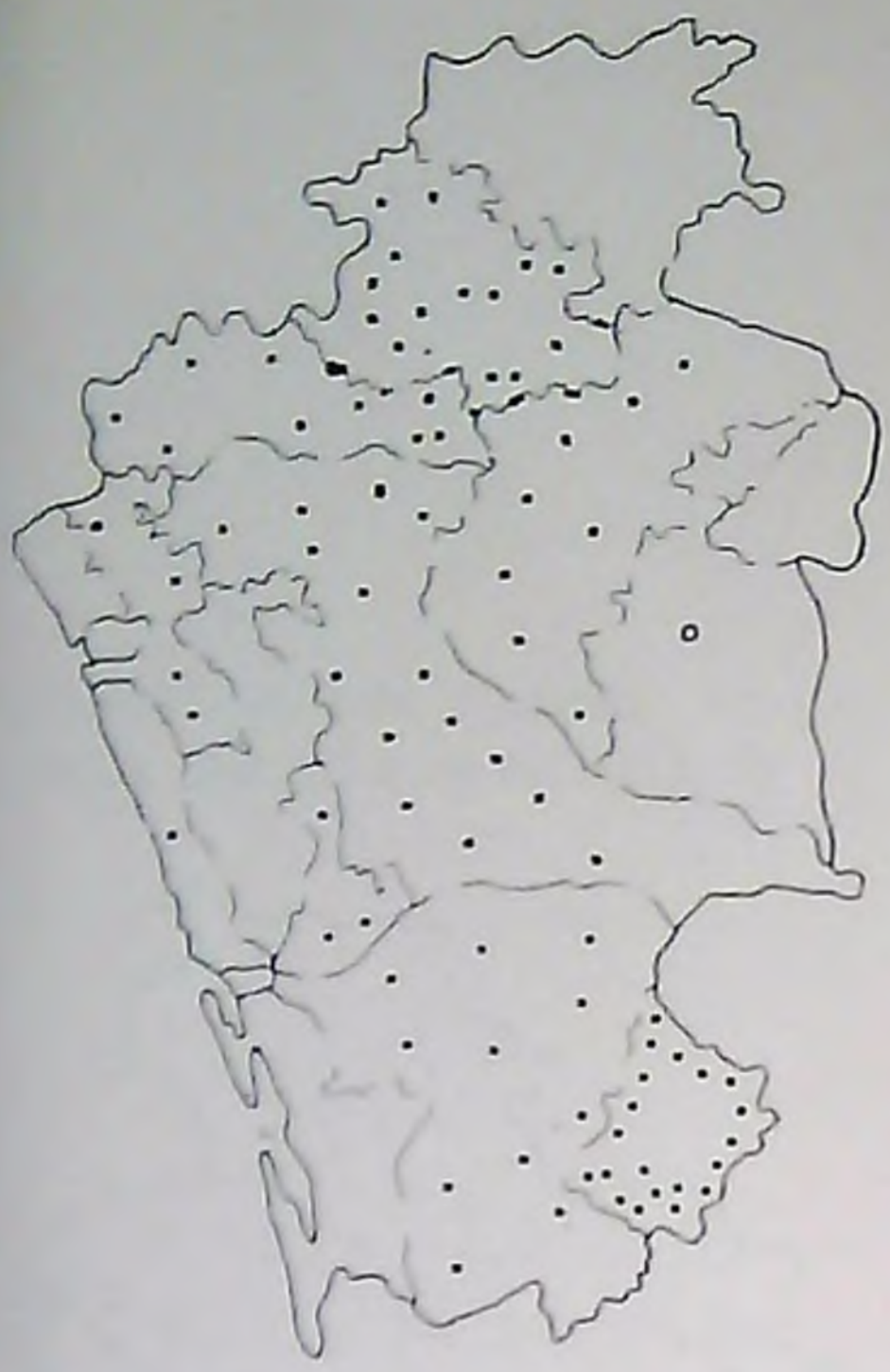
Fig. 22 DENSITY AND DISTRIBUTION OF RICE IN CENTRAL ZONE

• = 4000 ha

Fig. 23 DENSITY AND DISTRIBUTION OF PULSES IN CENTRAL ZONE

• = 100 ha

Fig. 24 DENSITY AND DISTRIBUTION OF BANANA IN CENTRAL ZONE



o Negligible area
● 100 ha

Fig. 25 DENSITY AND DISTRIBUTION OF SUGARCANE IN CENTRAL ZONE

• 100 ha

Fig. 26 DENSITY AND DISTRIBUTION OF TAPIOCA IN CENTRAL ZONE

• 1000 ha
o Negligible Area

Fig. 27 DENSITY AND DISTRIBUTION OF COTTON IN CENTRAL ZONE

• 100 ha

Fig. 28 DENSITY AND DISTRIBUTION OF GROUNDNUT IN CENTRAL ZONE

o Negligible Area
• 1500 ha

Fig. 29 DENSITY AND DISTRIBUTION OF PEPPER IN CENTRAL ZONE

o Negligible Area
• 100 ha

Fig. 30 DENSITY AND DISTRIBUTION OF COCONUT IN CENTRAL ZONE

• 1000 ha.

In the first crop season in Kanayannur taluk about 40% reduction of the area under paddy has occurred. In the second crop season, and summer crop the reduction in area in this taluk is not that serious

Chowghat taluk in Trichur district is another place where 40% reduction in paddy area is noticed. Barring this, there is not much variation in other taluks of this district. In Palghat district though there is reduction in the area, it is uniform in all the taluks. But Muvattupuzha, Kunnathunad and Alwaye in Ernakulam district showed a substantial increase in the area of paddy under summer (Punja) crop.

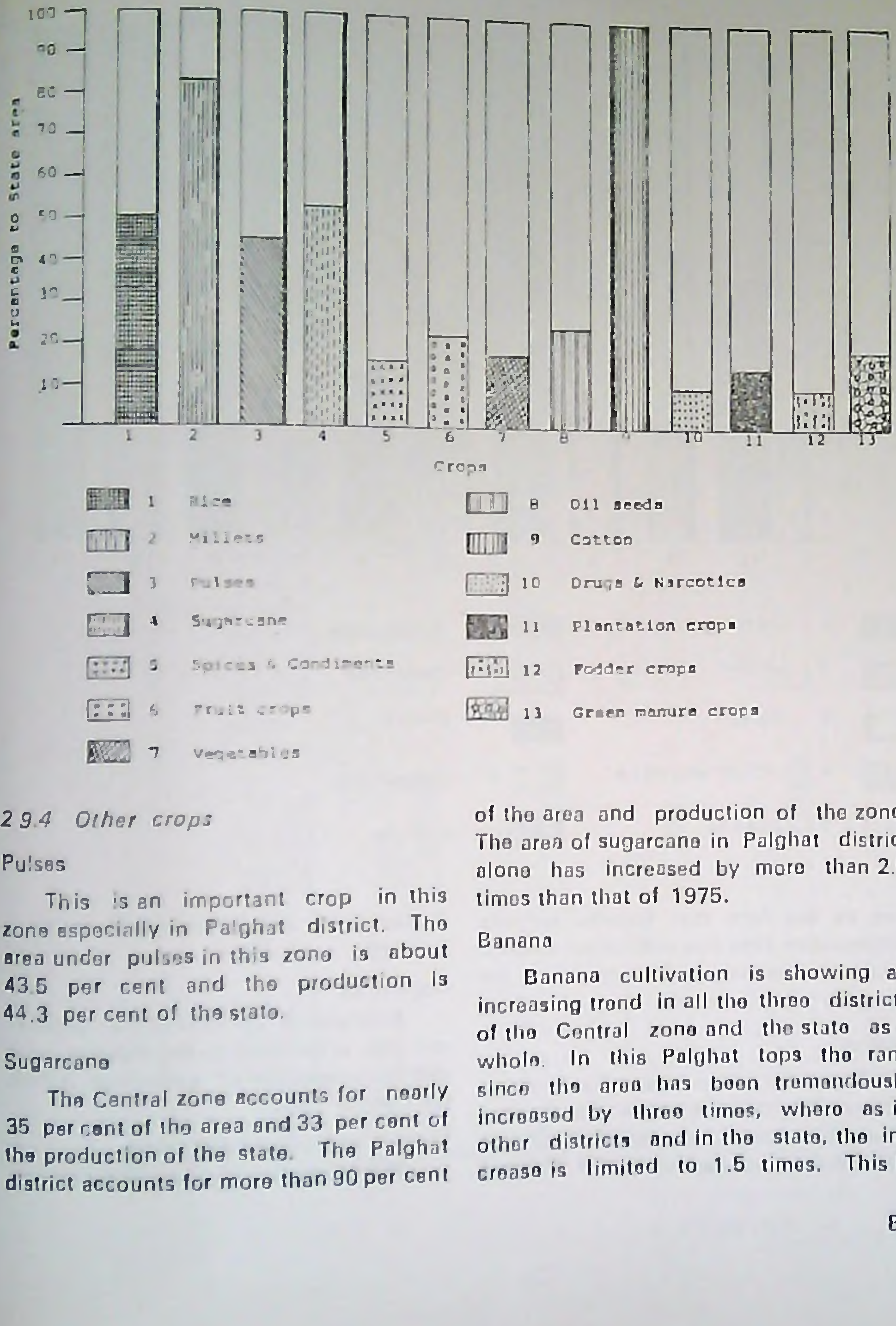
The production in each taluk and in each district is more or less related to the area cultivated under paddy (Annexure 69)

In productivity there are certain taluks in each district, which show a higher mean yield than other taluks. Kothamangalam, Muvattupuzha and Alwaye in Ernakulam district are showing better yields ie., more than 2000 kg/ha in most of the years. Thalappilly taluk in Trichur district is showing higher yield than other taluks. Cranganoor and Chowghat are showing lower mean yield because the soils here are of sandy and less fertile in nature. But in Palghat district all the taluks are showing higher yield than other taluks of the other districts. Chittur taluk ranks first in higher average yield, Alathur and Palghat come next in the rank

2 9 3 High yielding varieties of paddy

The area under high yielding varieties of paddy is not showing substantial increase except in 1980-81 and 81-22 (Annexure 70) In Palghat district the area has gone upto 2.5 to 3 times more in these years but it is coming down after 1983. In Ernakulam district in the first crop (autumn) season, the area under HYV are comparatively more ie roughly 40%. In the second crop season the area under HYV has been reduced to 5 to 8 percent only In Palghat also the area under HYV is more during first crop season. But in summer both in Trichur and Palghat the area under HYV is comparatively high and this is also true with the trend seen in the state area under HYV of paddy

Fig. 31. AREA UNDER PRINCIPAL CROPS IN CENTRAL ZONE - PERCENTAGE TO STATE AREA (1984 - 85)



2.9.4 *Other crops*

Pulses

This is an important crop in this zone especially in Palghat district. The area under pulses in this zone is about 43.5 per cent and the production is 44.3 per cent of the state.

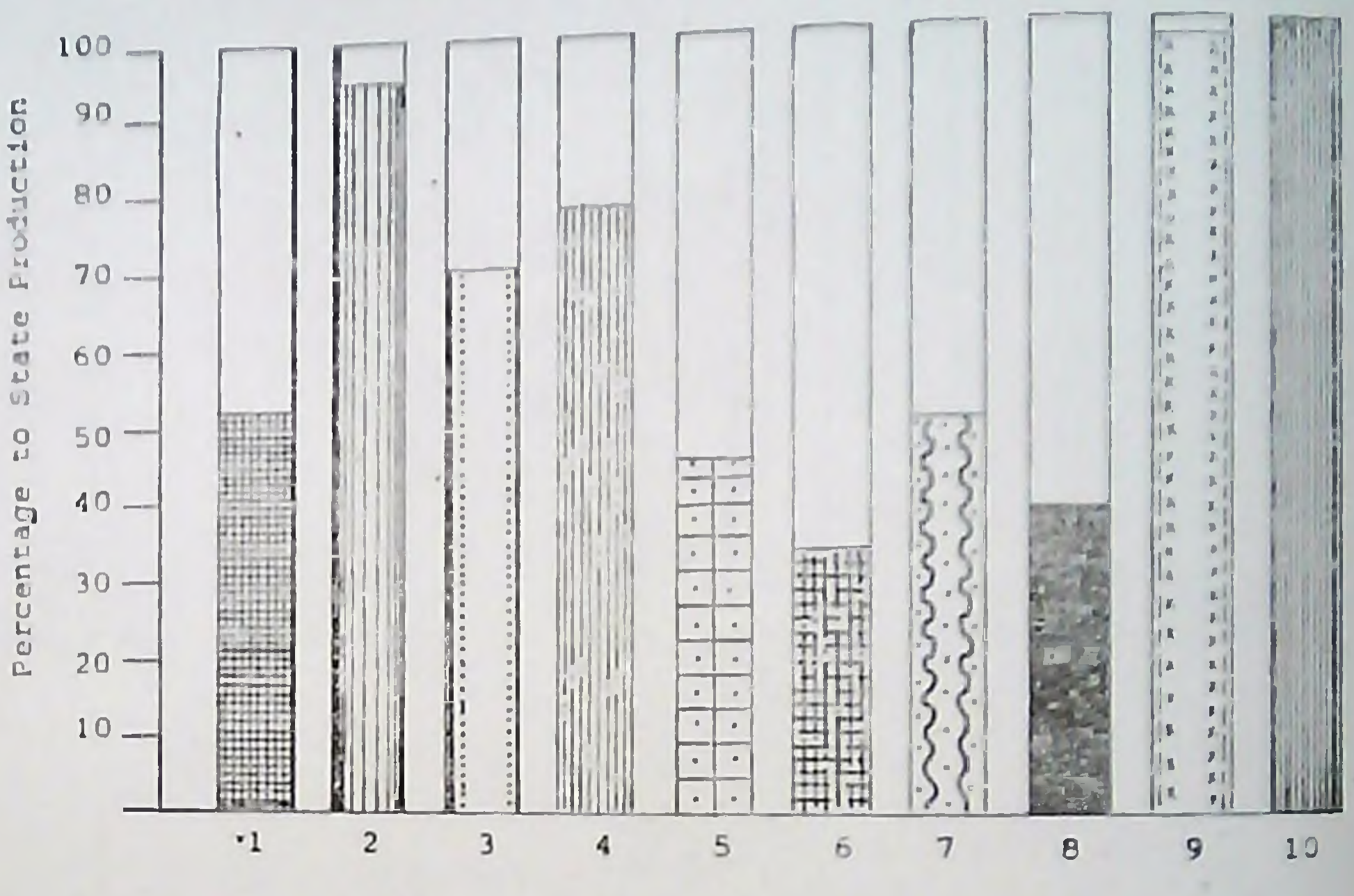
Sugarcane

The Central zone accounts for nearly 35 per cent of the area and 33 per cent of the production of the state. The Palghat district accounts for more than 90 per cent of the area and production of the zone. The area of sugarcane in Palghat district alone has increased by more than 2.5 times than that of 1975.

Banana

Banana cultivation is showing an increasing trend in all the three districts of the Central zone and the state as a whole. In this Palghat tops the rank since the area has been tremendously increased by three times, where as in other districts and in the state, the increase is limited to 1.5 times. This is

Fig. 32. PRODUCTION OF PRINCIPAL CROPS IN CENTRAL ZONE - PERCENTAGE TO STATE PRODUCTION (1984-85).



1 Rice
2 Jowar
3 Ragi
4 Other cereals
5 Pulses
6 Sugarcane
7 Tamarind
8 Mango
9 Groundnut
10 Cotton

due to the fact that banana is more remunerative than rice cultivation since it is labour intensive and wage rates are generally high in Kerala.

Cotton

The entire cotton area and production is from Palghat district of the Central zone. The black soil region at Chittur taluk of the north eastern part of Palghat district is the only suitable land available for cotton in the state.

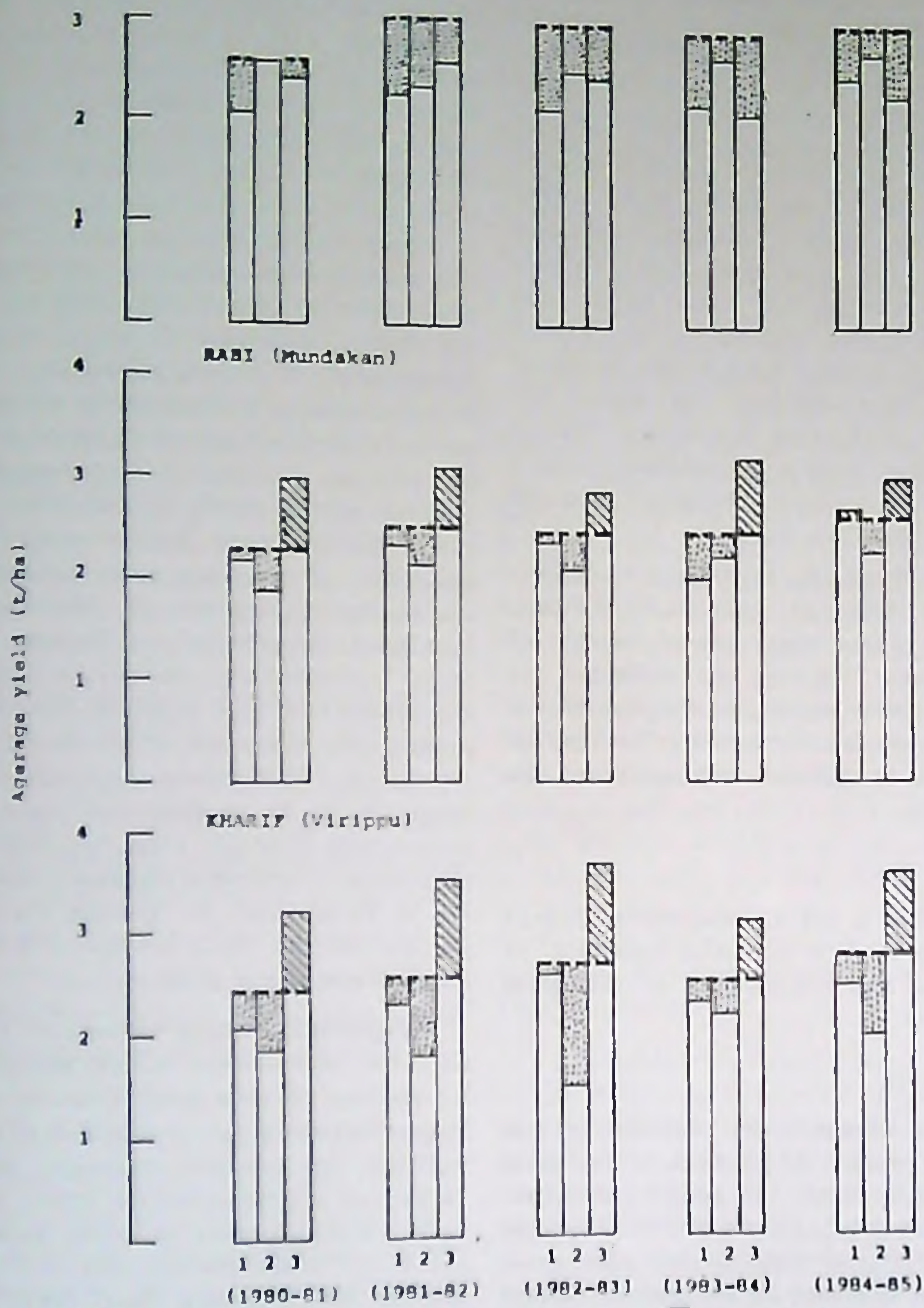
Groundnut

Similarly 99 per cent of the groundnut area is confined to the Palghat tract and the production of groundnut is from the Central zone.

Tapioca and other tuber crops

The production and area under tapioca

Fig. 33. TREND OF AVERAGE YIELD OF PADDY IN CENTRAL ZONE IN DIFFERENT SEASONS.



and sweet potato is showing reduction throughout the state. But surprisingly there is an increase in area of this crop in Palghat district during the recent years, whereas a decrease is set in Trichur district.

Coconut

Though a downward trend is seen in the area as a whole in the State, in the Central zone, about 1.2 times increase is seen for the past ten years. Palghat district recorded 1.5 times more area than the other districts. But Trichur district by having 62,438 ha. occupies the first place regarding the area in this zone. In production Ernakulam district stands first with a production of 363 million nuts, whereas Palghat accounts for only 76 million nuts.

Even if the area in Palghat district is only half of that of Ernakulam, the production is less than quarter of that of Ernakulam. This may be attributed to the dry spell prevailing in Palghat district and non availability of water for summer irrigation to coconut in majority of the area.

Rubber

Rubber is not an important crop in thle zone since it occupies only 18% of the area and 19 per cent of the state production.

Lemongrass

This essential oil obtained in this zone is about 23 per cent of the state production. Lack of proper varieties, agronomic practices and skill in extraction of oil by cheaper methods and non availability of firewood for the present method of extraction are the reasons for restricting the cultivation in this zone.

2.10 Horticultural status and Constraints.

Fruit trees form an invariable component of the homesteads of the zone. Trees of mango, jack, cashew, papaya and moringa are very commonly seen in any homestead with coconut as the pivotal crop. But monoculture of any of these fruit trees is a rare phenomenon in this zone. Even then calculating the coverage of these crops from their total numbers, they form no less important a component of the farming system in the zone occupying about 73123 hectares, accounting for 8.8 per cent of the total cropped area. This component is important to the farmer not only from the economic point of view but also as a source of food material, a sizeable part of which is utilized by himself. During peak fruit seasons, large quantities of mangoes, jack, banana etc. are marketed to states of Maharashtra, Karnataka, Tamil Nadu and Gujarat. The main constraint experienced in handling the produce is that most of the fruits mature after the onset of the South-West monsoon. This results in much decay, deterioration in quality and taste and consequent financial loss. Suitable cultural,manurial and yield staggering methods are to be evolved for getting the major portion of the fruit set before the outbreak of monsoon showers.

Vegetables occupy an area of 50556 hectares in the zone which account for 6.1 per cent of the total cropped area. Vegetables are largely grown in rice fallows utilizing the residual moisture, ground water and engaging mostly family labour only. Sizeable area is under vegetable cultivation in the eastern part of Palghat district bordering Tamil Nadu state. Vegetables are also grown in the dried up river banks and lake beds. The alluvial

soil available supports a very intensive vegetable crop in these areas, especially in the Bharathapuzha river banks from Lakkidi to Ponnani. The major constraints experienced in these areas are the lack of facilities and technology for post harvest handling, storage and marketing of produce during the peak seasons of harvest, with the result that large quantities of vegetables are damaged. Further middlemen exploit the farmers by bulk purchasing the produce at very cheap rates. Lack of quality seeds, improper plant protection measures and inefficient water management practices followed by the farmers are other areas of constraints to vegetable production in the zone. Lack of irrigation and inadequate and unpredictable rain in the eastern parts of Palghat district is the major constraint for vegetable production in this part. Proper irrigation facilities, post harvest technology and seed storage methods are to be evolved for overcoming these constraints to vegetable production.

Cashew is raised in about 244420 ha in the zone, which works out to 2.9 per cent of the total cropped area. The crop suffers constantly from the attack of tea mosquito bugs, which brings down the yield of nuts considerably. Similarly in mango also during the flowering season there is an attack of jassids which causes considerable loss. The flowering usually coincides with the cloudy days of the North-East monsoon period, which further worsens the intensity of attack. This is an area where proper cultural and plant protection technologies are to be formulated for overcoming this hardship facing cashew farmers. The cashew apple is mostly wasted. Proper processing technology for economic utilization of this raw material is wanting.

2.11. Agricultural machinery status

Agricultural Farm Machinery-Implements–Water Lifting devices—Agrobased Industries

The distribution pattern of land holding in the zone with more than 75 per cent of the holdings falling below a hectare in extent, is reflected very much in the types of implements and machinery employed in the farming sector. The undulating topography, light soil structure and higher rate of farm labour wages are other factors, which influenced the type and number of the implements and farm machineries commonly used in this zone. The details of the various items of these farm appliances are furnished in Annexure 71, 72 and 73. In the Central Zone the age old wooden country plough numbering 1,11,021 (48 per cent of the state) still occupies the top rank among the implements used for the farm operations, while the number of improved iron plough is only 12,433 (26 per cent the state). The next popular implement of this rice predominant farming sector is the wet land puddler (5802). Bullock carts are still popular in this zone with total number of 6763 which comes to 82.02 per cent of the total number in the state. So also bullock carts from the main transport means for the farmers of the zone, especially in Palghat district.

Regarding the appliances used for irrigation, a majority of electric pumpsets ie., about 68 per cent of the state is seen in the central zone. The oil engine accounts for only 37 per cent and the number is slowly coming down over the years. This is due to the fact that the lift irrigation is mainly prevalent in this part of the state due to erratic monsoons and the dry spell prevailing during summer.

Hence people in this tract who were using country devices either manual or animal operated, had replaced thereby inducting oil and electric pumpsets. Since electric pumpsets are easy to operate, cheaper in cost, easily available and each farming family needs it for irrigating homestead gardens and Punja (summer) rice, the electric pumpsets number has increased tremendously than that of oil engines.

The wage hike in the agricultural sector has influenced the rice farmers of this zone to go in for labour saving mechanised farming operations as far as possible. Thus a total number of 866 tractors are employed in this zone out of the 1334 number of tractors operating in the whole state (65 per cent). The same trend is observed in the case of tractor operated agricultural implements.

The main lacuna experienced, as regards dry sown and upland rice cultivation is concerned, is the non availability of suitable seed cum fertilizer drill, which can be operated either manually or by cattle draught.

There are nearly 1200 agro based factories registered in this zone of which 587 are saw mills utilizing the timber and soft woods, 210 rubber and 137 oil factories.

2.12.1 Livestock—Status and constraints

Similar to other parts of the state, the agriculture and livestock rearing are interdependent as far as the rural economy of the zone is concerned. In an area where mechanisation has not replaced animal power, many operations such as preparation of land, transport etc. are still carried out by draught bullocks and buffaloes. The farm yard manure occupies an important role as the main source of organic manure. The livestock and poultry rearing supplement the cultivators income by providing egg, milk, meat and manure.

2.12.2 Livestock and poultry population

The total livestock population of the zone is 15,77,936. This constitutes 28 per cent of the total livestock population of the state. The total cattle population of the zone is 8,11,835 forming 26.23 per cent of the cattle population of the state. Whereas the buffalo population of the zone 1,83,957 constitutes 45 per cent of the total of buffaloes in the state (Annexure 74).

Among the cattle in the zone 42.88 per cent are improved types and the rest Desi. This is slighly lower than the corresponding figure for the state (46.93 per cent).

Among the districts in the zone, Palghat is having the lowest percentage of improved cattle (35.22 per cent), while Trichur is having the highest percentage of improved cattle (48.12 per cent). The details are presented in Annexure 75.

The highest number of buffaloes are in Palghat district. Out of the total buffalo population of 1,83,957 of the zone 1,02,354 buffaloes are in Palghat district. This is largely due to the dependance on buffaloes for ploughing.

The goat population of the zone is 5,61,389 constituting 27.99 per cent of the total goats in the state (Annexure 76).

Ernakulam district accounts for 15,335 pigs out of a total of 18,435 pigs in the zone. The pig population is 14.17 per cent of the state.

The poultry population of the zone is 44,54,734. This accounts for 29.54% of the total poultry in the State (Annexure 77).

2.12.3. *Changes in population*

When the present population figures (1982 census) are compared with the figures of the previous census (1977 census) it is found that there is an overall increase of 4.56 per cent in the cattle population of the zone. But the increase in Desi cattle was only nominal (1.22 per cent) whereas the increase in the number of improved cattle was marked (9.36 per cent) while, the Trichur district had the highest increase (13.36 per cent) in the number of improved cattle over the previous census (Annexure 78). There is a decrease in the percentage of male cattle in 1982 census compared to the previous census. A similar decrease in the percentage of male buffaloes is also seen over this five year period. This may probably be due to the increased mechanisation in the farm and rural transport sectors.

The goat population of the zone has increased from 4,57,715 (in 1977) to 5,51,389 (in 1982). But the sex ratio remains almost the same.

2.12.4. *Systems of Livestock rearing*

Cattle are not reared in the villages on a herd basis mainly due to the paucity of grazing land. They are mainly fed on paddy straw and grass (cultivated or wild) available from the homestead.

The backyard system of poultry is more popular compared to the intensive rearing. About 90 per cent of the total poultry are reared in the backyard. Many of the household will have a few birds in their backyard.

2.12.5. *Institutions connected with livestock and poultry*

There are 3 dairy plants in the zone, each district has one dairy plant. In addition there are 4 chilling plants located in Attappady in Palghat district, Pattikkad and Chelakkara in Trichur district and Muvattupuzha in Ernakulam district. In Palghat district there is one Livestock Research Station located at Thiruvazhamkunnu, one bull station at Dhoni and one feed co npounding factory at Malampuzha.

In Trichur district there is one Veterinary College located at Mannuthy. The University Livestock Farm and Pig Breeding Farm are also located at Mannuthy. In addition there is one Cattle Breeding Farm at Thumburmuzhi near Chalakudy. In Ernakulam district, there is one pig breeding unit at Angamali.

The University Poultry Farm and the All India Co-ordinated Research Programme on Poultry for eggs are located at Mannuthy in Trichur district.

There are two Government Regional Poultry farms one at Malampuzha in Palghat district and another at Koovappady in Ernakulam district. There is also a broiler unit in Koovappady, Ernakulam district.

There are three large commercial hatcheries in the private sectors. Two of them are located in Ernakulam and the other in Trichur district.

2.12.6. *Fisheries*

The inland aquatic ecosystem of Palghat is one of the most productive culturable areas of Kerala. There is vast scope for utilization of existing inland waters such as ponds, tanks, seasonal ditches, reservoirs, and development of reservoirs such as Malampuzha, Peechi, Meenkara, Mangalam etc. The large ponds and tanks and seasonal ditches of Chittur and Thathamangalam area are notably good and ideal for composite culture of Indian major carps, and exotic carps such as *Cyprinus Carpio etenopharyugoden Idella* and *Hypothalamichthys*

molitrix. The average fish production of these semi-intensive fish culture ponds is 760 kg/ha. In Trichur district a total of 100 hectares and in Ernakulam 76 hectares surveyed and found suitable for developing aquaculture, but only 58 hectares and 67 hectares respectively are now utilized for inland fish culture. Inspite of the severe demand, the fingerlings of Indian and exotic carps could not be supplied to all farmers. The non-availability of fingerlings very adversely affect the production potentiality of the waters of this zone.

The back waters of Cochin are ideal for culturing euryhaline culturable species of fish and prawns. The trend to replace the traditional culture of prawns and fishes in Pokkali fields by introducing scientific technology in farming methods has appreciably increased. At present over 5500 hectares of Pokkali field and over 700 hectares of other low lying backwater area are utilized for fishing. There is ample scope for utilization of additional areas by simple and slight alterations and adjustments in the surroundings. Prawn filtration fields of Kerala are located in four districts viz. Alleppey, Kottayam, Trichur and Ernakulam of Kerala, in which 30 per cent area is located in the last two districts. A decade ago there were 1000 licences engaged in prawn filtration which, though exact data is not available, might have a 70 per cent increase in the number of licences.

In order to increase the total productivity of the culturable waters and to exploit the seasonal aquatic ecosystem intensive survey work has to be undertaken. A basic survey of this zone to assess the extent of possibilities of fish culture and to locate the lacuna in popularising the practice is to be undertaken. The farmers are to be given skill oriented training in the culture and induced breeding practices.

2.13. Agricultural Marketing—Status and Constraints:

Markets in the zone consists mainly of weekly village markets (shandis), wholesale markets and retail markets. Most of the villages have village markets which meet once or twice in a week. A variety of agricultural products—processed and unprocessed—are brought and sold in such markets. Wholesale markets are situated mainly at the district headquarters. However, the quantum of agricultural produce sold directly by farmers in wholesale markets is rather insignificant. Overwhelming proportions of agricultural produce are sold by farmers on the farm itself to village traders and intermediate merchants. It is these small traders who sell the agricultural produce in the village markets or wholesale markets. The predominance of farm sales is attributable to a variety of factors. (1) The average size of holdings being tiny and which itself is apportioned between subsistence and commercial crops, marketable surplus of agricultural produce of the vast majority of farmers is very small and often it is not economical to take the produce to the market (2) Substantial proportions of the farmers are engaged in non-agricultural pursuits, which leave them little time to be devoted to agricultural operations and more particularly to marketing, and (3) facilities for farm to market transportation, particularly for small loads hardly exist in most of the villages, though facilities for passenger transport are quite advanced.

Kerala has not enacted the Regulated Market Act, unlike many other states. However the zone has a couple of regulated markets which were established

when part of the territory of the zone was in the former Madras Presidency. But these markets are ill-equipped to function properly. Though an expert committee appointed by the Government recommended the establishment of Regulated Markets in the state, no decisions seem to have been taken in this direction. The major marketed crops in the zone are coconut, arecanut, rice banana, rubber, pepper, cashew, vegetables etc. While coconut markets in the zone appear to be well integrated with the state and national markets for copra and coconut oil, the same is not the case with the markets of other commodities

Agricultural production in the state and in the zone is characterised by Higher cost of production as compared to the other southern states and this has its adverse impact on marketing. The production, particularly of those commodities for which the state does not have any special natural advantage, suffers For example though there is a good and expanding market for vegetables in the zone and in the state, much of these is met through supplies from neighbouring Tamilnadu state, where the cost of production is cheaper, due to the low wage rates existing for the farm labourers.

The Co-operative sector has entered the marketing field in a small way in the zone. There are 91 Primary Agricultural Credit Societies engaged in marketing agricultural produce in the zone (Annexure-79). There are 18 Primary Marketing Societies functioning in this zone with a total membership of 25,839. Among these, eight societies have accrued profit while the other 10 are running on loss (Annexure-80).

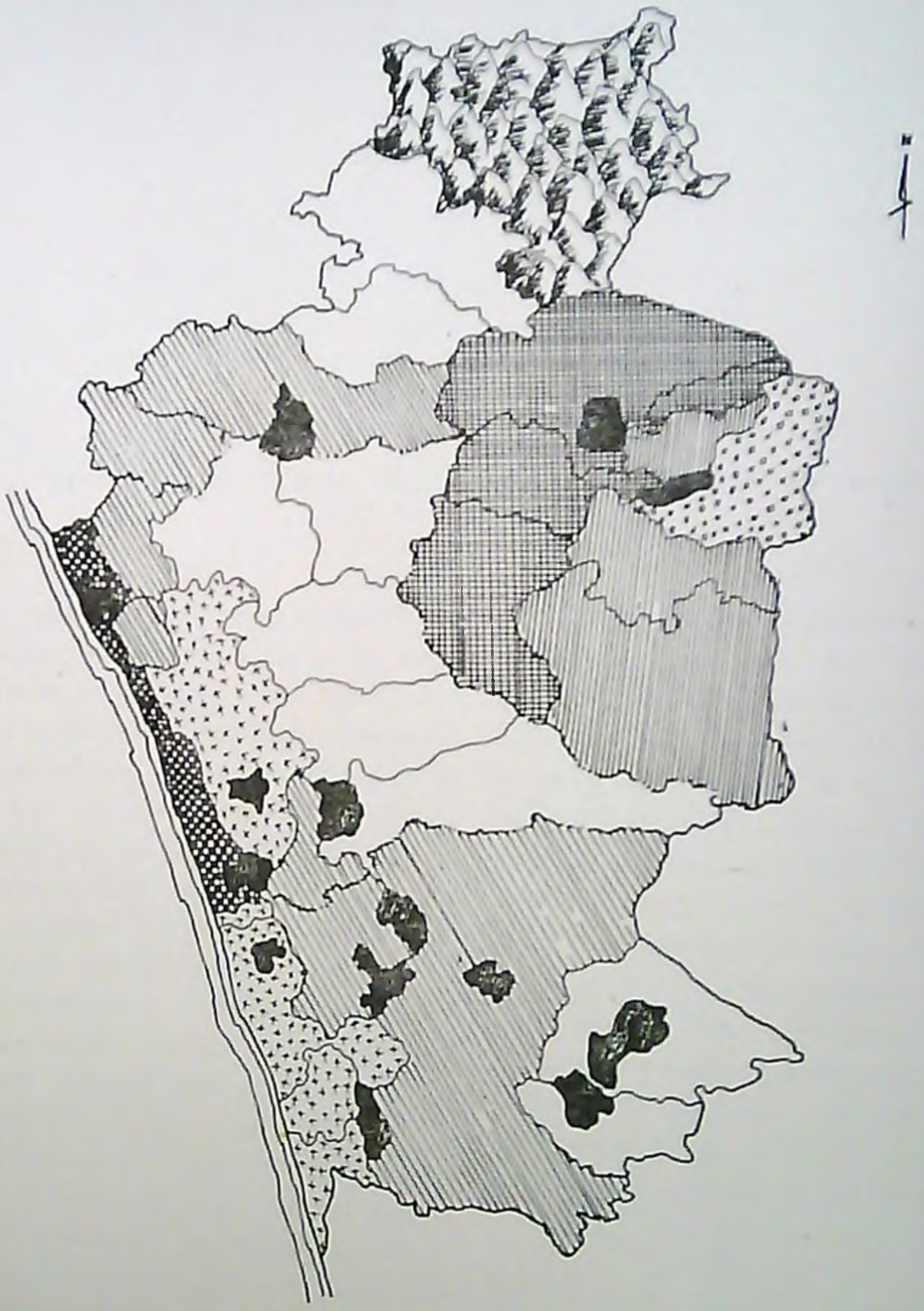
CHAPTER III

Agro ecological Situations in the Central Zone

As mentioned in earlier chapters, in the central zone there are pockets of specialised areas like Kole and Pokkali. These are mentioned in the ecological situations. If a block constitutes a majority of these areas, the details regarding area, production and productivity are excluded for calculating the percentage of the area under important crops and the cropping system. Since exact figures on cropping system is difficult to arrive at, the present figures given are based on the discussion with Agricultural Departmental Officers, bank reports on district and block level statistics from Directorate of Economics and Statistics

An authentic documentation of the traditional classification of Kerala into the three natural divisions of Low land, Mid-land and High land taking its singular configuration in physical features. A formula was evolved to delineate the zone into recognised divisions on the basis of contour lines. So altitude is considered as an important criteria for delineation of the agroecological situations of the central zone. The undulating topography of the zone throws much influence on the crops and cropping patterns followed in the zone. This aspect also has been identified as an important basis on which the zones are to be categorised. The rainfall pattern and intensity is another factor which influences the cropping systems and farming situations in the zone. Soil conditions like salinity, alkalinity, submergence and sea water inundations etc existing in the zone are to be accounted as important factors which influence and modify the farming situations of the zone. Hence these are the major characteristics of the zone which form the basis for the categorisation of the agro-ecological situations of the zone which is depicted in Figure 34.

Fig. 14. AGRO-ECOLOGICAL SITUATIONS OF CENTRAL ZONE



Agro-ecological situation - 1 CA - LE - HRF
Agro-ecological situation - 2 CA - LE - SHS - HRF
Agro-ecological situation - 3 ME - HRF
Agro-ecological situation - 4 HE - HRF
Agro-ecological situation - 5 HE - MRF
Agro-ecological situation - 6 HE - LRF
Agro-ecological situation - 7 ME - BS - LRF
Agro-ecological situation - 8 HR - LRF

3.1 Characteristics used to identify Agro ecological situations

Altitude	Annual Rainfall	Soil	Relief
Low elevation MSL to 7.5 M (LE)	Low Below 1500 mm (LRF)	Saline hydromorphic soil water water logged (SHS)	Coastal area (CA)
Medium elevation 7.5 to 75 M (ME)	Medium 1500 – 2500mm (MRF)	Alkaline Black soil (BS)	Lowland (Wet lands, Area below MSL-Kole, (Water logged)
High elevation 75 to 750 M (HE)	High 2500 and above (HRF)	—	Uplands (Garden land, Modan land, Palliyals, Hill slopes)

3 2 Agro ecological situations of central zone

No.

1 CA—LE—HRF (Coastal area—Low elevation—High rainfall)

2 CA—LE – SHS — HRF (Kole and Pokkali)*

3 ME—HRF (Medium elevation—High rainfall)

4 HE—HRF (High elevation -- High rainfall)

5 HE—MRF (High elevation — Medium rainfall)

6 HE—LRF (High elevation—Low rainfall)

7 ME—BS—LRF (Medium elevation—Black soil—Low rainfall)

8 HR—LRF (High ranges)*

* Though these situations exist in central zone, they are discussed in detail in the status reports of 'Special zone of problem areas' and High ranges respectively. Hence in describing the agro ecological situations, these are not included for calculating the area, percentage area to the zone etc.

Central zone—Summary of agro-ecological situations

No.	Agro-ecological situation and features	Principal crops (% of gross cropped area)	Major cropping systems (% of gross cropped area)	Special features	Location, Districts & Blocks
1	2	3	4	5	6
1	Coastal area, low elevation—high rain fall (CA-LE-HRF) a) Sandy soil coastal alluvium b) Low-level lands 7.5 m M.S.L. c) Rainfall 2500 mm	Rice (19.9), Coconut (73.0), Vegetables (0.5)	Rice-Rice-Fallow (15.7), water fallow-Rice-Vegetables (0.5), Rice, vegetables (1.3), Coconut (43.8), Rice-Banana (0.3)	Sandy soils-poor in plant nutrients, predominantly coconut area occasional salt water inundation	*Parts of Ernakulam* Vadakkekara (in Parur taluk) Pokkali* *Trichur* Cranganore, Thalikkulam, Mathilakam, Chowghat (Kole area*)
		Homesteads (29.2) with Coconut, Banana (0.2), Vegetables, Arecanut (2.9), Tapioca (0.4), Cashew (2.3)	Coconut and arecanut homesteads with intercrops like Banana, Arecanut, Vegetables, fruit trees like Mango and Cashew (35.1)	Raised garden lands-predominantly homesteads.	

1	2	3
2	Coastal area-low elevation-saline hydromorphic soil-high rainfall (CA-LE-SHS-HRF)	Rice* Coconut*
	a) Saline hydro-morphic soils (Pokkali) b) Low lands-salt water inundated (kole) Low lands, below MSL in certain areas c) Rainfall 2500 mm	
3	Medium elevation–Low lands–High rainfall (ME-HRF) a) Lateritic sandy loams	Rice (57.8) Coconut (17.00) Pulses (1.5) Vegetables (1.2) Banana (0.9) Tapioca (0.1)

*Since these situation comes under the purview of special from the concerned status report.

4	5	6
Rice-Prawns-Prawns Coconut*	Low level salt water inundated area-(Pokkali) rice raised on mounds and later split and distributed. Rice-Prawn mixed cropping, coconut raised on bunds.	*Ernakulam* (Pokkali) Vyttila, Edappally, Palluruthy, Cochin(C) Vypeen, Parur
Water fallow-Rice* Rice-water fallow-Coconut (on bunds only)	Areas mainly below MSL. Nitrogen & potassium rich, saline hydromorphic soil-Waterlogged, coconut planted on raised bunds only	*Trichur district* (Kole) Anthikad Vellangallur Irinjalakkuda Cherpu Puzhakkal (Part)
Rice-Rice-Rice (8 4) Rice-Rice-Fallow (46.1) Rice-Rice-Vegetables (1.1)	Low level lands First crop raised as rainfed, second & third crop with supplementary irrigation. Flooding experienced during	*Parts of Ernakulam* Pampakuda Vadavucode Coovapady Perumbavoor (M) Vazhakkulam

zone the area under different crops and cropping system may be referred

No.	Agro-ecological situation and features	Principal crops (% of gross cropped area)
	b) Low level lands c) Rain fall 2500 mm	Other crops like sesamum, sweet potato are grown in a small area
	Uplands	Coconut (1) Arecanut (3.2) Banana (0.4) Tapioca (6.9) Pepper (1.7) Fruit trees like Mango, Jack, Cashew, Pineapple, Papaya, perennial Vegetables

Major cropping systems (% of gross cropped area)	Special features	Location, Districts & Blocks
Rice-Vegetables/ Pulses (1.1) Rice-Rice–Green manure (0 9) Rice-Banana-Rice (2 year rotation) (0.9) Banana-Tapioca/ Yam (2 year/3 year) (0.1) Coconut (on bunds) (7)	South-west-monsoon period and drought during January-May months	Alwaye (M) Alangad Parakkadavu Angamali Mulamthuruthy *Trichur district* Mala Trichur (M) Kunnamkulam (M) Chowannur (except Kattakambal block) Mullassery *Palghat district* Thrithala Pattambi Ottappalam
Crops raised as home steads (17.4) Modan paddy (1.17) raised during South-west-monsoon period. Pulses Vegetables Tubers	Undulating topography and light textured lateritic soils help drainage—crops mainly raised as in homesteads as rainfed crops—supplementary irrigation provided in limited areas using water lifting	

1	2	3
		like Muringa, Culinary Mango) (2.1) Rice- Sesamum/ Pulses/ Vegetables | (1.1) Sweet potato and Small tubers in a small area. Rubber (7.5)
4	High elevation— Lowlands-— High rainfall (HE-HRF)	Rice (51.2) Banana (3.1) Coconut (14.5) Vegetables (0.1) Tubers (6.8)
	Uplands	
(a)	Lateritic loams	Coconut (4.9)
(b)	Undulating topography with terraces, slopes	Arecanut (2.4) Banana (1.1) Tapioca (1.7)

4	5	6
mainly rainfed (5.5)	devices, crops experience drought from January to May.	
Rice-Rice-Rice (6.7) Rice-Rice-Fallow (37.1) Rice-Rice-Vegetables/ Pulses (0.4) Rice-Vegetables/ Pulses/sesamum (0.2) Rice-Banana (2 years) (2.0) Rice-Tapioca/Yam (3 year/2 year) (5.1) Coconut (on bunds (9.6)	First crop rice mainly rainfed and second and third crops supplemented with irrigation, pulses and sesamum raised with residual moisture. Multi-year, crop rotations practiced in certain areas. Kootumundakan system of mixing I & II crop rice seeds and raising crop practiced in certain area.	*Parts of Ernakulam-I* Muvattupuzha Muvattupuzha (M) Kothamangalam *Trichur dist.* Trichur (M) Chalakudy Kodakara Ollukkara Wadakkancherry Pazhayannur *Palghat Dist.* Mannarghat Sreekrishnapuram
Crops raised in homesteads as poly crop mixtures (12)	Well drained uplands crop raised mainly as rainfed limited irrigation facilities.	

No.	Agro-ecological situation and features.	Principal crops (% of gross cropped area)	Major cropping systems (% of gross cropped area)	Special features	Location Districts & Blocks
	and hill tops	Pepper (2.4) Fruit trees (like Mango, Jack, Pineapple Papaya | Muringa | (0.2) Rice–Pulses/ Vegetables/ Sesamum (0.2), Sweet potato & Small tubers in small areas		Drought experienced during January-May months	
	Lowlands				
5	High elevation, Medium rainfall (HE–MRF) (a) Lateritic brown loamy soils (b) Rainfall 1500-2500 mm	Rice (81.6) Pulses (2.6) Vegetables (1.2) Groundnut (0.1) Coconut (5.4) Banana (1.1) a small area under sesamum	Rice-Rice-Rice (0.3), Rice-Rice-Pulses/Vegetables (2.5), Rice-Rice-fallow (77.5), Rice-Vegetables/ Sesamum/Pulses (1.1), Rice–Banana (0.1), Rice-Groundnut (0.1), Coconut on bunds (1.4)	Major area covered under irrigation soils slightly heavier in texture than laterites, fertile–High crop intensity area.	*Parts of Palghat Dist* Alathur, Palghat Palghat (M) Koyalmannam Ayilur and Nemmara Panchayats (Nemmara Taluk)

1	2	3
	Uplands	Coconut (4.0) Tapioca (4.9), Banana (1.0), Fruit trees (like Mango, Jack, Cashew Tamarind, Muringa (1.5), Pulses (0.3), Groundnut, Turmeric, Tubers and Pepper are found in small area
6	High elevation Low rainfall (HE-LRF) (a) Brown and Red soils (b)–Rainfall ∠1500 mm	Rice (62.0) Ragi, Jowar & other Millets (4.8) Coconut & Palmyrah (7.2), Groundnut (11.3), Pulses (4.8), Vegetables (2.5), Cotton (21.9) Turmeric (0.5), Coconut (7.2)
	Uplands	Coconut (4.8) Pepper, Tapioca, Fruit trees (like Mango, Jack, Cashew, Tamarind) (1.1) Groundnut (8.4) Cotton (3.5) Turmeric and Banana are grown in small areas.

4	5	6
Crops raised in homesteads as mixed crops (12)	Undulating topography with slopes, hill tops and terraced slopes and garden lands. Rainfall crop well supplemented with irrigation in ayacut areas	
Rice-Rice-Rice (0.5) Rice-Rice-Pulses/Vegetables (6.5), Rice-Cotton (1.5). Rice-Ragi/Jowar/Millets (2.9), Millets-Groundnut (2.9), Rice-Rice-Fallow (50 5) Coconut on bunds (2.4)	Soil near neutral in reaction clay loamy texture irrigation facilities in most of areas.	*Parts of Palghat Dist.* Kollangode Nemmara Block (Nemmara Taluk)
Crops raised as mixed crop in Homesteads (18)	Neutral soils clay loam texture, irrigation facilities only in limited areas.	

No.	Agro-ecological situation and features	Principal crops (% of gross cropped area)	Major cropping systems (% of gross cropped area)	Special features	Location District & Blocks
7.	Medium elevation Low lands Black soils Low Rainfall (ME–BS–LRF) (a) Black soil (b) Low level lands with impeded drainage (c) Rainfall <1500 mm	Rice (46.6) Sugarcane (5.8) Groundnut (22.4) Pulses (3.9) Coconut & Palmyrah (0.5) Cotton (12,8)	Rice–Rice-Rice (0.5) Rice–Rice-fallow (40.1) Rice–Rice-Pulses–Vegetable (4.4) Rice-Rice-Groundnut (1.0) Sugarcane (3 years) (5.8) Pulses-Cotton (3.9) Coconut & Palmyrah on bunds (0.1)	Black Alkaline soils Impeded drainage–Sulphide injury common-after-cultivation difficult (Poonthal padam)	*Falghat district* Chittur about 700 ha of Poonthalpadam in Pattanchery and Muthalamada blocks.
	Uplands	Coconut & Palmyrah (0.4) Fruit trees (like Mango Jack, Tamarind) (1.1) Cotton (8.8) Pulses (1.0) Tubers and Turmeric in small areas.	Crop raised in Homesteads as poly crop mixture (2.5)	Black soils of alkaline reaction–impeded drainage-Soil hard when dry, irrigation facilities available in major area.	

1	2	3	4	5	6
8.	High ranges* Low rainfall (HR-LRF) (a) Brown soil (b Low level lands (c) Rainfall <1000 mm	Vegetables Pulses-Rice Sugarcane Millets Wheat Oats Coffee Tea Orange Cardamom Grassland	Rice-Rice-Vegetables Millets-vegetables Millets-wheat/oats Groundnut-Potato Sesamum Wheat Sugarcane Crops raised as plantations Coffee Tea Orange Cardamom Grass land	Crop raised mainly as rainfed irrigation facilities meagre	*Parts of Palghat district* Attappadi Nelliyampathy (Nemmara taluk)

* Since this situation comes under purview of high ranges, the details of the area of important crops and cropping pattern may be referred from the concerned status report.

3.3. Agricultural Characteristics of each Agroecological situation:

3.3.1. Coastal area—low elevation—high rainfall:

1. Delineation

This situation mainly comprises of the coastal area in Trichur and Ernakulam districts with elevation 7.5m below MSL. The details of the development blocks coming under the purview of this situation is furnished in the table below:

2 Soil

The soil of this situation is mapped under the Manathala—Udayamperoor—Vypeen Association. This sand belt is formed out of coastal alluvial sediments. Soils of this association are young with immature profile developments.

The soils of this region are grouped under the type coastal alluvium. They have been developed from recent marine deposits and show incipient development expressed in immature AC profiles. The texture is dominated by sand fraction. They are excessively drained, with very rapid permeability. The horizons are usually thin and the surface textures observed are loamy sand and sandy loam. The water table is high in low-lying areas like Chowghat and parts of Nattika taluk. Profiles in these areas show mottlings in lower layers. These soils are poor in plant nutrients with low cat-ion exchange capacity. The native organic matter content of these soils is also very poor. In certain low lying regions, salt water inundation is experienced during high tides and problems due to salinity is noted during dry seasons

3. Climate

This tract comes under the heavy rainfall region of the zone, with annual precipitation crossing over 2500mm range. Being a coastal tract this situation enjoys a marine climate. This is well reflected in the mean temperature variations between the hottest and coldest month recording the narrowest 8.2°C compared to 15.2°C, and 17.3°C recorded for other situations. The mean daily relative humidity is around 77% and the mean annual wind speed is 8.1 Kmph.

4. Physiography

The area covered by this situation is generally low lying with possibility of submergence during peak monsoon periods. During dry periods salt water

District	Development Blocks/ Municipality	Geographical area in hectares
Trichur	Cranganore	3601
	Thalikulam	6551
	Mathilakam	7181
Ernakulam	Chowghat (Kole)*	8621
	Vadakkekkara Panchayat in Parur taluk (Pokkali)*	1114

* Come under special zone of problem soils, hence excluded in calculating area under crop and cropping system.

entry into low lying areas near river mouths is also experienced as a result of high tidal waves.

5. Irrigation

Being coastal area the water table is high. Lift irrigation is followed near river mouths and river banks. During summer months ponds and wells are utilized as sources for irrigation of summer vegetables and pulses to a small extent.

5. Major crops and cropping intensity:

Rice and coconut are the two important crops raised in this region Pulses, Tapioca, Banana, Vegetables, Arecanut and Cashew are the other major crops. The net area sown is 13742 ha. while the gross cropped area is 18973 ha. giving a crop intensity of 138 percent. The area excludes the Kole areas of Chowghat and Pokkali of Vadakkekkara (Parur taluk) of Trichur and Ernakulam districts respectively.

7. Major Cropping systems

The seasonal water logging, high water table and the light textured soils encountered in this coastal tract have influenced the cropping systems adopted by farmers under this situation. In sandy coastal area mono-cropping of coconut is generally followed. In low lands rice farming is practised and in the uplands, crops like Cashew, Arecanut, Mango and other fruit trees are raised in a homestead system of polyculture with coconut as the pivotal crop. The major cropping systems followed by the cultivators are presented in Fig. 35.

8. Important features of some of the major cropping systems

Rice

The first crop rice (Virippu) is usually dry sown and is subsequently maintained under water logged conditions. The crop is mainly dependent on rain and hence is affected much by the vagaries of weather. The application of basal fertilizers as well as top dressing is made difficult because of the heavy down pour immediately after the onset of the South West monsoon. The light texture of this sandy tract further adds to the misery of the farmers in containing the water soluble fertilizers. The rains received during the maturity period creates problems to the farmers in the processing of the grain and straw. The second crop planting season coincides with the peak harvest season of the first crop which results in the dearth of labourers during this peak cultivation period. High yielding varieties are rarely used during the first crop season while the farmers go in for HYV for their transplanted second crop.

The first crop is usually dry sown with the receipt of early monsoon showers received during April-May and harvested by July-August. The second crop is mainly transplanted with varieties of 130-150 days duration. The nurseries for this are generally raised during July-August and transplanted by September-October.

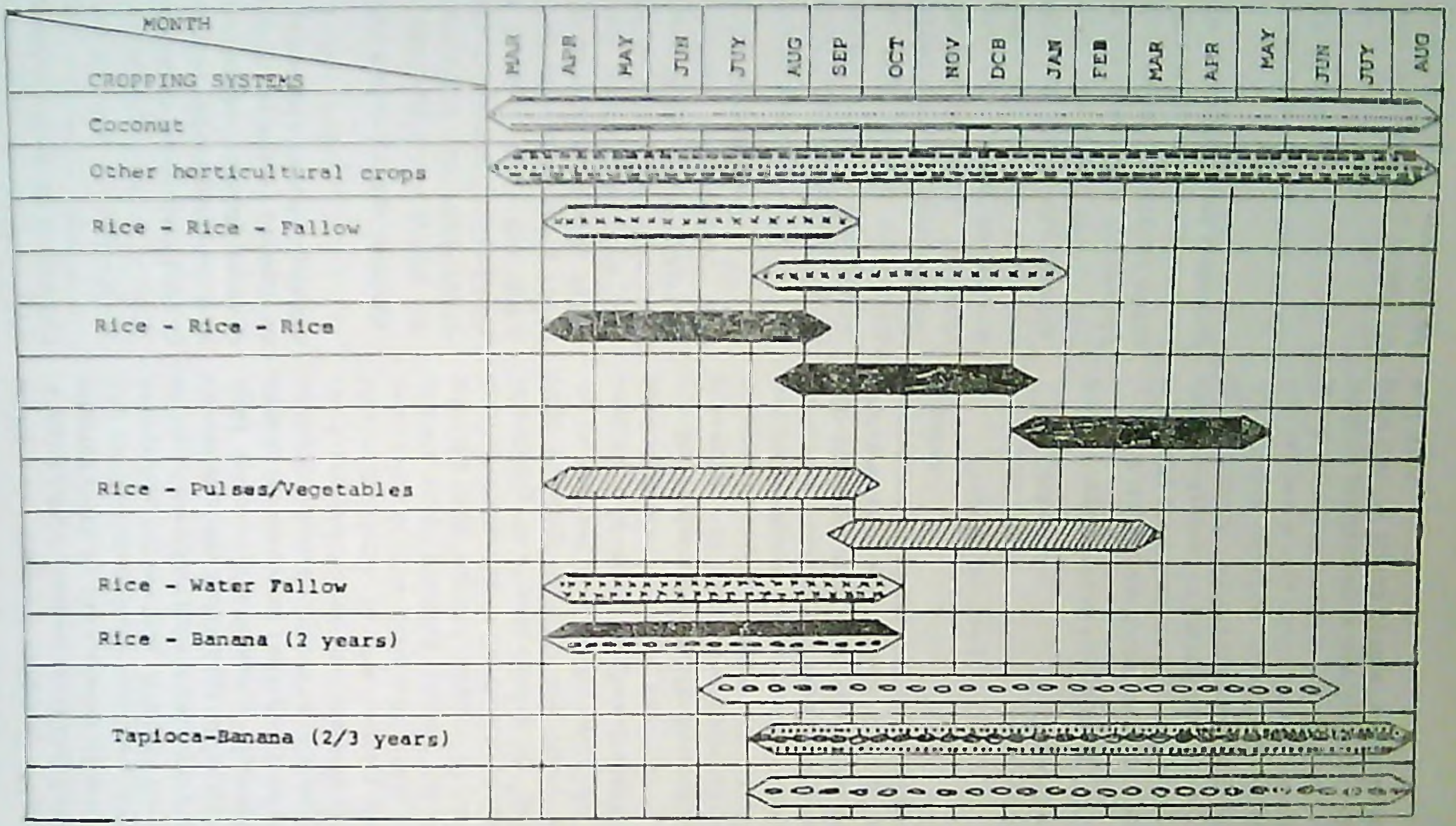
Production mean

I st crop	:	2200 kg/ha
IInd crop	:	2000 kg/ha

Pulses/Vegetables in rice fallows

The high water table of this tract is made use of by farmers in raising vegetables and pulses in limited areas employing family labour. As the cost of hired labour is high this practice of raising pulses in rice fallows is very much limited. Cowpea is the main pulse raised by farmers. The level of production is low because of the poor fertility status of this coastal sandy soil tract.

Fig. 35. CROPPING SYSTEMS - SITUATION - 1.



Coconut

Pure crop of coconut is commonly seen in this coastal tract, which is not very common under other situations. Coconut is also raised on the raised bunds of the rice fields and also as the pivotal crop of homesteads, which is a polycrop mixture type of farming. The average nut production per palm is around 40 per annum. The cultivators generally go for the West Coast tall types rather than the dwarfs and hybrids in this region.

Banana/Tapioca

In areas free from waterlogging for prolonged periods during monsoon seasons, bananas, mainly, Nendran variety, is grown rotated with rice/tapioca. The main problem is the damage due to sweeping wind of this coastal area. Protection by providing propping is a costly practice, even though farmers expect bunches of average weight of 12 kg. The planting of suckers is staggered and adjusted to get get maximum harvest during August-September months to coincide with Onam Festival season. Short duration tapioca varieties are preferred in this tract as water-logging is inevitable during July-August period, which this tuber crop cannot tolerate. Hence plantings are adjusted, so that the tubers are matured and harvested before this period. Farmers generally produced 15 to 17 MT of tubers per hectare.

Major crops raised in situations I—Coastal area—low elevation—High rainfall

No.	Crop	Gross area in ha. under the situation	% distribution in the situation	% of the total area of the crop in the zone
1	Rice	3942	19.9	1.2
2	Coconut	14482	73.0	18.0
3	Arecanut	566	2.9	4.0
4	Tapioca	85	0.4	0.8
5	Banana	100	0.5	1.9
6	Cashew	452	2.3	0.2
7	Pulses	80	0.4	0.5
8	Vegetables	100	0.5	2.6
9	Pepper	25	0.1	0.3

Major cropping systems in Coastal area—low elevation—High rainfall situation

No.	Cropping system	Area covered in ha. (Gross)	% distribution in the situation
1	Coconut pure crop	8690	43.8
2	Coconut—Arecanut—Fruit trees—homestead	5792	29.2
3	Rice—Rice—fallow	3105	15.7
4	Rice—Rice—Rice	400	2.0
5	Rice—Pulses/Vegetables	257	1.3
6	Rice—Banana	50	0.3
7	Tapioca—Banana	30	0.2
8	Rice—Water fallow	100	0.5

9. Adoption pattern and production constraints

The summary of recommendations of the package of practices for crop component of the cropping systems are brought out in volume-II of the Status Report. As most of the crops are raised mainly under rainfed conditions with limited or nil supplementary irrigation facilities, the crop productivity is influenced much and is depended on the vagaries of the weather conditions. During normal climatic conditions like timely receipt of monsoon showers, cultivators almost fully adopt the recommended practices. But as this phenomenon is rare, the farmers are reluctant to use high cost inputs in farming, because of the risks involved in loss of applied fertilizers, crop damage due to flooding and wind damage, pests and disease attack and crop loss at maturity due to drought as is common for second crop rice.

10. Specific production constraints —Rice

The first crop of rice is usually dry broadcasted, during April—May with expectations of the South-West monsoon early showers. If the monsoon is delayed the farming discipline is lost which result in the transplanting of the second crop being delayed. As such the first crop is affected by flooding during the vegetative phase and second crop during the productive phase due to drought. Lack of high yielding varieties sutable for dry sowing and technology for basal application of recommended doses of fertilizers under dry sown conditions, weed management under dry sown condtions are other constraints to rice production.

Coconut

Dearth of organic matter in the coastal tract stand in the way of adoption of the recommended doses of organic manures to coconuts in this sandy soil tracts which is poor in organic matter content. As the South-West monsoon is severe and as the downpour is within a short period of two months, farmers find it difficult to contain the fertilizers applied in the basins of the palms during season. The second split of fertilizer application is also made difficult if the North-East monsoon is delayed or meagre. The attack of the palms by Black headed caterpillar (*Nephantis*) and Red palm weevil and the stem bleeding disease are other problems faced by farmers. In certain patches the coconut root wilt disease also affects the nut productivity.

Pulses

Pulses raised in the rice fallows are generally affected by drought conditions and the inherent soil acidity problems. The high rate of labour wages existing in this region discourages the farmers from bringing extensive areas of rice fallows under pulses. Hence the pulses are raised in limited areas only utilizing family labour and limiting hired labour to the minimum.

Tapioca

Lack of high yielding short duration varieties suitable for accommodation in the rice fallows is the main drawback for extending areas under tapioca under this farming situation. The uplands being mainly occupied by coconut and other perennial crops, the tapioca is generally cultivated in the rice fallows.

Banana

There is good demand for banana bunches locally and there is little problem in marketing the same. Lack of suitable areas without prolonged waterlogging in this low elevation situation is the main

constraint for raising this crop. The high speed coastal winds also lead to crop damage at heading stage. Lack of irrigation facilities during summer months is another factor which discourage the extensive cultivation of this important crop. The Bunchy top disease as well as the spread of the new "Kokkan" disease of Banana are also problems encountered by the farmers.

3.3.2. Coastal area—low elevation—saline hydiomorphic soil—high rainfall

1. Delineation:

This situation covering about 75,000 ha. are confined to Trichur and Ernakulam districts only. The development blocks coming under this situation are furnished below:

District	Development Blocks/ Municipalities/ Corporations	Geographical area in ha.	
Ernakulam	Vyttila	3310	Majority Pokkali areas
	Edappally	7796	
	Palluruthy	3337	
	Cochin (C)	9488	
	Vypeen	8717	
	Parur	6781	
Trichur	Anthicad	7428	Majority 'Kole' areas
	Cherpu	8711	
	Vellangallur	10503	
	Irinjalakuda	9549	
	Puzhakkal (Part)		

As a major portion of these blocks constitute mainly Kole and Pokkali, they come under the purview of the special zone of Kerala with problematic soil conditions. The details of the agricultural characteristics may be referred in the status report for special zone.

3.3.3. Medium elevation—High rainfall

1. Delineation

This situation characterised by high rainfall and medium elevation is one of the major agro-ecological farming situation of the central zone. Development blocks from all the three districts of the zone come under purview of this farming situation as detailed in page 116.

2. Soils

The soil associations identified under this situation come under the geomorphic division of the mid undulating region of the zone characterised by the narrow and broad valleys, elevated plains and isolated in between the high lands of the east and back waters of the west. The soils mapped under the Thrikkakkara-Mulamthuruthy —Ayroor association are seen in nearly level to gently sloping paddy fields towards the central and western parts of Ernakulam district

Thrikkakkara soils are imperfectly drained, deep dark yellowish brown fine textured clay soils deposited over organic

District	Development blocks/ Municipalities/ Corporations	Area in ha.
Ernakulam	Pampakuda	21359
	Vadavancode	18593
	Koovapady	39099
	Perumbavoor (M)	1359
	Vazhakkulam	13163
	Alwaye (M)	718
	Alangad	7941
	Parakkadavu	10162
	Angamaly	18384
	Mulamthuruthy	11836
Trichur	Mala	12671
	Kunnamkulam (M) (Kole)	696
	Chowannur (excluding Katta Kambal)	10527
	Mullassery	6364
Palghat	Thrithala	17215
	Pattambi	22421
	Ottappalam	19773

debris. Soils grouped under Ayroor series are very deep greyish brown silty clay loam surface textured soils underlined by greyish brown clay loam to clay sub soils formed by mixed alluvium. Mulamthuruthy soils are deep to very deep, dark greyish brown sandy loam to sandy clay loam surface texture followed by highly mottled clay sub soils. These three soils have moderate water holding capacity and medium fertility level. They are medium to acidic in reaction. Thrikkakkara soils limit the choice of crops due to the lay of the land.

The Ayyanthole — Kizhupallikkara— Kolazhy association is located in narrow and broad valleys in the central part of Trichur district. The characteristics of soils of this association have already been detailed under the chapter II, para 2.3.

The soil type commonly associated with this situation is laterite, the characteristics of which has been detailed earlier in chapter II.

3. Climate

This situation enjoys heavy rainfall, the annual precipitation exceeding the 2500 mm level. The annual average ranges from 2950 mm recorded in Trichur area to 2800 mm at Alwaye. More than 60 per cent of this is received during the three months of June, July and August, 25 per cent as summer showers. Dry spell is experienced between December to February and hot weather from March to May. The variation between the temperatures of the hottest period and coldest period is widest in this situation (17.3) as compared to other situations of the region.

4. Physiography

This situation is covered by land mass having elevation between 7.5 M and 75 M above MSL. This mid undulating region is characterised by the narrow and broad valleys, elevated plains and isolated hillocks sandwiched between the eastern high lands and the coastal low lands.

5. Irrigation

Irrigation is mainly from lift irrigation sources, ponds and wells. Facilities for utilization of canal irrigation is meagre. The first crop being mainly rainfed, irrigation facilities are utilized for supplementing the second crop during the maturity phase when drought is experienced under this situation.

6. Major crops and cropping intensity

The major crops raised in the low lands are Rice, Pulses, Vegetables, Banana and Tapioca and also Coconut on raised bunds. The upland areas support important crops like Coconut, Arecanut, Tapioca, Pepper, Cashew and fruit trees. The net area sown is 151424 ha while the gross cropped area is 206315 ha. giving a cropping intensity of 136%.

7. Major cropping systems

The major cropping systems followed under this situation are enumerated below and the seasons are shown in Fig. 36.

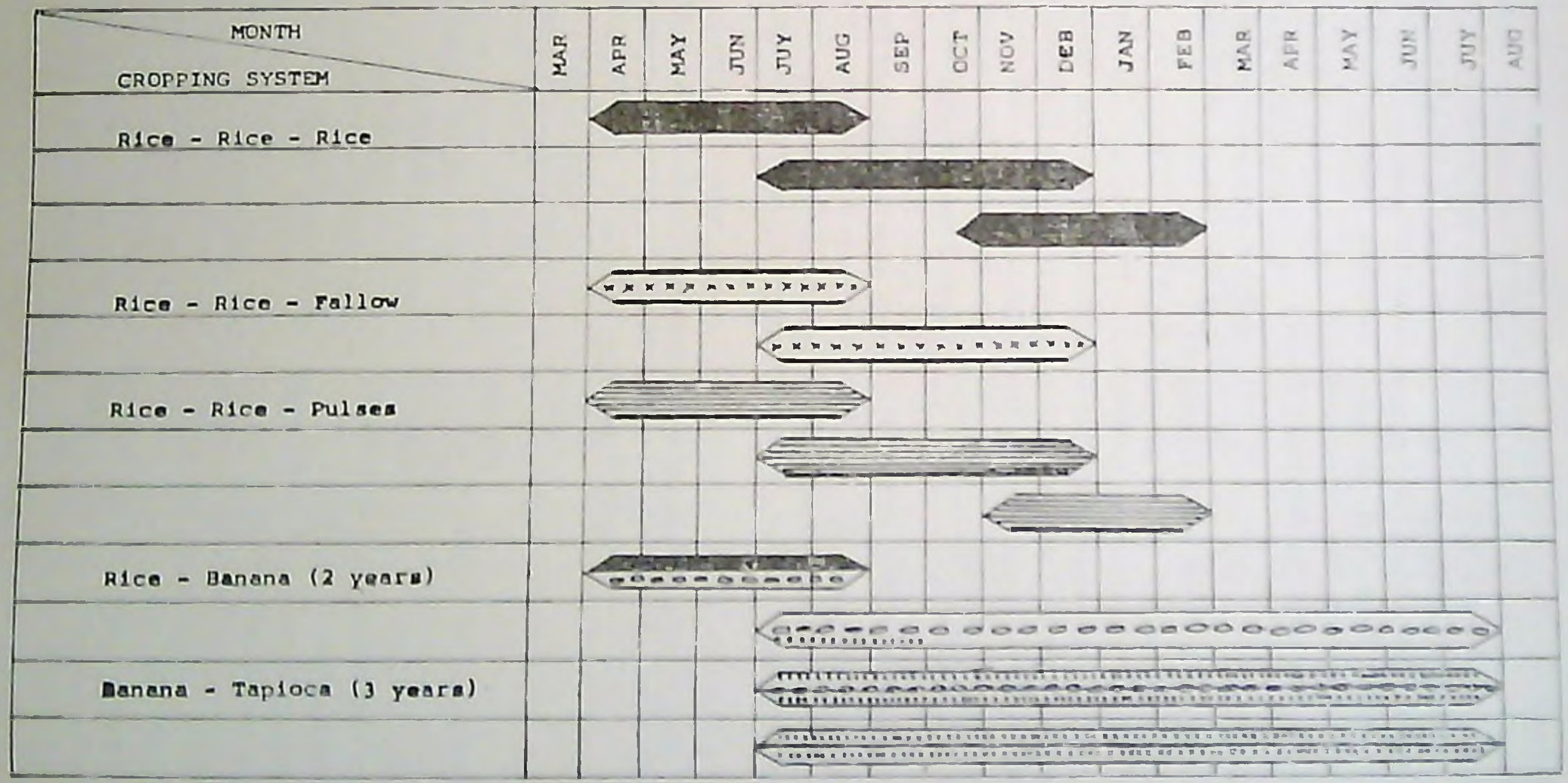
Rice-Rice-Rice

The third rice cropping system followed under this situation is similar to the rice-rice cropping system of the situation during the first two seasons. The third crop (puncha) is during November–December and harvested by February end. Generally varieties of 100 to 110 days duration are employed and for this crop only high yielding varieties are used. This system is adopted in areas of assured water resources till February end.

Major crops in situation 3—Medium elevation—high rainfall

No.	Crop	Total area (Gross)	% distribution in the situation	% of the total cropped area of the region
1	Rice	119305	57.08	39.7
2	Coconut	35043	17.0	44.7
3	Pepper	3531	1,7	30.3
4	Tapioca	14320	7.0	56.0
5	Pulses	3131	1.5	43.9
6	Banana	2601	1.3	30.6
7	Vegetables	2300	1.2	59.7
8	Cashew	3657	1.7	34.3
9	Arecanut	6603	3.2	59.6
10	Rubber	15524	7.5	39.0

Fig. 36. CROPPING SYSTEMS SITUATION - 3.



Situation 3— Medium elevation — High rainfall — Major cropping system

No.	Cropping system		Area covered (Gross) ha.	% distribution in the situation
1	Rice-Rice-Rice		17330	8.4
2	Rice-Rice-fallow		95025	46.1
3	Rice-Vegetables/ pulses		2200	1.1
4	Rice-Rice-Pulses/ vegetables/ green manure		2800	1.4
5	Rice-Banana-rice (2 years)		1950	0.9
6	Banana-Tapioca (3 years)		105	0.1
7	Coconut / Arecanut / Fruit trees / Tubers	In home-steads	9000	4.4

The cropping systems No. 2, 3 and 4 are raised in similar lines as that of situation No. 1. Rice—Banana—Rice two year rotation is adopted in areas where water-logging is not experienced for continuous periods, at the same time where water table is high and lift irrigation practices can be adopted for irrigating banana crop during summer months.

Banana-tapioca three year rotation is adopted by farmers in palliyal (uplands) lands where there are facilities for draining the fields during periods of waterlogging and also water resources are available for supplementing this rainfed cropping system during periods of drought.

The cropping system No.8 is common in Kerala State where an assortment of perennials and annuals are raised in homesteads. The constituents and their proportions differ from plot to plot but invariably coconut will be the pivotal crop of this farming system which will generally be located around or near the dwelling place of the farmer.

8 0 Adoption pattern

The extent of adoption of the recommended practices by the farmers are discussed in detail under Vol. II of the report. The main bottle neck in following the improved technologies is the extreme dependance of the farmers on rainfed farming. As such many of the improved practices cannot be followed by farmers if monsoons are delayed or advanced or if the dry spell is widened. In the case of third crop rice (Punja) farmers invariably follow the package of practices recommendations completely as they have the situations favourable and cultural practices can hence be taken up in time. This is very well reflected in the yield of third crop rice, which is comparatively better than the medium duration second crop rice.

9.0 Specific production constraints

Rice

As in the case of situation I, the extreme dependance on rainfed farming makes the rice farming vulnerable to the vagaries of nature. This is acute in areas lacking irrigation sources during drought spells

Banana/Tapioca

The torrential rains received during the short period of 90 days (June-August) under this situation leads to waterlogging for short periods in low lands causing decay and damage to these crops. Lack of

proper drainage facilities during this peak monsoon period, when all rivers and rivulets are in spate, is the main cause for this waterlogging.

Pepper crop is also affected by temporary waterlogging which the crop cannot tolerate. The quick wilt disease is prevalent in this situation, creating heavy damage to the pepper vines.

3.3.4 High elevation—High rainfall

1. Delineation

As in the case of situation 3, this farming situation also covers the development blocks of the three districts of the zone. This situation also covers a large extent of the Central zone. Details of the Development Blocks and Municipalities covered under this situation are furnished in the table below:

2. Soils

The soil associations mapped under the areas covering this situations are:

1. Thodupuzha—Punnamattam—Odakkali-I
2. Kothamangalam—Kuttamangalam—Charalada
3. Koratti—Anjur—Velappaya
4. Ayyanthole—Kizhuppallikkara—Kolazhy
5. Karakkurissy—Kummathara—Vadanamkurissy

The main characteristics of the soils covered by these associations and their distribution pattern were already elaborated under chapter-II. The lateritic nature of the type of soils prevalent in these areas also have been covered earlier.

3. Climate

The situation enjoys high rainfall with the annual precipitation crossing over 2500 mm. The bulk of the rains is received during the months of June to August. The rainfall pattern in the southern part of this situation is more uniform and in northern parts the summer showers are erratic. Dry spell is experienced between January to March and hot weather from April to May. However, occasional rains during summer months alleviates the ill effects of the dry spells in the southern parts of the situation. The variations in the levels of temperature are only marginal. The mean value for humidity is as high as 80 per

District	Development Blocks/ Municipalities	Geographical area (ha)
Ernakulam	Muvattupuzha	20291
	Muvattupuzha (M)	1318
	Kothamangalam	25192
Trichur	Chalakudy	67420
	Kodakara	29776
	Ollukkara	31573
	Wadakkanchery	29696
	Pazhayannur	23695
	Trichur (M)	12654
Palghat	Mannarghat	35893
	Sreekrishnapuram	21941

cent, and during the month of June to August recording values above 90 per cent.

4 Physiography

This forms part of the mid-undulating region of the zone, characterised by the narrow and broad valleys, elevated plains and isolated hillocks. The undulating topography helps in drainage of flood water and in certain areas gives way to erosion hazards.

5. Irrigation

This situation is benefitted by the Chalakkudy, Muvattupuzha, Vazhani and Malampuzha irrigation projects. Hence canal irrigation is available for raising rice crop in about 45,000 ha. of this situation. The lay out of the canal systems, reservoirs and dams are brought out in the figures of the concerned river basins furnished.

6. Major crops and cropping intensity

As this situation enjoys irrigation facilities from canals, the crop intensity is naturally higer than that of the situations covered so far. The net area sown is 138670 ha and the gross cropped area 161935 ha working out a crop intensity of 116%. The high rainfall coupled with irrigation facilities through canals makes this situation ideal for rice and rice based farming systems. The undulating topography favouring drainage of excess water, the situation is also ideal for perennials as well as annuals which cannot tolerate impeded drainage. Rice is the predominant crop followed by coconut, pepper, banana and tuber. Pulses are also extensively grown in rice fallows. The details of the major crops raised are furnished below.

7.0 Major cropping systems

Rice based farming systems are predominant in low lands and coconut based homestead farming in uplands. The practice of mixing first and second crop paddy seed and raising 'Kootumundakan' mixed crop is followed under this situation in certain areas like Sreekrishnapuram of Palghat district. Farmers do not generally stick on to one system

Major crops raised in situation No 4—High Elevation—High rainfall

No.	Crop	Area covered in ha (gross)	% distribution in the situation	% to the total area of the crop in the region
1.	Rice	82903	51.2	27.6
2.	Coconut	23476	14.5	29.9
3.	Tapioca	11052	6.8	43.6
4.	Banana	5088	3.1	60.0
5.	Pepper	3837	2.4	51.9
8.	Pulses	700	0.5	9.8
7.	Arecanut	3910	2.4	35.3
8.	Cashew	6495	4.0	61.3
9.	Rubber	24274	14.3	61.0
10.	Others	200	0.2	—

always. They change often depending on the commodity prices and market demand. The following are the major cropping systems followed in the situation and the seasons are brought out in Fig. 37.

Rice

The rice based farming systems of this situation are generally supplemented by canal/lift irrigation during summer months. The crop season discipline is maintained well, as there is irrigation resources for taking up timely cultivation operations. The only difficulty experienced is the dearth of labourers during peak cultivation periods like first crop harvest and second crop transplanting.

Pulses

Pulses are raised mainly in rice fallows utilizing the residual moisture.

Varieties with synchronised flowering are preferred by cultivators for minimising the number of pickings.

Banana, Tapioca, Small tubers and Vegetables are rotated in rice fallows depending on market prices and demands.

8. Adoption pattern and production constraints

The details are discussed in Vol. II of the report crop wise, which is almost similar in most of the situation identified in the region. As there are facilities for supplementary irrigation during periods of drought, in general the adoption of the recommended practices are better when compared to situations 1 to 3.

9. Specific production constraints

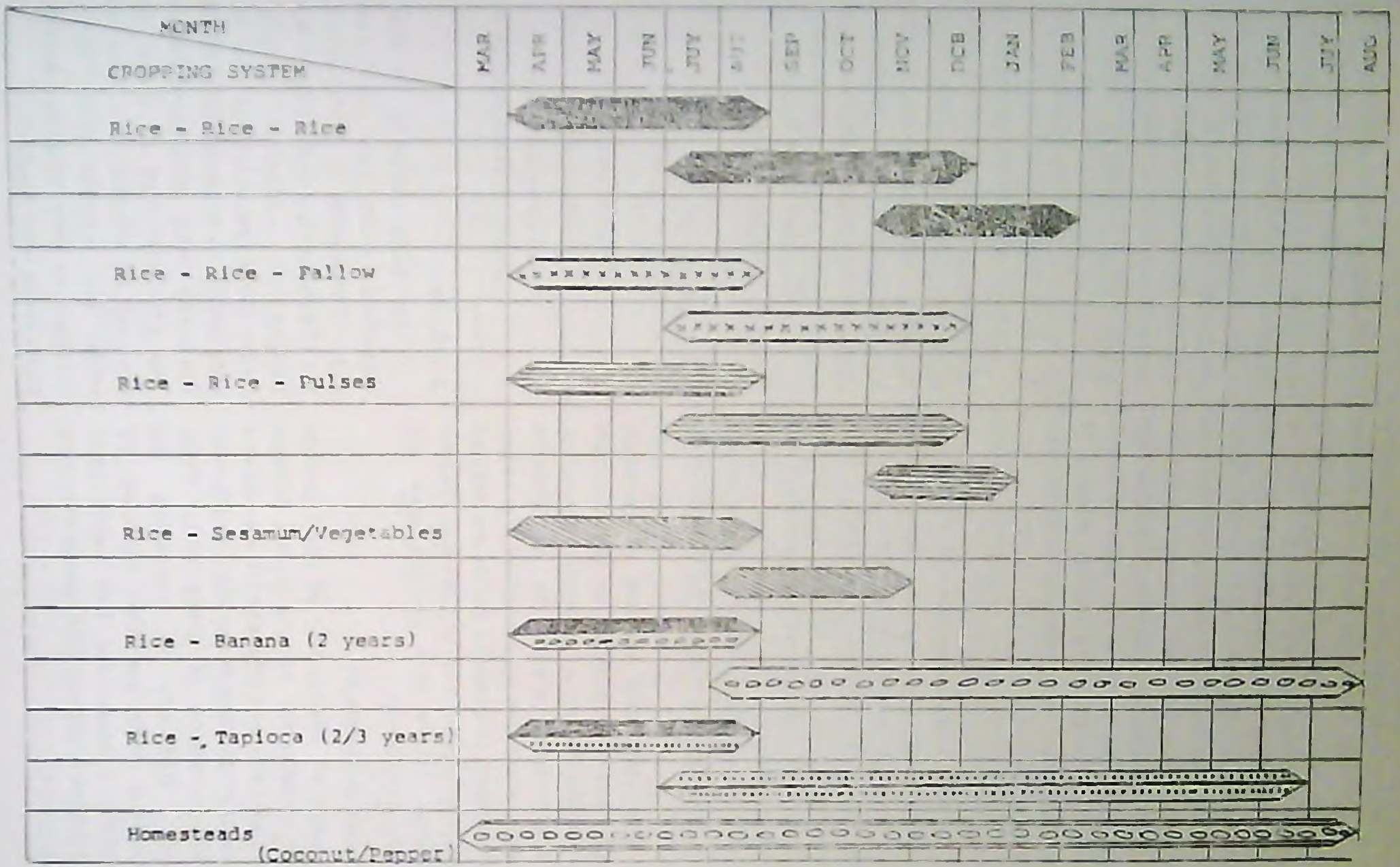
Rice

Even though irrigation source are available for supplementary irrigation during drought spells, the first crop rice is still raised as rainfed and later maintained under wet land conditions. As flooding invariably follows after the monsoon break, problems are created for timely application of basal fertilizers and manures. The crop intensity being more under this situation, scarcity of labour is experienced during peak cultivation seasons causing trouble for adoption and implementation of the improved agricultural technologies.

Major cropping systems followed in situation No. 4—High elevation – High Rainfall

No.	Cropping systems	Total area in ha. (Gross)	% distribution in the situation
1	Rice-Rice-Rice	10800	6.7
2	Rice-Rice-Fallow	60003	37.1
3	Rice–Rice–Vegetables/Pulses	600	0.4
4	Rice–Vegetables/Pulses/Sesamum	300	0.2
5	Rice-Banana (2 years)	3000	2.0
6	Rice–Tapioca/Yam (3 years/2 years)	8200	5.1
7	Coconut on bunds/homesteads	15576	9.6
8	Coconut-Pepper-Poly crop homesteads	7900	4.9

Fig. 37. CROPPING SYSTEMS SITUATION - 4.



Kottumundakan system of rice farming in which seeds of first and second crop rice are mixed and sown is getting popular among the cultivators. This is mainly due to the exhorbitant rise in labour wages and farmers find it difficult to limit the cost of cultivation of rice within economic levels. Hence they go in for rice farming like Koottumundakan by which they can reduce the cost of cultivation. But this has led to decline in crop yields and increased pest and disease attacks.

Pulses/Vegetables/Sesamum

Pulses, Vegetables and Oil seeds are raised as catch crops in rice fallows. But only limited areas are covered leaving potential rice fallows unutilized. This phenomenon is also caused due to the high rate of labour wages prevalent in Kerala. Farmers generally raise these crops in small plots utilizing family labour and limiting hired labour to the minimum.

Coconut

The root wilt disease of coconut, which was not noticed in the southern parts of the region is generally spreading in these areas also. As no suitable remedial measures are identified at present, yield decline in coconut palms are noticed in certain locations of Trichur and Palghat districts, where this disease was not present previously.

Groundnut/Sesamum

Lack of availability of good quality seeds suitable for raising in rice fallows and under the partially shaded conditions of coconut gardens is the main bottleneck in the extension of areas under these crops. Difficulty in marketing the groundnut pods are also reported by farmers as a reason for their hesitancy in adoption of improved technology in raising these crops.

Vegetables

Raising vegetables in rice fallows utilizing residual and surface water sources are practised by a limited number of farmers only. They are reluctant to extend areas under this crop due to the necessity of costly hired labour and difficulty in marketing the perishable vegetables which come to maturity at the same periods.

3.3.5. High elevation – Medium Rainfall

1. Delineation

This situation comes under the 'Palghat gap tract' of Kerala and is popularly known as 'the Rice bowl' of Kerala. This situation confined to the Palghat district is composed of four development blocks as shown below.

District	Development Block/ Municipality	Geographical area in ha
Palghat	Alathur	39569
	Palghat	45898
	Palghat (M)	2660
	Koyalmannam	31564
	Nemmara and Aiyulur block of Nemmara taluk	7778

2. Soils

The soils occuring in the tract are classified under two soil associations: (1) Peruvemba — Koduvayoor Valiya-Vallampathy and (2) Kottekkad Kanjikkulam — Mannur. Soils grouped under these associations are located on very gently to moderately sloping lands in the broad valley portion of Palghat taluk. The characteristics of these soils were covered in chapter-II. The soil come under the lateritic type, but the soil reaction in only slightly acidic and in some areas near neutral.

3 Climate

This situation differs from the previous ones in respect of the intensity of the annual rainfall. Being located in the Palghat gap area, the situation enjoys only a moderate annual rainfall range of 1500-2500 mm, the major portion of it being received during the three months of June, July and August. This tract records the highest temperature during summer months in the State. The difference between the average temperature of hottest month and that of the coldest month works out to 15.2°C. The mean daily relative humidity varies from 51% in February to 86% during the months of July-August. The monthly wind speed ranges between a minimum of 8.5 Kmph during the month of March and a maximum of 13.6 Kmph recorded during August, striking an annual mean mean of 10.8 Kmph.

4 Physiography

This situation is located mainly on very gently to moderately sloping lands in the broad valley portion of Palghat taluk.

5 Irrigation

This is one of the situations in Kerala which enjoys the benefits of canal irrigation almost throughout the crop growth periods. The benefits of Malampuzha project covers almost the entire tract of this situation. Water is let out in April for helping farmers to take up preparatory cultivation and even for raising green manure crops. Canals supplement and provide irrigation water upto February for raising the third crop rice.

6 Major crops and cropping intensity

In this cent percent irrigated situation, naturally the cropping intensity touches top position among the farming situations of Kerala. The net cropped area is 62423 ha and gross cropped area 72424 ha. working out a crop intensity of 116%. The major crops raised in this situation are tabulated below.

Major crops raised in the situation No.5—High elevation-Medium rainfall

No.	Crop	Total area (gross) ha.	% distribution in the situation	% of the total area of the crop in the region
1	Rice	59092	81.6	19.7
2	Pulses	1977	2.7	15.8
3	Vegetables	855	1.2	22.2
4	Groundnut	45	0.1	0.5
5	Banana	800	1.1	9.4
6	Coconut	3897	5.4	5.0
7	Tapioca	3603	4.9	14.2

The situation being very congenial for rice farming, the rice forms the predominant crop of this situation. The irrigation facilities enable the farmers to raise at least two crops of rice. The water made available during the summer season is made use of for raising pulses and vegetables besides raising the third crop rice in certain areas. This is one of the situation in the state where groundnut crop is raised on extensive scale. Sesamum is also grown in rice fallows of this tract. The cultivation of coconut is spreading in this tract and the native palmyrah palms are giving way for coconuts in uplands.

7 Major cropping systems

Cropping systems practised by farmers are summarised in fig 38.

The production levels obtained in this situation for crops like rice, pulses and groundnut are the highest in the State. This is the only tract in the state where pulses and groundnut are grown in rice fallows.

8. Adoption pattern

Regarding rice the adoption pattern is almost in line with the recommended practices except during Kharif rice, where the farmers are reluctant to apply the recommended levels of basal fertilizers for fear of washing out of the applied nutrients during the South-West monsoon down pour. For the rabi and summer rice they go in for only the high yielding varieties generally. Pulse crop also is raised adopting the improved recommended practices. The coconut being a recent introduction, the level of adoption of the improved technology, is low.

9. Specific production constraints

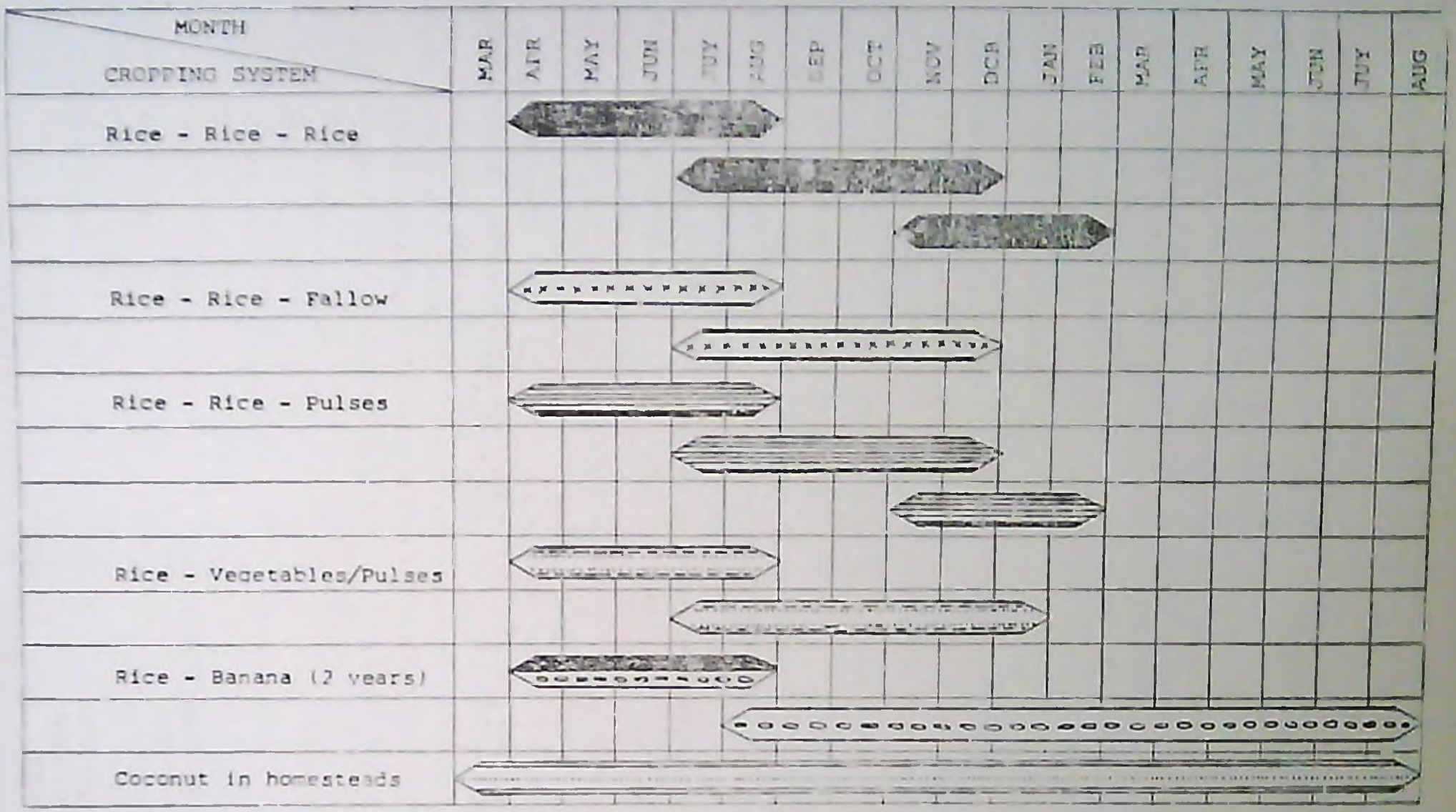
Rice:

Inadequacy in the availability of organic manures in this tract, limits the level of organic manures applied to the crop during all the seasons. This has resulted in depletion of the soil organic matter content. The lack of availability of high yielding varieties suitable for dry sowing during kharif season is another production constraint experienced in this situation. Difficulty in getting the field preparations completed in time is a major problem encountered by the rice farmers. Due to dearth of labourers during the peak cultivation seasons, farmers often plant their seedlings in lands which are not propsrly prepared. The exhorbitant rise in wage hike of the farm labourers

Major cropping systems in situation No.5—High elevation—Medium rainfall

No.	Cropping system	Total area in ha (Gross)	% distribution in the situation
1	Rice-Rice-Rice	230	0 3
2	Rice-Rice-Pulses	1800	2 5
3	Rice-Vegetables/Pulses	825	1.1
4	Rice-Rice-Fallow	66100	77.5
5	Rice-Groundnut	45	0 1
6	Rice-Banana-Rice (2 years)	92	0.1
7	Coconut in homesteads	2877	4.0

Fig. 38. CROPPING SYSTEM SITUATION - 5



prompt many farmers to adopt zero tillage, which give way to decline in crop yields.

Pulses:

Lack of improved varieties with synchronized flowering character is a main bottleneck for farmers, to take up pulse crop in extensive areas. If the pickings are prolonged, the requirement of labour for harvest is increased leading to uneconomic crop yields due to increase in cost of cultivation.

3.3.6 High elevation—low rainfall

1 Delineation

This situation is located in the rain shadow areas of Palghat district. The component development blocks of this situation is listed in the table below

District	Development blocks/Municipality	Geographical area in ha.
Palghat	Kollangode	32874
	Nelliyampathy* in (Nemmara taluk)	56404*

* This is excluded here as it comes under the High ranges.

2 Soils

The soils occurring under this situation is included in the Kollekkad—Kanjikkulam--Mannoor association. The soils grouped under this association occurring on the sloping lands and elevated plains are formed by the weathering of gneissic rocks under sub tropical climate. The detailed characteristics of the soils have been presented in Chapter II.

3 Climate

The rainfall pattern in this situation is quite different from the other parts of the Kerala State. This situation coming under the rain shadow areas of the Palghat gap, the annual precipitation touches the lowest ranges recorded in the State. The maximum temperature during the summer months recorded in this situation is the highest recorded in the state.

4 Physiography

This situation is characterised by sloping lands and elevated plains. Extensive areas of level lands occur in between.

5 Irrigation

Irrigation facilities from the Malampuzha dam are available to certain areas under this situation. The low lands of this situation are provided with canal waters from the units of Malampuzha project compiex.

6 Major crops and crop intensity

Rice farming is adopted in areas with irrigation facilities while dry farming is practised on a large scale in the low rainfall tract of this situation lacking irrigation facilities. The net area sown is 25552 ha. and gross cropped area is 27542 ha with a crop intensity of 107%. The major crops raised in this situation are listed in the table given below.

Major crops grown in the situation No. 6 – High elevation—low rainfall

No.	Crop	Total area in ha. (Gross)	% distribution in the situation	% of the total area of the crop in the region
1	Rice	17070	62.0	5.7
2	Coconut	1320	7.2	49 3
3	Ragi/Jowar/Millets	1985	4.8	1.7
4	Groundnut	3100	11.3	31 8
5	Cotton	1370	5 0	21 9
6	Pulses	1310	4.8	18 4
7	Vegetables	700	2.5	18 2
8	Sugarcane	400	1.5	15 3
9	Others	287	1.1	—

This is the major producing centre of the State with regard to cotton, millet and grcundnut.

7 Major Cropping systems

The cropping systems practised by farmers are summarised below and seasons are shown in Fig. 39

The rice based cropping systems are followed in low lands with supplementary irrigation facilities from canal, ponds and wells. Cotton, Millets, Turmeric, etc. are grown in, uplands which lack irrigation facilities. Pulses and groundnut cropping systems are practical mainly in rice fallows. The level of production is fair in the case of rice while it is moderate in the case of others. The farmers use high yielding varieties only in the case of rice.

8 0 Adoption pattern

Improved package of practices recommendations are followed by farmers only in the case of rice crop. Even in the case of rice, the percentage of adoption is low during dry sown kharif crop.

9 0. Specific production constraints

Severe drought experienced from December to May is the major constraint to production of this situation. The non-availability of high yielding varieties of the various crops suitable for this drought prone area is another important constraint. Lack of improved technology for the dry farming practices is a major research gap which exists in the case of this situation where dry farming is prominent.

3 3.7. Medium elevation—Black soil—Low Rainfall

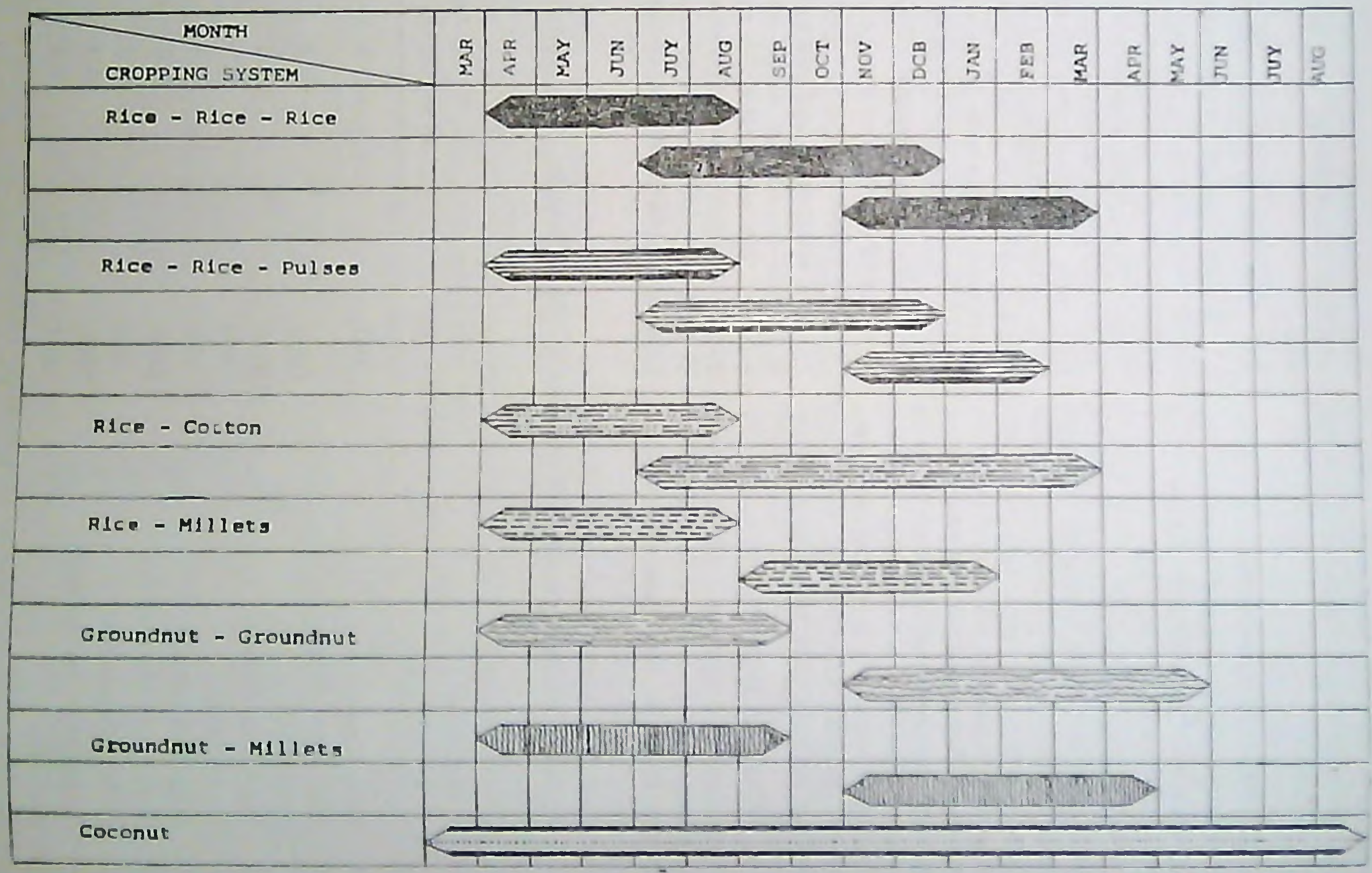
1 Delineation

This situation is confined to the black soil tract of Chittur taluk of Palghat district. The area under this situation is 27594 ha which seems to be an extension of the black cotton soils of the neighbouring Coimbatore district of Tamil Nadu.

Major cropping systems in situation 6—High elevation—Low rainfall

No.	Cropping systems	Total area under this situation (ha.)	% distribution in the situation
1	Rice-Rice-Rice	150	0 5
2	Rice-Rice-Pulses/ Vegetables	1800	6.5
3	Rice-Rice-Fallow	13920	50.5
4	Rice-Cotton	400	1.5
5	Rice-Ragi/Jowar	800	2.9
6	Ground nut-Ground nut	2300	8.4
7	Millets-Groundnut	800	2.9
8	Coconut in homesteads	1320	4.8
9	Others	287	1.0

Fig. 39. CROPPING SYSTEM - SITUATION 6



2. Soils

This is the only situation in Kerala where Black soils occur. The soil reaction crosses over the neutral range and in most places it is alkaline in reaction with scattered calcium carbonate mode in the soil profiles. The main characteristics of this black soil are brought out in detail under chapter II.

3 Climate

This situation also comes under the low rainfall, drought prone area of the state. The annual precipitation is the lowest in Kerala and is often below 900 mm. Dry conditions exist from December to May.

4. Physiography

This situation has slightly undulating topography interspersed with stretches of level lands. Extensive strethes of level lands are also seen in this situation.

5. Irrigation

The benefits from the Malampuzha irrigation project is derived by this situation also in raising rice and sugarcane crops. Besides the main source of canal waters, ponds and wells are also utilized in a limited scale for irrigation purposes.

6. Major crops and cropping intensity

The net area sown under this situation is 24917 ha while the gross cropped area comes to 38380 ha, working out a crop intensity of 150%. The major crops raised in this black soil tract is summarised below.

This is another important situation as regards cotton, groundnut and sugarcane cultivation in the State are concerned. Making use of the black cotton soil occurring in the region, good crops of sugarcane and cotton are raised under irrigated as well as rainfed conditions with supplementary irrigated crop.

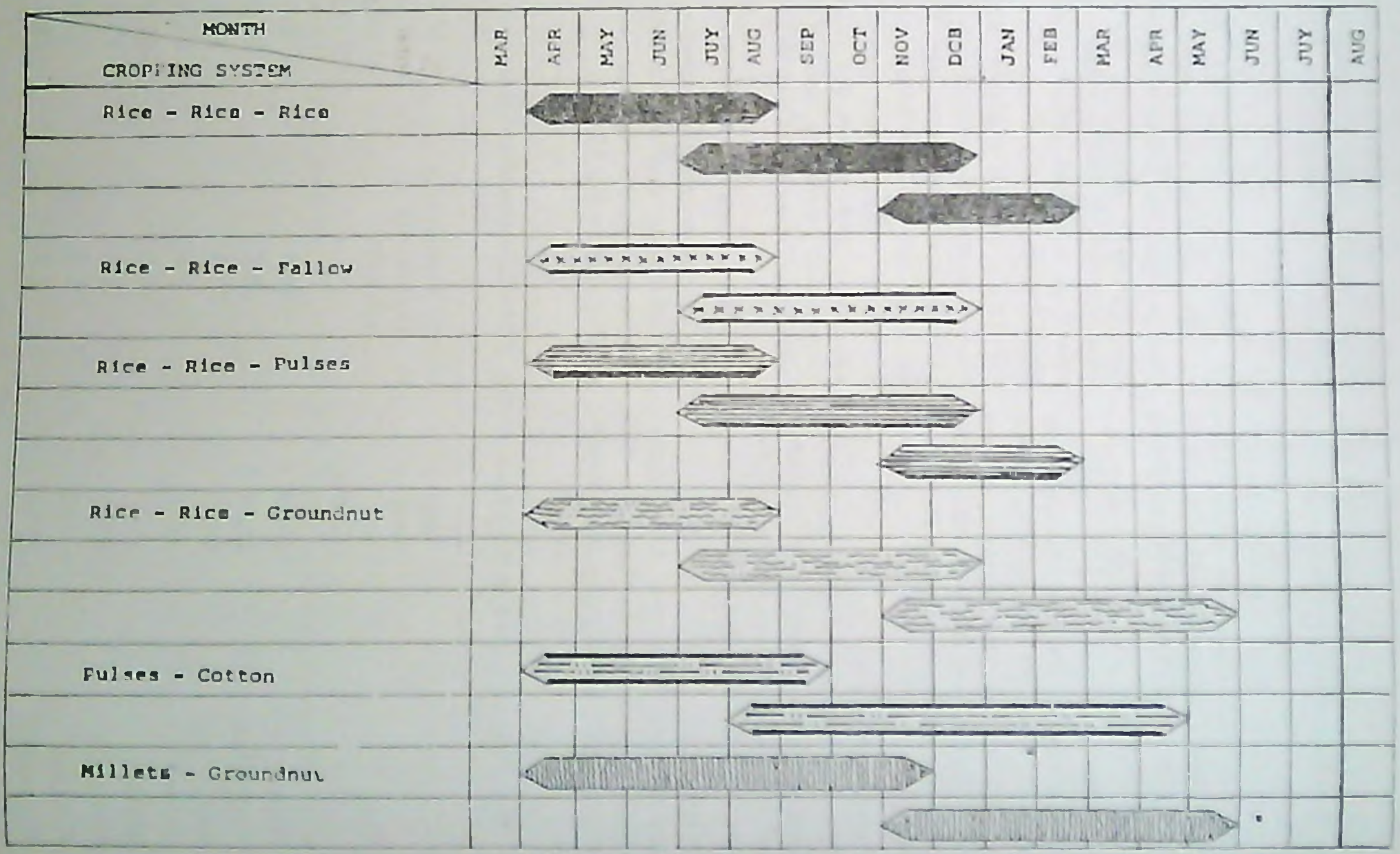
7. Major cropping systems

The major cropping systems followed by farmers of this low rainfall tract are summarised below and the seasons are enumerated in Fig 40

Major crops raised in the situation No. 7 Medium elevation—Low rainfall

No.	Crop	Total area in ha. (Gross)	% distribution in the situation	% of the total area of crop in the region
1	Rice	17882	46.6	6.0
2	Sugarcane	2215	5.8	85.0
3	Groundnut	8600	22.4	73.0
4	Pulses	1515	3.9	21.3
5	Millets	2043	5.3	50.7
6	Cotton	4875	12.7	78.1
7	Coconut	200	0.5	0.3
8	Vegetables	1050	2.7	46.7

Fig.40. CROPPING SYSTEM SITUATION - 7.



Major cropping systems in situation No. 7—Medium elevation—Black soil—Low rainfall

No.	Cropping system	Total area covered under the system (Gross) ha.	% distribution in the situation
1	Rice-Rice-Rice	180	0.5
2	Rice-Rice-Fallow	15632	40.7
3	Rice-Rice-Pulses/Vegetables	1670	4,4
4	Rice-Rice-Groundnut	400	1.0
5	Groundnut-G. Nut-G. Nut	1000	2.6
6	Groundnut-Groundnut	4400	11.5
7	Sugarcane (3 years)	2215	5.7
8	Pulses-Cotton	1500	3.8
9	Groundnut-Millets	800	2.1
10	Coconut in homesteads	200	0.5

The cropping systems from 1 to 5 are raised in areas where there are facilities for supplementary irrigation through canals and lift irrigation sources. Others are raised under rainfed dry farming conditions. The level of rice yields even in problem areas like Poonthalpadams comprising 700 ha in Pattanchery and Muthalamada blocks is high when compared with the State average as well as that of the other situations in the zone except that of Palghat area. In the crops grown under dry farming conditions, the yield levels are very much dependent on the vagaries of the monsoon.

8.0 Specific production constraints

Rice

In 'Poonthalpadam' soils during the second crop season sulphide injury is noticed. The ill drained soil conditions of this heavy textured black soils produce toxic gases soon after the transplanting of the rabi rice is over which damages the crop very much. In certain areas Zinc deficiency is noticed.

Sugarcane

Proper improved technology for raising sugarcane in the Chittur area is

lacking. At present the recommendations of the Coimbatore tract is followed in this situation also. There is research gap in this field.

Cotton

Lack of high yielding varieties suitable for this location is the main constraint to cotton production.

Groundnut

Lack of improved strains suitable for raising under the dry farming conditions of this tract is the main lacuna in the field of research of this crop which proves to be one of the main constraints to production. The tikka leaf spot disease is another factor which causes yield decline in this crop.

3.3.8 High Ranges—low rainfall

1. Delineation

The Attappadi block of the Palghat district covering an area of 22500 ha comes under the purview of this situation. As this comes under the territory of the High Ranges Zone, detailed discussions on this situation will be dealt within the Status report of that zone.

CHAPTER IV

RESEARCH AND EXTENSION LINKAGES

CHAPTER IV

Research and Extension linkages

4.1 Linkages between research activities

Regional Agricultural Research Station, Pattambi being the pioneer research station of the state was maintaining regular linkage with other research organisation of the state as well as other states. This being the lead station with regard to rice and pulses, the research responsibility for these crops for the state as a whole is shouldered by the Regional Agricultural Research Station, Pattambi. Constant consultation and guidance are offered to other stations which function as testing centres for rice, pulses and oil seeds.

4.1.1. Linkage within the zone

The central zone has seven stations. The particulars of which are given below.

Agricultural Research stations of the Central zone

Regional Station	Sub station/ special station	Lead function	Verification function	Area of operation
1	2	3	4	5
Pattambi	—	Rice Pulses, Horticultural crops	Coconut	Palghat Dt. Trichur Dt. Ernakulam Dt.
—	Eruthiampathy	—	Rice Groundnut Pulses	
—	Mannuthy	—	Rice Groundnut Tuber crops	
—	Chalakudy	Water management	—	
—	Kannara	Banana Pineapple	—	
—	Odakkali	Medicinal and Aromatic plants		
—	Thiruvazhamkunnu	Livestock and Agroforestry	Fodder crop	

The research activities taken up in the station are decided on priority basis after discussions in the regional workshops conducted every six months. Recently the Regional Associate Director (RAD) has been made responsible for the research management of the following research stations.

Agronomic Research Station—Chalakudy

Agricultural Research Station—Mannuthy

Operational Research Project—Ozhalapathy

National Agricultural Research Projects—Sub centre, Eruthiampathy

Cashew Research Station—Madakathara, Anakkayam

Banana and Pineapple Research Station—Kannara

4.1.2. Linkages between different stations and head quarters

During the Regional workshops conducted at Regional Agricultural Research Station, Pattambi, senior scientists from the stations are invited to participate in the deliberations. This is reciprocated by the Zonal Associate Director and the senior scientists of our stations during the Regional workshop of other regional research stations. Problems concerning rice and rice based farming system are referred to our station from the research stations of other regions for suggesting remedial measures.

4.1.3. Linkages with other central and other institutes and Universities

The following research centres Development units of the ICAR and State Department are operating within this zone.

Sl. No.	Research station/Institute	Crops/aspects of research/development
1	2	3
1	Central Plantation Crop Research Unit Sub Centre, Kannara	Arecanut, Arecanut based farming system
2	Central Marine Fisheries Research Institute, Ernakulam	Mariculture
3	Central Institute of Fish Technology, Cochin	Fisheries Technology
4	Kerala Forest Research Institute, Peechi, Trichur	Forestry
5	Kerala Engineering Research Institute, Peechi, Trichur	Irrigation and Agricultural machinery
6	Command Area Development Agency, Trichur	Command area management
7	National Bureau of Plant Genetic Resource, Regional Station, Vellanikkara, Trichur	Germplasm collection
8	Coconut Development Board, Cochin	Coconut Development

Besides these the Regional Agricultural Research Station, Pattambi maintains close lialson with the following central and international institutes.

Sl. No.	Research station/Institute	Crops/aspects of research/ development
1	AICRIP, Directorate of Rice Research, Hyderabad	Rice
2	Central Tuber Crops Research Institute, Sreekaryam, Trivandrum	Tapioca
3	Central Plantation Crops Research Institute, Kasaragode and Kayamkulam	Plantation crops
4	Sugarcane Breeding Institute, (ICAR), Coimbatore	Sugarcane
5	National Centre for Research on Spices, Calicut	Spices
6	Rubber Board, Kottayam	Rubber
7	Directorate of Pulses Research, Kanpur	Pulses
8	International Rice Research Institute, Philippines	Rice
9	International Crop Research Institute for Semi Arid Tropics, Hyderabad	Pulses and oil seeds
10	Government of India, Ministry of Agriculture, (Department of Agriculture and co-operation)	National Project on Development and use of Bio-fertilizers
11	Central Rice Research Institute, Cuttack	Rice
12	National Seed Corporation	Production of seeds
13	Breeder Seed Production	Production of seeds
14	Commonwealth Agricultural Bureau, International Mycological Institute, Kew, Surrey, England.	Identification of fungi

The Associate Director is a member in the state level training committee, and variety evaluation committee. He is also a member in the package of practice workshop which decides the package of practices for the State.

4.2 Linkages with extension agencies

The central zone has close linkage with the different departments and other agencies functioning in the region for the effective transfer of technology generated in the station.

Names of different departments with which the Regional Agricultural Research Station, Pattambi has linkage are given below.

1 Department of Agriculture
2 Development Department
3 Nationalised Banks
4 Forest Department
5 Tribal Welfare Department
6 Department of Co-operation
7 Department of Education
8 Farmer's Organisation
9 Input Agencies
10 Kerala Agricultural University

The Associate Director is the member of the programme committee of the All India Radio (AIR). This helps in the collaboration between the research stations of the central zone and the AIR in extending the relevant farm news to the farmers.

4.2.1 Pre-seasonal workshops

Scientists of the zone assist the Department of Agriculture in conducting the pre-season workshop of Malappuram, Palghat, Trichur and Ernakulam districts.

4.2.2 Monthly workshops

The monthly training and visit workshops of the Palghat and Malappuram districts are being conducted in this station. The Associate Director is the chairman of the Palghat district T & V workshop and another Senior Professor is the chairman of Malappuram district T & V workshop. The scientists of the research stations of the zone are the resource personnels for both workshops. These workshops meet every month to finalise the messages to be passed on to the farmers and also the feed back information obtained in the field.

4.2.3 Regional Workshops

Regional workshops are organised for two days twice in a year one for each season (rabi and kharif). Extension personnels of the Department of Agriculture from the status of Joint Director of Agriculture (JDA) to subject matter specialist (SMS) of the Palghat, Trichur and Ernakulam districts attend the regional workshop. Besides this, scientists from the Kerala Agricultural University (KAU), special invitees from Indian Council of Agricultural Research (ICAR), institutes like Central Plantation Crops Research Institute (CPCRI), Central Tuber Crops Research Institute (CTCRI), Development Boards like Rubber Board, Coconut Development Board and representatives from Central Water Resource Development and Management (CWRDM) and Command Area Development Agency (CADA) attend the deliberations. After the presentation of the research highlights of the region by the scientists concerned, the results of the field trials conducted by the Department of Agriculture (DOA), are also reviewed and conclusions arrived at. Action Programme of research and layout of Farm Trials for the next season is chalked out based on priorities.

4.2.4 Short training programmes

Various trainings to the extension personnel of Nationalised Banks, Department of Agriculture and Development Department are undertaken in this station. Trainings organised are.

1. Training on rice production technology
2. Training on pulse production
3. Training on social forestry.

The Krishi Vigyan Kendra (KVK) located in Regional Agricultural Research Station, Pattambi organises short training programmes for farmers, farm women and farm youth on Agriculture, Animal Husbandry, Fisheries and Home Science.

4.2.5 Joint field visits

Joint field visits under T & V system, by the scientists of Kerala Agricultural University with the extension personnel of the DOA are regularly conducted in the districts of Malappuram, Palghat, Trichur and Ernakulam and reports are prepared on the location specific problems assigned to this diagnostic team.

4.3 University's extension oriented activities

The scientists of the station are involved in the extension activities which help them to get a clear idea of the problems experienced by the farmers while following the techniques developed in the station.

The villages have been adopted for intensive extension programme to be directly undertaken by the scientists of the station. Frontline demonstrations, field days and short training programmes are organised in the adopted villages.

4.3.1 Krishi Vigyan Kendra

A Krishi Vigyan Kendra fully financed by the ICAR functions at the Regional Agricultural Research Station. The Krishi Vigyan Kendra organises skill oriented training for farmers, farm women, farm youths, STs and STCs of Palghat district in Agriculture, Animal Husbandry, Fisheries and Home Science.

4.3.2 Lab to Land programme

The Kerala Agricultural University is currently implementing this programme in 32 centres including Thrithala and Keezhayoor villages and undertaken by the Regional Agricultural Research Station, Pattambi. The programme is being implemented under the leadership of various scientists. A total of 160 farm families are benefited by this programme. Training programme on various aspects on agriculture, animal husbandry and fisheries are conducted to transfer the knowledge from lab to land. Critical inputs are also supplied to the beneficiaries.

4.3.3 National Demonstrations

National Demonstration programme is not under operation at present in this zone.

4.3.4 Operational research project

In collaboration with the Soil Conservation Department and the State Agricultural Department, Kerala Agricultural University has launched the operational research project at Ozhalapathy, Palghat district. Eight watershed areas have been identified and observational trials of improved varieties of ragi, sorghum, blackgram and redgram are undertaken in the farmers field of the identified water sheds. Demonstration plots for ragi, sorghum and pulses also have been laid out, in the farmers field. Water conservation work is undertaken by the soil conservation department.

4.3.5 Publication programme

Research articles based on the results emulating from trials conducted in the zone are regularly published by the scientists in the zone after the conclusion of the research projects, in journals like Kerala Agricultural Research Journal, Madras Agricultural Journal, and other national and international publications like IRRI news letter, Agronomy journal etc.

Scientists from the zone regularly contribute popular article in the regional language news papers in the Karshaka Rangam column. They also publish recommendations emulating from research trials in magazines like Kalpadhenu and Kerala Karshakan.

4.3.6 Radio/T. V. Programme

Radio talks by the scientists of the station on crop improvement, crop production and crop protection are broadcast over AIR, Calicut and Trichur seasonally. This helps the farmers to take timely decision on agricultural operations. Scientists of the research station of the zone also

provide materials to Communication Centre, Mannuthy for favour of broadcast by AIR daily.

4.4 Feed Back

New messages useful for the farmers to increase their production are being continuously generated which are being presented to the T & V programme extension workers during the monthly workshops. These messages are transmitted to the farmers through the field level workers by continuous planned trainings and visits. It is anticipated that the farmers by adopting this technology, will have experiences at field level and pass on the information on the adaptability and constraints, if any, to the field level workers who in turn transmit to the researchers. A proper feed back facility from the farmers and field level workers is therefore highly essential for the proper orientation of the research programmes. The present systems of monthly workshops, present joint visits by experts and extension personnel, regional workshops visits of farmers and extension personnel to research stations, training programmes for both farmers and officials create opportunities for the research workers to obtain necessary feed back for the proper orientation of the research projects. The participation of scientists at field level discussions, input seminars, on and off campus trainings provides them direct opportunity for studying in depth, the problems and the impact of the research findings on agricultural productivity.

4.5 Strategy for strengthening research—extension linkages

Increasing agricultural production through the application of latest scientific production technology, requires an effective linkage between research and extension. At present these linkages are established through the following.

1 Zonal research advisory committee
2 Pre-seasonal workshops
3 Monthly workshops
4 Joint field visits
5 Joint conduct of farm trials
6 Training programmes
7 Krishi Vigyan Kendra activities
8 Other transfer of technology programmes
9 Participation of scientists in input seminars and discussions
10 Visits of extension personnel to the research stations.

However, there is need for strengthening linkage by intensifying the joint field visits, farm trials etc. Providing technical help through publications, audio visual aids etc., will enhance the linkage between extension and research which is vital for the agricultural development of the region.

CHAPTER V

RESEARCH PRIORITIES AND STRATEGIES

CHAPTER V

Research Priorities and Strategies

The research needs of agriculture is more diversified than any other profession and hence a rationalisation of our research programme is becoming more and more important. One of the main objectives of NARP is to fulfil this by dividing each state into small agro-climatic regions and reorient the research programme to solve the location specific problems. Thus the package of practices for the whole state can be modified according to the needs of the location. This is achieved by strengthening the research activities in the regional stations and effecting perfect co-ordination between research, extension and the farmers.

5.1 Research gaps/needs

The adoption of the package of practices is not uniform and sometimes even good recommendations are not adopted due to various reasons. These are discussed in the constraints listed in Volume II. Identification of major constraints indicate the following research gaps.

5.1.1 Water Management

The most important research that is needed for this region is to have an efficient water utilisation technology to take more than one crop. Since pulses and oil seeds can be grown in rice fallows, the efficient use of water in late monsoon and summer periods has to be evolved to maximise the production with the available water. Potentialities of recycling drainage water and tapping sub surface water are also to be studied. Proper agronomic and water management practices are to be developed to overcome the drought like situations prevailing during the early phase of virippu (Autumn) and late phase of Mundakan (Winter) rice.

5.1.2 Cropping system

A multiple cropping system based on rice needs to be evolved to obtain the maximum output per unit area. In addition, crops with less water requirements having a market outlet, have to be identified particularly for the summer season. Research has to be initiated to evolve suitable and economically viable cropping patterns for various seasons and different situations like valley, terraced land and hill slopes.

5.1.3 Crop improvement

The main constraints in growing high yielding varieties is the increased cost of cultivation due to high fertilizer requirements, plant protection operations and weed control. Hence varieties with multiple resistance to pests like BPH, leaf roller and stem borer and to diseases like sheath and bacterial blight have to be evolved. This is one of the reasons that many of the farmers still prefer local varieties than high yielding ones.

Similarly in the second crop (mundakan) season there is a general yield

decline and the factors responsible to this thoroughly analysed and identified to overcome this situation. Farmer's preference for this season is for high yielding, photosensitive and medium tall varieties. Varieties with drought resistance have to be evolved. This will definitely be a research gap to be attended to maintain the production level in the second crop season.

Suitable varieties of pulses, oil seeds and tuber crops have to be identified or evolved for the rice based cropping system and coconut plantations. Breeding programmes for dry sown paddy, and for adverse conditions like ill drainage, flooding and soil pH have to be taken up. Short duration varieties of tapioca and sweet potato with six months duration have either to be evolved or selected to fit in the rice based cropping system.

Water scarcity is often experienced during the early stage of dry sown Virippu (autumn) rice and in the late phase of Mundakan (winter) rice; varieties to suit this water scarce conditions in these specified stages have to be evolved.

5.1.4. Soil Managament and Fertilizers

Application of water soluble fertilizers, especially that of Nitrogen and Potassium becomes a problem as major portion of the nutrient is lost due to leaching, as torrential rains are received during the peak seasons. Hence research on slow release formulations utilising cheaper technologies available and on the methodology and frequency of application of fertilizers for maximum efficiency have to be taken up Due to the lateritic nature of the soils, phosphorus and potassium nutrition of rice is adversely affected leading to the non responsiveness to the P and K. Hence research to evolve suitable remedial measures and micronutrient utilisation are to be intensified The fertilizer requirements of the soils should be viewed taking the cropping system as a unit rather than assessing the need of each crop separately.

In the central zone there are specialised rice cultivations, like,

a) 'Karimkura', where depth of water is heavy high during the planting season of I crop, the field is submerged and when it recedes in September, planting is done and harvested as that of second crop during December.

b) 'Koottumundakan' wherein a mixture non-photosensitive (first crop) variety of rice seeds with photosensitive variety (second crop) is mixed with 70:30 (w/w) ratio and sown in first crop season. Such systems require scientific recommendations of the varieties to be used and fertiliser requirements. Similarly, planting banana in rice fields is becoming a common practice with farmers and a recommendation of fertilizers and time of application have to be worked out scientifically.

5.1.5. Weed control

Studies on herbicide - cum - cultural methods of weed control have to be initiated to formulate an effective and economic weed management practice for upland and wet land rice cultivations.

5.1.6. Pests and diseases

Intergrated pest and disease management by identifying tolerant varieties, combining cultural, biological and chemical control has to be evolved to eliminate chemical pollution, and insecticide resistance. Pesticide residues on the produce should be analysed and ways and means to limit the residue below tolerance limits should be evolved.

Pest and disease surveillance should form an integral part of the plant protection and an early warning system has to be organised to reduce this avoidable loss in production.

5.1.7 Banana and Pineapple

Banana and pineapple yields are low in this zone and causes for this low level production are to be identified and remedial cultural practices formulated.

5.1.8. Vegetables and tubercrops

Vegetables are mainly raised in rice fallows of this zone. Even though an area of 2,82,195 hectare of rice fallow are available, only about 31,228 (ie. 11.07%) is alone utilised for raising the crop and also the high labour cost makes the problem acute and import of vegetables from neigbouring state is inevitable. Hence identification of suitable short duration vegetable crops and popularisation of vegetable cultivation becomes a priority area of research.

5.1.9 Other Horticultural crops

Research on fruit trees and plantation crops like coconut, cashew, mango, jack etc has to be intensified since these are the main constituents of the homestead farming system. Identification of good varieties, easy multiplication techniques fertilizer and water requirements, summer irrigation devices etc. have to be undertaken.

5.2 Research Priorities

5.2.1 Water Management

a) Studies on the moisture requirement at critical stages of plant growth needs immediate attention since acute shortage of water is experienced at the critical stage.

b) Conservation studies on the surface run off water.

c) Methods of application of water and the frequency.

d) Utilisation of drainage water and subsurface water.

e) Studies on the dry farming technology with a special reference to Eruthiampathy by standardising proper pre-monsoon tillage operations for moisture conservation, organic manuring for increasing moisture retention capacity and suitable tillage equipments.

f) Utilisation of polymer like 'Jalasakthi' for water management practices atleast in coconut gardens for reducing the frequency of irrigation.

5.2.2. Crop improvement

a) Evolving tolerant or multiple resistant varieties with a good yielding capacity against major posts like gall midge, leaf roller, BPH and stem borer and diseases like sheath blight, blast, and virus diseases.

b) Breeding suitable varieties for overcoming the yield decline in second crop after identifying the factors responsible.

c) Identification of suitable varieties which needs less water in crops like pulses, oil seeds and short duration tuber crops to maximise the production and to fit in the rice based cropping system, coconut gardens and rice fallows.

d) Identification of drought tolerant varieties for early phase of virippu (Autumn) and late phase of mundakan (Winter) rice.

5.2.3. *Soil management and fertilizers*

Identification of the reasons for low level in productivity of high yielding varieties of rice during second crop season should draw highar attention. Efficient soil and water management practices in addition to the identification of other factors should be started so that the yield gap can be narrowed down in this season. So slow release nitrogen sources, phosphorus and potassium nutrition in the lateritic soils are to be the main subjects for an indepth analysis. The fertilizer requirements should be standardised from the angle of cropping system to be followed like Rice—Banana, Rice—Tapioca, Rice—Vegetables, Rice—Groundnut etc., than the need of the individual crops.

5.2.4. *Weed control*

Herbicide cum cultural methods of weed control in wet lands and uplands and regulation of water have to be studied in detail for coming out with a practical and economically viable recommendation. The weed problem in the direct sown crop especially in the dry sown rice during 1st crop is often very acute and projects will be identified for scientific practices like levelling of the field, water regulation etc. Weed control operations in an integrated way is the approach to arrive at an efficient weed management programme. Rice varieties, which are less sensitive to the weedicides have to be identified since the weedicides causes yellowing in certain popular varieties and posses a problem to convince the farmers Unless we have an efficient method of weed control it becomes difficult to make the cultivators to impress upon the losses caused by weeds directly by absorbing nutrients and indirectly by harbouring dreadful pests and diseases. In addition, to over come the labour scarcity prevailing in II crop season and the high cost of labour in this state, labour saving equipments for weeding and transplanting have to be developed.

Pests and diseases.

The foremost problem is the cost of plant protection operations in terms of chemicals and application cost. So the best, cheap and less polluting methods have to be worked out. In this the priority is for identfying even moderately resistant varieties so that the pest and diseases are maintained below the economic threshold levels. With the resistant varieties as nucleus, it will be easier for the inclusion of other methods of control viz , cultural, biological and mechanical methods to effectively arrive at an integrated pest management system. Similarly the application of insecticides have to be judicial and less polluting so that the resurgence of the pest is avoided and the natural enemies populations are preserved and augmented.

Pest surveillance units have to be established at each taluk level for appropriate monitoring using light traps, field surveys, damage assessment etc. to follow an effective early warning systems and check the spread of the pests and diseases at the early stages with less harmful techniques.

5.3. Research strategies

A review of the present programme at this station and the sub centres is considered to formulate both short term and long term approaches. This is discussed as discipline wise.

5.3.1. *Water management*

Studies on the moisture harvest during the second crop season by initial moisture conservation techniques, preparation of a cropping pattern fitting a less water needed

crop in the late second crop or in the rice fallows. Assuring irrigation facilities or complementary irrigation by reutilisation or recycling of drainage water and sub surface water utilisation by deep borewells should be taken by in phases with scientific approaches. In the central region particularly this type of approach has to be initiated in the western portion of Palghat district where the rainfall is minimum for the region. The Chittur and Kollengode taluks of Palghat region constitute typically a dry farming situation and hence the research sub centre at Eruthiampathy has to be strengthened to take up a programme on dry farming technology covering both soil and water management, improvising tillage implements, soil moisture conservation techniques, testing the mulches etc. For this the scientific staff at the centre has to be provided with additional equipments and facilities. As a long term strategy at government level, action should be initiated for deep bore well programmes and water harvest technology on a community basis.

5.3.1. Cropping system

In the cropping system commonly followed here, pulses, sesamum and groundnut are cultivated in the rice fallows. Mostly these are local varieties Hence a rigorous crop improvement programme to identify high yielders and drought tolerant varieties have to be evolved or local selections have to be evolved or local selections to be made so that there will be an economically viable cropping system. Since single cropped rice area is becoming day by day uneconomical and causes a reduction in the rice area, such cropping system developed with economic consideration will be helpful on a long term, basis. More projects envisaging this point as an objective should be drawn up for introduction of new and more remunerative crops An education programme should be launched with developmental extension agencies to teach the farmers about the cropping system to make it more successful. This should be assigned priority in the forth coming Agronomy projects

5.3.2. Crop Improvement

Since rice is grown in all agro-ecological situations the research requirements are more diversified and at the same time interdependent. The breeding programme at this centre has to be intensified on a large scale with additional staff and interdisciplinary interactions. Improved high yielding varieties suited to different farming situations have to be evolved. Drought tolerant varieties, multiple resistant varieties for at least major pests and diseases even for seasonwise performance have to be evolved. Identification of the varieties with high yielding potential during second crop season has to be the priority problem.

Breeding programmes in crops for rice fallows like pulses, sesamum and oil seeds have to be intensified to increase the present yield level and for drought tolerance. Imparting knowledge to the farmers on other aspects like proper fertilizer application to these crops is to be followed rigorously as a long term strategy. Hence the existing centre for pulses and oil seeds should be given a higher prioirity to strengthen its research activities on this aspect.

5.3.3 Soil and Fertilizer Management

Regions with problem soils have to be first identified and the manurial and micronutrient requirements for the cropping pattern has to be worked out by reorienting our research programmes.

Since this zone constitutes a large number of valleys getting torrential rainfall during first crop season, soil erosion aspect should be critically reviewed and to avoid soil erosion a compact recommendation like contour formation, planting vetiver to prevent silting in the irrigation channels etc. have to be given a priority approach. Since most of the farmers are marginal and availability of organic manure is meagre, sowing of green and green leaf manures, mixed cropping with cattle, sheep and livestock rearing have to be fitted in the existing enterprise. Therefore economic and efficient crop livestock farming by selecting suitable leguminous fodder crop in the cropping pattern and efficient organic recycling have to be evolved. In this connection the new problems of pests like nematodes and diseases like coconut wilt have to be understood and a long term strategy for soil health is to be adopted. This is a need of the hour since Kerala in recent years faces more dreadful pests and diseases, which are aggravated by ill management of soils.

5.3.4 Weed control

In addition to the research on the chemical weed control, labour saving implements for mechanical weed control have to be designed and tested. Similarly direct sowing is practised in the first crop season and the labour scarcity is one of the major constraints. In the direct sown crop the weeds are a usual feature. Hence to encourage transplanting, paddy transplanters developed by Punjab Agricultural University and IRRI can be suitably by modified and tried under Kerala conditions.

5.3.5 Pests and disease:

Collection and analysis of weathery data using standard weeks for each of the major farming situtions and the development of pest and diseases have to be correlated. This will help in prediction of insect populations in certain agro climatic situations. Organisations like Indian Meteorological Departments have to be contacted for multi-disciplinary programme. This should be the strategy particularly for Kerala since the climate with high temperature and humidity is most congenial for pest and disease development. Disease pest calenders have to be prepared for each agroclimatic situations and the developmental agencies are to be trained to use the Climatographs, Biometers and prediction equations so that an early warning system can be practised in reality. Active participation of pathologists and entomologists in breeding programmes for helping the breeders to identify the major pest and developing multi resistant or tolerant varieties for different farming regions. This has to be a new strategy because the Kerala farmers in general feel that the high yielding varieties are more expensive due to increased plant protection measures to get higher yield. Since research of the plant protection appliances are normally monopolised by private, multinational companies, research on devising cheaper equipments, locally available plant products for pest and disease control have to be considered.

5.4 Emphasis on new programmes

a) Dry farming technology for less rainfall regions of western Palghat district.

b) Production gaps prominent in the case of vegetables, tubers, pineapple, banana etc. should be attended by giving importance to Horticultural research in this region.

c) Floriculture research can be started to increase the floriculture output of this zone.

d) Operation research programmes for transfer of technology like introduction of new crops for Rice based cropping system, management practices to increase the yield potential of rice particularly in the second crop

e) Mixed cropping by promoting Animal husbandry, pasture and grazing land development, utilisation of bye products of paddy viz straw and bran for processing and utilisation as animal feed.

f) Post-harvest technology is to be developed mainly for storing the first crop seeds since there is a heavy rainfall usually during harvest. This adversely affects the germination and viability. Hence a detailed programme on the factors responsible for seed deterioration, storage containers, seed pathology and storage pests, technique for breaking dormancy etc are to be initiated.

g) Horticultural research to concentrate on the fruit productions preservation and canning

Development Strategy

Research findings have to be properly transmitted to the farmers through Developmental agencies. Similarly the field problems and constraints in the recommended technology have to be identified. This two way feed back system existing now have to be intensified further since this zone constitutes more than 40 per cent of the rice area. This should be upgraded as the centre of excellence for Rice production Training programme and orientation at various levels to impart knowledge starting from the farmers to the Development Officers.

5 5.1 Strengthening of training facilities:

The existing training infrastructure at most of the research stations under this zone is less adequate for conducting classes, seminars and conferences. By improving the facilities and operational funds available these sub centres can orient their training programmes in their jurisdiction and more developmental agencies at lower cadre and in fact the farmers can be trained. At present most of the trainings are conducted at RARS Pattambi. The sub centres can be made responsible for smaller group contacts

5 4.1 Additional stations or additional responsibilities for existing stations

	Mandate	Station
1	Dry farming technology and efficient water use	Eruthiampathy
2	Water management and techniques for water use	Chalakudy
3	Horticultural crops, Banana and Pineapple	Kannara Vellanikkara
4	Tuberocrops, Pulses and Oil seeds	RARS, Pattambi
5	Animal husbandry for rice based cropping system, mixed farming	RARS, Pattambi
6	Research management, monitoring and reporting, Economic analysis of farming systems	RARS, Pattambi

and intensify their training activities. Such centres have to provided with audio-visual aids and demonstration of skills and discussion on their utility at micro level involvement (say farmers) may be Initiated.

5.5.2 Inservice training of extension staff

Extension agents at lower level have to be trained adequately about the latest developments in agriculture. Periodic review of the syllabus is essential and the training programmes should be formulated after the mutual consultation between departmental and University personnel.

5.5.3 Agricultural Education

The importance of a discipline in solving some of the major constraints to reduce the yield gap has to be located. Interdisciplinary approaches for identification and solving the constraints have to be stressed and considering the impact potential of the particular subject, these disciplines have to be strengthened in Agricultural University.

5.5.4 Diagnostic team visits

The objective of the diagnostic team visit has to be broadened. Now most of the team visits are restricted to a single garden, even a single plant showing some abnormality. When the problem is most drastic and large scale, the team should visit and find out the root cause of the problem. More time should be spent on the origin of the problem, duration and then only conclusion may be drawn. Similarly if more specific problems are encountered more than one team can be constituted. Follow up is very important In diagnostic team visits. The impact of the recommendation for solving the problem has to be monitored. Even if a correct solution is suggested sometimes it would not have followed either by the farmer or by the developmental agencies. Such recommendations are better demonstrated by scientists and Departmental Officers themselves instead of assigning the job to a lower developmental agent like Agricultural Demonstrators The efficiency of solving field problems has to be viewed in the sense, that the success will have an impact on the confidence of the farmers, which is most important for the transfer of newer technologies. All the activities of the diagnostic team visits have to be documented for future reference and guidance.

5.5.5 Co-ordination with input agencies

Availability of the input supplies during peak seasons may be sometimes limited. A closer monitoring and reviewing of the situation in monthly workshop is necessary. Similarly the quality control aspect of the inputs is to be reviewed to see that the supplies received and issued through the Department is of good quality. This applies to seeds, fertilizers, pesticides, fungicides and appliances.

5.5.6 On farm research

There may not be research stations in all the agroecological or farming siuations. For testing a developed technology we have to depend on the farms. These trials have to be well planned and executed with a sincere cooperation of research and extension agencies. This, in addition to ORP, should be carefully considered in the deliberations of regional workshop.

This is an Important aspect since the yield achieved in farmer's field and in research station leaves a wide gap. Hence on farm research will be helpful to understand the problems in the transfer of technology and suggestions to modify or convince the farmets.

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